Control	**0521-06-155, ETC.**
Project	**BR 2B24(547), ETC.**
Highway	**IH 410**
County	**BEXAR**

ADDENDUM ACKNOWLEDGMENT

Each bidder is required to acknowledge receipt of an addendum issued for a specific project. This page is provided for the purpose of acknowledging an addendum.

FAILURE TO ACKNOWLEDGE RECEIPT OF AN ADDENDUM WILL RESULT IN THE BID NOT BEING READ.

In order to properly acknowledge an addendum place a mark in the box next to the respective addendum.

ADDENDUM NO. 1 ☐

ADDENDUM NO. 2 ☐

ADDENDUM NO. 3 ☐

ADDENDUM NO. 4 ☐

ADDENDUM NO. 5 ☐

In addition, the bidder by affixing their signature to the signature page of the proposal is acknowledging that they have taken the addendum(s) into consideration when preparing their bid and that the information contained in the addendum will be included in the contract, if awarded by the Commission or other designees.

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Control	**0521-06-155, ETC.**
Project	**BR 2B24(547), ETC.**
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PROPOSAL TO THE TEXAS TRANSPORTATION COMMISSION

2014 SPECIFICATIONS

WORK CONSISTING OF INFRASTRUCTURE IMPROVEMENTS

BEXAR COUNTY, TEXAS

The quantities in the proposal are approximate. The quantities of work and materials may be increased or decreased as considered necessary to complete the work as planned and contemplated.

This project is to be completed in 1,383 working days and will be accepted when fully completed and finished to the satisfaction of the Executive Director or designee.

Provide a proposal guaranty in the form of a Cashier's Check, Teller's Check (including an Official Check) or Bank Money Order on a State or National Bank or Savings and Loan Association, or State or Federally chartered Credit Union made payable to the Texas Transportation Commission in the following amount:

ONE HUNDRED THOUSAND (Dollars) **($100,000)**

A bid bond may be used as the required proposal guaranty. The bond form may be detached from the proposal for completion. The proposal may not be disassembled to remove the bond form. The bond must be in accordance with Item 2 of the specifications.

Any addenda issued amending this proposal and/or the plans that have been acknowledged by the bidder, become part of this proposal.

By signing the proposal the bidder certifies:

1. the only persons or parties interested in this proposal are those named and the bidder has not directly or indirectly participated in collusion, entered into an agreement or otherwise taken any action in restraint of free competitive bidding in connection with the above captioned project.
2. in the event of the award of a contract, the organization represented will secure bonds for the full amount of the contract.
3. the signatory represents and warrants that they are an authorized signatory for the organization for which the bid is submitted and they have full and complete authority to submit this bid on behalf of their firm.
4. that the certifications and representations contained in the proposal are true and accurate and the bidder intends the proposal to be taken as a genuine government record.

- **Signed: ****

(1) _____ (2) _____ (3) _____

Print Name:

(1) _____ (2) _____ (3) _____

Title:

(1) _____ (2) _____ (3) _____

Company:

(1) _____ (2) _____ (3) _____

- Signatures to comply with Item 2 of the specifications.

**Note: Complete (1) for single venture, through (2) for joint venture and through (3) for triple venture.

*** When the working days field contains an asterisk (*) refer to the Special Provisions and General Notes.**

NOTICE TO CONTRACTORS

ANY CONTRACTORS INTENDING TO BID ON ANY WORK TO BE AWARDED BY THIS DEPARTMENT MUST SUBMIT A SATISFACTORY "AUDITED FINANCIAL STATEMENT" AND "EXPERIENCE QUESTIONNAIRE" AT LEAST TEN DAYS PRIOR TO THE LETTING DATE.

UNIT PRICES MUST BE SUBMITTED IN ACCORDANCE WITH ITEM 2 OF THE STANDARD SPECIFICATIONS OR SPECIAL PROVISION TO ITEM 2 FOR EACH ITEM LISTED IN THIS PROPOSAL.

TEXAS DEPARTMENT OF TRANSPORTATION

BID BOND

KNOW ALL PERSONS BY THESE PRESENTS,

That we, (Contractor Name) _____

_____

Hereinafter called the Principal, and (Surety Name) _____

_____

a corporation or firm duly authorized to transact surety business in the State of Texas, hereinafter called the Surety, are held and firmly bound unto the Texas Department of Transportation, hereinafter called the Obligee, in the sum of not less than two percent (2%) of the department's engineer's estimate, rounded to the nearest one thousand dollars, not to exceed one hundred thousand dollars ($100,000) as a proposal guaranty (amount displayed on the cover of the proposal), the payment of which sum will and truly be made, the said Principal and the said Surety, bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the principal has submitted a bid for the following project identified as:

Control	**0521-06-155, ETC.**
Project	**BR 2B24(547), ETC.**
Highway	**IH 410**
County	**BEXAR**

NOW, THEREFORE, if the Obligee shall award the Contract to the Principal and the Principal shall enter into the Contract in writing with the Obligee in accordance with the terms of such bid, then this bond shall be null and void. If in the event of failure of the Principal to execute such Contract in accordance with the terms of such bid, this bond shall become the property of the Obligee, without recourse of the Principal and/or Surety, not as a penalty but as liquidated damages.

Signed this _____ Day of _____ 20_____

By: _____

(Contractor/Principal Name)

_____

(Signature and Title of Authorized Signatory for Contractor/Principal)

*By: _____

(Surety Name)

_____

(Signature of Attorney-in-Fact)

*Attach Power of attorney (Surety) for Attorney-in-Fact

Impressed Surety Seal Only

This form may be removed from the proposal.

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BIDDER'S CHECK RETURN

IMPORTANT

The space provided for the return address must be completed to facilitate the return of your bidder's check. Care must be taken to provide a legible, accurate, and complete return address, including zip code. A copy of this sheet should be used for each different return address.

NOTE

Successful bidders will receive their guaranty checks with the executed contract.

RETURN BIDDERS CHECK TO (PLEASE PRINT):

Control	**0521-06-155, ETC.**
Project	**BR 2B24(547), ETC.**
Highway	**IH 410**
County	**BEXAR**

IMPORTANT

PLEASE RETURN THIS SHEET IN ITS ENTIRETY

Please acknowledge receipt of this check(s) at your earliest convenience by signing below in longhand, in ink, and returning this acknowledgement in the enclosed self addressed envelope.

Check Received By: _____ Date:_____

Title: _____

For (Contractor's Name): _____

Project _____ County_____

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NOTICE TO THE BIDDER

In the space provided below, please enter your total bid amount for this project. Only this figure will be read publicly by the Department at the public bid opening.

It is understood and agreed by the bidder in signing this proposal that the total bid amount entered below is not binding on either the bidder or the Department. It is further agreed that **the official total bid amount for this proposal will be determined by multiplying the unit bid prices for each pay item by the respective estimated quantities shown in this proposal and then totaling all of the extended amounts.**

$_____

Total Bid Amount

Control 0001-03-030
Project STP 2000(938)HES
Highway SH 20
County EL PASO

ALT	ITEM	DESC	SP	Bid Item Description	Unit	Quantity	Bid Price	Amount	Seq
	104	509		REMOV CONC (SDWLK)	SY	266.400	$10.000	$2,664.00	1

EXAMPLE

Total Bid Amount _____$2,664.00_____

Signed _____
Title _____
Date _____

Additional Signature for Joint Venture:

Signed _____
Title _____
Date _____

EXAMPLE OF BID PRICES SUBMITTED BY COMPUTER PRINTOUT

EXAMPLES

BID PRICES SUBMITTED BY HAND WRITTEN FORMAT

ALT	ITEM-CODE			UNIT BID PRICE ONLY WRITTEN IN WORDS	UNIT	APPROX QUANTITIES	DEPT USE ONLY
	ITEM NO	DESC NO	S.P. NO.				
	190	026		RED OAK 1 1/2 - 1 3/4 GAL BB	EA	9.000	1
				EXAMPLE: One hundred fifty DLRS and No CENTS			

Unit price for each plant in place

	249	014		FLEX BASE(DEL)(DENSCOT)(TY A GR4 CL2)	TON	56,787.00	14
				EXAMPLE: Seven DLRS and Fifty three CENTS			

Unit price for each ton of Flexible Base

	430	001	001	CL A CONC FOR EXT STR (CULV)	CY	45.000	27
				EXAMPLE: Three hundred five DLRS and No CENTS			

Unit price for each cubic yard of Concrete

	610	007	001	RDWY ILL ASSEM(TY ST 50T-8-8)(.4 KW)S	EA	13.000	7
				EXAMPLE: Fourteen hundred sixteen DLRS and Thirty seven CENTS			

Unit price of each Roadway Illumination Assembly

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ALT	ITEM-CODE			UNIT BID PRICE ONLY. WRITTEN IN WORDS	UNIT	APPROX QUANTITIES	DEPT USE ONLY
	ITEM NO	DESC CODE	S.P. NO.				
	100	6002		PREPARING ROW DOLLARS and CENTS	STA	55.000	1
	104	6001		REMOVING CONC (PAV) DOLLARS and CENTS	SY	12,078.000	2
	104	6009		REMOVING CONC (RIPRAP) DOLLARS and CENTS	SY	2,728.000	3
	104	6015		REMOVING CONC (SIDEWALKS) DOLLARS and CENTS	SY	1,736.000	4
	104	6023		REMOVING CONC (CTB) DOLLARS and CENTS	LF	2,623.000	5
	104	6029		REMOVING CONC (CURB OR CURB & GUT-TER) DOLLARS and CENTS	LF	5,805.000	6
	104	6044		REMOVING CONC (FLUME) DOLLARS and CENTS	SY	80.000	7
	104	6054		REMOVING CONCRETE(MOW STRIP) DOLLARS and CENTS	LF	5,231.000	8
	105	6094		REMOVING STAB BASE & ASPH PAV(12"-27") DOLLARS and CENTS	SY	40,480.000	9
	106	6002		OBLITERATING ABANDONED ROAD DOLLARS and CENTS	SY	407.000	10
	110	6001		EXCAVATION (ROADWAY) DOLLARS and CENTS	CY	78,726.000	11

ALT	ITEM-CODE			UNIT BID PRICE ONLY. WRITTEN IN WORDS	UNIT	APPROX QUANTITIES	DEPT USE ONLY
	ITEM NO	DESC CODE	S.P. NO.				
	132	6001		EMBANKMENT (FINAL)(ORD COMP)(TY A) DOLLARS and CENTS	CY	61,397.000	12
	132	6002		EMBANKMENT (FINAL)(DENS CONT)(TY A) DOLLARS and CENTS	CY	2,943.000	13
	160	6003		FURNISHING AND PLACING TOPSOIL (4") DOLLARS and CENTS	SY	31,606.000	14
	164	6039		DRILL SEEDING (PERM) (URBAN) (CLAY) DOLLARS and CENTS	SY	31,606.000	15
	164	6051		DRILL SEED (TEMP)(WARM OR COOL) DOLLARS and CENTS	SY	31,606.000	16
	168	6001		VEGETATIVE WATERING DOLLARS and CENTS	MG	984.000	17
	169	6001		SOIL RETENTION BLANKETS (CL 1) (TY A) DOLLARS and CENTS	SY	31,606.000	18
	216	6001		PROOF ROLLING DOLLARS and CENTS	HR	3.000	19
	247	6491	005	FB(CMP IN PLC)(TY D GR 1-2 OR 5)(12") DOLLARS and CENTS	SY	13,113.000	20
	247	6498	005	FLBS (CMP IN PLC)(TY D GR 1-2 OR 5)(8") DOLLARS and CENTS	SY	1,574.000	21
	276	6169		CEM TRT(PLNT MX) (CL L)(TYA)(GR1-2)(6") DOLLARS and CENTS	SY	1,247.000	22
	310	6027		PRIME COAT(MC-30 OR AE-P) DOLLARS and CENTS	GAL	1,729.000	23

ALT	ITEM-CODE			UNIT BID PRICE ONLY. WRITTEN IN WORDS	UNIT	APPROX QUANTITIES	DEPT USE ONLY
	ITEM NO	DESC CODE	S.P. NO.				
	351	6006		FLEXIBLE PAVEMENT STRUCTURE REPAIR(10") DOLLARS and CENTS	SY	1,947.000	24
	354	6023		PLANE ASPH CONC PAV(0" TO 4") DOLLARS and CENTS	SY	22,209.000	25
	356	6021		PAV JT UNDERSEAL (24") DOLLARS and CENTS	LF	184.000	26
	360	6002	001	CONC PVMT (CONT REINF - CRCP) (8") DOLLARS and CENTS	SY	1,267.000	27
	360	6007	001	CONC PVMT (CONT REINF - CRCP) (13") DOLLARS and CENTS	SY	37,875.000	28
	360	6064	001	CONC PVMT (CONT REINF-CRCP)(HES)(15") DOLLARS and CENTS	SY	538.000	29
	400	6005		CEM STABIL BKFL DOLLARS and CENTS	CY	3,776.000	30
	400	6007		CUT & RESTORE CONC PAVING DOLLARS and CENTS	SY	1,269.000	31
	400	6009		CEMENT STAB BACKFILL (INLET OR MH) DOLLARS and CENTS	CY	43.000	32
	401	6001		FLOWABLE BACKFILL DOLLARS and CENTS	CY	201.000	33
	402	6001		TRENCH EXCAVATION PROTECTION DOLLARS and CENTS	LF	1,898.000	34
	403	6001		TEMPORARY SPL SHORING DOLLARS and CENTS	SF	34,886.000	35

ALT	ITEM-CODE			UNIT BID PRICE ONLY. WRITTEN IN WORDS	UNIT	APPROX QUANTITIES	DEPT USE ONLY
	ITEM NO	DESC CODE	S.P. NO.				
	416	6001		DRILL SHAFT (18 IN) DOLLARS and CENTS	LF	286.000	36
	416	6005		DRILL SHAFT (42 IN) DOLLARS and CENTS	LF	2,212.000	37
	416	6006		DRILL SHAFT (48 IN) DOLLARS and CENTS	LF	42.000	38
	416	6010		DRILL SHAFT (72 IN) DOLLARS and CENTS	LF	1,806.000	39
	416	6015		DRILL SHAFT (NON - REINFORCED) (12 IN) DOLLARS and CENTS	LF	7.000	40
	416	6021		DRILL SHAFT (SIGN MTS) (42 IN) DOLLARS and CENTS	LF	764.000	41
	416	6023		DRILL SHAFT (SIGN MTS) (54 IN) DOLLARS and CENTS	LF	31.000	42
	416	6029		DRILL SHAFT (RDWY ILL POLE) (30 IN) DOLLARS and CENTS	LF	320.000	43
	416	6032		DRILL SHAFT (TRF SIG POLE) (36 IN) DOLLARS and CENTS	LF	13.000	44
	420	6013	001	CL C CONC (ABUT) DOLLARS and CENTS	CY	339.600	45
	420	6029	001	CL C CONC (CAP) DOLLARS and CENTS	CY	118.200	46
	420	6031	001	CL C CONC (CAP)(MASS) DOLLARS and CENTS	CY	1,079.200	47

ALT	ITEM-CODE			UNIT BID PRICE ONLY. WRITTEN IN WORDS	UNIT	APPROX QUANTITIES	DEPT USE ONLY
	ITEM NO	DESC CODE	S.P. NO.				
	420	6037	001	CL C CONC (COLUMN) DOLLARS and CENTS	CY	526.200	48
	420	6066	001	CL C CONC (RAIL FOUNDATION) DOLLARS and CENTS	CY	144.000	49
	420	6068	001	CL C CONC (SIGN COLUMN) DOLLARS and CENTS	CY	305.000	50
	420	6074	001	CL C CONC (MISC) DOLLARS and CENTS	CY	148.000	51
	420	6134	001	CL C CONC (SIGN FOOTING) DOLLARS and CENTS	CY	84.000	52
	422	6001		REINF CONC SLAB DOLLARS and CENTS	SF	148,665.000	53
	422	6015		APPROACH SLAB DOLLARS and CENTS	CY	642.900	54
	423	6001	005	RETAINING WALL (MSE) DOLLARS and CENTS	SF	43,721.000	55
	423	6003	005	RETAINING WALL (TEMP WALL) DOLLARS and CENTS	SF	19,376.000	56
	425	6041	001	PRESTR CONC GIRDER (TX70) DOLLARS and CENTS	LF	6,787.800	57
	427	6004	003	SILICONE RESIN PAINT FINISH DOLLARS and CENTS	SF	1,780.000	58
	429	6004		CONC STR REPAIR(RAPID DECK REP(PRT DPT) DOLLARS and CENTS	SF	60.000	59

ALT	ITEM-CODE			UNIT BID PRICE ONLY. WRITTEN IN WORDS	UNIT	APPROX QUANTITIES	DEPT USE ONLY
	ITEM NO	DESC CODE	S.P. NO.				
	429	6007		CONC STR REPAIR (VERTICAL & OVER-HEAD) DOLLARS and CENTS	SF	38.000	60
	432	6001		RIPRAP (CONC)(4 IN) DOLLARS and CENTS	CY	2,247.000	61
	432	6002		RIPRAP (CONC)(5 IN) DOLLARS and CENTS	CY	11.000	62
	432	6006		RIPRAP (CONC)(CL B) DOLLARS and CENTS	CY	7.500	63
	432	6043		RIPRAP(CONC)(SIGN MOUNTS)(CL B) DOLLARS and CENTS	CY	10.000	64
	432	6045		RIPRAP (MOW STRIP)(4 IN) DOLLARS and CENTS	CY	286.000	65
	434	6026	004	ELASTOMERIC BEARING (E7) DOLLARS and CENTS	EA	21.000	66
	434	6035	004	ELASTOMERIC BEARING (F7) DOLLARS and CENTS	EA	21.000	67
	434	6041	004	SLIDING ELASTOMERIC BEARING (ES 4) DOLLARS and CENTS	EA	42.000	68
	438	6001		CLEANING AND SEALING EXISTING JOINTS DOLLARS and CENTS	LF	98.000	69
	438	6011		CLEANING AND SEALING JOINTS (FOAM) DOLLARS and CENTS	LF	98.000	70
	442	6001	001	STR STEEL (PLATE GIRDER) DOLLARS and CENTS	LB	4,619,300.00	71

ALT	ITEM-CODE			UNIT BID PRICE ONLY. WRITTEN IN WORDS	UNIT	APPROX QUANTITIES	DEPT USE ONLY
	ITEM NO	DESC CODE	S.P. NO.				
	442	6008	001	STR STEEL (MISCELLANEOUS BRIDGE) DOLLARS and CENTS	LB	43,720.000	72
	442	6009	001	STR STEEL (DIAPHRAGM & STIFFENER) DOLLARS and CENTS	LB	375,130.000	73
	442	6010	001	STR STEEL (SHEAR CONNECTOR) DOLLARS and CENTS	LB	54,550.000	74
	450	6023	001	RAIL (TY SSTR) DOLLARS and CENTS	LF	9,511.000	75
	450	6054	001	RAIL (TY SSTR) (W/DRAIN SLOTS) DOLLARS and CENTS	LF	621.000	76
	450	6062	001	RAIL (TY SSTR)(MOD) DOLLARS and CENTS	LF	5,103.000	77
	450	6119	001	RAIL (CLF-RO) DOLLARS and CENTS	LF	1,140.000	78
	451	6062		RETROFIT RAIL (TY T2P) DOLLARS and CENTS	LF	409.000	79
	454	6018		SEALED EXPANSION JOINT (4 IN) (SEJ - M) DOLLARS and CENTS	LF	441.500	80
	454	6019		SEALED EXPANSION JOINT (5 IN) (SEJ - M) DOLLARS and CENTS	LF	441.000	81
	462	6001	002	CONC BOX CULV (3 FT X 2 FT) DOLLARS and CENTS	LF	1,009.000	82
	462	6003	002	CONC BOX CULV (4 FT X 2 FT) DOLLARS and CENTS	LF	810.000	83

ALT	ITEM-CODE			UNIT BID PRICE ONLY. WRITTEN IN WORDS	UNIT	APPROX QUANTITIES	DEPT USE ONLY
	ITEM NO	DESC CODE	S.P. NO.				
	462	6006	002	CONC BOX CULV (5 FT X 2 FT) DOLLARS and CENTS	LF	1,366.000	84
	462	6007	002	CONC BOX CULV (5 FT X 3 FT) DOLLARS and CENTS	LF	225.000	85
	464	6003	001	RC PIPE (CL III)(18 IN) DOLLARS and CENTS	LF	273.000	86
	464	6005	001	RC PIPE (CL III)(24 IN) DOLLARS and CENTS	LF	53.000	87
	464	6007	001	RC PIPE (CL III)(30 IN) DOLLARS and CENTS	LF	378.000	88
	464	6017	001	RC PIPE (CL IV)(18 IN) DOLLARS and CENTS	LF	56.000	89
	464	6018	001	RC PIPE (CL IV)(24 IN) DOLLARS and CENTS	LF	2,080.000	90
	464	6019	001	RC PIPE (CL IV)(30 IN) DOLLARS and CENTS	LF	512.000	91
	464	6020	001	RC PIPE (CL IV)(36 IN) DOLLARS and CENTS	LF	290.000	92
	465	6007	001	JCTBOX(COMPL)(PJB)(3FTX5FT) DOLLARS and CENTS	EA	1.000	93
	465	6013	001	INLET (COMPL)(PCO)(3FT)(NONE) DOLLARS and CENTS	EA	1.000	94
	465	6029	001	INLET (COMPL)(PCU)(3FT)(NONE) DOLLARS and CENTS	EA	2.000	95

ALT	ITEM-CODE			UNIT BID PRICE ONLY. WRITTEN IN WORDS	UNIT	APPROX QUANTITIES	DEPT USE ONLY
	ITEM NO	DESC CODE	S.P. NO.				
	465	6055	001	INLET (COMPL)(PSL)(SL)(4FTX4FT) DOLLARS and CENTS	EA	2.000	96
	465	6126	001	INLET (COMPL)(PSL)(FG)(3FTX3FT-3FTX-3FT) DOLLARS and CENTS	EA	4.000	97
	465	6128	001	INLET (COMPL)(PSL)(FG)(4FTX4FT-4FTX-4FT) DOLLARS and CENTS	EA	5.000	98
	465	6158	001	INLET(COMPL)(PAZD)(FG)(3FTX3FT-3FTX-3FT) DOLLARS and CENTS	EA	1.000	99
	465	6160	001	INLET(COMPL)(PAZD)(FG)(4FTX4FT-4FTX-4FT) DOLLARS and CENTS	EA	1.000	100
	465	6178	001	INLET (COMPL)(TY MSE1) DOLLARS and CENTS	EA	6.000	101
	465	6179	001	INLET (COMPL)(TY MSE2) DOLLARS and CENTS	EA	7.000	102
	465	6338	001	INLET (COMPL)(ARMOR CURB SLOT) DOLLARS and CENTS	EA	3.000	103
	467	6109		SET (TY I)(S=3 FT)(HW= 3 FT)(6:1)(C) DOLLARS and CENTS	EA	2.000	104
	467	6110		SET (TY I)(S=3 FT)(HW= 3 FT)(6:1)(P) DOLLARS and CENTS	EA	2.000	105
	467	6142		SET (TY I)(S= 4 FT)(HW= 3 FT)(6:1) (P) DOLLARS and CENTS	EA	2.000	106

ALT	ITEM-CODE			UNIT BID PRICE ONLY. WRITTEN IN WORDS	UNIT	APPROX QUANTITIES	DEPT USE ONLY
	ITEM NO	DESC CODE	S.P. NO.				
	467	6168		SET (TY I)(S= 5 FT)(HW= 2 FT)(6:1) (P) DOLLARS and CENTS	EA	1.000	107
	467	6174		SET (TY I)(S= 5 FT)(HW= 3 FT)(6:1) (P) DOLLARS and CENTS	EA	2.000	108
	467	6180		SET (TY I)(S= 5 FT)(HW= 4 FT)(6:1) (P) DOLLARS and CENTS	EA	2.000	109
	467	6391		SET (TY II) (24 IN) (RCP) (4: 1) (P) DOLLARS and CENTS	EA	2.000	110
	467	6394		SET (TY II) (24 IN) (RCP) (6: 1) (C) DOLLARS and CENTS	EA	1.000	111
	467	6395		SET (TY II) (24 IN) (RCP) (6: 1) (P) DOLLARS and CENTS	EA	6.000	112
	467	6423		SET (TY II) (30 IN) (RCP) (6: 1) (P) DOLLARS and CENTS	EA	5.000	113
	471	6007		GRATE AND FRAME (BRIDGE DRAIN) DOLLARS and CENTS	EA	14.000	114
	481	6013		PIPE (PVC) (SCH 40) (6 IN) DOLLARS and CENTS	LF	279.000	115
	496	6002		REMOV STR (INLET) DOLLARS and CENTS	EA	8.000	116
	496	6004		REMOV STR (SET) DOLLARS and CENTS	EA	14.000	117
	496	6005		REMOV STR (WINGWALL) DOLLARS and CENTS	EA	3.000	118

ALT	ITEM-CODE			UNIT BID PRICE ONLY. WRITTEN IN WORDS	UNIT	APPROX QUANTITIES	DEPT USE ONLY
	ITEM NO	DESC CODE	S.P. NO.				
	496	6006		REMOV STR (HEADWALL) DOLLARS and CENTS	EA	6.000	119
	496	6007		REMOV STR (PIPE) DOLLARS and CENTS	LF	5,663.000	120
	496	6008		REMOV STR (BOX CULVERT) DOLLARS and CENTS	LF	620.000	121
	496	6010		REMOV STR (BRIDGE 100 - 499 FT LENGTH) DOLLARS and CENTS	EA	2.000	122
	496	6040		REMOV STR (RET WALL) DOLLARS and CENTS	LF	340.000	123
	500	6001		MOBILIZATION DOLLARS and CENTS	LS	1.000	124
	502	6001	008	BARRICADES, SIGNS AND TRAFFIC HAN-DLING DOLLARS and CENTS	MO	54.000	125
	506	6001	005	ROCK FILTER DAMS (INSTALL) (TY 1) DOLLARS and CENTS	LF	540.000	126
	506	6011	005	ROCK FILTER DAMS (REMOVE) DOLLARS and CENTS	LF	540.000	127
	506	6038	005	TEMP SEDMT CONT FENCE (INSTALL) DOLLARS and CENTS	LF	3,600.000	128
	506	6039	005	TEMP SEDMT CONT FENCE (REMOVE) DOLLARS and CENTS	LF	3,600.000	129
	506	6041	005	BIODEG EROSN CONT LOGS (INSTL) (12") DOLLARS and CENTS	LF	438.000	130

ALT	ITEM-CODE			UNIT BID PRICE ONLY. WRITTEN IN WORDS	UNIT	APPROX QUANTITIES	DEPT USE ONLY
	ITEM NO	DESC CODE	S.P. NO.				
	506	6043	005	BIODEG EROSN CONT LOGS (REMOVE) DOLLARS and CENTS	LF	438.000	131
	508	6003		CONSTRUCTING DETOURS (TY 1) DOLLARS and CENTS	SY	22,904.000	132
	508	6004		CONSTRUCTING DETOURS (TY 2) DOLLARS and CENTS	SY	400.000	133
	510	6001		ONE-WAY TRAF CONT (FLAGGER CONT) DOLLARS and CENTS	HR	1,260.000	134
	510	6002		ONE-WAY TRAF CONT (PILOT CAR) DOLLARS and CENTS	HR	252.000	135
	512	6001		PORT CTB (FUR & INST)(SGL SLOPE)(TY 1) DOLLARS and CENTS	LF	27,014.000	136
	512	6009		PORT CTB (FUR & INST)(LOW PROF)(TY 1) DOLLARS and CENTS	LF	7,758.000	137
	512	6010		PORT CTB (FUR & INST)(LOW PROF)(TY 2) DOLLARS and CENTS	LF	280.000	138
	512	6025		PORT CTB (MOVE)(SGL SLP)(TY 1) DOLLARS and CENTS	LF	19,604.000	139
	512	6033		PORT CTB (MOVE)(LOW PROF)(TY 1) DOLLARS and CENTS	LF	9,411.000	140
	512	6034		PORT CTB (MOVE)(LOW PROF)(TY 2) DOLLARS and CENTS	LF	1,967.000	141
	512	6037		PORT CTB (STKPL)(SGL SLP)(TY 1) DOLLARS and CENTS	LF	667.000	142

ALT	ITEM-CODE			UNIT BID PRICE ONLY. WRITTEN IN WORDS	UNIT	APPROX QUANTITIES	DEPT USE ONLY
	ITEM NO	DESC CODE	S.P. NO.				
	512	6045		PORT CTB (STKPL)(LOW PROF)(TY 1) DOLLARS and CENTS	LF	934.000	143
	512	6046		PORT CTB (STKPL)(LOW PROF)(TY 2) DOLLARS and CENTS	LF	20.000	144
	512	6049		PORT CTB (REMOVE)(SGL SLP)(TY 1) DOLLARS and CENTS	LF	21,547.000	145
	512	6057		PORT CTB (REMOVE)(LOW PROF)(TY 1) DOLLARS and CENTS	LF	7,055.000	146
	512	6058		PORT CTB (REMOVE)(LOW PROF)(TY 2) DOLLARS and CENTS	LF	180.000	147
	514	6001		PERM CTB (SGL SLOPE) (TY 1) (42) DOLLARS and CENTS	LF	1,026.000	148
	514	6003		PERM CTB (SGL SLOPE) (TY 3) (42) DOLLARS and CENTS	LF	77.000	149
	514	6036		PERM CTB (TRAN SSCB TO SSTR) (MOD) DOLLARS and CENTS	LF	30.000	150
	529	6001		CONC CURB (TY I) DOLLARS and CENTS	LF	6,746.000	151
	531	6003		CONC SIDEWALKS (6") DOLLARS and CENTS	SY	3,156.000	152
	531	6004		CURB RAMPS (TY 1) DOLLARS and CENTS	EA	4.000	153
	531	6005		CURB RAMPS (TY 2) DOLLARS and CENTS	EA	2.000	154

ALT	ITEM-CODE			UNIT BID PRICE ONLY. WRITTEN IN WORDS	UNIT	APPROX QUANTITIES	DEPT USE ONLY
	ITEM NO	DESC CODE	S.P. NO.				
	531	6008		CURB RAMPS (TY 5) DOLLARS and CENTS	EA	3.000	155
	531	6010		CURB RAMPS (TY 7) DOLLARS and CENTS	EA	1.000	156
	531	6016		CURB RAMPS (TY 21) DOLLARS and CENTS	EA	2.000	157
	536	6002		CONC MEDIAN DOLLARS and CENTS	SY	36.000	158
	540	6001	001	MTL W-BEAM GD FEN (TIM POST) DOLLARS and CENTS	LF	2,640.000	159
	540	6006	001	MTL BEAM GD FEN TRANS (THRIE-BEAM) DOLLARS and CENTS	EA	8.000	160
	540	6016	001	DOWNSTREAM ANCHOR TERMINAL SEC-TION DOLLARS and CENTS	EA	5.000	161
	542	6001		REMOVE METAL BEAM GUARD FENCE DOLLARS and CENTS	LF	5,000.000	162
	542	6002		REMOVE TERMINAL ANCHOR SECTION DOLLARS and CENTS	EA	8.000	163
	542	6003		REMOVE DOWNSTREAM ANCHOR TERMI-NAL DOLLARS and CENTS	EA	7.000	164
	542	6004		RM MTL BM GD FENCE TRANS (THRIE-BEAM) DOLLARS and CENTS	EA	8.000	165

ALT	ITEM-CODE			UNIT BID PRICE ONLY. WRITTEN IN WORDS	UNIT	APPROX QUANTITIES	DEPT USE ONLY
	ITEM NO	DESC CODE	S.P. NO.				
	544	6001		GUARDRAIL END TREATMENT (INSTALL) DOLLARS and CENTS	EA	8.000	166
	545	6003		CRASH CUSH ATTEN (MOVE & RESET) DOLLARS and CENTS	EA	15.000	167
	545	6005		CRASH CUSH ATTEN (REMOVE) DOLLARS and CENTS	EA	14.000	168
	545	6007		CRASH CUSH ATTEN (INSTL)(L)(N)(TL3) DOLLARS and CENTS	EA	4.000	169
	545	6010		CRASH CUSH ATTEN (INSTL)(L)(W)(TL3) DOLLARS and CENTS	EA	1.000	170
	545	6019		CRASH CUSH ATTEN (INSTL)(S)(N)(TL3) DOLLARS and CENTS	EA	21.000	171
	610	6009		REMOVE RD IL ASM (TRANS-BASE) DOLLARS and CENTS	EA	12.000	172
	610	6102		REPLACE LUMINAIRE W/LED (250W EQ) DOLLARS and CENTS	EA	4.000	173
	610	6104		IN RD IL (U/P) (TY 1) (150W EQ) LED DOLLARS and CENTS	EA	10.000	174
	610	6216		IN RD IL (TY SA) 40T-10 (250W EQ) LED DOLLARS and CENTS	EA	10.000	175
	610	6272		IN RD IL (TY SA) 50B-10 (400W EQ) LED DOLLARS and CENTS	EA	14.000	176
	610	6289		IN RD IL (TY SA) 50T-10-10(400W EQ)LED DOLLARS and CENTS	EA	9.000	177

ALT	ITEM-CODE			UNIT BID PRICE ONLY. WRITTEN IN WORDS	UNIT	APPROX QUANTITIES	DEPT USE ONLY
	ITEM NO	DESC CODE	S.P. NO.				
	617	6001		TEMP RD IL (RD IL ASM) DOLLARS and CENTS	EA	21.000	178
	618	6023		CONDT (PVC) (SCH 40) (2") DOLLARS and CENTS	LF	9,405.000	179
	618	6031		CONDT (PVC) (SCH 40) (3") (CONC ENCSE) DOLLARS and CENTS	LF	4,865.000	180
	618	6046		CONDT (PVC) (SCH 80) (2") DOLLARS and CENTS	LF	10.000	181
	618	6047		CONDT (PVC) (SCH 80) (2") (BORE) DOLLARS and CENTS	LF	5,465.000	182
	618	6053		CONDT (PVC) (SCH 80) (3") DOLLARS and CENTS	LF	10.000	183
	618	6054		CONDT (PVC) (SCH 80) (3") (BORE) DOLLARS and CENTS	LF	5,455.000	184
	618	6062		CONDT (RM) (3/4") DOLLARS and CENTS	LF	445.000	185
	618	6070		CONDT (RM) (2") DOLLARS and CENTS	LF	10.000	186
	618	6074		CONDT (RM) (3") DOLLARS and CENTS	LF	1,775.000	187
	620	6002		ELEC CONDR (NO.14) INSULATED DOLLARS and CENTS	LF	8,710.000	188
	620	6007		ELEC CONDR (NO.8) BARE DOLLARS and CENTS	LF	1,730.000	189

ALT	ITEM-CODE			UNIT BID PRICE ONLY. WRITTEN IN WORDS	UNIT	APPROX QUANTITIES	DEPT USE ONLY
	ITEM NO	DESC CODE	S.P. NO.				
	620	6008		ELEC CONDR (NO.8) INSULATED DOLLARS and CENTS	LF	230.000	190
	620	6009		ELEC CONDR (NO.6) BARE DOLLARS and CENTS	LF	10,940.000	191
	620	6010		ELEC CONDR (NO.6) INSULATED DOLLARS and CENTS	LF	27,560.000	192
	620	6015		ELEC CONDR (NO.2) BARE DOLLARS and CENTS	LF	1,270.000	193
	620	6016		ELEC CONDR (NO.2) INSULATED DOLLARS and CENTS	LF	2,530.000	194
	621	6005		TRAY CABLE (4 CONDR) (12 AWG) DOLLARS and CENTS	LF	700.000	195
	624	6002		GROUND BOX TY A (122311)W/APRON DOLLARS and CENTS	EA	34.000	196
	624	6010		GROUND BOX TY D (162922)W/APRON DOLLARS and CENTS	EA	22.000	197
	624	6028		REMOVE GROUND BOX DOLLARS and CENTS	EA	10.000	198
	627	6003		TIMBER POLE (CL 2) 50 FT DOLLARS and CENTS	EA	4.000	199
	628	6152		ELC SRV TY D 120/240 060(NS)SS(N)SP(O) DOLLARS and CENTS	EA	3.000	200
	636	6001	001	ALUMINUM SIGNS (TY A) DOLLARS and CENTS	SF	111.000	201

ALT	ITEM-CODE			UNIT BID PRICE ONLY. WRITTEN IN WORDS	UNIT	APPROX QUANTITIES	DEPT USE ONLY
	ITEM NO	DESC CODE	S.P. NO.				
	636	6002	001	ALUMINUM SIGNS (TY G) DOLLARS and CENTS	SF	38.000	202
	636	6003	001	ALUMINUM SIGNS (TY O) DOLLARS and CENTS	SF	1,182.000	203
	644	6001		IN SM RD SN SUP&AM TY10BWG(1)SA(P) DOLLARS and CENTS	EA	6.000	204
	644	6004		IN SM RD SN SUP&AM TY10BWG(1)SA(T) DOLLARS and CENTS	EA	19.000	205
	644	6030		IN SM RD SN SUP&AM TYS80(1)SA(T) DOLLARS and CENTS	EA	3.000	206
	644	6034		IN SM RD SN SUP&AM TYS80(1)SA(U-1EXT) DOLLARS and CENTS	EA	1.000	207
	644	6065		IN BRIDGE MNT CLEARANCE SGN ASSM(TY S) DOLLARS and CENTS	EA	4.000	208
	644	6066		IN SM RD SN SUP&AM (RAIL MOUNT) DOLLARS and CENTS	EA	5.000	209
	644	6076		REMOVE SM RD SN SUP&AM DOLLARS and CENTS	EA	30.000	210
	647	6001		INSTALL LRSS (STRUCT STEEL) DOLLARS and CENTS	LB	197.000	211
	647	6003		REMOVE LRSA DOLLARS and CENTS	EA	4.000	212
	650	6041		INS OH SN SUP(35 FT CANT)(SPAN ONLY) DOLLARS and CENTS	EA	2.000	213

ALT	ITEM-CODE			UNIT BID PRICE ONLY. WRITTEN IN WORDS	UNIT	APPROX QUANTITIES	DEPT USE ONLY
	ITEM NO	DESC CODE	S.P. NO.				
	650	6066		INS OH SN SUP(55 FT BRDG)(SPAN ONLY) DOLLARS and CENTS	EA	1.000	214
	650	6071		INS OH SN SUP(60 FT BRDG)(SPAN ONLY) DOLLARS and CENTS	EA	1.000	215
	650	6086		INS OH SN SUP(75 FT BRDG)(SPAN ONLY) DOLLARS and CENTS	EA	1.000	216
	650	6096		INS OH SN SUP(85 FT BRDG)(SPAN ONLY) DOLLARS and CENTS	EA	1.000	217
	658	6014		INSTL DEL ASSM (D-SW)SZ (BRF)CTB (BI) DOLLARS and CENTS	EA	9.000	218
	658	6047		INSTL OM ASSM (OM-2Y)(WC)GND DOLLARS and CENTS	EA	10.000	219
	658	6063		INSTL DEL ASSM (D-SW)SZ 1(BRF)GF2(BR) DOLLARS and CENTS	EA	46.000	220
	658	6065		INSTL DEL ASSM (D-SY)SZ 1(BRF)GF2(BR) DOLLARS and CENTS	EA	22.000	221
	658	6069		INSTL DEL ASSM (D-SW)SZ (BRF)CTB (BR) DOLLARS and CENTS	EA	69.000	222
	658	6070		INSTL DEL ASSM (D-SY)SZ (BRF)CTB (BR) DOLLARS and CENTS	EA	87.000	223
	662	6005		WK ZN PAV MRK NON-REMOV (W)6"(BRK) DOLLARS and CENTS	LF	1,026.000	224
	662	6008		WK ZN PAV MRK NON-REMOV (W)6"(SLD) DOLLARS and CENTS	LF	5,190.000	225

ALT	ITEM-CODE			UNIT BID PRICE ONLY. WRITTEN IN WORDS	UNIT	APPROX QUANTITIES	DEPT USE ONLY
	ITEM NO	DESC CODE	S.P. NO.				
	662	6037		WK ZN PAV MRK NON-REMOV (Y)6"(SLD) DOLLARS and CENTS	LF	5,858.000	226
	662	6064		WK ZN PAV MRK REMOV (W)6"(BRK) DOLLARS and CENTS	LF	12,203.000	227
	662	6065		WK ZN PAV MRK REMOV (W)6"(DOT) DOLLARS and CENTS	LF	87.000	228
	662	6067		WK ZN PAV MRK REMOV (W)6"(SLD) DOLLARS and CENTS	LF	43,816.000	229
	662	6073		WK ZN PAV MRK REMOV (W)12"(SLD) DOLLARS and CENTS	LF	2,084.000	230
	662	6080		WK ZN PAV MRK REMOV (W)(ARROW) DOLLARS and CENTS	EA	4.000	231
	662	6098		WK ZN PAV MRK REMOV (Y)6"(SLD) DOLLARS and CENTS	LF	43,655.000	232
	666	6018	007	REFL PAV MRK TY I (W)6"(DOT)(100MIL) DOLLARS and CENTS	LF	182.000	233
	666	6036	007	REFL PAV MRK TY I (W)8"(SLD)(100MIL) DOLLARS and CENTS	LF	1,018.000	234
	666	6048	007	REFL PAV MRK TY I (W)24"(SLD)(100MIL) DOLLARS and CENTS	LF	428.000	235
	666	6081	007	REFL PAV MRK TY I(W)(ENTR GORE)(100MIL) DOLLARS and CENTS	EA	6.000	236
	666	6084	007	REFL PAV MRK TY I(W)(EXIT GORE)(100MIL) DOLLARS and CENTS	EA	3.000	237

ALT	ITEM-CODE			UNIT BID PRICE ONLY. WRITTEN IN WORDS	UNIT	APPROX QUANTITIES	DEPT USE ONLY
	ITEM NO	DESC CODE	S.P. NO.				
	666	6225	007	PAVEMENT SEALER 6" DOLLARS and CENTS	LF	37,157.000	238
	666	6226	007	PAVEMENT SEALER 8" DOLLARS and CENTS	LF	1,018.000	239
	666	6230	007	PAVEMENT SEALER 24" DOLLARS and CENTS	LF	428.000	240
	666	6239	007	PAVEMENT SEALER (ENTR GORE) DOLLARS and CENTS	EA	6.000	241
	666	6240	007	PAVEMENT SEALER (EXIT GORE) DOLLARS and CENTS	EA	3.000	242
	666	6306	007	RE PM W/RET REQ TY I (W)6"(BRK)(100MIL) DOLLARS and CENTS	LF	3,416.000	243
	666	6309	007	RE PM W/RET REQ TY I (W)6"(SLD)(100MIL) DOLLARS and CENTS	LF	10,960.000	244
	666	6321	007	RE PM W/RET REQ TY I (Y)6"(SLD)(100MIL) DOLLARS and CENTS	LF	10,650.000	245
	666	6343	007	REF PROF PAV MRK TY I(W)6"(SLD)(100MIL) DOLLARS and CENTS	LF	5,425.000	246
	666	6347	007	REF PROF PAV MRK TY I(Y)6"(SLD)(100MIL) DOLLARS and CENTS	LF	6,524.000	247
	668	6006		PREFAB PAV MRK TY B (W)(6")(BRK) DOLLARS and CENTS	LF	2,509.000	248
	668	6007		PREFAB PAV MRK TY B (W)(6")(SLD) DOLLARS and CENTS	LF	7,806.000	249

ALT	ITEM-CODE			UNIT BID PRICE ONLY. WRITTEN IN WORDS	UNIT	APPROX QUANTITIES	DEPT USE ONLY
	ITEM NO	DESC CODE	S.P. NO.				
	668	6008		PREFAB PAV MRK TY B (W)(6")(DOT) DOLLARS and CENTS	LF	224.000	250
	668	6010		PREFAB PAV MRK TY B (W)(6")(BRK)CNTST DOLLARS and CENTS	LF	5,018.000	251
	668	6019		PREFAB PAV MRK TY B (W)(ARROW) DOLLARS and CENTS	EA	14.000	252
	668	6020		PREFAB PAV MRK TY B (W)(DBL ARROW) DOLLARS and CENTS	EA	2.000	253
	668	6025		PREFAB PAV MRK TY B (W)(LNDP ARROW) DOLLARS and CENTS	EA	2.000	254
	668	6027		PREFAB PAV MRK TY B (W)(WORD) DOLLARS and CENTS	EA	16.000	255
	668	6028		PREFAB PAV MRK TY B (W)(ENTR GORE) DOLLARS and CENTS	EA	3.000	256
	668	6029		PREFAB PAV MRK TY B (W)(EXIT GORE) DOLLARS and CENTS	EA	2.000	257
	668	6034		PREFAB PAV MRK TY B (W)(36")(YLD TRI) DOLLARS and CENTS	EA	18.000	258
	668	6047		PREFAB PAV MRK TY B (Y)(6")(SLD) DOLLARS and CENTS	LF	6,770.000	259
	668	6059		PREFAB PAV MRK TY B (MULTI)(SHIELD) DOLLARS and CENTS	EA	4.000	260
	672	6007		REFL PAV MRKR TY I-C DOLLARS and CENTS	EA	51.000	261

ALT	ITEM-CODE			UNIT BID PRICE ONLY. WRITTEN IN WORDS	UNIT	APPROX QUANTITIES	DEPT USE ONLY
	ITEM NO	DESC CODE	S.P. NO.				
	672	6009		REFL PAV MRKR TY II-A-A DOLLARS and CENTS	EA	30.000	262
	672	6010		REFL PAV MRKR TY II-C-R DOLLARS and CENTS	EA	690.000	263
	677	6001		ELIM EXT PAV MRK & MRKS (4") DOLLARS and CENTS	LF	5,396.000	264
	677	6003		ELIM EXT PAV MRK & MRKS (8") DOLLARS and CENTS	LF	3,026.000	265
	681	6001		TEMP TRAF SIGNALS DOLLARS and CENTS	EA	1.000	266
	684	6009		TRF SIG CBL (TY A)(12 AWG)(4 CONDR) DOLLARS and CENTS	LF	275.000	267
	684	6012		TRF SIG CBL (TY A)(12 AWG)(7 CONDR) DOLLARS and CENTS	LF	2,519.000	268
	684	6080		TRF SIG CBL (TY C)(14 AWG)(2 CONDR) DOLLARS and CENTS	LF	270.000	269
	690	6001		REMOVAL OF CONDUIT DOLLARS and CENTS	LF	927.000	270
	690	6009		REMOVAL OF CABLES DOLLARS and CENTS	LF	1,791.000	271
	690	6021		REMOVAL OF TIMBER POLES DOLLARS and CENTS	EA	1.000	272
	730	6001		STRIP MOWING DOLLARS and CENTS	AC	6.530	273

ALT	ITEM-CODE			UNIT BID PRICE ONLY. WRITTEN IN WORDS	UNIT	APPROX QUANTITIES	DEPT USE ONLY
	ITEM NO	DESC CODE	S.P. NO.				
	734	6001		LITTER REMOVAL DOLLARS and CENTS	AC	21.410	274
	735	6001		DEBRIS REMOVAL (CNTR MEDIANS/ MAINLANES) DOLLARS and CENTS	CYC	30.000	275
	735	6003		DEBRIS REMOVAL (FRONTAGE ROADS) DOLLARS and CENTS	CYC	30.000	276
	735	6005		DEBRIS REMOVAL (ENTRANCE/EXIT RAMPS) DOLLARS and CENTS	CYC	30.000	277
	738	6001		CLEANING / SWEEPING (CENTER MEDIAN) DOLLARS and CENTS	CYC	30.000	278
	738	6003		CLEANING / SWEEPING (OUTSIDE MAIN LANE) DOLLARS and CENTS	CYC	30.000	279
	738	6005		CLEANING / SWEEPING (FRONTAGE ROAD) DOLLARS and CENTS	CYC	30.000	280
	738	6007		CLEANING / SWEEPING(ENTRANCE/EXIT RAMP) DOLLARS and CENTS	CYC	30.000	281
	740	6004		ANTI - GRAFFITI COATING(PERMNENT-TY II) DOLLARS and CENTS	SF	34,075.000	282
	3076	6001		D-GR HMA TY-B PG64-22 DOLLARS and CENTS	TON	14,322.000	283
	3076	6035		D-GR HMA TY-D PG64-22 DOLLARS and CENTS	TON	112.000	284

ALT	ITEM-CODE			UNIT BID PRICE ONLY. WRITTEN IN WORDS	UNIT	APPROX QUANTITIES	DEPT USE ONLY
	ITEM NO	DESC CODE	S.P. NO.				
	3076	6066		TACK COAT DOLLARS and CENTS	GAL	315.000	285
	3077	6033		SP MIXES SP-C SAC-A PG76-22 DOLLARS and CENTS	TON	5,707.000	286
	3084	6001		BONDING COURSE DOLLARS and CENTS	GAL	1,743.000	287
	3085	6001		UNDERSEAL COURSE DOLLARS and CENTS	GAL	3,990.000	288
	4021	6001		TIP TESTING(DRILL SHAFT) DOLLARS and CENTS	EA	4.000	289
	4171	6001		INSTALL BRIDGE IDENTIFICATION NUM-BERS DOLLARS and CENTS	EA	3.000	290
	6004	6032		ITS COM CBL (SERIAL) DOLLARS and CENTS	LF	410.000	291
	6007	6011		FIBER OPTIC CBL (SNGLE-MODE)(12 FIBER) DOLLARS and CENTS	LF	1,005.000	292
	6007	6017		FIBER OPTIC CBL (SNGLE-MODE)(144 FIBER) DOLLARS and CENTS	LF	26,200.000	293
	6007	6021		FIBER OPTIC SPLICE ENCLOSURE DOLLARS and CENTS	EA	7.000	294
	6007	6023		FIBER OPTIC PATCH PANEL (12 POSITION) DOLLARS and CENTS	EA	6.000	295
	6007	6026		FIBER OPTIC CABLE ROAD MARKER DOLLARS and CENTS	EA	20.000	296

ALT	ITEM-CODE			UNIT BID PRICE ONLY. WRITTEN IN WORDS	UNIT	APPROX QUANTITIES	DEPT USE ONLY
	ITEM NO	DESC CODE	S.P. NO.				
	6007	6027		FIBER OPTIC PATCH PANEL (144 POSITION) DOLLARS and CENTS	EA	1.000	297
	6007	6094		FIBER OPTIC FUSION SPLICE DOLLARS and CENTS	EA	240.000	298
	6007	6109		FIBER OPTIC JUMPERS DOLLARS and CENTS	EA	168.000	299
	6008	6040		ITS GND MNT CAB(TY 6)(CONF 1)(INS ONLY) DOLLARS and CENTS	EA	1.000	300
	6010	6002		CCTV FIELD EQUIPMENT (DIGITAL) DOLLARS and CENTS	EA	2.000	301
	6010	6004		CCTV MOUNT (POLE) DOLLARS and CENTS	EA	2.000	302
	6010	6013		REMOVE CCTV FIELD EQUIPMENT DOLLARS and CENTS	EA	2.000	303
	6027	6003		CONDUIT (PREPARE) DOLLARS and CENTS	LF	2,005.000	304
	6027	6008		GROUND BOX (PREPARE) DOLLARS and CENTS	EA	11.000	305
	6028	6001		INSTALL DMS (POLE MTD CABINET) DOLLARS and CENTS	EA	1.000	306
	6064	6019	001	ITS POLE (40 FT)(90 MPH) DOLLARS and CENTS	EA	2.000	307
	6064	6037	001	ITS POLE (50 FT)(90 MPH) DOLLARS and CENTS	EA	1.000	308

ALT	ITEM-CODE			UNIT BID PRICE ONLY. WRITTEN IN WORDS	UNIT	APPROX QUANTITIES	DEPT USE ONLY
	ITEM NO	DESC CODE	S.P. NO.				
	6064	6055	001	ITS POLE (60 FT)(90 MPH) DOLLARS and CENTS	EA	2.000	309
	6064	6072	001	ITS POLE MNT CAB (TY 1)(CONF 1) DOLLARS and CENTS	EA	1.000	310
	6064	6075	001	ITS POLE MNT CAB (TY 1)(CONF 1)(REM) DOLLARS and CENTS	EA	1.000	311
	6064	6080	001	ITS POLE MNT CAB (TY 2)(CONF 1) DOLLARS and CENTS	EA	4.000	312
	6084	6001		MODIFY EXISTING ELECTRICAL SERVICE DOLLARS and CENTS	EA	2.000	313
	6093	6011		REMOVE EXIST FIB OPT DMS SYS(TY-3) DOLLARS and CENTS	EA	1.000	314
	6093	6014		RELOCATE EXIST FIB OPT DMS SYS(TY-3) DOLLARS and CENTS	EA	1.000	315
	6123	6001		ETHERNET SWITCH (INSTALL ONLY) DOLLARS and CENTS	EA	6.000	316
	6125	6001		TERMINAL SERVER (INSTALL ONLY) DOLLARS and CENTS	EA	5.000	317
	6155	6002		RADAR COMMUNICATION CABLE DOLLARS and CENTS	LF	1,817.000	318
	6185	6002	002	TMA (STATIONARY) DOLLARS and CENTS	DAY	234.000	319
	6185	6005	002	TMA (MOBILE OPERATION) DOLLARS and CENTS	DAY	44.000	320

ALT	ITEM-CODE			UNIT BID PRICE ONLY. WRITTEN IN WORDS	UNIT	APPROX QUANTITIES	DEPT USE ONLY
	ITEM NO	DESC CODE	S.P. NO.				
	6186	6002		ITS GND BOX(PCAST) TY 1 (243636)W/APRN DOLLARS and CENTS	EA	8.000	321
	6186	6008		ITS GND BOX(PCAST) TY 2 (366036)W/APRN DOLLARS and CENTS	EA	7.000	322
	6263	6002		BLUETOOTH DETECTION SYSTEM (INSTALL) DOLLARS and CENTS	EA	2.000	323
	6304	6001		ITS RVSD (DATA COLLECT ONLY) SYS DOLLARS and CENTS	EA	5.000	324
	6319	6001		LED WRONG WAY DRIVER SYSTEM DOLLARS and CENTS	EA	1.000	325
	7194	6016		SAN SWR STRUCTURES (RECONSTRUCT EX MH) DOLLARS and CENTS	EA	1.000	326
	7194	6038		SAN SWR BYPASS PUMPING (LARGE DIA) DOLLARS and CENTS	LS	1.000	327
	7196	6001		TRENCH EXCAVATION PROTECTION DOLLARS and CENTS	LF	1,299.000	328
	7196	6002		DUCTILE IRON FITTINGS DOLLARS and CENTS	TON	7.010	329
	7196	6003		HYDROSTATIC PRESSURE TEST DOLLARS and CENTS	EA	3.000	330
	7196	6004		TEMPORARY BLOW-OFF(COMPLETE)(2") DOLLARS and CENTS	EA	3.000	331
	7196	6005		FLOWABLE FILL BACKFILL DOLLARS and CENTS	CY	29.000	332

ALT	ITEM-CODE			UNIT BID PRICE ONLY. WRITTEN IN WORDS	UNIT	APPROX QUANTITIES	DEPT USE ONLY
	ITEM NO	DESC CODE	S.P. NO.				
	7196	6030		GATE VALVE & BOX (COMPLETE)(16") DOLLARS and CENTS	EA	2.000	333
	7196	6032		FIRE HYDRANT ASSEMBLY DOLLARS and CENTS	EA	3.000	334
	7196	6034		TIE-IN (COMPLETE)(12") DOLLARS and CENTS	EA	1.000	335
	7196	6035		TIE-IN (COMPLETE)(16") DOLLARS and CENTS	EA	2.000	336
	7196	6039		PIPE WATER MAIN (PVC) (12") DOLLARS and CENTS	LF	13.000	337
	7196	6049		PIPE WATER MAIN (PVC) (16") DOLLARS and CENTS	LF	64.000	338
	7196	6059		AIR RELEASE VALVE (COMPLETE)(2") DOLLARS and CENTS	EA	1.000	339
	7196	6060		WTR (JACK, BORE OR TUNNEL) (42") DOLLARS and CENTS	LF	295.000	340
	7196	6064		STEEL CASING (42") (BORE) DOLLARS and CENTS	LF	295.000	341
	7196	6066		TEMPORARY BLOW-OFF (COMPLETE)(4 IN) DOLLARS and CENTS	EA	1.000	342
	7196	6073		PIPE WATER MAIN (PVC) (24") DOLLARS and CENTS	LF	1,157.000	343
	7196	6075		BUTTERFLY VALVE AND BOX (COMPL) (24") DOLLARS and CENTS	EA	2.000	344

ALT	ITEM-CODE			UNIT BID PRICE ONLY. WRITTEN IN WORDS	UNIT	APPROX QUANTITIES	DEPT USE ONLY
	ITEM NO	DESC CODE	S.P. NO.				
	7196	6076		TIE-IN (COMPLETE) (24") DOLLARS and CENTS	EA	1.000	345
	7196	6078		CARRIER PIPE (OPEN CUT) (PVC) (24") DOLLARS and CENTS	LF	65.000	346
	7196	6080		STEEL CASING (42") (OPEN CUT) DOLLARS and CENTS	LF	65.000	347
	7196	6082		GROUT ABANDONMENT WATER MAIN (24") DOLLARS and CENTS	LF	281.000	348
	7196	6126		WATER MAIN REMOVAL (LARGER THAN 16") DOLLARS and CENTS	LF	348.000	349
	7196	6164		CARRIER PIPE (BORE)(PVC)(24") DOLLARS and CENTS	LF	295.000	350

CERTIFICATION OF INTEREST IN OTHER BID PROPOSALS FOR THIS WORK

By signing this proposal, the bidding firm and the signer certify that the following information, as indicated by checking “Yes” or “No” below, is true, accurate, and complete.

A. Quotation(s) have been issued in this firm's name to other firm(s) interested in this work for consideration for performing a portion of this work.

_____ YES

_____ NO

B. If this proposal is the low bid, the bidder agrees to provide the following information prior to award of the contract.

1. Identify firms which bid as a prime contractor and from which the bidder received quotations for work on this project.
2. Identify all the firms which bid as a prime contractor to which the bidder gave quotations for work on this project.

DISCLOSURE OF LOBBYING ACTIVITIES

Complete this form to disclose lobbying activities pursuant to 31 U.S.C. 1352 (See reverse for public burden disclosure.)

1. Type of Federal Action: a. contract b. grant c. cooperative agreement d. loan e. loan guarantee f. loan insurance	2. Status of Federal Action: a. bid/offer/application b. initial award c. post-award	3. Report Type: a. initial filing b. grant For material change only: year _____ quarter _____ date of last report _____

4. **Name and Address of Reporting Entity:** ? Prime ? Subawardee Tier _____, if known: **Congressional District**, if known:	5. **If Reporting Entity in No. 4 is Subawardee,** Enter Name and Address of Prime: **Congressional District**, if known:
6. **Federal Department/Agency:**	7. **Federal Program Name/Description:** CFDA Number, if applicable: _____
8. **Federal Action Number**, if known:	9. **Award Amount,** if known: $ _____
10. a. Name and Address of Lobbying Entity (if individual, last name, first name, MI):	b. Individuals Performing Services (including address if different from No. 10a) (last name, first name, MI):

(attach Continuation Sheet(s) SF-LLL-A, if necessary)

11. Amount of Payment (check all that apply): $ _____ actual planned 12. Form of Payment (check all that apply) a. cash b. in-kind; specify: nature _____ value _____	13. Type of Payment (check all that apply): a. retainer b. one-time fee c. commission d. contingent fee e. deferred f. other; specify: _____

14. Brief Description of Services Performed or to be Performed and Date(s) of Service, including officer(s), employee(s), or Member(s) contacted, for Payment Indicated in Item 11:

(attach Continuation Sheet(s) SF-LLL-A, if necessary)

15. **Continuation Sheet(s) SF-LLL-A attached:** ? Yes ? No

16. Information requested through this form is authorized by title 31 U.S.C. section 1352. This disclosure of lobbying activities is a material representation of fact upon which reliance was placed by the tier above when this transaction was made or entered into. This disclosure is required pursuant to 31 U.S.C. 1352. This information will be reported to the Congress semi-annually and will be available for public inspection. Any person who fails to file the required disclosure shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.	Signature: _____ Print Name: _____ Title: _____ Telephone No: _____ Date: _____

FEDERAL USE ONLY	Authorized for Local Reproduction Standard Form - LLL

INSTRUCTIONS FOR COMPLETION OF SF-LLL, DISCLOSURE OF LOBBYING ACTIVITIES

This disclosure form shall be completed by the reporting entity, whether subawardee or prime Federal recipient, at the initiation or receipt of a covered Federal action, or a material change to a previous filing, pursuant to title 31 U.S.C section 1352. The filing of a form is required for each payment or agreement to make payment to any lobbying entity for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with a covered Federal action. Use the SF-LLL-A Continuation Sheet for additional information if the space on the form is inadequate. Complete all items that apply for both the initial filing and material change report. Refer to the implementing guidance published by the Office of Management and Budget for additional information.

1. Identify the type of covered Federal action for which lobbying activity is and/or has been secured to influence the outcome of a covered Federal action.
2. Identify the status of the covered Federal action.
3. Identify the appropriate classification of this report. If this is a follow-up report caused by a material change to the information previously reported, enter the year and quarter in which the change occurred. Enter the date of the last previously submitted report by this reporting entity or this covered Federal action.
4. Enter the full name, address, city, state and zip code of the reporting entity. Include Congressional District, if known. Check the appropriate classification of the reporting entity that designates if it is, or expects to be, a prime or subaward recipient. Identify the tier of the subawardee, e.g., the first subawardee of the prime is the 1st tier. Subawards include but are not limited to subcontracts, subgrants and contract awards under grants.
5. If the organization filing the report in item 4 checks "Subawardee", then enter the full name, address, city, state and zip code of the prime Federal recipient. Include Congressional District, if known.
6. Enter the name of the Federal agency making the award or loan commitment. Include at least one organizational level below agency name, if known. For example, Department of Transportation, United States Coast Guard.
7. Enter the Federal program name or description for the covered Federal action (item 1). If known, enter the full Catalog of Federal Domestic Assistance (CFDA) number for grants, cooperative agreements, loans, and loan commitments.
8. Enter the most appropriate Federal identifying number available for the Federal action identified in item 1 (e.g., Request for Proposal (RFP) number; Invitation for Bid (IFB) number; grant announcement number, the contract, grant, or loan award number; the application/proposal control number assigned by the Federal agency). Include prefixes, e.g., "RFP-DE-90-001."
9. For a covered Federal action where there has been an award or loan commitment by the Federal agency, enter the Federal amount of the award/loan commitment for the prime entity identified in item 4 or 5.
10. (a) Enter the full name, address, city, state and zip code of the lobbying entity engaged by the reporting entity identified in item 4 to influence the covered Federal action.
    (b) Enter the full names of the individual(s) performing services, and include full address if different from 10(a). Enter Last Name, First Name, and Middle Initial (MI).
11. Enter the amount of compensation paid or reasonably expected to be paid by the reporting entity (item 4) to the lobbying entity (item 10). Indicate whether the payment has been made (actual) or will be made (planned). Check all boxes that apply. If this is a material change report, enter the cumulative amount of payment made or planned to be made.
12. Check the appropriate box(es). Check all boxes that apply. If payment is made through an in-kind contribution, specify the nature and value of the in-kind payment.
13. Check the appropriate box(es). Check all boxes that apply. If other, specify nature.
14. Provide a specific and detailed description of the services that the lobbyist has performed, or will be expected to perform, and the date(s) of any services rendered. Include all preparatory and related activity, not just time spent in actual contact with Federal officials. Identify the Federal official(s) or employee(s) contacted or the officer(s), employee(s), or Member(s) of Congress that were contacted.
15. Check whether or not a SF-LLL-A Continuation Sheet(s) is attached.
16. The certifying official shall sign and date the form, print his/her name, title, and telephone number.

DISCLOSURE OF LOBBYING ACTIVITIES

Approved by OMB

0348-0046

CONTINUATION SHEET

Reporting Entity: _____ Page _____ of _____

CONTRACTOR'S ASSURANCE

(Subcontracts-Federal Aid Projects)

By signing this proposal, the contractor is giving assurances that all subcontract agreements will incorporate the Standard Specification and Special Provisions to Section 9.9., Payment Provisions for Subcontractors, all subcontract agreements exceeding $2,000 will incorporate the applicable Wage Determination Decision, and all subcontract agreements will incorporate the following:

Special Provision	Certification of Nondiscrimination in Employment
Special Provision	Notice of Requirement for Affirmative Action to Ensure Equal Employment Opportunity (Executive Order 11246)
Special Provision	Standard Federal Equal Employment Opportunity
Construction	Construction Specifications (Executive Order 11246)
Form FHWA 1273	Required Contract Provisions Federal-aid Construction Contracts (Form FHWA 1273 must also be physically attached to subcontracts and all lower-tier subcontracts)
Special Provision	Nondiscrimination (Include provisions of Sections 3.1 – 3.6 in all subcontracts and agreements for materials)
Special Provision	Cargo Preference Act Requirements in Federal-Aid Contracts
Special Provision	Disadvantaged Business Enterprise in Federal-Aid Contracts

ENGINEER SEAL

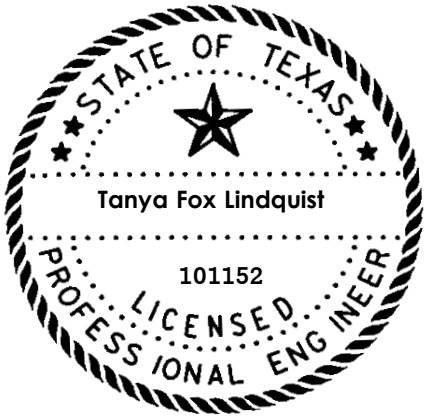
Control **0521-06-155, ETC.**

Project **BR 2B24(547), ETC.**

Highway **IH 410**

County **BEXAR**

The enclosed Texas Department of Transportation Specifications, Special Specifications, Special Provisions, General Notes and Specification Data in this document have been selected by me, or under my responsible supervision as being applicable to this project. Alteration of a sealed document without proper notification to the responsible engineer is an offense under the Texas Engineering Practice Act.



The seal appearing on this document was authorized by

Tanya Fox Lindquist, P.E.

JULY 01, 2024

County: Bexar

Highway: IH35/IH 410S

**********GENERAL NOTES**********
2014 Specification Book (Revised September 25, 2023)

========== **Basis of Estimate** ==========

Item	Description	Rate	Area	Quantity
310	Prime Coat (SBML widen, SBFR, RAMPS)	0.12 GAL/SY	14,408 SY	1,729 GAL
3076	Tack Coat (Mill/Inlay)	0.2 GAL/SY	1,575 SY	315 GAL
3084	Bonding Course	0.12 GAL/SY	14,525 SY	1,743 GAL
3085	Underseal (Mill/Inlay)	0.2 GAL/SY	19,950 SY	3,990 GAL

Item	Description	Depth	Area	Quantity
247	Flex Base (FR, RMP, XS)	12”	13,113 SY	4,371 CY
247	Flex Base (SBML widen)	8”	1,574 SY	350 CY
276	Cem Trt (Plnt MX) (SBML)	6”	1,247 SY	208 CY
351	Flex Pvmt Str Repair	10”	1947 SY	541 CY
360	CRCP (SBML widen)	8”	1,267 SY	282 CY
360	CRCP (ML)	13”	37,875 SY	13,677 CY
360	CRCP (SBML)	15”	538 SY	224 CY

========== **Asphalt Concrete Pavement** ==========

Type	Location	Depth	Rate	Area	Quantity
HMA TY-B	ML, FR, RMP, XS	5”	115 LB/SY-IN	50,887 SY	14,322 Tons
HMA TY-D SUPERPAVE MIXTURE SP-C	SBML widen	1.5”	115 LB/SY-IN	1,299 SY	112 Tons
SAC-A SUPERPAVE MIXTURE SP-C	FR, RMP, XS	3”	115 LB/SY-IN	12,765 SY	2,202 Ton
SAC-A	SBML widen	2.5”	115 LB/SY-IN	24,382 SY	3,505 Tons

--General--
The following State, District, Local and/or Utility Standards have been modified: SSTR Aesthetic Details, IGEB, SGMD, SGEB, BD-1, BD-3, BL-SSTR, CLF-RO, TYPE SSTR, MISSION THEME CANTILEVERED OVERHEAD SIGN SUPPORT(COSS), MISSION THEME OVERHEAD SIGN COLUMN,CC-RAIL-R, CLEANING AND SEALING EXISTING BRIDGE JOINTS

County: Bexar

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Contact the Engineer or the City when construction operations are within 400 feet of a signalized intersection to determine/verify the location of loop detectors, conduit, ground-boxes, etc. Repair or replace any signal equipment damaged by construction operations. The method of repair or replacement shall be pre-approved and inspected. Depending on the type and extent of the damage, the Engineer reserves the right to perform the repair or replacement work and the Contractor will be billed for this work.

City of San Antonio: (210) 207-8642
City of New Braunfels: (830) 221-4049

Any materials removed and not reused and determined to be salvageable shall be stored within the project limits at an approved location or delivered undamaged to the storage yard as directed. Deface traffic signs so that they will not reappear in public as signs.

Any sign panels that are adjusted or removed and replaced, shall be done the same workday unless otherwise approved. This work shall be considered subsidiary to Item 502.

Notify the Engineer at least two weeks prior to a proposed traffic pattern change(s) that will require a revision to traffic signals.

Locate and reference all manholes and valves within the construction area with station and offset or GPS. Each manhole and valve shall be identified by its owner (SAWS, CPS, etc.). No roadwork will begin until this list has been submitted. All valves and manhole covers have to be accessible at all times, therefore; temp. CTB, material stockpiles, etc. cannot be placed over these valves or covers.

The Contractor has the option to adjust or construct all manholes and valves to final pavement elevations prior to the final mat of HMA or after final mat of HMA. If between the final elevation adjustment and the final mat of HMA, the manholes and valves are going to be exposed to traffic, place temporary asphalt around the manhole and valve to provide a +/- 50:1 taper. The cost of elevation adjustment and the concrete apron around the manhole and valve will be part of the manhole and valve work. The asphalt tapers are part of the HMA work.

Hurricane Evacuation

Hurricane Season is from June 1 thru November 30. As the closest metropolitan city inland from the Texas Coast, the City of San Antonio is a major shelter destination during mandatory hurricane evacuations. As such, planned work zone lane or road closures may be restricted and/or suspended during mandatory hurricane evacuation operations. The District will coordinate these restrictions at a minimum H-120 from any projected impact to the Texas Coast.

No time charges will be made if the Engineer determines that work on the project was impacted by the hurricane.

The Engineer may order changes in the Traffic Control Plan to accommodate evacuation traffic, and may suspend the work, all or in part, to ensure timely completion of this work. All work to implement changes in the Traffic Control Plan will be paid through existing bid prices or through Item 9.5, Force Account. However, the Department will not entertain any request for delay damages, loss of efficiency that may be attributed to the restriction or suspension of road or lane closures, or to changes in the Traffic Control Plan.

The Contractor should be aware that the "City Public Service" (CPS) will be consulted by the Engineer in matters concerning the execution of the work, materials and testing related to the CPS work. As such, a CPS employee may be observing the construction and related operations as they progress.

If a sanitary sewer overflow (SSO) occurs:

1. Attempt to eliminate the source of the SSO.
2. Contain sewage from the SSO to the extent possible to prevent contamination of waterways.
3. Call SAWS at (210) 233-2015.

The Contractor should be aware that the “San Antonio Water System” (SAWS) will be consulted by the Engineer in matters concerning the execution of the joint bid Water and/or Sanitary work. This may include reviewing material submittals and testing related to this work, as well as inspection and observation of the actual work. As such, a SAWS employee may be reviewing submittals and test results as well as observing the construction and related operations as they progress.

Submit locate request for SAWS water and sewer to TXDOTlocates@saws.org.

In accordance with the Underground Facility Damage Prevention Act (One Call Bill) the phone number for a utility locator is 811. It is the Contractor's responsibility to plan for utility locators as needed.

Underground utilities owned by the Texas Department of Transportation may be present within the Right-Of-Way. Call or email the TxDOT offices listed below for locates a minimum of 48 hours in advance of excavation. If city or town owned irrigation facilities are present, call the appropriate department of the local city or town a minimum of 48 hours in advance of excavation. The Contractor is liable for all damages incurred to the above-mentioned utilities when working without having the utilities located prior to excavation.

For signal and ITS locates call TransGuide at 210-731-5136 or email sat_its_locates@txdot.gov for ITS locates and signal.request@txdot.gov for signal locates.

Contractor questions on this project are to be addressed to the following individual(s):

County: Bexar

Highway: IH35/IH 410S

Christen Longoria, Christen.Longoria@txdot.gov
Lea Jacobson, Lea.Jacobson@txdot.gov

Contractor questions will be accepted through email, phone and in person by the above individuals. Questions may also be submitted via the Letting Pre-Bid Q&A web page. This webpage can be accessed from the Notice to Contractors dashboard located at the following Address:
https://tableau.txdot.gov/views/ProjectInformationDashboard/NoticetoContractors

All contractor questions will be reviewed by the Engineer. All questions and any corresponding responses that are generated will be posted through the same Letting Pre-Bid Q&A web page.

The Letting Pre-Bid Q&A web page for each project can be accessed by using the dashboard to navigate to the project you are interested in by scrolling or filtering the dashboard using the controls on the left. Hover over the blue hyperlink for the project you want to view the Q&A for and click on the link in the window that pops up.

The Contractor must measure the vertical clearance at each structure after the final surface of the roadway is completed and provide the vertical clearance measurement to the Engineer.

--Item 5--
Taper ACP placed at curb inlets, traffic inlets and slotted drains.

A horizontal boom or equivalent equipment is required for construction in the vicinity of the CPS Energy electric lines to provide vertical clearance of equipment during construction. Contact CPS Energy Utility Coordination Group sixteen (16) week in anticipation of pole bracing. The estimated duration for pole bracing is 6 to 10 weeks (or longer if temporary construction easements are required) after invoice is paid. For de-energizing or sleeving of the overhead electrical lines depicted on the plans, please contact CPS Energy Utility Coordination Group sixteen (16) week in anticipation of needed de-energization. The estimated duration for de-energizing is approximately 4 to 6 weeks (after invoice is paid) but could vary on system scenario and back feed requirements. De-energizing may not be possible in all instances or may be restricted during specific periods of time due to load demand. Contractor will be reimbursed for the invoice cost for pole bracing and/or de-energizing or sleeving through force account.

Prevention of Migratory Bird Nesting

It is anticipated that migratory birds, a protected group of species, may try to nest on bridges, culverts, vegetation, or gravel substrate, at any time of the year. The preferred nesting season for migratory birds is from February 15 through October 1. When practicable, schedule construction operations outside of the preferred nesting season. Otherwise, nests containing migratory birds must be avoided and no work will be performed in the nesting areas until the young birds have fledged.

County: Bexar

Highway: IH35/IH 410S

Structures

Bridge and culvert construction operations cannot begin until swallow nesting prevention is implemented, until after October 1 if it's determined that swallow nesting is actively occurring, or until it's determined swallow nests have been abandoned. If the State installed nesting deterrent on the bridges and culverts, maintain the existing nesting deterrent to prevent swallow nesting until October 1 or completion of the bridge and culvert work, whichever occurs earlier. If new nests are built and occupied after the beginning of the work, do not perform work that can interfere with or discourage swallows from returning to their nests. Prevention of swallow nesting can be performed by one of the following methods:

1. By February 15 begin the removal of any existing mud nests and all other mud placed by swallows for the construction of nests on any portion of the bridge and culverts. The Engineer will inspect the bridges and culverts for nest building activity. If swallows begin nest building, scrape, or wash down all nest sites. Perform these activities daily unless the Engineer determines the need to do this work more frequently. Remove nests and mud through October 1 or until bridge and culvert construction operations are completed.

2. By February 15 place a nesting deterrent (which prevents access to the bridge and culvert by swallows) on the entire bridge (except deck and railing) and culverts. This work is subsidiary to the various bid items.

No extension of time or compensation payment will be granted for a delay or suspension of work caused by nesting swallows.

Provide a non-intrusive back-up alarm system on all heavy equipment used in close proximity to residential areas. This item is subsidiary to various bid items.

When a precast or cast-in-place concrete element is included in the plans, a precast concrete alternate may be submitted in accordance with "Standard Operating Procedure for Alternate Precast Proposal Submission" found online at https://www.txdot.gov/inside-txdot/forms-publications/consultants-contractors/publications/bridge.html#design. Acceptance or denial of an alternate is at the sole discretion of the Engineer. Impacts to the project schedule and any additional costs resulting from the use of alternates are the sole responsibility of the Contractor.

Excavation within 5 feet of an existing CPS Energy pole will require pole bracing. Contact CPS Energy utility coordination to request pole bracing (Customer Engineering 210-353-4050). The estimated duration for the pole bracing process is approximately 10 to 15 weeks.

County: Bexar

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--Item 6--
Show the stockpile lot and/or sub lot numbers on all tickets for all materials.

Steel Wrapped or Asbestos Utility Lines:

Existing steel wrapped natural gas and/or asbestos cement (AC) water lines that will no longer be in service are usually abandoned in place (AIP). However, if any of these lines have to be removed for whatever reason (in the way of other construction, to make tie-ins, etc.), comply with Item 6.

If removal of AC water lines is included in the construction contract, then notify the Engineer of proposed dates of removal of the AC water lines in accordance to Item 6. Excavate to the top of the AC water line to allow a separate contractor hired by the State to remove the AC water line. The excavation for the AC water line removal is subsidiary to the work that created the need for the removal (excavation for structures, roadway, a new line, tie-ins, etc.).

To comply with the latest provisions of Build America, Buy America Act (BABA Act) of the Bipartisan Infrastructure Law, the contractor must submit an original notarized original of the TxDOT Construction Material Buy America Certification Form for all items classified as construction materials. This form is not required for materials classified as a manufactured product.
Refer to the Buy America Material Classification Sheet for clarification on material categorization.

The Buy America Material Classification Sheet is located at the below link.
https://www.txdot.gov/business/resources/materials/buy-america-material-classification-sheet.html for clarification on material categorization.

--Item 7--
The project's total disturbed area is 6.53 Acres. The disturbed area in all project locations and Contractor project specific locations (PSL's), within 1/4 mile of the project limits, will further establish the authorization requirements for storm water discharges. The department will obtain an authorization to discharge storm water from the Texas Commission on Environmental Quality (TCEQ) for the construction activities shown on the plans. Obtain any required authorization from the TCEQ for any PSL's on or off the ROW. When the total area disturbed on the project and PSL's within 1/4 mile of the project exceeds 5 acres, provide a copy of the Contractor NOI for PSL's to the Engineer (to the appropriate MS4 operator when the project is on an off-state system route).

Notify the Engineer of the disturbed acreage within one (1) mile of the project limits. Obtain authorization from the TCEQ for Contractor PSL's for construction support activities on or off ROW.

County: Bexar

Highway: IH35/IH 410S

Roadway closures during the following key dates and/or special event are prohibited.
See the general notes under Item 502 for these dates.

--Item 8--
Working days will be computed and charged in accordance with Article 8.3.1.2:Six-Day work week.

A Special Provision to Item 8 for a delayed authorized date to begin work has been included in the contract in accordance with Special Provision 008-056. The reason for including the Special Provision is for allowing the substantial completion of utility relocations that could impact the critical path for the contractor to reach substantial completion.

Create and maintain a Critical Path Method (CPM) schedule.

The CPM schedule shall be created and maintained using software fully compatible with Primavera Project Planner version P6 Professional R15.2.

Provide a Project Schedule Summary Report.

A lane closure assessment fee will be assessed as per the “Lane Closure Assessment Fee Table” in the plans and in accordance with special provision 008-045.

Incentive using road-user cost or contract administration liquidated damage values and disincentive using road-user cost will be paid in accordance with special provision 008-006.

The road-user cost liquidated damages shall be the following per roadway and per day.

Roadway	Average Road User Cost Per Day
IH 410	See Lane Closure Fee Table
IH 410 SB Exit Ramp	See Lane Closure Fee Table

Notes for Milestones

Substantial Completion of Work is defined in Special Provision to Item 8.

Milestone A: IH 410 Southbound Exit to WW White Rd Closure.

See the traffic control plans (TCP) for a detailed description of the work included in Milestone A.

The daily road-user cost for incentive and disincentive for Milestone A will be $20,000 per day.

County: Bexar

Highway: IH35/IH 410S

The contractor will have 24 working days for Substantial Completion of Work for Milestone A.

Working day time charges for Milestone A will be computed and charged in accordance with Article 8.3.1.2: Six-Day.

The time charges for the purpose of computing incentive and disincentive for Milestone A will begin when traffic is moved to the lane arrangement shown in the TCP for Milestone A.

The time charges for the purpose of computing incentive and disincentive for Milestone A will end with Substantial Completion of Work for Milestone A.

Milestone A begins with the start of closing the IH 410 Southbound Exit ramp to WW White Rd for the completion of the gore pavement as shown in Phase 1 Step 3.

The maximum number of working days for computing the incentive credit for Milestone A will be 24 days. The maximum credit allowable for early completion of Milestone A is $100,000.

Failure of Substantial Completion of Work for Milestone A within the established number of working days shown above will result in the assessment of disincentives using the daily road-user costs shown above for each working day more than those allowed for Milestone A.

Substantial Completion of Work is defined in Special Provision to Item 8.

The daily road-user cost for Substantial Completion of Work for the project will be $25,000 per day, which will be assessed as an incentive for the early Substantial Completion of Work for the project under the number of working days bid by the Contractor and will be assessed as a disincentive for failure of Substantial Completion of Work for the project within the established number of working days bid by the Contractor.

Working day time charges for Substantial Completion of Work for the project will be computed and charged in accordance with Article 8.3.1.2: Six-Day.

The time charges for the purpose of computing incentive and disincentive for Substantial Completion of Work for the project will begin when time charges begin for the project.

The time charges for the purpose of computing incentive and disincentive for Substantial Completion of Work for the project will end when all project work is completed according to the definition of Substantial Completion of Work in Special Provision to Item 8.

The maximum number of working days for computing the incentive credit for Substantial Completion of Work for the project will be 1337 days. The maximum credit allowable for early completion is $2,500,000.

County: Bexar

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The number of working days for final acceptance will be 46 working days after the Substantial Completion of Work date for the project. Failure of completing the work within this established number of working days will result in the assessment of disincentives using the schedule of liquidated damages and any additional road user cost specified by Special Provision to Item 000 and general notes to Item 8 for each working day more than those allowed for final acceptance of the project.

--Item 9--
When approved, provide uniformed, off-duty law enforcement officers with marked vehicles during work that requires a lane closure. The officer in marked vehicles shall be located as approved to monitor or direct traffic during the closure. The method used to direct traffic at signalized intersections shall be as approved. Additional officers and vehicles may be provided when approved or directed.

Complete the daily tracking form provided by the department and submit invoices that agree with the tracking form for payment at the end of each month approved services were provided.

Show proof of certification by the Texas Commission on Law Enforcement Standards.

All law enforcement personnel used in Work Zone Traffic Control shall be trained for performing duties in work zones and are required to take "Safe and Effective Use of Law Enforcement Personnel in Work Zones" (Course #133119) which can be found online at the following site: www.nhi.fhwa.dot.gov

Certificates of completion should be available to all who finish the course. These should be kept by the officers to substantiate completion when reporting to the work site.

Minimums, scheduling fees, etc. will not be paid; TxDOT will consider paying cancellation fees on a case-by-case basis.

--Item 100--
Trim and remove brush and trees within the stations noted in the plans and as needed for construction operations. Unless shown otherwise in the plans or a designated non-mow area, perform trimming or removal for areas to the ROW limits. Trim or remove to provide minimum of 5 ft. of horizontal clearance and 7 ft. of vertical clearance for the following: sidewalks, paths, guard fence, rails, signs, object markers, and structures. Trim to provide a minimum of 12 ft. vertical clearance under all trees.

Obtain approval for proposed method of tree and brush trimming and removal. Vertical flailing equipment is not allowed. Treat damaged or cut branches, roots and/or stumps of all oak trees with a commercial tree wound dressing. Disinfect all pruning tools with a solution of 70%

alcohol before moving from one tree to another. Unless otherwise approved remove all resulting vegetative debris from the ROW within 24 hours. The Engineer can stop all construction operations if the dressing, cut and removal requirements are not followed.

Removal and disposal of existing abandoned utilities that were unable to be identified before letting required to support this project's construction shall be performed under the overall Preparing Right of Way. If you are uncertain whether the utility is active, contact the District Utility Section.

--Item 164--
Drill seeding of permanent grasses requires the use of approved grass seeding equipment capable of properly storing and metering the release of small seeds (such as Bermuda grass) separately from fluffy type seeds (such as bluestems). Equipment manufactured for planting grain crops is acceptable for planting temporary cool season seeds, but not for planting the permanent seed mix.

If performing a permanent seeding in an area with established temporary grass cover and mowing is performed instead of tilling, seed and fertilizer may be distributed simultaneously during "Broadcast Seeding" operations, provided each component is applied at the specified rate.

--Item 168--
Provide a logbook showing daily water usage and receipts of water applied, in addition to metering the water equipment. Apply vegetative watering as needed to supplement natural rainfall during the vegetation establishment period. Plan quantity of irrigation water is based on the application of a total of 1.3 gal of water each week for each sq. yd. of area that is sodded or seeded. Establishment time is estimated to be 12 weeks for both sod and permanent seed mixes. Temporary seeding will require less time for establishment. Provide a schedule and coordinate watering cycles and rates per cycle with the Engineer. Obtain approval if the quantity of water to be applied is expected to exceed the plan quantity. Adjust the amount of water applied with each cycle and the number of cycles each wk. according to actual site conditions. Drought or other conditions, as determined by the Engineer, may require the application of supplemental irrigation during hours other than normal working hours.

--Item 247--
There is no minimum PI requirement for this project.

--Item 316--
Asphalt season will be year-round but meet temperature limitations specified in the standard specifications for Item 316.

Ensure that the asphalt for precoating the aggregate and the asphalt used for the surface treatment will not result in a reaction that may adversely affect the bonding of the aggregate and asphalt during the surface treatment operation.

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Do not add bag house fines in the production of precoated material.

Clean all concrete curbs, islands, medians, etc. that get coated with asphalt.

--Item 320--
Construct all longitudinal ACP joints adjacent to a travel lane with a joint maker device that will create a 3:1 to 6:1 taper. For placement of 2 inches or more, the device shall provide a maximum ½ inch vertical edge. Taper outside edges (next to the grass) or backfill (shoulder-up) the same day.

Provide a material transfer device capable of providing a continuous flow of material to the paver. The material transfer device will consist of a windrow elevator or better.

--Item 354--
The Contractor to retain planed material.

Take precaution to avoid damage to existing bridge decks and armor joints. Repair any damage to the bridge decks and/or armor joints as approved. This work will not be paid directly but will be performed at the Contractor's expense.

--Item 401--
A shrinkage compensator is not required for when used for backfilling pipes.

--Item 403--
The Contractor and/or Contractor's Engineer who selects and designs the temporary shoring is responsible for the overall (global) stability calculations as well as internal stability and sliding calculations (including mat and soil nail pullout) as per the TxDOT Bridge Division Geotechnical Manual. If the Contractor chooses a Temporary Earth Retaining Wall for Temporary Shoring, then the Contractor and/or Contractor's Engineer is required also to provide wire struts as shown on these plans. Designs for any type of Retaining Wall used for Temporary Special Shoring shall conform to the TXDOT Geotechnical Manual Chapter 6: Retaining Walls.

The Contractor is responsible for maintaining positive drainage during construction of temp shoring operations and permanent wall structures.

--Item 410 & 411--
1 Soil Nail and Rock Nail proof and verification testing to be coordinated with TxDOT a minimum of one week prior to the desired testing date. The location of the test nails will be approved by the Engineer. TxDOT personnel may be present during testing, and may choose to monitor the applied test load using their own equipment. Test anchors must project out from the face of the cut enough to accommodate the Contractor's loading and measurement devices, as well as an additional 1 foot for the Department's load cell. Perform testing as specified in the Standard

Specification Item 410 "Soil Nail Anchors" and Item 411 “Rock Nail Anchors” to the maximum test load stated.

2 No less than 10 nails per 50 nails of consistent soil nail lengths may be proof tested. If nail lengths vary, then no less than 5 nails per varying soil nail lengths may be proof tested according to ratios approved by the Engineer. No less than 3 verification test nails may be used for specific soil nail length when variable soil nail lengths are called for in the design. If widely varying soil conditions are encountered, the Engineer may require additional test nails.

3 Unless contract plans show otherwise, soil nail test loads are as follows for the specific lengths:

Nail Length	Test Load
10’	16 kips
12’	20 kips
14’	23 kips
16’	25 kips
18’	28 kips
20’	34 kips
24’	38 kips
26’	41 kips
30’	46 kips

4 For varying soil conditions, anchor size and length (especially greater than 30’), Contractor shall submit plans and calculations signed and sealed by a registered professional engineer based on verified and documented geotechnical data. This submittal must be approved by the engineer of record.

5 Verification test anchors shall be #8 Dywidag or Williams Steel threadbar or equal.
Proof test anchors shall be bar size shown on contract plans.

6 If test load is not achieved or soil nail fails, Engineer may continue to require additional tests until requirements are satisfied and Engineer gains confidence in the results. All nails that fail in any way, if production nails, are to be supplemented by additional nails and testing to the satisfaction of the Engineer and Owner. Contractor is to provide a summary of test nail results. This summary is to include the test data in tabular form and a plot of the test data following the guidelines shown in FHWA publication, FHWA-NHI-14-007, FHWA GEC 007, February 2015. Test results are to be provided to the Engineer no more than 48 hours after testing.

7 The Contractor is responsible for maintaining positive drainage during construction of temp shoring operations and permanent wall structures.

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--Item 420--
Mass concrete will be measured in place.

Pier and Bent Concrete will be paid for as "Plans Quantity".

--Item 421--
Use an automated ticket that contains the same information as shown in the standard specification. Submit the ticket for approval prior to use. The concrete producer will contact the District Laboratory or the Engineer's Office (outside the San Antonio area) to inform TxDOT of scheduled structural concrete batching. The Engineer may suspend concrete operations if ticket information is incomplete/incorrect.

Entrained air is allowed for Class P and Class HES concrete only. Air content testing is waived for all classes of concrete.

Poly-fiber reinforced concrete may be used as an option, with the approval by the Engineer, for riprap, sidewalk, curb/gutter, and mow strip. Use a TxDOT approved manufacturer or producer for the poly-fiber. The poly-fibers shall be combined with the concrete in proportions as recommended by the manufacturer. A concrete mix design must be approved by the Engineer.

--Item 422--
For construction of approach slabs, longitudinal joints shall be placed on lane lines. Joints may be either a saw-cut crack control joint or a construction joint. Saw cut joints shall terminate 1'-0" before reaching the edge of the slab, must be saw cut as soon as possible after placement of concrete, and will be cut within 12 hours of concrete placement. Once sawing begins, it should be a continuous operation and should only be stopped if raveling occurs. Saw cut will be to a depth of 1.5" and filled with approved joint sealant.

--Item 423--
The backfill material for precast retaining walls shall be approved before placement. Build stockpile(s) in lifts not to exceed 2 feet and a minimum working face of not less than 10 feet, but not more than 20 feet.

Use the approved Concrete Block Retaining wall systems listed at:
Concrete block retaining wall systems (txdot.gov)

Use the approved Mechanically Stabilized Earth (MSE) wall systems listed at:
Mechanically stabilized earth (txdot.gov)

TxDOT does not allow the use of experimental systems on projects with over 50,000 square feet walls over 25 ft. tall, or walls supporting or immediately adjacent to interstate highways.

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When proprietary wall systems are used, a qualified representative of the retaining wall manufacturer must be available upon request during wall construction. As requested, or required the manufacturer's representative must be on site to assist with the initial stages of wall construction, provide training to the Contractor wall crew and ensure proper interpretation of MSE wall shop drawings and details. Specific attention must be given to nonstandard wall installation details. The Contractor's wall crew foreman must be on site for the duration of wall construction. Any change to the wall crew foreman may require additional training by the wall supplier. The Contractor will ensure that the retaining walls are installed per the details presented in the construction drawings and as per the proprietary wall system requirements. The Engineer reserves the right to suspend wall construction activities due to any construction issue encountered.

Horizontal and vertical nail spacing on temp or permanent soil nail walls shall not exceed 4 ft.

Type DS material will be required on MSE walls in the area of the reinforcement mats.

--Item 425--
Vertical clearance over roadway at the following location(s) is(are) less than or equal to 20 feet. Provide Bars C and CH for the full length of the girder per the IGD standard.

- IH-410 NBML Overpass at Binz-Engleman Rd, UPRR and FM 78
  - Span 1: All girders
  - Span 5: All girders
- IH-410 SBML Overpass at Binz-Engleman Rd, UPRR and FM 78
  - Span 1: All girders
  - Span 5: All girders
- IH-410 SBFR Overpass at Binz-Engleman Rd, UPRR and FM 78
  - Span 1: All girders
  - Span 5: All girders

--Item 462--
Precast or cast-in-place concrete box culvert and drains may be used.

--Item 465--
Concrete Class B invert shaping is required at all inlets, manholes and junction boxes to insure positive flow. The material and work performed for the placement of the inverts shall be considered subsidiary to this item.

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--Item 496--
The Contractor will submit a demolition plan for all structures to be replaced and/or removed in accordance with Item 496.

The structure(s) to be removed have surface coatings that contain hazardous materials as follows:

Bridge	NBI Number
IH-410 NBML Overpass at Binz-Engleman Rd, UPRR and FM 78	15-015-0-0521-06-216
IH-410 SBML Overpass at Binz-Engleman Rd, UPRR and FM 78	15-015-0-0521-06-217

Provide for the safety and health of employees and abide by all OSHA Standards and Regulations. All costs incurred for proper management, shall be subsidiary to this Item.

--Item 500--
"Materials on Hand" payments will not be considered in determining percentages for mobilization payments.

--Item 502--
General

In addition to providing a Contractor's Responsible Person and a phone number for emergency contact, have an employee available to respond on the project for emergencies and for taking corrective measures within 2 hours or within a reasonable time frame as specified by the Engineer.

Treat the pavement drop-offs as shown in the TCP.

Avoid placing stockpiles, equipment, and other construction materials within the roadway's horizontal clear zone or at any location that will constitute a hazard and will endanger traffic. If a stockpile is placed within the clear zone, address in accordance with the TMUTCD.

If Nighttime work is required and work is not behind positive barrier then full Class 3 reflective gear is required to be worn by all workers, hard hat halos are required to be worn by the flaggers at flagging stations, TY III barricades are required to be spaced at 500 ft, and a mandatory night work meeting is required.

The Contractor Force Account "Safety Contingency" that has been established for this project is intended to be utilized for work zone enhancements, to improve the effectiveness of the Traffic Control Plan, that could not be foreseen in the project planning and design stage. These enhancements will be mutually agreed upon by the Engineer and the Contractor's Responsible Person based on weekly or more frequent traffic management reviews on the project. The

Engineer may choose to use existing bid items if it does not slow the implementation of enhancement.

Mounting and moving the mailbox as needed for the various construction phases is subsidiary to Item 502.

Access to adjoining property must be maintained at all times.
Barricades, Signs, and Traffic Control Devices

When advanced warning flashing arrow panels and/or changeable message sign is specified, have one standby unit in good condition at the job site. Standby time shall be considered subsidiary to the bid item.

After written notification, the time frame is provided on the Form 599 to provide properly maintained signs and barricades before considered in non-compliance with this item.

Temporary Rumble Strips are to be used according to WZ (RS)-22.

Use 3 rumble strip arrays.
Moving an existing sign to a temporary location is subsidiary to Item 502. Installations with permanent supports at permanent locations will be paid for under the applicable bid item(s).

Cover permanent signs if not used. This is subsidiary to Item 502.

Lane and Ramp Closures and Detours

Notify the Engineer in writing 10 business days in advance of any temporary or permanent lane, ramp, connector, etc. closures/detours, restrictions to lane widths, alterations to vertical clearances, or modifications to radii. Any other modifications to the roadway that may adversely affect the mobility of oversized/overweight trucks also require 10 business days advance written notice to the Engineer. At least one lane must always remain open.

For closures not listed in the TCP; the lane closures are limited to between the hours of 9p-5a and at least one lane must remain open at all times.

At no time shall two consecutive intersecting roadways be closed at one time during construction.

At no time shall two consecutive ramps be closed at one time during construction or overlay operations.

Unless otherwise noted in the plans and/or as directed by the Engineer, daily lane closures shall be limited according to the following restrictions:

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Nighttime: 9p-5a.
(With uniformed off duty law enforcement officers)

Weekend closures when approved by the Engineer: Friday 9p until Monday 5a.

No lane closures will be permitted for the following dates and/or special events:
Between December 15 and January 1
Fiesta Week and Sales Tax Holidays
Wednesday before Thanksgiving thru the Sunday after Thanksgiving
Saturday and Sunday before Memorial Day and Labor Day
Saturday or Sunday when July 4 falls on a Friday or Monday
Election days
During major events at the AT&T Center (Spurs home games, Rodeo, concerts, etc.)
Alamodome, and/or Convention Center (Bexar County Only)
Friday, April 18 through Sunday April 20, 2025 (Easter Weekend)
Friday, April 3 through Sunday April 5, 2026 (Easter Weekend)
Friday, March 26 through Sunday March 28, 2027 (Easter Weekend)
Friday, April 14 through Sunday April 16, 2028 (Easter Weekend)
Friday, March 30 through Sunday April 1, 2029 (Easter Weekend)

Traffic Signals

There are traffic signals at the intersection of FM 78 and IH 410 Northbound Frontage Road and FM 78 and IH 410 Southbound Frontage Road. Always keep the signals in operation except when necessary for specific installation operations, including any modifications to existing signal heads to always maintain clear visibility. Adjustment of any signal head will be subsidiary to Item 502. When it is necessary for a signal to be turned off, or when left-turn lanes are closed, hire off duty police officers to control the traffic until the signals are back in satisfactory condition.

Moving or adjustment of traffic signal heads, VIVDS, and radar detection for the purpose of alignment with the shifting of lanes in conjunction with the traffic control plan will be subsidiary to various bid items.

Coordinate with the appropriate entity (City of San Antonio, City of New Braunfels, etc.) or TxDOT when left-turn lanes are closed and/or for signal timing revisions as necessary.

Hauling

The use of rubber-tired equipment will be required for moving dirt or other materials along or across pavement surfaces. Where the contractor desires to move any equipment not licensed for

operation on public highways, on or across pavement, they shall protect the pavement from damage as directed/approved by the Engineer.

Throughout construction operations, the Contractor will be required to conduct their hauling operations in a manner such that vehicles will not haul over previously recompacted subgrade or compacted base material, except in short sections for dumping manipulations.

The Contractor shall keep the roadway clean and free of dirt or other materials during hauling operations. If the Contractor does not maintain a clean roadway, they shall cease all construction operations, when directed by the Engineer, to clean the roadway to the satisfaction of the Engineer.

--Item 504--
For field office Type E Structure. Provide at least 1200 sq. ft. of gross floor area in rooms 8 ft. high. Partition the floor area into at least 4 interconnected rooms with doors, 2 exterior doors, and at least 2 windows in each room. Provide at least 10 parking spaces for pull-through parking.

Enclose the field office, laboratory and the parking area as shown in 504.2.1.1 and provide security lighting.

Provide high speed internet service with WIFI signal and a laser jet printer/scanner/copier as directed.

Provide essential supplies, including: toilet paper, hand soap, paper towels, printing paper, potable water, and printer ink.

Provide a Type E Structure for a Concrete Field Laboratory with at least 200 sq. ft. of gross floor area in a room 8 ft. high, furnished with an exterior door and at least 2 windows. Provide required equipment for testing (moist cabinet, moist room, or water storage tank in accordance with Tex-498-A, Table 32 and Concrete Compression Testing Machine in accordance with Tex-498-A, Table 18). Provide associated calibration documents, as outlined in Tex-498-A, for all contractor provided testing equipment.
A Type D Structure (Asphalt Mix Control Laboratory) is required for all projects that do not have a previously approved laboratory structure for TxDOT's exclusive use. The structure will include high speed internet service with WIFI signal, one desk, two chairs, and one file cabinet.

All labs and offices will include cleaning at least once a week. The cleaning will include sweeping and mopping of floors, cleaning the toilet and lavatory, and emptying wastebaskets. Space heaters are not considered adequate heating.

--Item 506--
An Inspector will perform a regularly scheduled SWP3 inspection every 7 calendar days.

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Failure to address items noted on the SW3P inspection report within two report cycles may result in the Department stopping all construction operations, exclusive of time charges, or withholding that month's estimate until the SW3P deficiencies are corrected unless the Engineer determines that the area is too wet to correct SW3P deficiencies.

Failure to correctly maintain daily monitoring reports and submitting to TxDOT on a daily/weekly basis may result in the monthly estimate being withheld.

--Item 510--
The length of the one-way traffic control section is limited to 0.6 miles.

For Pilot Car Method, additional flaggers other than the 2 required on each approach, when directed by the Engineer, will be measured by the Flagger Control Method. This may involve stationing additional flaggers at all intersections, public driveways, and commercial driveways as determined by the Engineer.

--Item 512--
Only Single Slope shape CTB may be furnished on the inside shoulder/inside median of the Interstate or Freeway Main Lanes.

More than one shape type of CTB may be furnished on a project, although no mixing of CTB shape types will be permitted along a continuous segment of CTB.

CTB reflectors will not be paid for directly but will be considered subsidiary to the barrier.

--Item 514--
The Type 3 CTB taper from the Type 2 at obstructions (OSB's, bridge, columns, etc.) shall be 40:1. If gravel is used between the barriers as shown by the Standard Sheet, the top six inches shall be CL A concrete.

Any permanent CTB requiring conduit for illumination must be cast in place or slip formed.

Item 529--
Curb inlets and extensions are based on an exposed curb height of 7 inches. The roadway curb height and shape will be transitioned to the inlet's curb with a 40: 1 taper.

--Item 531--
The curb ramp locations shown in the plans have considered the geometric features of the intersection, traffic signals, and the pavement markings. If anything changes during construction, the location of curb ramps must be adjusted to ensure they meet TAS requirements.

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--Item 540--
Guard fence posts placed in proposed and/or existing areas of riprap, sidewalks or other concrete shall have an 18 inch +/- (square or round) leave-out in the concrete as shown in the state standard for MBGF Mow Strip. After the posts are installed, fill the leave-outs with a Grout mixture as shown in the state standard for MBGF Mow Strip.

When connecting a Thrie-Beam to a concrete wingwall, bridge rail, CTB, etc., drill the holes for bolt placement using rotary or core type equipment. Use a core type drill when reinforcing steel is encountered. Do not use percussion or impact drilling. Repair damage to the concrete and spalls exceeding ½" from the edge of the hole.

--Item 545--
See the Crash Cushion Summary Sheet.

The following CCA's are required for permanent CCA installation:
Narrow Options: TAU(M)(N)-19, QGUARD (M10) (N)-20
Wide Options: SMTC(W)-16, QGELITE (M10) (W)-20

Use a reinforced concrete pad for the foundation and anchoring.

--Item 556--
Coarse Aggregate Grade 3 meeting requirements of Item 421, Table 4, is acceptable for Filter Material.

--Item 610--
Ballast/capacitors removed from the light assembly, will remain the property of the State. Assume all ballast/capacitors contain Polychlorinated Biphenyl (PCB), unless a notation appears on the outside of the unit that specifies it does not contain PCB's. All ballast/capacitors with PCB's shall be placed in 55 gallon open top drum in accordance with Department of Transportation (DOT) specifications. Place six (6) inches of sawdust or other absorbent material in the bottom of the drum. Furnish and place a DOT approved PCB warning label on the outside of the drum. Do not fill a drum more than ¾ of capacity. Avoid rupturing the ballast/capacitor(s). If a ballast/capacitor is ruptured, use proper procedures, specialist trained staff and personal protective equipment for the clean-up operations.

The lamps in light fixtures may contain hazardous levels of mercury, halide, and sodium vapors. Observe and comply with all federal, state, and local laws, ordinances, and regulations regarding the management of these lamps. Prevent the breakage of the lamps. At a minimum, package all lamps removed from the light fixture(s) in a container that minimizes the breakage of the lamps. Broken lamps shall be collected in a sealed plastic bag (i.e. Ziploc). Broken lamps shall be stored in separate containers from unbroken lamps. Furnish a suitable container and attach a label stating "Universal Waste Lamps" on the container. Write the date the first lamp was placed in the container on the "Universal Waste Lamp" label. Within one (1) week after the first lamp is

placed in a container, notify the Engineer. The lamps and PCB containing ballast/capacitors, placed in properly labeled containers, will remain the property of the State. Place the container in an area where it is protected from damage and the elements. The Engineer will plan to collect, transport, and dispose/recycle the container. The ballast/capacitor and lamp's removal and storage are subsidiary to this item.

Stencil each illumination assembly with the circuit, light and relay service in black paint on the roadway side of the pole at a 45-degree angle. The numbers shall be in 3" tall and begin 6' from the top of the foundation. This work will be considered subsidiary to this item.

Provide and install steel, locking, theft-deterrent doors on transformer bases to protect against copper theft. Return standard t-base doors to TxDOT.

--Item 618--
It might be necessary to cut concrete for placement of conduit. Saw cut existing concrete, remove the concrete from the steel reinforcement (bars or fabric) and bend the steel to install the conduit. After the conduit has been placed, bend the steel back to its original position and back-fill the trench with an approved concrete. This work is subsidiary to this Item.

The conduit depth for illumination under the City of San Antonio streets is 36 inches.

--Item 628--
Make all arrangements for electrical service, and compliance with local standards and practices for proper installations.

--Item 636--
Coordinate all relocations of general services blue signs with LoneStar Logos at (512) 462-1310.

--Item 644--
The wedge anchor system shown on State Standard Sheet SMD (TWT) is not allowed.

Triangular Slipbase Systems with set screws are not allowed.

--Item 666--
Use TY II markings (vs. an acrylic or epoxy) on asphalt surfaces as the sealer for the TY I markings, unless otherwise approved by the Engineer.

--Item 672--
Place all adhesive material directly from the heated dispenser to the pavement. Do not use portable or non-heated containers. Use adhesive of sufficient thickness so that when the marker is pressed into the adhesive, 1/8" or more adhesive will remain under 100% of the marker. The adhesive should extend not less than 1/2" but not more than 1 1/2" beyond the perimeter of the marker.

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--Item 677--
Obtain approval before using the mechanical method for the elimination of existing thermoplastic pavement markings.

--Item 680--
Furnish and install all required materials and equipment necessary for the complete and operating traffic signal installation at the following intersections:
FM 78 and IH 410 Southbound Frontage Road and FM 78 and IH 410 Northbound Frontage Road.

The locations shown on the plans for signal pole foundations, controller foundations, conduit and other items may be adjusted to better fit field conditions as approved.

Furnish and install a new Henke Enterprises or Mobotrex eight-phase NEMA TS2 Type 2 controller and cabinet, meeting the requirements of Departmental Materials Specifications DMS-11170. Provide detector panel toggle switches that additionally permit the user to disconnect the detector. For both ground and pole-mount cabinets, provide cabinet configuration with 16 position load bay.

Deliver TS type 2 controller cabinet and assembly to the TxDOT San Antonio district signal shop for programming and testing two weeks in advance prior to contractor installing equipment in the field. Coordinate drop off and pick up with Mark Perez (210) 218-7430.

Connect all field wiring to the controller assembly into the polyphaser. The Signal Shop representative will assist in determining how the detection cables are to be connected, and will also program the controller for operation, hook up the malfunction management unit (MMU) or conflict monitor, detector units, and other equipment, and turn on the controller. Have a qualified technician on the project site to place the traffic signals in operation.

Once final punch list is complete, contractor is allowed to begin flashing signal operations. Signal shall flash for a minimum of 7 days prior to full operation, unless otherwise approved by the Engineer.

Use LED lamps from the prequalified material producer lists as shown on the Texas Department of Transportation (TxDOT) – Construction Division's (CST) material producer list. Category is "Roadway Illumination and Electrical Supplies." under item 610. No substitutions will be allowed for materials found on this list.

Demonstrate that the field wiring is properly installed. Install the electrical equipment in a neat and workmanlike manner.

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Use the following wiring sequence when connecting signal sections to the cabinet:

Conductor No.	Base Color	Tracer Color	Signal Face
1	Black		Yellow Ball
2	White		Neutral
3	Red		Red Ball
4	Green		Green Ball
5	Orange		Yellow Arrow
6	Blue		Green Arrow
7	White	Black	Spare

All existing signal equipment with the exception of the signal controller and related equipment become the property of the Contractor. Deliver the controller and related equipment to the Signal shop, located at 4615 NW Loop 410 (corner of IH 410 and Callaghan Road) in San Antonio, Texas or to the Area Office as directed.

Use qualified personnel to respond to and diagnose all trouble calls during the thirty-day test period. Repair any malfunction to Contractor-supplied signal equipment. Provide to the Engineer a local telephone number, not subject to frequent changes and available on a 24-hour basis, for reporting trouble calls. Response time to reported calls must be less than 2 hours. Make appropriate repairs within 24 hours. Place a logbook in the controller cabinet and keep a record of each trouble call reported. Notify the Engineer of each trouble call. Do not clear the error log in the conflict monitor or MMU during the thirty-day test period without approval.

Integrate the proposed traffic signal(s) into the existing Advanced Traffic Management System (ATMS) as shown on the plans. Centracs ATMS software, which utilizes Econolite controllers, is currently in use in the San Antonio District. Provide controllers on this project that fully communicate with the existing ATMS software.

This project includes the installation of at least one cellular modem at the location(s) specified in the plans. Cellular modem(s) and power supply(s) will be furnished by the department. Provide all materials not supplied by the department necessary for the cellular modem installation. All materials provided by the contractor must be new unless otherwise shown on the plans. Equipment provided by the department shall be stored by the department for pick up at the TxDOT San Antonio TransGuide Office, 3500 NW Loop 410 San Antonio, TX 78229. Prevent damage to all cellular modem components supplied by the department. Replace any component

that is damaged or lost during transportation or installation at the contractor's expense. Verify operation of the cellular modem(s) together with operation of its links; demonstrate that data can be transmitted at a satisfactory rate from the field location to the central location. Demonstrate that the cellular modem(s) data packets are being received at the central site via a networked computer. Transportation, installation and incidentals for installation of the cellular modem(s) shall be considered subsidiary to item 680.

Provide a submittal compliance matrix with all traffic signal submittals.

Field verify the depths of the drill shafts to meet the minimum clearances specified in the plans before ordering materials.

Ensure that all TMS (Traffic Management System) equipment furnished and installed is completely compatible with the existing hardware and software located within the TransGuide operations center (i.e. TransGuide central software). The contractor shall contact the traffic management engineer for details on the system network architecture.

Contractor shall be responsible for integrating and testing all new TMS equipment and any existing TMS equipment that is relocated into the existing network management system, subsidiary to the various bid items.

--Item 682--
Pedestrian signals may be by a different manufacturer than the vehicle signal heads.

Cover all signal faces until placed in operation. This work is subsidiary to various bid items.

All mounting attachments shall be constructed of steel pipe and mounted as shown on the plans.

--Item 684--
Provide an extra 10' for each cable terminating in the controller cabinet. All cables must be continuous without splices from terminal point to terminal point. All proposed signal cable must be #12 AWG stranded copper.

--Item 686 & 687--
Provide all signal poles from the same manufacturer. Pedestrian poles may be from a different manufacturer.

--Item 688--
The sealant used for vehicle loop wire must be approved.

The button placement must be coordinated with the concrete pad to access the button according to ADA and TAS. If any mounting modifications are needed (extensions, brackets, etc.) to meet

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ADA and TAS requirements the adjustment will be subsidiary to Item 688. The concrete pad (if required) will be paid separately.

The pedestrian push button must be wired with a 2/C#14 loop detector cable in lieu of a #12 A.W.G. XHHW wire.

Furnish and install new Polara Enterprises accessible pedestrian signals (APS) push buttons or approved equivalent.

--Item 730--
Mow full-width and hand trim the right of way, including newly seeded or sodded areas, when vegetation reaches a height of 16" or when directed. Removal of brush sprouts growing within guardrail, concrete barriers or at other locations where mowing or hand trimming is done within the limits of construction is required and subsidiary to this item. Mowing may be required more often in newly sodded or seeded areas than in other parts of the project because of the supplemental irrigation these areas receive and the resulting weed growth. Coordinate mowing to avoid rutting or compaction of the soil when mowing where supplemental irrigation is being used. Use mowing equipment that will not adversely affect soil retention blankets or mulches that have been applied. Work performed under this item does not replace the mowing required when placing permanent seeding in an area that has established temporary seeding as described in Article 164.3, Construction.

--Item 734--
Perform Litter Removal once a month or as directed by the Engineer.

During hurricane season (June-October), special attention should be given to remove and dispose of litter and debris from the right of way.

--Item 735--
Perform Debris Removal as directed by the Engineer.

During hurricane season (June-October), special attention should be given to keep center medians, mainlanes, HOV lanes, shoulders, frontage roads, entrance and exit ramps, and direct connector ramps clear of debris.

--Item 738--
Perform Cleaning and Sweeping Highways once a month or as directed by the Engineer.

During hurricane season (June-October), special attention should be given to keep center medians, mainlanes, HOV lanes, shoulders, frontage roads, entrance and exit ramps, and/or direct connector ramps clear of debris.

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--Item 3076

1. Table 10 in Item 3076 and Table 11in Item 3077, Hamburg Wheel Test Requirements tested in accordance with Tex-242-F are changed for PG 64-22 or lower and PG 70-22. Minimum number of passes at 12.55 mm Rut Depth, Tested at 50 degrees C will be 5,000 and 10,000 respectively.

2. Submit a copy of the Tex 233-F production charts on a weekly basis. At the end of the ACP work, provide all originals.

3. Crushing of aggregate for hot mix and immediate use for production of the mix is not allowed. Stockpile the aggregate until enough material is available for five days of production unless prior approval is provided

4. Hold a pre-paving meeting one month prior to the placement of the hot mix. The date and time of pre-paving meeting should be coordinated with the Engineer prior to scheduling.

5. Do not use diesel or solvents as asphalt release agents in production, transportation, or construction. A list of approved asphalt release agents is available from the District Laboratory.

6. No more than one hot mix lot will be open for any specific type of hot mix, unless authorized. After a lot is open and the Contractor gets approval to change plants, the previous lot will be closed, and a new lot will be opened. The numbering for the lots produced at the new plant will start with No. 1. If allowed to switch back to the original or previous plant, the next lot from that plant will resume numbering sequentially from the last lot produced by that plant.

--Item 3084 & 3085 --

The minimum application rates are listed in Table UC/BC. The Engineer may adjust the application rates taking into consideration the existing pavement surface conditions.

Table UC/BC

Material	Minimum Application Rate (gal. per square yard)
TRAIL – Hot Asphalt	0.15
Spray Applied Underseal Membrane	0.20
Seal Coat – Emulsion (CHFRS-2P, CRS-2P)	0.25
Seal Coat – Asphalt (AC-15P, AC-20-5TR, AC-20XP, AC10-2TR)	0.23
Aggregate for Seal Coat Options TY PB GR 4(AC) or TY B GR 4(Emulsion)	1 CY:120 SY

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--Item 4171--
Install bridge identification numbers shown below for each of the following listed bridges in accordance with the special specification and San Antonio District Standard. Install the bridge identification number on two locations as shown on the plans, or as directed. For bridges in a two-way condition, install the bridge identification number on each outside beam on the upstream side of traffic. For bridges in a one-way condition, install the bridge identification number on each side, opposite corners on each outside beam. For culverts less than 5 ft. in height, install the bridge identification number on the headwall on upstream and downstream location. For culverts greater than 5 ft. in height, install the bridge identification number inside the first barrel on the upstream side of traffic and inside the last barrel on the opposite corner in the direction of traffic.

--Item 6185--
6 shadow vehicles with TMA will be required for this project. The TMA's will be measured and paid for by the DAY for each TMA/TA set up and operational on the worksite. The contractor will be responsible for determining if one or more of these operations will be ongoing at the same time to determine the total number of TMA's needed for the project. See TMA and TA Summary sheet in the plans.

--Item 6292--
Radar presence detection device must utilize true-presence detection. Systems using locking algorithms to attempt presence detection will not be accepted. In addition, radar systems will not be allowed to use extensions/delays or place the controller on locking detection to aid in presence detection.

Radar presence detection device must be able to detect up to 10 lanes with a minimum offset of 6' and have at least 16 zones and channels per unit.

Radar presence detection device must be mounted on the same side of the intersection as the lanes it is set to detect.

Final placement of radar devices must be approved by the engineer.

Furnish and install new Wavetronix SmartSensor Matrix, or approved equivalent, for radar presence detectors and Wavetronix SmartSensor Advance, or approved equivalent, for radar advanced detection devices.

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--TMS General Notes--
All references to the TransGuide mainframe are references to the TransGuide Lonestar network.

"TMS" is the abbreviation for Traffic Management System. "ITS" is the abbreviation for Intelligent Transportations System. For this project "TMS" and "ITS" are synonymous.

All work will be performed in accordance to the standards and specifications found in these plans or as directed by the Engineer.

Coordinate the installation of permanent TMS equipment, conduit, manholes, ground boxes, etc. with the construction phasing so as to prohibit any open cuts across new construction.

Coordinate with the Engineer any lane closures needed for TMS related activities and provide a TCP layout for approval. Coordinate TMS removals activities with roadway construction.

Provide a submittal compliance matrix with all TMS submittals.

Perform all TMS Prototype approval, Design approval, and Demonstration tests within the State of Texas.

Contractor is made aware that before beginning construction the installation and activation of the relocated CCTV shown in the TMS Removal & Temporary plan must be completed first. A 48 hour maximum downtime will be allowed when transferring from the existing communication phase to the temporary communication phase, as well as transferring from the temporary phase to the proposed permanent phase. After the installation of the permanent equipment, a standalone test will be required. Relocated equipment will be in the same functioning & physical condition as documented in the pre-removal test. Any necessary replacements due to damages in the removal and relocating process will be done at no cost to TxDOT.

Not previously used TMS equipment:
Test any TMS Equipment (including but not limited to CCTV field equipment), which has not previously been proven to be fully operational and fully compatible with the existing TransGuide software and hardware in the following manner:

Conduct tests for each type of TMS equipment, as directed by the Engineer, to determine compatibility of the equipment with the existing TransGuide software and hardware. Prior to field installation, test one complete unit with all components to ensure that it is fully compatible with the existing TransGuide system. Test all aspects of the system to show full functionality of the equipment and to show full compatibility with the TransGuide software and hardware. Failure to perform to the requirements of any test will be considered as a defect, and the equipment will be subject to rejection by the Engineer. Rejected equipment may be offered again for retest provided all noncompliance's have been corrected and retested by the Contractor

and evidence thereof submitted to the Engineer. Testing is considered subsidiary to the particular bid item, with no payment made.

Partial payments:
The contractor will receive partial payments for the following TMS items unless otherwise approved by the Engineer.

- Item 6010: Closed Circuit Television (CCTV) Field Equipment
- Item 6028: Dynamic Message Sign
- Item 6029: Radar Vehicle Sensing Device
- Item 6096: Wrong Way Driver Signs(s) and Radar Equipment
- Force Account – Bluetooth System

Partial Payments Consist of The Following:

Materials On Hand: The Contractor's paid amount is based on the invoices for the material received and stored in his/her yard.

Field Installation for the CCTV Field Equipment and Dynamic Message Sign: When the Contractor has completed the support structure, mounted the CCTV camera and installed the Dynamic Message Sign, the department will pay up to 80% of the bid item.

Stand-Alone Test: When the CCTV Field Equipment and Dynamic Message Sign have passed the Stand-Alone Test, the Department will pay up to 95% of the bid item.

When the CCTV Field Equipment and Dynamic Message Sign have passed the test portion of the final acceptance test, the Department will pay the final 5% of the bid item.

Field Installation for the Radar Vehicle Sensing Device and Bluetooth System: When the Contractor has completed installation of the Radar Vehicle Sensing Device and the Bluetooth System, the department will pay up to 80% of the bid item.

Stand-Alone Test: When the Radar Vehicle Sensing Device and Bluetooth System have passed the Stand-Alone Test, the Department will pay up to 95% of the bid item.

When the Radar Vehicle Sensing Device and Bluetooth System have passed the test portion of the final acceptance test, the Department will pay the final 5% of the bid item.

Field Installation for the Wrong Way Driver Signs(s) and Radar Equipment: When the Contractor has completed installation of the Wrong Way Driver Signs(s) and Radar Equipment, the department will pay up to 80% of the bid item.

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Stand-Alone Test: When the Wrong Way Driver Signs(s) and Radar Equipment have passed the Stand-Alone Test, the Department will pay up to 95% of the bid item.

When the Wrong Way Driver Signs(s) and Radar Equipment have passed the test portion of the final acceptance test, the Department will pay the final 5% of the bid item

TMS Submittals:
Include in all TMS submittals the respective bid item (specification number and descriptive code). Indicate compliance on a paragraph by paragraph basis. Ensure that the statements claiming compliance reference the appropriate documentation and the referenced documentation supporting this claim is included with the submittal. Provide referenced documentation that contains the same numbering system as referenced in the submittal. For example, submittal item XXXX-XXXX, Section 2.3, Paragraph 3, Meets Requirements (See Attachment "B"). The supporting documentation for Item XXXX-XXXX, Section 2.3, Paragraph 2, would be titled as Attachment "B". Provide submittals with the same numbering system as stated in the specification. Failure to submit accordingly will result in rejection by the Engineer.

A TMS submittal will be considered as incomplete and therefore rejected, if it contains items listed as "being furnished by others". It is the responsibility of the Contractor to make sure the submittal addresses all items of the specification.

Provide the following TMS submittals (to be received by TxDOT San Antonio Traffic Management office) within the designated time. The time frame is in calendar days.

Item Description	Submitted By Contractor W/I Days After Authorization To Begin Work	Returned By State W/I Days
Equipment & Interconnect Wiring Schematic	30	30
*CCTV Field Equipment	30	30
*CCTV Equipment Cabinet	30	30
*Camera Pole Structure	30	30
Radar Vehicle Sensing Device (RVSD)	30	30
Fiber Optic cable (Single Mode)	60	30
Final Acceptance Plan	90	30

Submit those items designated with the (*), if any, together as a Package.

Submit the Final Acceptance Plan in electronic form.

The Contractor may submit items sooner if needed for construction, but no later than the dates stated above.

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Submit a layout of equipment and interconnect wiring schematic for the TransGuide Control Center and field network equipment for approval by the Engineer prior to ordering materials.

Consider all interconnect wiring within the TransGuide Control Center and all interconnect wiring for all equipment in the plans and described within the specifications as subsidiary to the various Bid Items with no direct payment.

Provide, to the Engineer, as-built plans in MicroStation format (.dgn flies) to the TMS portion of this project when the project is complete. TxDOT will provide the .dgn files of the TMS plan sheets. Update these files with all TMS items as ACTUALLY CONSTRUCTED in the field.

Cost to provide the as-built plans as described is subsidiary to the various Bid Items with no direct payment.

Customize all training specifically for the TransGuide System; generic training will not be accepted on this project. Training materials and labor are subsidiary to the various Bid Items with no direct payment.

TMS equipment and conduit locations are approximate; the precise location is to be determined in the field, therefore the Contractor should not scale equipment off of plan sheets. Plan sheets are to be used for visual location (vicinity). Equipment locations may have to be adjusted due to conflicts with utilities or other structures, as approved by the Engineer. Do not obstruct the natural flow of water with Traffic Management equipment. In low water areas, place Traffic Management equipment on high side of ditch.

Replace or repair any existing to remain Traffic Management Equipment, conduit, cables, etc. damaged during construction, subsidiary to the various bid items with no direct payment.

Replace all pavement, sidewalk, curb, rip-rap or any item damaged during construction, subsidiary to the various bid items with no direct payment.

Stencil structure numbers on all new TMS structures for permanent identification as directed by the Engineer.

Ensure that all TMS equipment furnished and installed is completely compatible with the existing hardware and software located within the TransGuide operations center (i.e. TransGuide central software). The Contractor should contact the Traffic Management Engineer for details on the system network architecture.

All new TMS equipment and any existing TMS equipment that is relocated will be incorporated into the existing Network management System, subsidiary to the various Bid Items with no direct payment.

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Security against theft and vandalism of all Traffic Management equipment is the full responsibility of the Contractor until the date of final acceptance of the project by the Engineer. All required documentation must be turned in before TxDOT will accept the project for maintenance.

Maintenance of all Traffic Management equipment furnished and installed on this project is the full responsibility of the Contractor until date of final acceptance of the project by the Engineer. All required documentation must be turned in before TxDOT will accept the project for maintenance.

Adjustment and/or removal of sign panels on OSB structures discovered to be necessary to mount Dynamic Message Signs shall be considered subsidiary to the various Bid Items with no direct payment, as directed by the Engineer.

Perform all TMS electrical work and provide all TMS electrical materials in accordance with the National Electrical Code.

The location of utilities (including TMS), either underground or overhead, if shown within the right of way are approximate and must be verified by the Contractor before beginning construction operations. TRANSGUIDE will provide the approximate location of TMS equipment; however, it is the responsibility of the Contractor to determine the depth of the Traffic Management conduit.

Initial locates for ITS/TMS utilities for a project may be provided by TransGuide ITS/TMS maintenance upon written request. Submit locate requests for ITS/TMS utilities to SAT_LOCATES@txdot.gov. **Once initial locates have been provided by Transguide ITS/TMS maintenance - it shall be the contractor's responsibility to survey and or maintain the initial locate field markings provided by TransGuide ITS/TMS maintenance**. Any ITS/TMS utilities that need to be re-located after the initial locates provided by TransGuide ITS/TMS maintenance for the project shall be at the expense of the contractor.

In accordance with the Underground Facility Damage Prevention Act (One Call Bill) the phone number for a utility locator is 1-800-545-6005. It is the Contractor's responsibility to make arrangements for utility locators as needed.

TxDOT (Traffic Management)	(210) 669-2647
TxDOT (Traffic Signal)	(210) 218-7430

The contractor is responsible for contacting all electrical and telephone companies to have services installed for each CCTV Camera and/or DMS location. The electrical and communication service will be installed under the contractor's name. Once the project is completed the contractor will transfer ownership of the electrical and communication services to TxDOT.

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In preparing holes for TMS posts and/or foundations, use care so as not to rupture existing drainage structures, sprinkler systems, electrical conduits and public utilities.

When installing TMS foundations where rip-rap presently exists, use care in breaking out existing rip-rap. Do not break out area greater than is required for placement of the foundations.

Replace broken out rip-rap with class "B" concrete to the exact slope, pattern and thickness of the existing rip-rap in accordance with item 432, subsidiary to the various bid items with no direct payment.

Notify the TransGuide maintenance manager at (210) 731-5109, two weeks in advance of any new fiber to existing fiber splicing operations, and of any fiber optic cable cuts show in the plans.

Contractor shall connect all field wiring and make traffic signal controllers fully operational with the TransGuide system or as directed by the Engineer, subsidiary the various bid items with no direct payment.

The following items will be furnished by TxDOT via a Force Account "Material Furnished by the State (Participating)";

Item Description	Unit	Quantity
Field Ethernet Switch (Antaira LMP-1204G-SFP-bt)	EA	6
40km SFP (Cisco glc-fe-100ex)	EA	168
Transcoder	EA	2
Field Terminal Server (Digi)	EA	5
Bluetooth System (Iteris Vantage Velocity)	EA	2
DMS System (Daktronics Full Color, Freeway, Front Access DMS & pole-mount cabinet with controller)	EA	1
Concrete Fiber Hub	EA	1

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PROJECT : BR 2B24(547), ETC
HIGHWAY : IH 410
COUNTY : BEXAR

TEXAS DEPARTMENT OF TRANSPORTATION

GOVERNING SPECIFICATIONS AND SPECIAL PROVISIONS

ALL SPECIFICATIONS AND SPECIAL PROVISIONS APPLICABLE TO THIS PROJECT ARE IDENTIFIED AS FOLLOWS:

STANDARD SPECIFICATIONS: ADOPTED BY THE TEXAS DEPARTMENT OF TRANSPORTATION NOVEMBER 1, 2014. STANDARD SPECIFICATIONS ARE INCORPORATED INTO THE CONTRACT BY REFERENCE.

ITEMS 1 TO 9 INCL., GENERAL REQUIREMENTS AND COVENANTS
ITEM 100 PREPARING RIGHT OF WAY (103)
ITEM 104 REMOVING CONCRETE
ITEM 105 REMOVING TREATED AND UNTREATED BASE AND ASPHALT PAVEMENT
ITEM 106 OBLITERATING ABANDONED ROAD
ITEM 110 EXCAVATION (132)
ITEM 132 EMBANKMENT (100)(160)(204)(210)(216)(260)<275>(400)
ITEM 160 TOPSOIL (168)
ITEM 164 SEEDING FOR EROSION CONTROL (162)(166)(168)
ITEM 168 VEGETATIVE WATERING
ITEM 169 SOIL RETENTION BLANKETS
ITEM 216 PROOF ROLLING (210)
ITEM 247 FLEXIBLE BASE (105)(204)(210)(216)(520)
ITEM 276 CEMENT TREATMENT (PLANT-MIXED) (204)(210)(216)(247)(300)(310)<520><3096>
ITEM 310 PRIME COAT (300)(316)<3096>
ITEM 340 DENSE-GRADED HOT-MIX ASPHALT (SMALL QUANTITY) (300)(301)<316>(320)<340><341><347><348>(520)(585)<3079><3081><3082><3096>
ITEM 351 FLEXIBLE PAVEMENT STRUCTURE REPAIR (132)(204)(247)(260)(263)(275)(276)(292)(310)(316)(330)(334)(340)<341><3076>
ITEM 354 PLANING AND TEXTURING PAVEMENT
ITEM 356 FABRIC UNDERSEAL (300)(316)(520)<3096>
ITEM 360 CONCRETE PAVEMENT (421)(422)(438)(440)(529)(585)
ITEM 400 EXCAVATION AND BACKFILL FOR STRUCTURES (110)(132)(401)(402)(403)(416)(420)(421)(423)
ITEM 401 FLOWABLE BACKFILL (421)
ITEM 402 TRENCH EXCAVATION PROTECTION
ITEM 403 TEMPORARY SPECIAL SHORING (410)(411)(423)
ITEM 416 DRILLED SHAFT FOUNDATIONS (405)(420)(421)(423)(440)(448)

ITEM 420 CONCRETE SUBSTRUCTURES (400)(404)(421)(422)(426)(427)(440)(441)(448)

ITEM 422 CONCRETE SUPERSTRUCTURES (420)(421)(424)(438)(440)(448)(454)<780>

ITEM 423 RETAINING WALLS (110)(132)(216)(400)(416)(420)(421)(424)(440)(445)<458><556>

ITEM 425 PRECAST PRESTRESSED CONCRETE STRUCTURAL MEMBERS (409)(420)(421)(424)(426)(427)(434)(440)(442)(445)<448>

ITEM 427 SURFACE FINISHES FOR CONCRETE (420)

ITEM 429 CONCRETE STRUCTURE REPAIR (421)(431)(440)(780)

ITEM 432 RIPRAP (247)(420)(421)(431)(440)

ITEM 434 BRIDGE BEARINGS (420)(441)(442)(445)(446)(449)

ITEM 438 CLEANING AND SEALING JOINTS

ITEM 442 METAL FOR STRUCTURES (441)(445)(446)(447)(448)

ITEM 450 RAILING (420)(421)(422)(424)(440)(441)(442)(445)(446)(448)<540>

ITEM 451 RETROFIT RAILING (421)(429)(440)(442)(445)(446)(450)(540)

ITEM 454 BRIDGE EXPANSION JOINTS (429)(442)(785)

ITEM 462 CONCRETE BOX CULVERTS AND DRAINS (400)(402)(403)(420)(421)(422)(424)(440)(464)(476)

ITEM 464 REINFORCED CONCRETE PIPE (400)(402)(403)(467)(476)

ITEM 465 JUNCTION BOXES, MANHOLES, AND INLETS (400)(420)(421)(424)(440)(471)

ITEM 467 SAFETY END TREATMENT (400)(420)(421)(432)(440)(442)(445)(460)(464)

ITEM 471 FRAMES, GRATES, RINGS, AND COVERS (441)(445)(448)(465)

ITEM 481 PIPE FOR DRAINS (400)

ITEM 496 REMOVING STRUCTURES

ITEM 500 MOBILIZATION

ITEM 502 BARRICADES, SIGNS, AND TRAFFIC HANDLING

ITEM 504 FIELD OFFICE AND LABORATORY

ITEM 506 TEMPORARY EROSION, SEDIMENTATION, AND ENVIRONMENTAL CONTROLS (161)(432)(556)

ITEM 508 CONSTRUCTING DETOURS

ITEM 510 ONE-WAY TRAFFIC CONTROL (502)

ITEM 512 PORTABLE TRAFFIC BARRIER (420)(421)(424)(440)(442)

ITEM 514 PERMANENT CONCRETE TRAFFIC BARRIER (400)(416)(420)(421)(424)(440)(442)(448)

ITEM 529 CONCRETE CURB, GUTTER, AND COMBINED CURB AND GUTTER (360)(420)(421)(440)

ITEM 531 SIDEWALKS (104)(360)(420)(421)(440)(530)

ITEM 536 CONCRETE MEDIANS AND DIRECTIONIONAL ISLANDS (420)(421)(427)(440)(529)

ITEM 540 METAL BEAM GUARD FENCE (421)(441)(445)<492>(529)

ITEM 542 REMOVING METAL BEAM GUARD FENCE

ITEM 544 GUARDRAIL END TREATMENTS

ITEM 545 CRASH CUSHION ATTENUATORS (421)

ITEM 610 ROADWAY ILLUMINATION ASSEMBLIES (416)(421)(432)(441)(442)(445)(449)(614)(616)(618)(620)(622)(624)(628)

ITEM 617 TEMPORARY ROADWAY ILLUMINATION (416)(610)(613)(614)(618)(620)(621)(622)(624)(627)(628)

ITEM 618 CONDUIT (400)(476)

ITEM 620 ELECTRICAL CONDUCTORS (610)(628)

ITEM 621 TRAY CABLE (620)

ITEM 624 GROUND BOXES <302>(420)(421)(432)(440)(618)(620)
ITEM 627 TREATED TIMBER POLES
ITEM 628 ELECTRICAL SERVICES (441)(445)(449)(618)(620)(627)(656)
ITEM 636 SIGNS (643)
ITEM 644 SMALL ROADSIDE SIGN ASSEMBLIES (421)(440)(441)(442)(445)
(636)(643)(656)
ITEM 647 LARGE ROADSIDE SIGN SUPPORTS AND ASSEMBLIES (416)(421)
(440)(441)(442)(445)(636)
ITEM 650 OVERHEAD SIGN SUPPORTS (416)(420)(421)(441)(442)(445)
(449)(618)(636)(654)
ITEM 658 DELINEATOR AND OBJECT MARKER ASSEMBLIES (445)
ITEM 662 WORK ZONE PAVEMENT MARKINGS (666)(668)(672)(677)
ITEM 666 RETROREFLECTORIZED PAVEMENT MARKINGS (316)(502)(662)(677)
(678)<6438>
ITEM 668 PREFABRICATED PAVEMENT MARKINGS (678)
ITEM 672 RAISED PAVEMENT MARKERS (677)(678)
ITEM 677 ELIMINATING EXISTING PAVEMENT MARKINGS AND MARKERS (300)
(302)(316)<3096>
ITEM 681 TEMPORARY TRAFFIC SIGNALS (416)(610)(618)(620)(621)(622)
(624)(625)(627)(628)(636)<644>(656)(680)(682)(684)(686)
(687)(688)<690>
ITEM 684 TRAFFIC SIGNAL CABLES
ITEM 690 MAINTENANCE OF TRAFFIC SIGNALS (416)(421)(476)(610)(618)
(620)(622)(624)(625)(627)(628)(636)(656)(680)(682)(684)
(685)(686)(687)(688)
ITEM 730 ROADSIDE MOWING
ITEM 734 LITTER REMOVAL
ITEM 735 DEBRIS REMOVAL (734)(738)
ITEM 738 CLEANING AND SWEEPING HIGHWAYS
ITEM 740 GRAFFITI REMOVAL AND ANTI-GRAFFITI COATING (427)(446)

SPECIAL PROVISIONS: SPECIAL PROVISIONS WILL GOVERN AND TAKE
---------- PRECEDENCE OVER THE SPECIFICATIONS ENUMERATED
HEREON WHEREVER IN CONFLICT THEREWITH.

REQUIRED CONTRACT PROVISIONS, FEDERAL-AID CONSTRUCTION CONTRACTS
(FORM FHWA 1273)
WAGE RATES
SPECIAL PROVISION "NONDISCRIMINATION" (000---002)
SPECIAL PROVISION "CERTIFICATION OF NONDISCRIMINATION IN EMPLOYMENT"
(000---003)
SPECIAL PROVISION "NOTICE OF REQUIREMENT FOR AFFIRMATIVE ACTION TO
ENSURE EQUAL EMPLOYMENT OPPORTUNITY (EXECUTIVE
ORDER 112" (000---004)
SPECIAL PROVISION "STANDARD FEDERAL EQUAL EMPLOYMENT OPPORTUNITY
CONSTRUCTION CONTRACT SPECIFICATIO" (000---005)
SPECIAL PROVISION "ONTHEJOB TRAINING PROGRAM" (000---006)
SPECIAL PROVISION "AMERICANS WITH DISABILITIES ACT CURB RAMP WORKSHOP
" (000---025)
SPECIAL PROVISION "IMPORTANT NOTICE TO CONTRACTORS" (000--1017)
SPECIAL PROVISION "CERTIFICATE OF INTERESTED PARTIES (FORM 1295)"
(000--1019)

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SPECIAL PROVISION "SCHEDULE OF LIQUIDATED DAMAGES" (000--1243)
SPECIAL PROVISION "CARGO PREFERENCE ACT REQUIREMENTS IN FEDERAL AID
                   CONTRAC" (000---241)
SPECIAL PROVISION "DISADVANTAGED BUSINESS ENTERPRISE IN FEDERALAID
                   CONTR" (000---394)
SPECIAL PROVISION "IMPORTANT NOTICE TO CONTRACTORS" (000---395)
SPECIAL PROVISION "NOTICE OF CONTRACTOR PERFORMANCE EVALUATIONS"
                   (000---659)
SPECIAL PROVISIONS TO ITEM     2  (002---009)(002---013)(002---014)
                                  (002---015)
SPECIAL PROVISIONS TO ITEM     3  (003---011)(003---013)
SPECIAL PROVISIONS TO ITEM     5  (005---002)(005---003)
SPECIAL PROVISIONS TO ITEM     6  (006---001)(006---012)(006---040)
SPECIAL PROVISIONS TO ITEM     7  (007---004)(007---008)(007---010)
                                  (007---011)(007---013)
SPECIAL PROVISIONS TO ITEM     8  (008---006)(008---030)(008---033)
                                  (008---045)(008---054)(008---056)
SPECIAL PROVISIONS TO ITEM     9  (009---010)(009---016)
SPECIAL PROVISION  TO ITEM   247  (247---005)
SPECIAL PROVISION  TO ITEM   300  (300---020)
SPECIAL PROVISION  TO ITEM   302  (302---003)
SPECIAL PROVISION  TO ITEM   316  (316---002)
SPECIAL PROVISION  TO ITEM   334  (334---004)
SPECIAL PROVISION  TO ITEM   340  (340---004)
SPECIAL PROVISION  TO ITEM   341  (341---004)
SPECIAL PROVISION  TO ITEM   342  (342---005)
SPECIAL PROVISION  TO ITEM   344  (344---005)
SPECIAL PROVISION  TO ITEM   346  (346---004)
SPECIAL PROVISION  TO ITEM   347  (347---003)
SPECIAL PROVISION  TO ITEM   348  (348---004)
SPECIAL PROVISION  TO ITEM   360  (360---001)
SPECIAL PROVISION  TO ITEM   420  (420---001)
SPECIAL PROVISION  TO ITEM   421  (421---012)
SPECIAL PROVISION  TO ITEM   423  (423---005)
SPECIAL PROVISION  TO ITEM   425  (425---001)
SPECIAL PROVISION  TO ITEM   426  (426---005)
SPECIAL PROVISION  TO ITEM   427  (427---003)
SPECIAL PROVISION  TO ITEM   434  (434---004)
SPECIAL PROVISION  TO ITEM   440  (440---005)
SPECIAL PROVISION  TO ITEM   441  (441---004)
SPECIAL PROVISION  TO ITEM   442  (442---001)
SPECIAL PROVISION  TO ITEM   446  (446---005)
SPECIAL PROVISION  TO ITEM   447  (447---001)
SPECIAL PROVISION  TO ITEM   448  (448---001)
SPECIAL PROVISION  TO ITEM   449  (449---002)
SPECIAL PROVISION  TO ITEM   450  (450---001)
SPECIAL PROVISION  TO ITEM   462  (462---002)
SPECIAL PROVISION  TO ITEM   464  (464---001)
SPECIAL PROVISION  TO ITEM   465  (465---001)
SPECIAL PROVISION  TO ITEM   502  (502---008)
SPECIAL PROVISION  TO ITEM   506  (506---005)
SPECIAL PROVISION  TO ITEM   520  (520---002)
SPECIAL PROVISION  TO ITEM   540  (540---001)
SPECIAL PROVISION  TO ITEM   636  (636---001)
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SPECIAL PROVISION TO ITEM 643 (643---001)
SPECIAL PROVISION TO ITEM 654 (654---001)
SPECIAL PROVISION TO ITEM 656 (656---001)
SPECIAL PROVISION TO ITEM 666 (666---007)
SPECIAL PROVISION TO ITEM 680 (680---006)
SPECIAL PROVISION TO SPECIAL SPECIFICATION ITEM 3096 (3096--003)
SPECIAL PROVISION TO SPECIAL SPECIFICATION ITEM 6064 (6064--001)
SPECIAL PROVISION TO SPECIAL SPECIFICATION ITEM 6185 (6185--002)

SPECIAL SPECIFICATIONS:

ITEM 3002 SPRAY APPLIED UNDERSEAL MEMBRANE (320)
ITEM 3076 DENSE-GRADED HOT-MIX ASPHALT <300><301><316><320><340>
<341><342><347><348><520><585><3079><3081><3082><3096>
ITEM 3077 SUPERPAVE MIXTURES <300><301><316><320><340><342><344>
<348><520><585><3079><3081><3082><3096>
ITEM 3079 PERMEABLE FRICTION COURSE (PFC) <300><301><320><342><520>
<585><3096>
ITEM 3081 THIN OVERLAY MIXTURES (TOM) <300><301><320><346><520>
<585><3096>
ITEM 3082 THIN BONDED FRICTION COURSES <210><300><301><320><342>
<348><520><585><3079><3096>
ITEM 3084 BONDING COURSE <300><3002><3096>
ITEM 3085 UNDERSEAL COURSE <300><302><316><3002><3096>
ITEM 3096 ASPHALTS, OILS, AND EMULSIONS
ITEM 4021 THERMAL INTEGRITY PROFILER (TIP) TESTING OF DRILLED SHAFTS
ITEM 4171 INSTALL BRIDGE IDENTIFICATION NUMBERS <427>
ITEM 6004 NETWORKING INTELLINGENT TRANSPORTATION SYSTEM (ITS)
COMMUNICATIONS CABLE
ITEM 6005 TESTING, TRAINING, DOCUMENTATION, FINAL ACCEPTANCE, AND
WARRANTY
ITEM 6006 ELECTRONIC COMPONENTS
ITEM 6007 FIBER OPTIC CABLE (618)(620)(625)(6016)
ITEM 6008 ITS FIELD EQUIPMENT CABINET (421)(440)(449)(618)(620)
(656)(687)(740)(6005)(6006)
ITEM 6010 CCTV FIELD EQUIPMENT (6005)(6006)
ITEM 6016 MULTI-DUCT CONDUIT SYSTEM (400)(401)(402)(421)(445)(476)
(618)(620)
ITEM 6027 PREPARATION OF EXISTING CONDUITS, GROUND BOXES, OR
MANHOLES <432><440>(465)<495>(618)(624)
ITEM 6028 INSTALLATION OF DYNAMIC MESSAGE SIGN SYSTEM <416>(432)
(441)(445)(449)(618)(620)<650><654><656>
ITEM 6062 INTELLIGENT TRANSPORTATION SYSTEM (ITS) RADIO
ITEM 6063 INTELLIGENT TRANSPORTATION SY STEM (ITS) SOLAR POWER
SYSTEM <416><421><440><442><445><449><618><620><624><627>
<687>
ITEM 6064 INTELLIGENT TRANSPORTATION SY STEM (ITS) POLE WITH CABINET
(416)(421)(440)(441)(442)(445)(449)(496)(618)(620)(740)
ITEM 6084 MODIFYING EXISTING ELECTRICAL SERVICES <441><445><618>
<620><628>
ITEM 6093 EXISTING TRAFFIC MANAGEMENT EQUIPMENT <416><656>
ITEM 6123 ETHERNET SWITCH <618><620>

ITEM 6125 TERMINAL SERVER <618><620>
ITEM 6155 RADAR DETECTOR AND COMMUNICATION CABLE (680)
ITEM 6185 TRUCK MOUNTED ATTENUATOR (TMA) AND TRAILER ATTENUATOR (TA)
ITEM 6186 INTELLIGENT TRANSPORTATION SYSTEM(ITS) GROUND BOX <400> (420)(421)(432)(440)(471)(618)(620)<6016>
ITEM 6263 BLUETOOTH DETECTION SYSTEM
ITEM 6304 INTELLIGENT TRANSPORTATION SYSTEM (ITS) RADAR VEHICLE SENSING DEVICE <6005><6006>
ITEM 6319 LED WRONG WAY DRIVER SYSTEM <620><644><656><687><6006> <6062><6063><6304>
ITEM 6438 MOBILE RETROREFLECTIVITY DATA COLLECTION FOR PAVEMENT MARKINGS
ITEM 7194 SANITARY SEWER <100><400><402><403><421><479><529><530> <531><536>
ITEM 7196 WATER MAINS AND SERVICE LINES <401>

GENERAL: THE ABOVE-LISTED SPECIFICATION ITEMS ARE THOSE UNDER WHICH PAYMENT IS TO BE MADE. THESE, TOGETHER WITH SUCH OTHER PERTINENT ITEMS, IF ANY, AS MAY BE REFERRED TO IN THE ABOVE-LISTED SPECIFICATION ITEMS, AND INCLUDING THE SPECIAL PROVISIONS LISTED ABOVE, CONSTITUTE THE COMPLETE SPECIFICATIONS FOR THIS PROJECT.

Control **0521-06-155, ETC.**

Project **BR 2B24(547), ETC.**

Highway **IH 410**

County **BEXAR**

DISADVANTAGED BUSINESS ENTERPRISE REQUIREMENTS

The following goal for disadvantaged business enterprises is established:

DBE
9.0%

Certification of DBE Goal Attainment

By signing the proposal, the Bidder certifies that the above DBE goal will be met by committing to DBE participation that meets or exceeds the goal or providing adequate documentation of good faith efforts (GFE) to achieve the goal.

The DBE participation or GFE must be submitted within five (5) calendar days after bid opening. If the fifth day falls on a weekend or a day when TxDOT offices are closed, the deadline moves to the next business day.

The Department may impose remedies as defined by state or local law if a bidder fails to submit required documentation, including forfeiting the bid proposal guaranty and exclusion from rebidding on the contract if it is re-advertised.

CHILD SUPPORT STATEMENT

Under Section 231.006, Family Code, the vendor or applicant certifies that the individual or business entity named in this contract, bid, or application is not ineligible to receive the specified grant, loan, or payment and acknowledges that this contract may be terminated and payment may be withheld if this certification is inaccurate.

CONFLICT OF INTEREST CERTIFICATION

Pursuant to Texas Government Code Section 2261.252(b), the Department is prohibited from entering into contracts in which Department officers and employees have a financial interest.

By signing the Contract, the Contractor certifies that it is not prohibited from entering into a Contract with the Department as a result of a financial interest as defined under Texas Government Code Section 2261.252(b), and that it will exercise reasonable care and diligence to prevent any actions or conditions that could result in a conflict of interest with the Department.

The Contractor also certifies that none of the following individuals, nor any of their family members within the second degree of affinity or consanguinity, owns 1% or more interest or has a financial interest as defined under Texas Government Code Section 2261.252(b) in the Contractor:

- Any member of the Texas Transportation Commission; and
- The Department's Executive Director, General Counsel, Chief of Procurement and Field Support Operations, Director of Procurement, and Director of Contract Services.

Violation of this certification may result in action by the Department.

E-VERIFY CERTIFICATION

Pursuant to Texas Transportation Code §223.051, all TxDOT contracts for construction, maintenance, or improvement of a highway must include a provision requiring Contractors and subcontractors to use the U.S. Department of Homeland Security's E-Verify system to determine employment eligibility. By signing the contract, the Contractor certifies that prior to the award of the Contract:

- the Contractor has registered with and will, to the extent permitted by law, utilize the United States Department of Homeland Security's E-Verify system during the term of the Contract to determine the eligibility of all persons hired to perform duties within Texas during the term of the agreement; and
- the Contractor will require that all subcontractors also register with and, to the extent permitted by law, utilize the United States Department of Homeland Security's E-Verify system during the term of the subcontract to determine the eligibility of all persons hired to perform duties within Texas during the term of the agreement.

Violation of this requirement constitutes a material breach of the Contract, subjects a subcontractor to removal from the Contract, and subjects the Contractor or subcontractors to possible sanctions in accordance with Title 43, Texas Administrative Code, Chapter 10, Subchapter F, "Sanctions and Suspension for Ethical Violations by Entities Doing Business with the Department."

Certification Regarding Disclosure of Public Information

Pursuant to Subchapter J, Chapter 552, Texas Government Code, contractors executing a contract with a governmental body that results in the expenditure of at least $1 million in public funds must:

1) preserve all contracting information* as provided by the records retention requirements applicable to Texas Department of Transportation (TxDOT) for the duration of the contract,
2) on request of TxDOT, promptly provide any contracting information related to the contract that is in the custody or possession of the entity, and
3) on completion of the contract, either:
    A. provide, at no cost to TxDOT, all contracting information related to the contract that is in the custody or possession of the entity, or
    B. preserve the contracting information related to the contract as provided by the records retention requirements applicable to TxDOT

The requirements of Subchapter J, Chapter 552, Government Code, may apply to this contract, and the contractor or vendor agrees that the contract can be terminated if the contractor or vendor knowingly or intentionally fails to comply with a requirement of that subchapter.

By entering into Contract, the Contractor agrees to:

- provide, or make available, to TxDOT and any authorized governmental investigating or auditing agency all records, including electronic and payment records related to the contract, for the same period provided by the records retention schedule applicable to TxDOT, and
- ensure that all subcontracts include a clause requiring the same.

* As defined in Government Code §552.003, "Contracting information" means the following information maintained by a governmental body or sent between a governmental body and a vendor, contractor, potential vendor, or potential contractor:

1) information in a voucher or contract relating to the receipt or expenditure of public funds by a governmental body;
2) solicitation or bid documents relating to a contract with a governmental body;
3) communications sent between a governmental body and a vendor, contractor, potential vendor, or potential contractor during the solicitation, evaluation, or negotiation of a contract;
4) documents, including bid tabulations, showing the criteria by which a governmental body evaluates each vendor, contractor, potential vendor, or potential contractor responding to a solicitation and, if applicable, an explanation of why the vendor or contractor was selected; and
5) communications and other information sent between a governmental body and a vendor or contractor related to the performance of a final contract with the governmental body or work performed on behalf of the governmental body.

CERTIFICATION TO NOT BOYCOTT ISRAEL

Pursuant to Texas Government Code §2271.002, the Department must include a provision requiring a written verification affirming that the Contractor does not boycott Israel, as defined in Government Code §808.001, and will not boycott Israel during the term of the contract. This provision applies to a contract that:

1) is with a Contractor that is not a sole proprietorship,
2) is with a Contractor with 10 or more full-time employees, and
3) has a value of $100,000 or more.

By signing the contract, the Contractor certifies that it does not boycott Israel and will not boycott Israel during the term of this contract. “Boycott” means refusing to deal with, terminating business activities with, or otherwise taking any action that is intended to penalize, inflict economic harm on, or limit commercial relations specifically with Israel, or with a person or entity doing business in Israel or in an Israeli-controlled territory, but does not include an action made for ordinary business purposes.

Violation of this certification may result in action by the Department.

CERTIFICATION TO NOT BOYCOTT ENERGY COMPANIES

Pursuant to Texas Government Code §2274.002, the Department must include a provision requiring a written verification affirming that the Contractor does not boycott energy companies, as defined in Government Code §809.001, and will not boycott energy companies during the term of the contract. This provision applies to a contract that:

1) is with a Contractor that is not a sole proprietorship,
2) is with a Contractor with 10 or more full-time employees, and
3) has a value of $100,000 or more.

By signing the contract, the Contractor certifies that it does not boycott energy companies and will not boycott energy companies during the term of this contract. “Boycott” means taking any action that is intended to penalize, inflict economic harm on, or limit commercial relations with a company because the company: (1) engages in the exploration, production, utilization, transportation, sale, or manufacturing of fossil fuel-based energy and does not commit or pledge to meet environmental standards beyond applicable federal and state law; or (2) does business with a company described by (1).

Violation of this certification may result in action by the Department.

CERTIFICATION TO NOT DISCRIMINATE AGAINST FIREARM ENTITIES OR FIREARM TRADE ASSOCIATIONS

Pursuant to Texas Government Code §2274.002, the Department must include a provision requiring a written verification affirming that the Contractor:

1) does not have a practice, policy, guidance, or directive that discriminates against a firearm entity or firearm trade association, as defined in Government Code §2274.001, and
2) will not discriminate against a firearm entity or firearm trade association during the term of the contract.

This provision applies to a contract that:

1) is with a Contractor that is not a sole proprietorship,
2) is with a Contractor with 10 or more full-time employees, and
3) has a value of $100,000 or more.

By signing the contract, the Contractor certifies that it does not discriminate against a firearm entity or firearm trade association as described and will not do so during the term of this contract. "Discriminate against a firearm entity or firearm trade association" means, with respect to the entity or association, to: (1) refuse to engage in the trade of any goods or services with the entity or association based solely on its status as a firearm entity or firearm trade association; (2) refrain from continuing an existing business relationship with the entity or association based solely on its status as a firearm entity or firearm trade association; or (3) terminate an existing business relationship with the entity or association based solely on its status as a firearm entity or firearm trade association. "Discriminate against a firearm entity or firearm trade association" does not include: (1) the established policies of a merchant, retail seller, or platform that restrict or prohibit the listing or selling of ammunition, firearms, or firearm accessories; (2) a company's refusal to engage in the trade of any goods or services, decision to refrain from continuing an existing business relationship, or decision to terminate an existing business relationship to comply with federal, state, or local law, policy, or regulations or a directive by a regulatory agency, or for any traditional business reason that is specific to the customer or potential customer and not based solely on an entity 's or association's status as a firearm entity or firearm trade association.

Violation of this certification may result in action by the Department.

PROHIBITION ON CERTAIN TELECOMMUNICATIONS EQUIPMENT OR SERVICES

The Federal Register Notice issued the Final Rule and states that the amendment to 2 CFR 200.216 is effective on August 13, 2020. The new 2 CFR 200.471 regulation provides clarity that the telecommunications and video surveillance costs associated with 2 CFR 200.216 are unallowable for services and equipment from these specific providers. OMB's Federal Register Notice includes the new 2 CFR 200.216 and 2 CFR 200.471 regulations.

https://www.federalregister.gov/documents/2020/08/13/2020-17468/guidance-for-grants-and-agreements

Per the Federal Law referenced above, use of services, systems, or services or systems that contain components produced by any of the following manufacturers is strictly prohibited for use on this project. Therefore, for any telecommunications, CCTV, or video surveillance equipment, services or systems cannot be manufactured by, or have components manufactured by:

- Huawei Technologies Company,
- ZTE Corporation (any subsidiary and affiliate of such entities),
- Hyatera Communications Corporation,
- Hangzhou Hikvision Digital Technology Company,
- Dahua Technology Company (any subsidiary and affiliate of such entities).

Violation of this prohibition will require replacement of the equipment at the contractor's expense.

REQUIRED CONTRACT PROVISIONS
FEDERAL-AID CONSTRUCTION CONTRACTS

I. GENERAL

1. Form FHWA-1273 must be physically incorporated in each construction contract funded under title 23, United States Code, as required in 23 CFR 633.102(b) (excluding emergency contracts solely intended for debris removal). The contractor (or subcontractor) must insert this form in each subcontract and further require its inclusion in all lower tier subcontracts (excluding purchase orders, rental agreements and other agreements for supplies or services). 23 CFR 633.102(e).

The applicable requirements of Form FHWA-1273 are incorporated by reference for work done under any purchase order, rental agreement or agreement for other services. The prime contractor shall be responsible for compliance by any subcontractor, lower-tier subcontractor or service provider. 23 CFR 633.102(e).

Form FHWA-1273 must be included in all Federal-aid design-build contracts, in all subcontracts and in lower tier subcontracts (excluding subcontracts for design services, purchase orders, rental agreements and other agreements for supplies or services) in accordance with 23 CFR 633.102. The design-builder shall be responsible for compliance by any subcontractor, lower-tier subcontractor or service provider.

Contracting agencies may reference Form FHWA-1273 in solicitation-for-bids or request-for-proposals documents, however, the Form FHWA-1273 must be physically incorporated (not referenced) in all contracts, subcontracts and lower-tier subcontracts (excluding purchase orders, rental agreements and other agreements for supplies or services related to a construction contract). 23 CFR 633.102(b).

2. Subject to the applicability criteria noted in the following sections, these contract provisions shall apply to all work performed on the contract by the contractor's own organization and with the assistance of workers under the contractor's immediate superintendence and to all work performed on the contract by piecework, station work, or by subcontract. 23 CFR 633.102(d).

3. A breach of any of the stipulations contained in these Required Contract Provisions may be sufficient grounds for withholding of progress payments, withholding of final payment, termination of the contract, suspension / debarment or any other action determined to be appropriate by the contracting agency and FHWA.

4. Selection of Labor: During the performance of this contract, the contractor shall not use convict labor for any purpose within the limits of a construction project on a Federal-aid highway unless it is labor performed by convicts who are on parole, supervised release, or probation. 23 U.S.C. 114(b). The term Federal-aid highway does not include roadways functionally classified as local roads or rural minor collectors. 23 U.S.C. 101(a).

II. NONDISCRIMINATION (23 CFR 230.107(a); 23 CFR Part 230, Subpart A, Appendix A; EO 11246)

The provisions of this section related to 23 CFR Part 230, Subpart A, Appendix A are applicable to all Federal-aid construction contracts and to all related construction subcontracts of $10,000 or more. The provisions of 23 CFR Part 230 are not applicable to material supply, engineering, or architectural service contracts.

In addition, the contractor and all subcontractors must comply with the following policies: Executive Order 11246, 41 CFR Part 60, 29 CFR Parts 1625-1627, 23 U.S.C. 140, Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S.C. 794), Title VI of the Civil Rights Act of 1964, as amended (42 U.S.C. 2000d et seq.), and related regulations including 49 CFR Parts 21, 26, and 27; and 23 CFR Parts 200, 230, and 633.

The contractor and all subcontractors must comply with: the requirements of the Equal Opportunity Clause in 41 CFR 60-1.4(b) and, for all construction contracts exceeding $10,000, the Standard Federal Equal Employment Opportunity Construction Contract Specifications in 41 CFR 60-4.3.

Note: The U.S. Department of Labor has exclusive authority to determine compliance with Executive Order 11246 and the policies of the Secretary of Labor including 41 CFR Part 60, and 29 CFR Parts 1625-1627. The contracting agency and the FHWA have the authority and the responsibility to ensure compliance with 23 U.S.C. 140, Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S.C. 794), and Title VI of the Civil Rights Act of 1964, as amended (42 U.S.C. 2000d et seq.), and related regulations including 49 CFR Parts 21, 26, and 27; and 23 CFR Parts 200, 230, and 633.

The following provision is adopted from 23 CFR Part 230, Subpart A, Appendix A, with appropriate revisions to conform to the U.S. Department of Labor (US DOL) and FHWA requirements.

1. Equal Employment Opportunity: Equal Employment Opportunity (EEO) requirements not to discriminate and to take affirmative action to assure equal opportunity as set forth under laws, executive orders, rules, regulations (*see* 28 CFR Part 35, 29 CFR Part 1630, 29 CFR Parts 1625-1627, 41 CFR Part 60 and 49 CFR Part 27) and orders of the Secretary of Labor as modified by the provisions prescribed herein, and imposed pursuant to 23 U.S.C. 140, shall constitute the EEO and specific affirmative action standards for the contractor's project activities under this contract. The provisions of the Americans with Disabilities Act of 1990 (42 U.S.C. 12101 et seq.) set forth under 28 CFR Part 35 and 29 CFR Part 1630 are incorporated by reference in this contract. In the execution of this contract, the contractor agrees to comply with the following minimum specific requirement activities of EEO:

a. The contractor will work with the contracting agency and the Federal Government to ensure that it has made every good faith effort to provide equal opportunity with respect to all of its terms and conditions of employment and in their review of activities under the contract. 23 CFR 230.409 (g)(4) & (5).

b. The contractor will accept as its operating policy the following statement:

> "It is the policy of this Company to assure that applicants are employed, and that employees are treated during employment, without regard to their race, religion, sex, sexual orientation, gender identity, color, national origin, age or disability. Such action shall include: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship, pre-apprenticeship, and/or on-the-job training."

2. EEO Officer: The contractor will designate and make known to the contracting officers an EEO Officer who will have the responsibility for and must be capable of effectively administering and promoting an active EEO program and who must be assigned adequate authority and responsibility to do so.

3. Dissemination of Policy: All members of the contractor's staff who are authorized to hire, supervise, promote, and discharge employees, or who recommend such action or are substantially involved in such action, will be made fully cognizant of and will implement the contractor's EEO policy and contractual responsibilities to provide EEO in each grade and classification of employment. To ensure that the above agreement will be met, the following actions will be taken as a minimum:

a. Periodic meetings of supervisory and personnel office employees will be conducted before the start of work and then not less often than once every six months, at which time the contractor's EEO policy and its implementation will be reviewed and explained. The meetings will be conducted by the EEO Officer or other knowledgeable company official.

b. All new supervisory or personnel office employees will be given a thorough indoctrination by the EEO Officer, covering all major aspects of the contractor's EEO obligations within thirty days following their reporting for duty with the contractor.

c. All personnel who are engaged in direct recruitment for the project will be instructed by the EEO Officer in the contractor's procedures for locating and hiring minorities and women.

d. Notices and posters setting forth the contractor's EEO policy will be placed in areas readily accessible to employees, applicants for employment and potential employees.

e. The contractor's EEO policy and the procedures to implement such policy will be brought to the attention of employees by means of meetings, employee handbooks, or other appropriate means.

4. Recruitment: When advertising for employees, the contractor will include in all advertisements for employees the notation: "An Equal Opportunity Employer." All such advertisements will be placed in publications having a large circulation among minorities and women in the area from which the project work force would normally be derived.

a. The contractor will, unless precluded by a valid bargaining agreement, conduct systematic and direct recruitment through public and private employee referral sources likely to yield qualified minorities and women. To meet this requirement, the contractor will identify sources of potential minority group employees and establish with such identified sources procedures whereby minority and women applicants may be referred to the contractor for employment consideration.

b. In the event the contractor has a valid bargaining agreement providing for exclusive hiring hall referrals, the contractor is expected to observe the provisions of that agreement to the extent that the system meets the contractor's compliance with EEO contract provisions. Where implementation of such an agreement has the effect of discriminating against minorities or women, or obligates the contractor to do the same, such implementation violates Federal nondiscrimination provisions.

c. The contractor will encourage its present employees to refer minorities and women as applicants for employment. Information and procedures with regard to referring such applicants will be discussed with employees.

5. Personnel Actions: Wages, working conditions, and employee benefits shall be established and administered, and personnel actions of every type, including hiring, upgrading, promotion, transfer, demotion, layoff, and termination, shall be taken without regard to race, color, religion, sex, sexual orientation, gender identity, national origin, age or disability. The following procedures shall be followed:

a. The contractor will conduct periodic inspections of project sites to ensure that working conditions and employee facilities do not indicate discriminatory treatment of project site personnel.

b. The contractor will periodically evaluate the spread of wages paid within each classification to determine any evidence of discriminatory wage practices.

c. The contractor will periodically review selected personnel actions in depth to determine whether there is evidence of discrimination. Where evidence is found, the contractor will promptly take corrective action. If the review indicates that the discrimination may extend beyond the actions reviewed, such corrective action shall include all affected persons.

d. The contractor will promptly investigate all complaints of alleged discrimination made to the contractor in connection with its obligations under this contract, will attempt to resolve such complaints, and will take appropriate corrective action

within a reasonable time. If the investigation indicates that the discrimination may affect persons other than the complainant, such corrective action shall include such other persons. Upon completion of each investigation, the contractor will inform every complainant of all of their avenues of appeal.

6. Training and Promotion:

a. The contractor will assist in locating, qualifying, and increasing the skills of minorities and women who are applicants for employment or current employees. Such efforts should be aimed at developing full journey level status employees in the type of trade or job classification involved.

b. Consistent with the contractor's work force requirements and as permissible under Federal and State regulations, the contractor shall make full use of training programs (i.e., apprenticeship and on-the-job training programs for the geographical area of contract performance). In the event a special provision for training is provided under this contract, this subparagraph will be superseded as indicated in the special provision. The contracting agency may reserve training positions for persons who receive welfare assistance in accordance with 23 U.S.C. 140(a).

c. The contractor will advise employees and applicants for employment of available training programs and entrance requirements for each.

d. The contractor will periodically review the training and promotion potential of employees who are minorities and women and will encourage eligible employees to apply for such training and promotion.

7. Unions: If the contractor relies in whole or in part upon unions as a source of employees, the contractor will use good faith efforts to obtain the cooperation of such unions to increase opportunities for minorities and women. 23 CFR 230.409. Actions by the contractor, either directly or through a contractor's association acting as agent, will include the procedures set forth below:

a. The contractor will use good faith efforts to develop, in cooperation with the unions, joint training programs aimed toward qualifying more minorities and women for membership in the unions and increasing the skills of minorities and women so that they may qualify for higher paying employment.

b. The contractor will use good faith efforts to incorporate an EEO clause into each union agreement to the end that such union will be contractually bound to refer applicants without regard to their race, color, religion, sex, sexual orientation, gender identity, national origin, age, or disability.

c. The contractor is to obtain information as to the referral practices and policies of the labor union except that to the extent such information is within the exclusive possession of the labor union and such labor union refuses to furnish such information to the contractor, the contractor shall so certify to the contracting agency and shall set forth what efforts have been made to obtain such information.

d. In the event the union is unable to provide the contractor with a reasonable flow of referrals within the time limit set forth in the collective bargaining agreement, the contractor will, through independent recruitment efforts, fill the employment vacancies without regard to race, color, religion, sex, sexual orientation, gender identity, national origin, age, or disability; making full efforts to obtain qualified and/or qualifiable minorities and women. The failure of a union to provide sufficient referrals (even though it is obligated to provide exclusive referrals under the terms of a collective bargaining agreement) does not relieve the contractor from the requirements of this paragraph. In the event the union referral practice prevents the contractor from meeting the obligations pursuant to Executive Order 11246, as amended, and these special provisions, such contractor shall immediately notify the contracting agency.

8. Reasonable Accommodation for Applicants / Employees with Disabilities: The contractor must be familiar with the requirements for and comply with the Americans with Disabilities Act and all rules and regulations established thereunder. Employers must provide reasonable accommodation in all employment activities unless to do so would cause an undue hardship.

9. Selection of Subcontractors, Procurement of Materials and Leasing of Equipment: The contractor shall not discriminate on the grounds of race, color, religion, sex, sexual orientation, gender identity, national origin, age, or disability in the selection and retention of subcontractors, including procurement of materials and leases of equipment. The contractor shall take all necessary and reasonable steps to ensure nondiscrimination in the administration of this contract.

a. The contractor shall notify all potential subcontractors, suppliers, and lessors of their EEO obligations under this contract.

b. The contractor will use good faith efforts to ensure subcontractor compliance with their EEO obligations.

10. Assurances Required:

a. The requirements of 49 CFR Part 26 and the State DOT's FHWA-approved Disadvantaged Business Enterprise (DBE) program are incorporated by reference.

b. The contractor, subrecipient or subcontractor shall not discriminate on the basis of race, color, national origin, or sex in the performance of this contract. The contractor shall carry out applicable requirements of 49 CFR part 26 in the award and administration of DOT-assisted contracts. Failure by the contractor to carry out these requirements is a material breach of this contract, which may result in the termination of this contract or such other remedy as the recipient deems appropriate, which may include, but is not limited to:
(1) Withholding monthly progress payments;
(2) Assessing sanctions;
(3) Liquidated damages; and/or
(4) Disqualifying the contractor from future bidding as non-responsible.

c. The Title VI and nondiscrimination provisions of U.S. DOT Order 1050.2A at Appendixes A and E are incorporated by reference. 49 CFR Part 21.

11. Records and Reports: The contractor shall keep such records as necessary to document compliance with the EEO requirements. Such records shall be retained for a period of three years following the date of the final payment to the contractor for all contract work and shall be available at reasonable times and places for inspection by authorized representatives of the contracting agency and the FHWA.

a. The records kept by the contractor shall document the following:

(1) The number and work hours of minority and non-minority group members and women employed in each work classification on the project;

(2) The progress and efforts being made in cooperation with unions, when applicable, to increase employment opportunities for minorities and women; and

(3) The progress and efforts being made in locating, hiring, training, qualifying, and upgrading minorities and women.

b. The contractors and subcontractors will submit an annual report to the contracting agency each July for the duration of the project indicating the number of minority, women, and non-minority group employees currently engaged in each work classification required by the contract work. This information is to be reported on Form FHWA-1391. The staffing data should represent the project work force on board in all or any part of the last payroll period preceding the end of July. If on-the-job training is being required by special provision, the contractor will be required to collect and report training data. The employment data should reflect the work force on board during all or any part of the last payroll period preceding the end of July.

III. NONSEGREGATED FACILITIES

This provision is applicable to all Federal-aid construction contracts and to all related construction subcontracts of more than $10,000. 41 CFR 60-1.5.

As prescribed by 41 CFR 60-1.8, the contractor must ensure that facilities provided for employees are provided in such a manner that segregation on the basis of race, color, religion, sex, sexual orientation, gender identity, or national origin cannot result. The contractor may neither require such segregated use by written or oral policies nor tolerate such use by employee custom. The contractor's obligation extends further to ensure that its employees are not assigned to perform their services at any location under the contractor's control where the facilities are segregated. The term "facilities" includes waiting rooms, work areas, restaurants and other eating areas, time clocks, restrooms, washrooms, locker rooms and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing provided for employees. The contractor shall provide separate or single-user restrooms and necessary dressing or sleeping areas to assure privacy between sexes.

IV. DAVIS-BACON AND RELATED ACT PROVISIONS

This section is applicable to all Federal-aid construction projects exceeding $2,000 and to all related subcontracts and lower-tier subcontracts (regardless of subcontract size), in accordance with 29 CFR 5.5. The requirements apply to all projects located within the right-of-way of a roadway that is functionally classified as Federal-aid highway. 23 U.S.C. 113. This excludes roadways functionally classified as local roads or rural minor collectors, which are exempt. 23 U.S.C. 101. Where applicable law requires that projects be treated as a project on a Federal-aid highway, the provisions of this subpart will apply regardless of the location of the project. Examples include: Surface Transportation Block Grant Program projects funded under 23 U.S.C. 133 [excluding recreational trails projects], the Nationally Significant Freight and Highway Projects funded under 23 U.S.C. 117, and National Highway Freight Program projects funded under 23 U.S.C. 167.

The following provisions are from the U.S. Department of Labor regulations in 29 CFR 5.5 “Contract provisions and related matters” with minor revisions to conform to the FHWA-1273 format and FHWA program requirements.

1. Minimum wages (29 CFR 5.5)

a. *Wage rates and fringe benefits.* All laborers and mechanics employed or working upon the site of the work (or otherwise working in construction or development of the project under a development statute), will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act (29 CFR part 3)), the full amount of basic hourly wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor and such laborers and mechanics. As provided in paragraphs (d) and (e) of 29 CFR 5.5, the appropriate wage determinations are effective by operation of law even if they have not been attached to the contract. Contributions made or costs reasonably anticipated for bona fide fringe benefits under the Davis-Bacon Act (40 U.S.C. 3141(2)(B)) on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph 1.e. of this section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics must be paid the appropriate wage rate and fringe benefits on the wage determination for the classification(s) of work actually performed, without regard to skill, except as provided in paragraph 4. of this section. Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: *Provided,* That the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classifications and wage rates conformed under paragraph 1.c. of this section) and the Davis-Bacon poster (WH–1321) must be posted at all times by the contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

b. *Frequently recurring classifications.* (1) In addition to wage and fringe benefit rates that have been determined to be prevailing under the procedures set forth in 29 CFR part 1, a wage determination may contain, pursuant to § 1.3(f), wage and fringe benefit rates for classifications of laborers and mechanics for which conformance requests are regularly submitted pursuant to paragraph 1.c. of this section, provided that:

(i) The work performed by the classification is not performed by a classification in the wage determination for which a prevailing wage rate has been determined;

(ii) The classification is used in the area by the construction industry; and

(iii) The wage rate for the classification bears a reasonable relationship to the prevailing wage rates contained in the wage determination.

(2) The Administrator will establish wage rates for such classifications in accordance with paragraph 1.c.(1)(iii) of this section. Work performed in such a classification must be paid at no less than the wage and fringe benefit rate listed on the wage determination for such classification.

c. *Conformance.* (1) The contracting officer must require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract be classified in conformance with the wage determination. Conformance of an additional classification and wage rate and fringe benefits is appropriate only when the following criteria have been met:

(i) The work to be performed by the classification requested is not performed by a classification in the wage determination; and

(ii) The classification is used in the area by the construction industry; and

(iii) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

(2) The conformance process may not be used to split, subdivide, or otherwise avoid application of classifications listed in the wage determination.

(3) If the contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the contracting officer agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken will be sent by the contracting officer by email to *DBAconformance@dol.gov*. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30–day period that additional time is necessary.

(4) In the event the contractor, the laborers or mechanics to be employed in the classification or their representatives, and the contracting officer do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the contracting officer will, by email to *DBAconformance@dol.gov*, refer the questions, including the views of all interested parties and the recommendation of the contracting officer, to the Administrator for determination. The Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30–day period that additional time is necessary.

(5) The contracting officer must promptly notify the contractor of the action taken by the Wage and Hour Division under paragraphs 1.c.(3) and (4) of this section. The contractor must furnish a written copy of such determination to each affected worker or it must be posted as a part of the wage determination. The wage rate (including fringe benefits where appropriate) determined pursuant to paragraph 1.c.(3) or (4) of this section must be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.

d. *Fringe benefits not expressed as an hourly rate.* Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor may either pay the benefit as stated in the wage determination or may pay another bona fide fringe benefit or an hourly cash equivalent thereof.

e. *Unfunded plans.* If the contractor does not make payments to a trustee or other third person, the contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, *Provided,* That the Secretary of Labor has found, upon the written request of the contractor, in accordance with the criteria set forth in § 5.28, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

f. *Interest.* In the event of a failure to pay all or part of the wages required by the contract, the contractor will be required to pay interest on any underpayment of wages.

2. Withholding (29 CFR 5.5)

a. *Withholding requirements.* The contracting agency may, upon its own action, or must, upon written request of an authorized representative of the Department of Labor, withhold or cause to be withheld from the contractor so much of the accrued payments or advances as may be considered necessary to satisfy the liabilities of the prime contractor or any subcontractor for the full amount of wages and monetary relief, including interest, required by the clauses set forth in this section for violations of this contract, or to satisfy any such liabilities required by any other Federal contract, or federally assisted contract subject to Davis-Bacon labor standards, that is held by the same prime contractor (as defined in § 5.2). The necessary funds may be withheld from the contractor under this contract, any other Federal contract with the same prime contractor, or any other federally assisted contract that is subject to Davis-Bacon labor standards requirements and is held by the same prime contractor, regardless of whether the other contract was awarded or assisted by the same agency, and such funds may be used to satisfy the contractor liability for which the funds were withheld. In the event of a contractor's failure to pay any laborer or mechanic, including any apprentice or helper working on the site of the work all or part of the wages required by the contract, or upon the contractor's failure to submit the required records as discussed in paragraph 3.d. of this section, the contracting agency may on its own initiative and after written notice to the contractor, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

b. *Priority to withheld funds.* The Department has priority to funds withheld or to be withheld in accordance with paragraph

2.a. of this section or Section V, paragraph 3.a., or both, over claims to those funds by:

(1) A contractor's surety(ies), including without limitation performance bond sureties and payment bond sureties;

(2) A contracting agency for its reprocurement costs;

(3) A trustee(s) (either a court-appointed trustee or a U.S. trustee, or both) in bankruptcy of a contractor, or a contractor's bankruptcy estate;

(4) A contractor's assignee(s);

(5) A contractor's successor(s); or

(6) A claim asserted under the Prompt Payment Act, 31 U.S.C. 3901–3907.

3. Records and certified payrolls (29 CFR 5.5)

a. *Basic record requirements* (1) *Length of record retention.* All regular payrolls and other basic records must be maintained by the contractor and any subcontractor during the course of the work and preserved for all laborers and mechanics working at the site of the work (or otherwise working in construction or development of the project under a development statute) for a period of at least 3 years after all the work on the prime contract is completed.

(2) *Information required.* Such records must contain the name; Social Security number; last known address, telephone number, and email address of each such worker; each worker's correct classification(s) of work actually performed; hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in 40 U.S.C. 3141(2)(B) of the Davis-Bacon Act); daily and weekly number of hours actually worked in total and on each covered contract; deductions made; and actual wages paid.

(3) *Additional records relating to fringe benefits.* Whenever the Secretary of Labor has found under paragraph 1.e. of this section that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in 40 U.S.C. 3141(2)(B) of the Davis-Bacon Act, the contractor must maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits.

(4) *Additional records relating to apprenticeship.* Contractors with apprentices working under approved programs must maintain written evidence of the registration of apprenticeship programs, the registration of the apprentices, and the ratios and wage rates prescribed in the applicable programs.

b. *Certified payroll requirements* (1) *Frequency and method of submission.* The contractor or subcontractor must submit weekly, for each week in which any DBA- or Related Acts-covered work is performed, certified payrolls to the contracting agency. The prime contractor is responsible for the submission of all certified payrolls by all subcontractors. A contracting agency or prime contractor may permit or require contractors to submit certified payrolls through an electronic system, as long as the electronic system requires a legally valid electronic signature; the system allows the contractor, the contracting agency, and the Department of Labor to access the certified payrolls upon request for at least 3 years after the work on the prime contract has been completed; and the contracting agency or prime contractor permits other methods of submission in situations where the contractor is unable or limited in its ability to use or access the electronic system.

(2) *Information required.* The certified payrolls submitted must set out accurately and completely all of the information required to be maintained under paragraph 3.a.(2) of this section, except that full Social Security numbers and last known addresses, telephone numbers, and email addresses must not be included on weekly transmittals. Instead, the certified payrolls need only include an individually identifying number for each worker (*e.g.,* the last four digits of the worker's Social Security number). The required weekly certified payroll information may be submitted using Optional Form WH–347 or in any other format desired. Optional Form WH–347 is available for this purpose from the Wage and Hour Division website at *https://www.dol.gov/sites/dolgov/files/WHD/legacy/files/wh347/.pdf* or its successor website. It is not a violation of this section for a prime contractor to require a subcontractor to provide full Social Security numbers and last known addresses, telephone numbers, and email addresses to the prime contractor for its own records, without weekly submission by the subcontractor to the contracting agency.

(3) *Statement of Compliance.* Each certified payroll submitted must be accompanied by a "Statement of Compliance," signed by the contractor or subcontractor, or the contractor's or subcontractor's agent who pays or supervises the payment of the persons working on the contract, and must certify the following:

(i) That the certified payroll for the payroll period contains the information required to be provided under paragraph 3.b. of this section, the appropriate information and basic records are being maintained under paragraph 3.a. of this section, and such information and records are correct and complete;

(ii) That each laborer or mechanic (including each helper and apprentice) working on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in 29 CFR part 3; and

(iii) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification(s) of work actually performed, as specified in the applicable wage determination incorporated into the contract.

(4) *Use of Optional Form WH–347.* The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH–347 will satisfy the requirement for submission of the "Statement of Compliance" required by paragraph 3.b.(3) of this section.

(5) *Signature.* The signature by the contractor, subcontractor, or the contractor's or subcontractor's agent must be an original handwritten signature or a legally valid electronic signature.

(6) *Falsification.* The falsification of any of the above certifications may subject the contractor or subcontractor to civil or criminal prosecution under 18 U.S.C. 1001 and 31 U.S.C. 3729.

(7) *Length of certified payroll retention.* The contractor or subcontractor must preserve all certified payrolls during the course of the work and for a period of 3 years after all the work on the prime contract is completed.

c. *Contracts, subcontracts, and related documents.* The contractor or subcontractor must maintain this contract or subcontract and related documents including, without limitation, bids, proposals, amendments, modifications, and extensions. The contractor or subcontractor must preserve these contracts, subcontracts, and related documents during the course of the work and for a period of 3 years after all the work on the prime contract is completed.

d. *Required disclosures and access* (1) *Required record disclosures and access to workers.* The contractor or subcontractor must make the records required under paragraphs 3.a. through 3.c. of this section, and any other documents that the contracting agency, the State DOT, the FHWA, or the Department of Labor deems necessary to determine compliance with the labor standards provisions of any of the applicable statutes referenced by § 5.1, available for inspection, copying, or transcription by authorized representatives of the contracting agency, the State DOT, the FHWA, or the Department of Labor, and must permit such representatives to interview workers during working hours on the job.

(2) *Sanctions for non-compliance with records and worker access requirements.* If the contractor or subcontractor fails to submit the required records or to make them available, or refuses to permit worker interviews during working hours on the job, the Federal agency may, after written notice to the contractor, sponsor, applicant, owner, or other entity, as the case may be, that maintains such records or that employs such workers, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available, or to permit worker interviews during working hours on the job, may be grounds for debarment action pursuant to § 5.12. In addition, any contractor or other person that fails to submit the required records or make those records available to WHD within the time WHD requests that the records be produced will be precluded from introducing as evidence in an administrative proceeding under 29 CFR part 6 any of the required records that were not provided or made available to WHD. WHD will take into consideration a reasonable request from the contractor or person for an extension of the time for submission of records. WHD will determine the reasonableness of the request and may consider, among other things, the location of the records and the volume of production.

(3) *Required information disclosures.* Contractors and subcontractors must maintain the full Social Security number and last known address, telephone number, and email address of each covered worker, and must provide them upon request to the contracting agency, the State DOT, the FHWA, the contractor, or the Wage and Hour Division of the Department of Labor for purposes of an investigation or other compliance action.

4. Apprentices and equal employment opportunity (29 CFR 5.5)

a. *Apprentices* (1) *Rate of pay.* Apprentices will be permitted to work at less than the predetermined rate for the work they perform when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Office of Apprenticeship (OA), or with a State Apprenticeship Agency recognized by the OA. A person who is not individually registered in the program, but who has been certified by the OA or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice, will be permitted to work at less than the predetermined rate for the work they perform in the first 90 days of probationary employment as an apprentice in such a program. In the event the OA or a State Apprenticeship Agency recognized by the OA withdraws approval of an apprenticeship program, the contractor will no longer be permitted to use apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(2) *Fringe benefits.* Apprentices must be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringe benefits must be paid in accordance with that determination.

(3) *Apprenticeship ratio.* The allowable ratio of apprentices to journeyworkers on the job site in any craft classification must not be greater than the ratio permitted to the contractor as to the entire work force under the registered program or the ratio applicable to the locality of the project pursuant to paragraph 4.a.(4) of this section. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated in paragraph 4.a.(1) of this section, must be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under this section must be paid not less than the applicable wage rate on the wage determination for the work actually performed.

(4) *Reciprocity of ratios and wage rates.* Where a contractor is performing construction on a project in a locality other than the locality in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyworker's hourly rate) applicable within the locality in which the construction is being performed must be observed. If there is no applicable ratio or wage rate for the locality of the project, the ratio and wage rate specified in the contractor's registered program must be observed.

b. *Equal employment opportunity.* The use of apprentices and journeyworkers under this part must be in conformity with

the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR part 30.

c. Apprentices and Trainees (programs of the U.S. DOT).

Apprentices and trainees working under apprenticeship and skill training programs which have been certified by the Secretary of Transportation as promoting EEO in connection with Federal-aid highway construction programs are not subject to the requirements of paragraph 4 of this Section IV. 23 CFR 230.111(e)(2). The straight time hourly wage rates for apprentices and trainees under such programs will be established by the particular programs. The ratio of apprentices and trainees to journeyworkers shall not be greater than permitted by the terms of the particular program.

5. Compliance with Copeland Act requirements. The contractor shall comply with the requirements of 29 CFR part 3, which are incorporated by reference in this contract as provided in 29 CFR 5.5.

6. Subcontracts. The contractor or subcontractor must insert FHWA-1273 in any subcontracts, along with the applicable wage determination(s) and such other clauses or contract modifications as the contracting agency may by appropriate instructions require, and a clause requiring the subcontractors to include these clauses and wage determination(s) in any lower tier subcontracts. The prime contractor is responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in this section. In the event of any violations of these clauses, the prime contractor and any subcontractor(s) responsible will be liable for any unpaid wages and monetary relief, including interest from the date of the underpayment or loss, due to any workers of lower-tier subcontractors, and may be subject to debarment, as appropriate. 29 CFR 5.5.

7. Contract termination: debarment. A breach of the contract clauses in 29 CFR 5.5 may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

8. Compliance with Davis-Bacon and Related Act requirements. All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR parts 1, 3, and 5 are herein incorporated by reference in this contract as provided in 29 CFR 5.5.

9. Disputes concerning labor standards. As provided in 29 CFR 5.5, disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the contractor (or any of its subcontractors) and the contracting agency, the U.S. Department of Labor, or the employees or their representatives.

10. Certification of eligibility. a. By entering into this contract, the contractor certifies that neither it nor any person or firm who has an interest in the contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of 40 U.S.C. 3144(b) or § 5.12(a).

b. No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of 40 U.S.C. 3144(b) or § 5.12(a).

c. The penalty for making false statements is prescribed in the U.S. Code, Title 18 Crimes and Criminal Procedure, 18 U.S.C. 1001.

11. Anti-retaliation. It is unlawful for any person to discharge, demote, intimidate, threaten, restrain, coerce, blacklist, harass, or in any other manner discriminate against, or to cause any person to discharge, demote, intimidate, threaten, restrain, coerce, blacklist, harass, or in any other manner discriminate against, any worker or job applicant for:

a. Notifying any contractor of any conduct which the worker reasonably believes constitutes a violation of the DBA, Related Acts, this part, or 29 CFR part 1 or 3;

b. Filing any complaint, initiating or causing to be initiated any proceeding, or otherwise asserting or seeking to assert on behalf of themselves or others any right or protection under the DBA, Related Acts, this part, or 29 CFR part 1 or 3;

c. Cooperating in any investigation or other compliance action, or testifying in any proceeding under the DBA, Related Acts, this part, or 29 CFR part 1 or 3; or

d. Informing any other person about their rights under the DBA, Related Acts, this part, or 29 CFR part 1 or 3.

V. CONTRACT WORK HOURS AND SAFETY STANDARDS ACT

Pursuant to 29 CFR 5.5(b), the following clauses apply to any Federal-aid construction contract in an amount in excess of $100,000 and subject to the overtime provisions of the Contract Work Hours and Safety Standards Act. These clauses shall be inserted in addition to the clauses required by 29 CFR 5.5(a) or 29 CFR 4.6. As used in this paragraph, the terms laborers and mechanics include watchpersons and guards.

1. Overtime requirements. No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek. 29 CFR 5.5.

2. Violation; liability for unpaid wages; liquidated damages. In the event of any violation of the clause set forth in paragraph 1. of this section the contractor and any subcontractor responsible therefor shall be liable for the unpaid wages and interest from the date of the underpayment. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or

mechanic, including watchpersons and guards, employed in violation of the clause set forth in paragraph 1. of this section, in the sum currently provided in 29 CFR 5.5(b)(2)* for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph 1. of this section.

* $31 as of January 15, 2023 (See 88 FR 88 FR 2210) as may be adjusted annually by the Department of Labor, pursuant to the Federal Civil Penalties Inflation Adjustment Act of 1990.

3. Withholding for unpaid wages and liquidated damages

a. *Withholding process.* The FHWA or the contracting agency may, upon its own action, or must, upon written request of an authorized representative of the Department of Labor, withhold or cause to be withheld from the contractor so much of the accrued payments or advances as may be considered necessary to satisfy the liabilities of the prime contractor or any subcontractor for any unpaid wages; monetary relief, including interest; and liquidated damages required by the clauses set forth in this section on this contract, any other Federal contract with the same prime contractor, or any other federally assisted contract subject to the Contract Work Hours and Safety Standards Act that is held by the same prime contractor (as defined in § 5.2). The necessary funds may be withheld from the contractor under this contract, any other Federal contract with the same prime contractor, or any other federally assisted contract that is subject to the Contract Work Hours and Safety Standards Act and is held by the same prime contractor, regardless of whether the other contract was awarded or assisted by the same agency, and such funds may be used to satisfy the contractor liability for which the funds were withheld.

b. *Priority to withheld funds.* The Department has priority to funds withheld or to be withheld in accordance with Section IV paragraph 2.a. or paragraph 3.a. of this section, or both, over claims to those funds by:

(1) A contractor's surety(ies), including without limitation performance bond sureties and payment bond sureties;

(2) A contracting agency for its reprocurement costs;

(3) A trustee(s) (either a court-appointed trustee or a U.S. trustee, or both) in bankruptcy of a contractor, or a contractor's bankruptcy estate;

(4) A contractor's assignee(s);

(5) A contractor's successor(s); or

(6) A claim asserted under the Prompt Payment Act, 31 U.S.C. 3901–3907.

4. Subcontracts. The contractor or subcontractor must insert in any subcontracts the clauses set forth in paragraphs 1. through 5. of this section and a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor is responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs 1. through 5. In the event of any violations of these clauses, the prime contractor and any subcontractor(s) responsible will be liable for any unpaid wages and monetary relief, including interest from the date of the underpayment or loss, due to any workers of lower-tier subcontractors, and associated liquidated damages and may be subject to debarment, as appropriate.

5. Anti-retaliation. It is unlawful for any person to discharge, demote, intimidate, threaten, restrain, coerce, blacklist, harass, or in any other manner discriminate against, or to cause any person to discharge, demote, intimidate, threaten, restrain, coerce, blacklist, harass, or in any other manner discriminate against, any worker or job applicant for:

a. Notifying any contractor of any conduct which the worker reasonably believes constitutes a violation of the Contract Work Hours and Safety Standards Act (CWHSSA) or its implementing regulations in this part;

b. Filing any complaint, initiating or causing to be initiated any proceeding, or otherwise asserting or seeking to assert on behalf of themselves or others any right or protection under CWHSSA or this part;

c. Cooperating in any investigation or other compliance action, or testifying in any proceeding under CWHSSA or this part; or

d. Informing any other person about their rights under CWHSSA or this part.

VI. SUBLETTING OR ASSIGNING THE CONTRACT

This provision is applicable to all Federal-aid construction contracts on the National Highway System pursuant to 23 CFR 635.116.

1. The contractor shall perform with its own organization contract work amounting to not less than 30 percent (or a greater percentage if specified elsewhere in the contract) of the total original contract price, excluding any specialty items designated by the contracting agency. Specialty items may be performed by subcontract and the amount of any such specialty items performed may be deducted from the total original contract price before computing the amount of work required to be performed by the contractor's own organization (23 CFR 635.116).

a. The term “perform work with its own organization” in paragraph 1 of Section VI refers to workers employed or leased by the prime contractor, and equipment owned or rented by the prime contractor, with or without operators. Such term does not include employees or equipment of a subcontractor or lower tier subcontractor, agents of the prime contractor, or any other assignees. The term may include payments for the costs of hiring leased employees from an employee leasing firm meeting all relevant Federal and State regulatory requirements. Leased employees may only be included in this term if the prime contractor meets all of the following conditions: (based on longstanding interpretation)

(1) the prime contractor maintains control over the supervision of the day-to-day activities of the leased employees;
(2) the prime contractor remains responsible for the quality of the work of the leased employees;

(3) the prime contractor retains all power to accept or exclude individual employees from work on the project; and

(4) the prime contractor remains ultimately responsible for the payment of predetermined minimum wages, the submission of payrolls, statements of compliance and all other Federal regulatory requirements.

b. "Specialty Items" shall be construed to be limited to work that requires highly specialized knowledge, abilities, or equipment not ordinarily available in the type of contracting organizations qualified and expected to bid or propose on the contract as a whole and in general are to be limited to minor components of the overall contract. 23 CFR 635.102.

2. Pursuant to 23 CFR 635.116(a), the contract amount upon which the requirements set forth in paragraph (1) of Section VI is computed includes the cost of material and manufactured products which are to be purchased or produced by the contractor under the contract provisions.

3. Pursuant to 23 CFR 635.116(c), the contractor shall furnish (a) a competent superintendent or supervisor who is employed by the firm, has full authority to direct performance of the work in accordance with the contract requirements, and is in charge of all construction operations (regardless of who performs the work) and (b) such other of its own organizational resources (supervision, management, and engineering services) as the contracting officer determines is necessary to assure the performance of the contract.

4. No portion of the contract shall be sublet, assigned or otherwise disposed of except with the written consent of the contracting officer, or authorized representative, and such consent when given shall not be construed to relieve the contractor of any responsibility for the fulfillment of the contract. Written consent will be given only after the contracting agency has assured that each subcontract is evidenced in writing and that it contains all pertinent provisions and requirements of the prime contract. (based on long-standing interpretation of 23 CFR 635.116).

5. The 30-percent self-performance requirement of paragraph (1) is not applicable to design-build contracts; however, contracting agencies may establish their own self-performance requirements. 23 CFR 635.116(d).

VII. SAFETY: ACCIDENT PREVENTION

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts.

1. In the performance of this contract the contractor shall comply with all applicable Federal, State, and local laws governing safety, health, and sanitation (23 CFR Part 635). The contractor shall provide all safeguards, safety devices and protective equipment and take any other needed actions as it determines, or as the contracting officer may determine, to be reasonably necessary to protect the life and health of employees on the job and the safety of the public and to protect property in connection with the performance of the work covered by the contract. 23 CFR 635.108.

2. It is a condition of this contract, and shall be made a condition of each subcontract, which the contractor enters into pursuant to this contract, that the contractor and any subcontractor shall not permit any employee, in performance of the contract, to work in surroundings or under conditions which are unsanitary, hazardous or dangerous to his/her health or safety, as determined under construction safety and health standards (29 CFR Part 1926) promulgated by the Secretary of Labor, in accordance with Section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C. 3704). 29 CFR 1926.10.

3. Pursuant to 29 CFR 1926.3, it is a condition of this contract that the Secretary of Labor or authorized representative thereof, shall have right of entry to any site of contract performance to inspect or investigate the matter of compliance with the construction safety and health standards and to carry out the duties of the Secretary under Section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C. 3704).

VIII. FALSE STATEMENTS CONCERNING HIGHWAY PROJECTS

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts.

In order to assure high quality and durable construction in conformity with approved plans and specifications and a high degree of reliability on statements and representations made by engineers, contractors, suppliers, and workers on Federal-aid highway projects, it is essential that all persons concerned with the project perform their functions as carefully, thoroughly, and honestly as possible. Willful falsification, distortion, or misrepresentation with respect to any facts related to the project is a violation of Federal law. To prevent any misunderstanding regarding the seriousness of these and similar acts, Form FHWA-1022 shall be posted on each Federal-aid highway project (23 CFR Part 635) in one or more places where it is readily available to all persons concerned with the project:

18 U.S.C. 1020 reads as follows:

"Whoever, being an officer, agent, or employee of the United States, or of any State or Territory, or whoever, whether a person, association, firm, or corporation, knowingly makes any false statement, false representation, or false report as to the character, quality, quantity, or cost of the material used or to be used, or the quantity or quality of the work performed or to be performed, or the cost thereof in connection with the submission of plans, maps, specifications, contracts, or costs of construction on any highway or related project submitted for approval to the Secretary of Transportation; or

Whoever knowingly makes any false statement, false representation, false report or false claim with respect to the character, quality, quantity, or cost of any work performed or to be performed, or materials furnished or to be furnished, in connection with the construction of any highway or related project approved by the Secretary of Transportation; or

Whoever knowingly makes any false statement or false representation as to material fact in any statement, certificate, or report submitted pursuant to provisions of the Federal-aid Roads Act approved July 11, 1916, (39 Stat. 355), as amended and supplemented;

Shall be fined under this title or imprisoned not more than 5 years or both."

IX. IMPLEMENTATION OF CLEAN AIR ACT AND FEDERAL WATER POLLUTION CONTROL ACT (42 U.S.C. 7606; 2 CFR 200.88; EO 11738)

This provision is applicable to all Federal-aid construction contracts in excess of $150,000 and to all related subcontracts. 48 CFR 2.101; 2 CFR 200.327.

By submission of this bid/proposal or the execution of this contract or subcontract, as appropriate, the bidder, proposer, Federal-aid construction contractor, subcontractor, supplier, or vendor agrees to comply with all applicable standards, orders or regulations issued pursuant to the Clean Air Act (42 U.S.C. 7401-7671q) and the Federal Water Pollution Control Act, as amended (33 U.S.C. 1251-1387). Violations must be reported to the Federal Highway Administration and the Regional Office of the Environmental Protection Agency. 2 CFR Part 200, Appendix II.

The contractor agrees to include or cause to be included the requirements of this Section in every subcontract, and further agrees to take such action as the contracting agency may direct as a means of enforcing such requirements. 2 CFR 200.327.

X. CERTIFICATION REGARDING DEBARMENT, SUSPENSION, INELIGIBILITY AND VOLUNTARY EXCLUSION

This provision is applicable to all Federal-aid construction contracts, design-build contracts, subcontracts, lower-tier subcontracts, purchase orders, lease agreements, consultant contracts or any other covered transaction requiring FHWA approval or that is estimated to cost $25,000 or more – as defined in 2 CFR Parts 180 and 1200. 2 CFR 180.220 and 1200.220.

1**. Instructions for Certification – First Tier Participants:**

a. By signing and submitting this proposal, the prospective first tier participant is providing the certification set out below.

b. The inability of a person to provide the certification set out below will not necessarily result in denial of participation in this covered transaction. The prospective first tier participant shall submit an explanation of why it cannot provide the certification set out below. The certification or explanation will be considered in connection with the department or agency's determination whether to enter into this transaction. However, failure of the prospective first tier participant to furnish a certification or an explanation shall disqualify such a person from participation in this transaction. 2 CFR 180.320.

c. The certification in this clause is a material representation of fact upon which reliance was placed when the contracting agency determined to enter into this transaction. If it is later determined that the prospective participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the contracting agency may terminate this transaction for cause of default. 2 CFR 180.325.

d. The prospective first tier participant shall provide immediate written notice to the contracting agency to whom this proposal is submitted if any time the prospective first tier participant learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances. 2 CFR 180.345 and 180.350.

e. The terms "covered transaction," "debarred," "suspended," "ineligible," "participant," "person," "principal," and "voluntarily excluded," as used in this clause, are defined in 2 CFR Parts 180, Subpart I, 180.900-180.1020, and 1200. “First Tier Covered Transactions” refers to any covered transaction between a recipient or subrecipient of Federal funds and a participant (such as the prime or general contract). “Lower Tier Covered Transactions” refers to any covered transaction under a First Tier Covered Transaction (such as subcontracts). “First Tier Participant” refers to the participant who has entered into a covered transaction with a recipient or subrecipient of Federal funds (such as the prime or general contractor). “Lower Tier Participant” refers any participant who has entered into a covered transaction with a First Tier Participant or other Lower Tier Participants (such as subcontractors and suppliers).

f. The prospective first tier participant agrees by submitting this proposal that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency entering into this transaction. 2 CFR 180.330.

g. The prospective first tier participant further agrees by submitting this proposal that it will include the clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion-Lower Tier Covered Transactions," provided by the department or contracting agency, entering into this covered transaction, without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions exceeding the $25,000 threshold. 2 CFR 180.220 and 180.300.

h. A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. 2 CFR 180.300; 180.320, and 180.325. A participant is responsible for ensuring that its principals are not suspended, debarred, or otherwise ineligible to participate in covered transactions. 2 CFR 180.335. To verify the eligibility of its principals, as well as the eligibility of any lower tier prospective participants, each participant may, but is not required to, check the System for Award Management website (https://www.sam.gov/). 2 CFR 180.300, 180.320, and 180.325.

i. Nothing contained in the foregoing shall be construed to require the establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of the prospective participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

j. Except for transactions authorized under paragraph (f) of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department or agency may terminate this transaction for cause or default. 2 CFR 180.325.

* * * * *

2. Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion – First Tier Participants:

a. The prospective first tier participant certifies to the best of its knowledge and belief, that it and its principals:

(1) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participating in covered transactions by any Federal department or agency, 2 CFR 180.335;.

(2) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property, 2 CFR 180.800;

(3) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (a)(2) of this certification, 2 CFR 180.700 and 180.800; and

(4) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default. 2 CFR 180.335(d).

(5) Are not a corporation that has been convicted of a felony violation under any Federal law within the two-year period preceding this proposal (USDOT Order 4200.6 implementing appropriations act requirements); and

(6) Are not a corporation with any unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted, or have lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability (USDOT Order 4200.6 implementing appropriations act requirements).

b. Where the prospective participant is unable to certify to any of the statements in this certification, such prospective participant should attach an explanation to this proposal. 2 CFR 180.335 and 180.340.

* * * * *

3. **Instructions for Certification - Lower Tier Participants:**

(Applicable to all subcontracts, purchase orders, and other lower tier transactions requiring prior FHWA approval or estimated to cost $25,000 or more - 2 CFR Parts 180 and 1200). 2 CFR 180.220 and 1200.220.

a. By signing and submitting this proposal, the prospective lower tier participant is providing the certification set out below.

b. The certification in this clause is a material representation of fact upon which reliance was placed when this transaction was entered into. If it is later determined that the prospective lower tier participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the department, or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

c. The prospective lower tier participant shall provide immediate written notice to the person to which this proposal is submitted if at any time the prospective lower tier participant learns that its certification was erroneous by reason of changed circumstances. 2 CFR 180.365.

d. The terms "covered transaction," "debarred," "suspended," "ineligible," "participant," "person," "principal," and "voluntarily excluded," as used in this clause, are defined in 2 CFR Parts 180, Subpart I, 180.900 – 180.1020, and 1200. You may contact the person to which this proposal is submitted for assistance in obtaining a copy of those regulations. “First Tier Covered Transactions” refers to any covered transaction between a recipient or subrecipient of Federal funds and a participant (such as the prime or general contract). “Lower Tier Covered Transactions” refers to any covered transaction under a First Tier Covered Transaction (such as subcontracts). “First Tier Participant” refers to the participant who has entered into a covered transaction with a recipient or subrecipient of Federal funds (such as the prime or general contractor). “Lower Tier Participant” refers any participant who has entered into a covered transaction with a First Tier Participant or other Lower Tier Participants (such as subcontractors and suppliers).

e. The prospective lower tier participant agrees by submitting this proposal that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency with which this transaction originated. 2 CFR 1200.220 and 1200.332.

f. The prospective lower tier participant further agrees by submitting this proposal that it will include this clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion-Lower Tier Covered Transaction," without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions exceeding the $25,000 threshold. 2 CFR 180.220 and 1200.220.

g. A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant is responsible for ensuring that its principals are not suspended, debarred, or otherwise ineligible to participate in covered transactions. To verify the eligibility of its principals, as well as the eligibility of any lower tier prospective participants, each participant may, but is not required to, check the System for Award Management website (https://www.sam.gov/), which is compiled by the General Services Administration. 2 CFR 180.300, 180.320, 180.330, and 180.335.

h. Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

i. Except for transactions authorized under paragraph e of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily

excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment. 2 CFR 180.325.

* * * * *

4. Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion--Lower Tier Participants:

a. The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principals:

(1) is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participating in covered transactions by any Federal department or agency, 2 CFR 180.355;

(2) is a corporation that has been convicted of a felony violation under any Federal law within the two-year period preceding this proposal (USDOT Order 4200.6 implementing appropriations act requirements); and

(3) is a corporation with any unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted, or have lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability. (USDOT Order 4200.6 implementing appropriations act requirements)

b. Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant should attach an explanation to this proposal.

* * * * *

XI. CERTIFICATION REGARDING USE OF CONTRACT FUNDS FOR LOBBYING

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts which exceed $100,000. 49 CFR Part 20, App. A.

1. The prospective participant certifies, by signing and submitting this bid or proposal, to the best of his or her knowledge and belief, that:

a. No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

b. If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

2. This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by 31 U.S.C. 1352. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

3. The prospective participant also agrees by submitting its bid or proposal that the participant shall require that the language of this certification be included in all lower tier subcontracts, which exceed $100,000 and that all such recipients shall certify and disclose accordingly.

XII. USE OF UNITED STATES-FLAG VESSELS:

This provision is applicable to all Federal-aid construction contracts, design-build contracts, subcontracts, lower-tier subcontracts, purchase orders, lease agreements, or any other covered transaction. 46 CFR Part 381.

This requirement applies to material or equipment that is acquired for a specific Federal-aid highway project. 46 CFR 381.7. It is not applicable to goods or materials that come into inventories independent of an FHWA funded-contract.

When oceanic shipments (or shipments across the Great Lakes) are necessary for materials or equipment acquired for a specific Federal-aid construction project, the bidder, proposer, contractor, subcontractor, or vendor agrees:

1. To utilize privately owned United States-flag commercial vessels to ship at least 50 percent of the gross tonnage (computed separately for dry bulk carriers, dry cargo liners, and tankers) involved, whenever shipping any equipment, material, or commodities pursuant to this contract, to the extent such vessels are available at fair and reasonable rates for United States-flag commercial vessels. 46 CFR 381.7.

2. To furnish within 20 days following the date of loading for shipments originating within the United States or within 30 working days following the date of loading for shipments originating outside the United States, a legible copy of a rated, ‘on-board’ commercial ocean bill-of-lading in English for each shipment of cargo described in paragraph (b)(1) of this section to both the Contracting Officer (through the prime contractor in the case of subcontractor bills-of-lading) and to the Office of Cargo and Commercial Sealift (MAR-620), Maritime Administration, Washington, DC 20590. (MARAD requires copies of the ocean carrier's (master) bills of lading, certified onboard, dated, with rates and charges. These bills of lading may contain business sensitive information and therefore may be submitted directly to MARAD by the Ocean Transportation Intermediary on behalf of the contractor). 46 CFR 381.7.

ATTACHMENT A - EMPLOYMENT AND MATERIALS PREFERENCE FOR APPALACHIAN DEVELOPMENT HIGHWAY SYSTEM OR APPALACHIAN LOCAL ACCESS ROAD CONTRACTS (23 CFR 633, Subpart B, Appendix B)
This provision is applicable to all Federal-aid projects funded under the Appalachian Regional Development Act of 1965.

1. During the performance of this contract, the contractor undertaking to do work which is, or reasonably may be, done as on-site work, shall give preference to qualified persons who regularly reside in the labor area as designated by the DOL wherein the contract work is situated, or the subregion, or the Appalachian counties of the State wherein the contract work is situated, except:

a. To the extent that qualified persons regularly residing in the area are not available.

b. For the reasonable needs of the contractor to employ supervisory or specially experienced personnel necessary to assure an efficient execution of the contract work.

c. For the obligation of the contractor to offer employment to present or former employees as the result of a lawful collective bargaining contract, provided that the number of nonresident persons employed under this subparagraph (1c) shall not exceed 20 percent of the total number of employees employed by the contractor on the contract work, except as provided in subparagraph (4) below.

2. The contractor shall place a job order with the State Employment Service indicating (a) the classifications of the laborers, mechanics and other employees required to perform the contract work, (b) the number of employees required in each classification, (c) the date on which the participant estimates such employees will be required, and (d) any other pertinent information required by the State Employment Service to complete the job order form. The job order may be placed with the State Employment Service in writing or by telephone. If during the course of the contract work, the information submitted by the contractor in the original job order is substantially modified, the participant shall promptly notify the State Employment Service.

3. The contractor shall give full consideration to all qualified job applicants referred to him by the State Employment Service. The contractor is not required to grant employment to any job applicants who, in his opinion, are not qualified to perform the classification of work required.

4. If, within one week following the placing of a job order by the contractor with the State Employment Service, the State Employment Service is unable to refer any qualified job applicants to the contractor, or less than the number requested, the State Employment Service will forward a certificate to the contractor indicating the unavailability of applicants. Such certificate shall be made a part of the contractor's permanent project records. Upon receipt of this certificate, the contractor may employ persons who do not normally reside in the labor area to fill positions covered by the certificate, notwithstanding the provisions of subparagraph (1c) above.

5. The provisions of 23 CFR 633.207(e) allow the contracting agency to provide a contractual preference for the use of mineral resource materials native to the Appalachian region.

6. The contractor shall include the provisions of Sections 1 through 4 of this Attachment A in every subcontract for work which is, or reasonably may be, done as on-site work.

The wage rates listed herein are those predetermined by the Secretary of Labor and State Statue and listed in the United States Department of Labor's (USDOL) General Decisions dated 01-05-2024 and are the minimum wages to be paid accordingly for each specified classification. To determine the applicable wage rate zone, a list entitled "TEXAS COUNTIES IDENTIFIED BY WAGE RATE ZONES" is provided in the contract. Any wage rate that is not listed herein and not in the USDOL's general decision, must be requested by the contractor through the completion of an Additional Classification and Wage Rate Request and be submitted for approval. IMPORTANT NOTICE FOR STATE PROJECTS: only the controlling wage rate zone applies to the contract. Effective 01-05-2024.

CLASS. #	CLASSIFICATION DESCRIPTION	ZONE TX02 *(TX20240002)	ZONE TX03 *(TX20240003)	ZONE TX04 *(TX20240004)	ZONE TX05 *(TX20240005)	ZONE TX06 *(TX20240006)	ZONE TX07 *(TX20240007)	ZONE TX08 *(TX20240008)	ZONE TX24 *(TX20240024)	ZONE TX25 *(TX20240025)	ZONE TX27 *(TX20240027)	ZONE TX28 *(TX20240028)	ZONE TX29 *(TX20240029)	ZONE TX30 *(TX20240030)	ZONE TX37 *(TX20240037)	ZONE TX38 *(TX20240038)	ZONE TX42 *(TX20240042)
1428	Agricultural Tractor Operator						$12.69					$12.35			$11.75		
1300	Asphalt Distributor Operator	$14.87	$13.48	$13.88	$15.72	$15.58	$15.55	$15.72	$13.28	$15.32	$15.62	$14.36	$14.25	$14.03	$13.75	$14.06	$14.40
1303	Asphalt Paving Machine Operator	$13.40	$12.25	$12.35	$13.87	$14.05	$14.36	$14.20	$13.26	$13.99	$14.68	$12.92	$13.44	$12.53	$14.00	$14.32	$12.99
1106	Asphalt Raker	$12.28	$10.61	$12.02	$14.21	$11.65	$12.12	$11.64	$11.44	$12.69	$12.05	$11.34	$11.67	$11.40	$12.59	$12.36	$11.78
1112	Batching Plant Operator, Asphalt																
1115	Batching Plant Operator, Concrete																
1214	Blaster																
1615	Boom Truck Operator						$18.36										
1444	Boring Machine Operator																
1305	Broom or Sweeper Operator	$11.21	$10.33	$10.08	$11.99		$11.04	$11.62		$11.74	$11.41	$10.30		$10.23	$10.60	$12.68	$11.05
1144	Communications Cable Installer																
1124	Concrete Finisher, Paving and Structures	$13.55	$12.46	$13.16	$12.85	$12.64	$12.56	$12.77	$12.44	$14.12	$13.04	$13.38	$12.64	$12.80	$12.79	$12.98	$13.32
1318	Concrete Pavement Finishing Machine Operator				$16.05		$15.48			$16.05		$19.31				$13.07	
1315	Concrete Paving, Curing, Float, Texturing Machine Operator											$16.34				$11.71	
1333	Concrete Saw Operator				$14.67					$14.48	$17.33					$13.99	
1399	Concrete/Gunite Pump Operator																
1344	Crane Operator, Hydraulic 80 tons or less				$18.22		$18.36			$18.12	$18.04	$20.21			$18.63	$13.86	
1345	Crane Operator, Hydraulic Over 80 Tons																
1342	Crane Operator, Lattice Boom 80 Tons or Less	$16.82	$14.39	$13.85	$17.27		$15.87			$17.27		$14.67			$16.42	$14.97	$13.87
1343	Crane Operator, Lattice Boom Over 80 Tons				$20.52		$19.38			$20.52		$17.49			$25.13	$15.80	
1306	Crawler Tractor Operator	$13.96	$16.63	$13.62	$14.26		$15.67			$14.07	$13.15	$13.38			$14.60	$13.68	$13.50
1351	Crusher or Screen Plant Operator																
1446	Directional Drilling Locator						$11.67										
1445	Directional Drilling Operator				$20.32		$17.24										
1139	Electrician	$20.96		$19.87	$19.80		$26.35		$20.27	$19.80		$20.92				$27.11	$19.87
1347	Excavator Operator, 50,000 pounds or less	$13.46	$12.56	$13.67	$17.19		$12.88	$14.38	$13.49	$17.19		$13.88			$14.09	$12.71	$14.42
1348	Excavator Operator, Over 50,000 pounds		$15.23	$13.52	$17.04		$17.71			$16.99	$18.80	$16.22				$14.53	$13.52
1150	Flagger	$9.30	$9.10	$8.50	$10.28	$8.81	$9.45	$8.70		$10.06	$9.71	$9.03	$8.81	$9.08	$9.90	$10.33	$8.10
1151	Form Builder/Setter, Structures	$13.52	$12.30	$13.38	$12.91	$12.71	$12.87	$12.38	$12.26	$13.84	$12.98	$13.07	$13.61	$12.82	$14.73	$12.23	$12.25
1160	Form Setter, Paving & Curb	$12.36	$12.16	$13.93	$11.83	$10.71	$12.94			$13.16	$12.54	$11.33	$10.69		$13.33	$12.34	$13.93
1360	Foundation Drill Operator, Crawler Mounted				$17.99					$17.99						$17.43	
1363	Foundation Drill Operator, Truck Mounted		$16.86	$22.05	$21.51		$16.93			$21.07	$20.20	$20.76		$17.54	$21.39	$15.89	$22.05
1369	Front End Loader Operator, 3 CY or Less	$12.28	$13.49	$13.40	$13.85		$13.04	$13.15	$13.29	$13.69	$12.64	$12.89			$13.51	$13.32	$12.17
1372	Front End Loader Operator, Over 3 CY	$12.77	$13.69	$12.33	$14.96		$13.21	$12.86	$13.57	$14.72	$13.75	$12.32			$13.19	$13.17	$13.02
1329	Joint Sealer																
1172	Laborer, Common	$10.30	$9.86	$10.08	$10.51	$10.71	$10.50	$10.24	$10.58	$10.72	$10.45	$10.30	$10.25	$10.03	$10.54	$11.02	$10.15
1175	Laborer, Utility	$11.80	$11.53	$12.70	$12.17	$11.81	$12.27	$12.11	$11.33	$12.32	$11.80	$11.53	$11.23	$11.50	$11.95	$11.73	$12.37
1346	Loader/Backhoe Operator	$14.18	$12.77	$12.97	$15.68		$14.12			$15.18	$13.58	$12.87		$13.21	$14.13	$14.29	$12.90
1187	Mechanic	$20.14	$15.47	$17.47	$17.74	$17.00	$17.10			$17.68	$18.94	$18.58	$17.00	$16.61	$18.46	$16.96	$17.47

CLASS. #	CLASSIFICATION DESCRIPTION	ZONE TX02 *(TX20240002)	ZONE TX03 *(TX20240003)	ZONE TX04 *(TX20240004)	ZONE TX05 *(TX20240005)	ZONE TX06 *(TX20240006)	ZONE TX07 *(TX20240007)	ZONE TX08 *(TX20240008)	ZONE TX24 *(TX20240024)	ZONE TX25 *(TX20240025)	ZONE TX27 *(TX20240027)	ZONE TX28 *(TX20240028)	ZONE TX29 *(TX20240029)	ZONE TX30 *(TX20240030)	ZONE TX37 *(TX20240037)	ZONE TX38 *(TX20240038)	ZONE TX42 *(TX20240042)
1380	Milling Machine Operator	$15.54	$14.64	$12.22	$14.29		$14.18			$14.32	$14.35	$12.86			$14.75	$13.53	$12.80
1390	Motor Grader Operator, Fine Grade	$17.49	$16.52	$16.88	$17.12	$18.37	$18.51	$16.69	$16.13	$17.19	$18.35	$17.07	$17.74	$17.47	$17.08	$15.69	$20.01
1393	Motor Grader Operator, Rough	$16.15	$14.62	$15.83	$16.20	$17.07	$14.63	$18.50		$16.02	$16.44	$15.12	$16.85	$14.47	$17.39	$14.23	$15.53
1413	Off Road Hauler			$10.08	$12.26		$11.88			$12.25		$12.23			$13.00	$14.60	
1196	Painter, Structures					$21.29	$18.34						$21.29			$18.62	
1396	Pavement Marking Machine Operator	$16.42		$13.10	$13.55		$19.17	$12.01		$13.63	$14.60	$13.17		$16.65	$10.54	$11.18	$13.10
1443	Percussion or Rotary Drill Operator																
1202	Piledriver															$14.95	
1205	Pipelayer		$11.87	$14.64	$13.17	$11.17	$12.79		$11.37	$13.24	$12.66	$13.24	$11.17	$11.67		$12.12	$14.64
1384	Reclaimer/Pulverizer Operator	$12.85			$11.90		$12.88			$11.01		$10.46					
1500	Reinforcing Steel Worker	$13.50	$14.07	$17.53	$16.17		$14.00			$16.18	$12.74	$15.83		$17.10		$15.15	$17.72
1402	Roller Operator, Asphalt	$10.95		$11.96	$13.29		$12.78	$11.61		$13.08	$12.36	$11.68			$11.71	$11.95	$11.50
1405	Roller Operator, Other	$10.36		$10.44	$11.82		$10.50	$11.64		$11.51	$10.59	$10.30		$12.04	$12.85	$11.57	$10.66
1411	Scraper Operator	$10.61	$11.07	$10.85	$12.88		$12.27		$11.12	$12.96	$11.88	$12.43		$11.22	$13.95	$13.47	$10.89
1417	Self-Propelled Hammer Operator																
1194	Servicer	$13.98	$12.34	$14.11	$14.74		$14.51	$15.56	$13.44	$14.58	$14.31	$13.83		$12.43	$13.72	$13.97	$14.11
1513	Sign Erector																
1708	Slurry Seal or Micro-Surfacing Machine Operator																
1341	Small Slipform Machine Operator									$15.96							
1515	Spreader Box Operator	$12.60		$13.12	$14.71		$14.04			$14.73	$13.84	$13.68		$13.45	$11.83	$13.58	$14.05
1705	Structural Steel Welder															$12.85	
1509	Structural Steel Worker						$19.29									$14.39	
1339	Subgrade Trimmer																
1143	Telecommunication Technician																
1145	Traffic Signal/Light Pole Worker						$16.00										
1440	Trenching Machine Operator, Heavy						$18.48										
1437	Trenching Machine Operator, Light																
1609	Truck Driver Lowboy-Float	$14.46	$13.63	$13.41	$15.00	$15.93	$15.66			$16.24	$16.39	$14.30	$16.62	$15.63	$14.28	$16.03	$13.41
1612	Truck Driver Transit-Mix				$14.14					$14.14							
1600	Truck Driver, Single Axle	$12.74	$10.82	$10.75	$13.04	$11.61	$11.79	$13.53	$13.16	$12.31	$13.40	$10.30	$11.61		$11.97	$11.46	$10.75
1606	Truck Driver, Single or Tandem Axle Dump Truck	$11.33	$14.53	$11.95	$12.95		$11.68		$14.06	$12.62	$11.45	$12.28		$13.08	$11.68	$11.48	$11.10
1607	Truck Driver, Tandem Axle Tractor withSemi Trailer	$12.49	$12.12	$12.50	$13.42		$12.81	$13.16		$12.86	$16.22	$12.50			$13.80	$12.27	$12.50
1441	Tunneling Machine Operator, Heavy																
1442	Tunneling Machine Operator, Light																
1706	Welder		$14.02		$14.86		$15.97		$13.74	$14.84					$13.78		
1520	Work Zone Barricade Servicer	$10.30	$12.88	$11.46	$11.70	$11.57	$11.85	$10.77		$11.68	$12.20	$11.22	$11.51	$12.96	$10.54	$11.67	$11.76

Notes:

*Represents the USDOL wage decision.

Any worker employed on this project shall be paid at the rate of one and one half (1-1/2) times the regular rate for every hour worked in excess of forty (40) hours per week.

For reference, the titles and descriptions for the classifications listed here are detailed further in the AGC of Texas' *Standard Job Classifications and Descriptions for Highway, Heavy, Utilities, and Industrial Construction in Texas* posted on the AGC's Web site for any contractor.

TEXAS COUNTIES IDENTIFIED BY
WAGE RATE ZONES: 2, 3, 4, 5, 6, 7, 8, 24, 25, 27, 28, 29, 30, 37, 38, 42

County Name	Zone	County Name	Zone	County Name	Zone	County Name	Zone
Anderson	28	Donley	37	Karnes	27	Reagan	37
Andrews	37	Duval	30	Kaufman	25	Real	37
Angelina	28	Eastland	37	Kendall	7	Red River	28
Aransas	29	Ector	2	Kenedy	30	Reeves	8
Archer	25	Edwards	8	Kent	37	Refugio	27
Armstrong	2	El Paso	24	Kerr	27	Roberts	37
Atascosa	7	Ellis	25	Kimble	37	Robertson	7
Austin	38	Erath	28	King	37	Rockwall	25
Bailey	37	Falls	28	Kinney	8	Runnels	37
Bandera	7	Fannin	28	Kleberg	27	Rusk	4
Bastrop	7	Fayette	27	Knox	37	Sabine	28
Baylor	37	Fisher	37	Lamar	28	San Augustine	28
Bee	27	Floyd	37	Lamb	37	San Jacinto	38
Bell	7	Foard	37	Lampasas	7	San Patricio	29
Bexar	7	Fort Bend	38	LaSalle	30	San Saba	37
Blanco	27	Franklin	28	Lavaca	27	Schleicher	37
Borden	37	Freestone	28	Lee	27	Scurry	37
Bosque	28	Frio	27	Leon	28	Shackelford	37
Bowie	4	Gaines	37	Liberty	38	Shelby	28
Brazoria	38	Galveston	38	Limestone	28	Sherman	37
Brazos	7	Garza	37	Lipscomb	37	Smith	4
Brewster	8	Gillespie	27	Live Oak	27	Somervell	28
Briscoe	37	Glasscock	37	Llano	27	Starr	30
Brooks	30	Goliad	29	Loving	37	Stephens	37
Brown	37	Gonzales	27	Lubbock	2	Sterling	37
Burleson	7	Gray	37	Lynn	37	Stonewall	37
Burnet	27	Grayson	25	Madison	28	Sutton	8
Caldwell	7	Gregg	4	Marion	28	Swisher	37
Calhoun	29	Grimes	28	Martin	37	Tarrant	25
Callahan	25	Guadalupe	7	Mason	27	Taylor	2
Cameron	3	Hale	37	Matagorda	27	Terrell	8
Camp	28	Hall	37	Maverick	30	Terry	37
Carson	2	Hamilton	28	McCulloch	37	Throckmorton	37
Cass	28	Hansford	37	McLennan	7	Titus	28
Castro	37	Hardeman	37	McMullen	30	Tom Green	2
Chambers	38	Hardin	38	Medina	7	Travis	7
Cherokee	28	Harris	38	Menard	37	Trinity	28
Childress	37	Harrison	42	Midland	2	Tyler	28
Clay	25	Hartley	37	Milam	28	Upshur	4
Cochran	37	Haskell	37	Mills	37	Upton	37
Coke	37	Hays	7	Mitchell	37	Uvalde	30
Coleman	37	Hemphill	37	Montague	37	Val Verde	8
Collin	25	Henderson	28	Montgomery	38	Van Zandt	28
Collingsworth	37	Hidalgo	3	Moore	37	Victoria	6
Colorado	27	Hill	28	Morris	28	Walker	28
Comal	7	Hockley	37	Motley	37	Waller	38
Comanche	37	Hood	28	Nacogdoches	28	Ward	37
Concho	37	Hopkins	28	Navarro	28	Washington	28
Cooke	37	Houston	28	Newton	28	Webb	3
Coryell	7	Howard	37	Nolan	37	Wharton	27
Cottle	37	Hudspeth	8	Nueces	29	Wheeler	37
Crane	37	Hunt	25	Ochiltree	37	Wichita	5
Crockett	8	Hutchinson	37	Oldham	37	Wilbarger	37
Crosby	2	Irion	2	Orange	38	Willacy	30
Culberson	8	Jack	28	Palo Pinto	28	Williamson	7
Dallam	37	Jackson	27	Panola	28	Wilson	7
Dallas	25	Jasper	28	Parker	25	Winkler	37
Dawson	37	Jeff Davis	8	Parmer	37	Wise	25
Deaf Smith	37	Jefferson	38	Pecos	8	Wood	28
Delta	25	Jim Hogg	30	Polk	28	Yoakum	37
Denton	25	Jim Wells	27	Potter	2	Young	37
DeWitt	27	Johnson	25	Presidio	8	Zapata	30
Dickens	37	Jones	25	Rains	28	Zavala	30
Dimmit	30			Randall	2		

01/05/2024

Special Provision to Item 000
Nondiscrimination

1. DESCRIPTION

All recipients of federal financial assistance are required to comply with various nondiscrimination laws including Title VI of the Civil Rights Act of 1964, as amended, (Title VI). Title VI forbids discrimination against anyone in the United States on the grounds of race, color, or national origin by any agency receiving federal funds.

Texas Department of Transportation, as a recipient of Federal financial assistance, and under Title VI and related statutes, ensures that no person shall on the grounds of race, religion (where the primary objective of the financial assistance is to provide employment per 42 U.S.C. § 2000d-3), color, national origin, sex, age or disability be excluded from participation in, be denied the benefits of, or otherwise be subjected to discrimination under any Department programs or activities.

2. DEFINITION OF TERMS

Where the term “contractor” appears in the following six nondiscrimination clauses, the term “contractor” is understood to include all parties to contracts or agreements with the Texas Department of Transportation.

3. NONDISCRIMINATION PROVISIONS

During the performance of this contract, the contractor agrees as follows:

3.1. **Compliance with Regulations**. The Contractor shall comply with the Regulations relative to nondiscrimination in Federally-assisted programs of the Department of Transportation (hereinafter, “DOT”) Title 49, Code of Federal Regulations, Part 21, as they may be amended from time to time, (hereinafter referred to as the Regulations), which are herein incorporated by reference and made a part of this contract.

3.2. **Nondiscrimination**. The contractor, with regard to the work performed by it during the contract, shall not discriminate on the grounds of race, color, or national origin in the selection and retention of subcontractors, including procurements of materials and leases of equipment. The contractor shall not participate either directly or indirectly in the discrimination prohibited by section 21.5 of the Regulations, including employment practices when the contract covers a program set forth in Appendix B of the Regulations.

3.3. **Solicitations for Subcontracts, Including Procurements of Materials and Equipment:** In all solicitations either by competitive bidding or negotiation made by the contractor for work to be performed under a subcontract, including procurements of materials or leases of equipment, each potential subcontractor or supplier shall be notified by the contractor of the contractor's obligations under this contract and the Regulations relative to nondiscrimination on the grounds of race, color, or national origin.

3.4. **Information and Reports:** The contractor shall provide all information and reports required by the Regulations or directives issued pursuant thereto, and shall permit access to its books, records, accounts, other sources of information, and its facilities as may be determined by the Recipient or the Texas Department of Transportation to be pertinent to ascertain compliance with such Regulations, orders and instructions. Where any information required of a contractor is in the exclusive possession of another who fails or refuses to furnish this information the contractor shall so certify to the Recipient, or the Texas Department of Transportation as appropriate, and shall set forth what efforts it has made to obtain the information.

3.5. **Sanctions for Noncompliance**. In the event of the contractor's noncompliance with the nondiscrimination provisions of this contract, the Recipient shall impose such contract sanctions as it or the Texas Department of Transportation may determine to be appropriate, including, but not limited to:

- withholding of payments to the contractor under the contract until the contractor complies, and/or
- cancellation, termination or suspension of the contract, in whole or in part.

3.6. **Incorporation of Provisions**. The contractor shall include the provisions of paragraphs (1) through (6) in every subcontract, including procurements of materials and leases of equipment, unless exempt by the Regulations, or directives issued pursuant thereto. The contractor shall take such action with respect to any subcontract or procurement as the Recipient or the Texas Department of Transportation may direct as a means of enforcing such provisions including sanctions for non-compliance: Provided, however, that, in the event a contractor becomes involved in, or is threatened with, litigation with a subcontractor or supplier as a result of such direction, the contractor may request the Recipient to enter into such litigation to protect the interests of the Recipient, and, in addition, the contractor may request the United States to enter into such litigation to protect the interests of the United States.

Special Provision to Item 000
Certification of Nondiscrimination in Employment

1. GENERAL

By signing this proposal, the Bidder certifies that he has participated in a previous contract or subcontract subject to the equal opportunity clause, as required by Executive Orders 10925, 11114, or 11246, or if he has not participated in a previous contract of this type, or if he has had previous contract or subcontracts and has not filed, he will file with the Joint Reporting Committee, the Director of the Office of Federal Contract Compliance, a Federal Government contracting or administering agency, or the former President's Committee on Equal Employment Opportunity, all reports due under the applicable filing requirements.

Note—The above certification is required by the Equal Employment Opportunity Regulations of the Secretary of Labor (41 CFR 60-1.7(b)(1)), and must be submitted by Bidders and proposed subcontractors only in connection with contracts and subcontracts which are subject to the equal opportunity clause. Contracts and subcontracts which are exempt from the equal opportunity clause are set forth in 41 CFR 60-1.5. (Generally only contracts or subcontracts of $10,000 or under are exempt.)

Currently, Standard Form 100 (EEO-1) is the only report required by the Executive Orders or their implementing regulations.

Proposed prime contractors and subcontractors who have participated in a previous contract or subcontract subject to the Executive Orders and have not filed the required reports should note that 41 CFR 60-1.7(b)(1) prevents the award of contracts and subcontracts unless such contractor submits a report covering the delinquent period or such other period specified by the Federal Highway Administration or by the Director, Office of Federal Contract Compliance, U.S. Department of Labor.

Special Provision to Item 000

Notice of Requirement for Affirmative Action to Ensure Equal Employment Opportunity (Executive Order 11246)

1. GENERAL

In addition to the affirmative action requirements of the Special Provision titled "Standard Federal Equal Employment Opportunity Construction Contract Specifications" as set forth elsewhere in this proposal, the Bidder's attention is directed to the specific requirements for utilization of minorities and females as set forth below.

2. GOALS

2.1. Goals for minority and female participation are hereby established in accordance with 41 CFR 60-4.

2.2. The goals for minority and female participation expressed in percentage terms for the Contractor's aggregate work force in each trade on all construction work in the covered area are as follows:

Goals for minority participation in each trade, %	Goals for female participation in each trade, %
See Table 1	6.9

2.3. These goals are applicable to all the Contractor's construction work (whether or not it is Federal or federally assisted) performed in the covered area. If the Contractor performs construction work in a geographical area located outside of the covered area, it will apply the goals established for such geographical area where the work is actually performed. With regard to this second area, the Contractor also is subject to the goals for both its federally involved and non-federally involved construction. The Contractor's compliance with the Executive Order and the regulations in 41 CFR Part 60-4 will be based on its implementation of the Standard Federal Equal Employment Opportunity Construction Contract Specifications Special Provision and its efforts to meet the goals. The hours of minority and female employment and training must be substantially uniform throughout the length of the Contract, and in each trade, and the Contractor must make a good faith effort to employ minorities and women evenly on each of its projects. The transfer of minority and female employees or trainees from Contractor to Contractor or from project to project for the sole purpose of meeting the Contractor's goals will be a violation of the Contract, the Executive Order and the regulations in 41 CFR Part 60-4. Compliance with the goals will be measured against the total work hours performed.

2.4. A Contractor or subcontractor will be considered in compliance with these provisions by participation in the Texas Highway-Heavy Branch, AGC, Statewide Training and Affirmative Action Plan. Provided that each Contractor or subcontractor participating in this plan must individually comply with the equal opportunity clause set forth in 41 CFR 60-1.4 and must make a good faith effort to achieve the goals set forth for each participating trade in the plan in which it has employees. The overall good performance of other Contractors and subcontractors toward a goal in an approved plan does not excuse any covered Contractor's or subcontractor's failure to make good faith efforts to achieve the goals contained in these provisions. Contractors or subcontractors participating in the plan must be able to demonstrate their participation and document their compliance with the provisions of this Plan.

3. SUBCONTRACTING

The Contractor must provide written notification to the Department within 10 working days of award of any construction subcontract in excess of $10,000 at any tier for construction work under the Contract resulting from this solicitation pending concurrence of the Department in the award. The notification will list the names,

address and telephone number of the subcontractor; employer identification number; estimated dollar amount of the subcontract; estimated starting and completion dates of the subcontract; and the geographical area in which the Contract is to be performed.

4. COVERED AREA

As used in this special provision, and in the Contract resulting from this solicitation, the geographical area covered by these goals for female participation is the State of Texas. The geographical area covered by these goals for other minorities are the counties in the State of Texas as indicated in Table 1.

5. REPORTS

The Contractor is hereby notified that he may be subject to the Office of Federal Contract Compliance Programs (OFCCP) reporting and record keeping requirements as provided for under Executive Order 11246 as amended. OFCCP will provide direct notice to the Contractor as to the specific reporting requirements that he will be expected to fulfill.

Table 1
Goals for Minority Participation

County	Participation, %	County	Participation, %
Anderson	22.5	Chambers	27.4
Andrews	18.9	Cherokee	22.5
Angelina	22.5	Childress	11.0
Aransas	44.2	Clay	12.4
Archer	11.0	Cochran	19.5
Armstrong	11.0	Coke	20.0
Atascosa	49.4	Coleman	10.9
Austin	27.4	Collin	18.2
Bailey	19.5	Collingsworth	11.0
Bandera	49.4	Colorado	27.4
Bastrop	24.2	Comal	47.8
Baylor	11.0	Comanche	10.9
Bee	44.2	Concho	20.0
Bell	16.4	Cooke	17.2
Bexar	47.8	Coryell	16.4
Blanco	24.2	Cottle	11.0
Borden	19.5	Crane	18.9
Bosque	18.6	Crockett	20.0
Bowie	19.7	Crosby	19.5
Brazoria	27.3	Culberson	49.0
Brazos	23.7	Dallam	11.0
Brewster	49.0	Dallas	18.2
Briscoe	11.0	Dawson	19.5
Brooks	44.2	Deaf Smith	11.0
Brown	10.9	Delta	17.2
Burleson	27.4	Denton	18.2
Burnet	24.2	DeWitt	27.4
Caldwell	24.2	Dickens	19.5
Calhoun	27.4	Dimmit	49.4
Callahan	11.6	Donley	11.0
Cameron	71.0	Duval	44.2
Camp	20.2	Eastland	10.9
Carson	11.0	Ector	15.1
Cass	20.2	Edwards	49.4
Castro	11.0	Ellis	18.2

County	Participation, %	County	Participation, %
El Paso	57.8	Kenedy	44.2
Erath	17.2	Kent	10.9
Falls	18.6	Kerr	49.4
Fannin	17.2	Kimble	20.0
Fayette	27.4	King	19.5
Fisher	10.9	Kinney	49.4
Floyd	19.5	Kleberg	44.2
Foard	11.0	Knox	10.9
Fort Bend	27.3	Lamar	20.2
Franklin	17.2	Lamb	19.5
Freestone	18.6	Lampasas	18.6
Frio	49.4	LaSalle	49.4
Gaines	19.5	Lavaca	27.4
Galveston	28.9	Lee	24.2
Garza	19.5	Leon	27.4
Gillespie	49.4	Liberty	27.3
Glasscock	18.9	Limestone	18.6
Goliad	27.4	Lipscomb	11.0
Gonzales	49.4	Live Oak	44.2
Gray	11.0	Llano	24.2
Grayson	9.4	Loving	18.9
Gregg	22.8	Lubbock	19.6
Grimes	27.4	Lynn	19.5
Guadalupe	47.8	Madison	27.4
Hale	19.5	Marion	22.5
Hall	11.0	Martin	18.9
Hamilton	18.6	Mason	20.0
Hansford	11.0	Matagorda	27.4
Hardeman	11.0	Maverick	49.4
Hardin	22.6	McCulloch	20.0
Harris	27.3	McLennan	20.7
Harrison	22.8	McMullen	49.4
Hartley	11.0	Medina	49.4
Haskell	10.9	Menard	20.0
Hays	24.1	Midland	19.1
Hemphill	11.0	Milam	18.6
Henderson	22.5	Mills	18.6
Hidalgo	72.8	Mitchell	10.9
Hill	18.6	Montague	17.2
Hockley	19.5	Montgomery	27.3
Hood	18.2	Moore	11.0
Hopkins	17.2	Morris	20.2
Houston	22.5	Motley	19.5
Howard	18.9	Nacogdoches	22.5
Hudspeth	49.0	Navarro	17.2
Hunt	17.2	Newton	22.6
Hutchinson	11.0	Nolan	10.9
Irion	20.0	Nueces	41.7
Jack	17.2	Ochiltree	11.0
Jackson	27.4	Oldham	11.0
Jasper	22.6	Orange	22.6
Jeff Davis	49.0	Palo Pinto	17.2
Jefferson	22.6	Panola	22.5
Jim Hogg	49.4	Parker	18.2
Jim Wells	44.2	Parmer	11.0
Johnson	18.2	Pecos	18.9
Jones	11.6	Polk	27.4
Karnes	49.4	Potter	9.3
Kaufman	18.2	Presidio	49.0
Kendall	49.4	Randall	9.3

County	Participation, %	County	Participation, %
Rains	17.2	Reagan	20.0
Real	49.4	Throckmorton	10.9
Red River	20.2	Titus	20.2
Reeves	18.9	Tom Green	19.2
Refugio	44.2	Travis	24.1
Roberts	11.0	Trinity	27.4
Robertson	27.4	Tyler	22.6
Rockwall	18.2	Upshur	22.5
Runnels	20.0	Upton	18.9
Rusk	22.5	Uvalde	49.4
Sabine	22.6	Val Verde	49.4
San Augustine	22.5	Van Zandt	17.2
San Jacinto	27.4	Victoria	27.4
San Patricio	41.7	Walker	27.4
San Saba	20.0	Waller	27.3
Schleicher	20.0	Ward	18.9
Scurry	10.9	Washington	27.4
Shackelford	10.9	Webb	87.3
Shelby	22.5	Wharton	27.4
Sherman	11.0	Wheeler	11.0
Smith	23.5	Wichita	12.4
Somervell	17.2	Wilbarger	11.0
Starr	72.9	Willacy	72.9
Stephens	10.9	Williamson	24.1
Sterling	20.0	Wilson	49.4
Stonewall	10.9	Winkler	18.9
Sutton	20.0	Wise	18.2
Swisher	11.0	Wood	22.5
Tarrant	18.2	Yoakum	19.5
Taylor	11.6	Young	11.0
Terrell	20.0	Zapata	49.4
Terry	19.5	Zavala	49.4

Special Provision to Item 000

Standard Federal Equal Employment Opportunity Construction Contract Specifications (Executive Order 11246)

1. GENERAL

1.1. As used in these specifications:

- "Covered area" means the geographical area described in the solicitation from which this Contract resulted;
- "Director" means Director, Office of Federal Contract Compliance Programs, United States Department of Labor, or any person to whom the Director delegates authority;
- "Employer identification number" means the Federal Social Security number used on the Employer's Quarterly Federal Tax Return, U.S. Treasury Department Form 941.
- "Minority" includes:
  - Black (all persons having origins in any of the Black African racial groups not of Hispanic origin);
  - Hispanic (all persons of Mexican, Puerto Rican, Cuban, Central or South American or other Spanish Culture or origin, regardless of race);
  - Asian and Pacific Islander (all persons having origins in any of the original peoples of the Far East, Southeast Asia, the Indian Subcontinent, or the Pacific Islands); and
  - American Indian or Alaskan Native (all persons having origins in any of the original peoples of North American and maintaining identifiable tribal affiliations through membership and participation or community identification).

1.2. Whenever the Contractor, or any Subcontractor at any tier, subcontracts a portion of the work involving any construction trade, it will physically include in each subcontract in excess of $10,000 the provisions of these specifications and the Notice which contains the applicable goals for minority and female participation and which is set forth in the solicitations from which this Contract resulted.

1.3. If the Contractor is participating (pursuant to 41 CFR 60-4.5) in a Hometown Plan approved by the U. S. Department of Labor in the covered area either individually or through an association, its affirmative action obligations on all work in the Plan area (including goals and timetables) will be in accordance with that plan for those trades which have unions participating in the Plan. Contractors must be able to demonstrate their participation in and compliance with the provisions of any such Hometown Plan. Each Contractor or Subcontractor participating in an approved Plan is individually required to comply with its obligations under the equal employment opportunity (EEO) clause, and to make a good faith effort to achieve each goal under the Plan in each trade in which it has employees. The overall good faith performance by other Contractors or Subcontractors toward a goal in an approved Plan does not excuse any covered Contractor's or Subcontractor's failure to take good faith efforts to achieve the Plan goals and timetables.

1.4. The Contractor will implement the specific affirmative action standards provided in Section 1.7.1. through Section 1.7.16. of these specifications. The goals set forth in the solicitation from which this Contract resulted are expressed as percentages of the total hours of employment and training of minority and female utilization the Contractor should reasonably be able to achieve in each construction trade in which it has employees in the covered area. Covered construction Contractors performing Contracts in geographical areas where they do not have a Federal or federally assisted construction Contract will apply the minority and female goals established for the geographical area where the Contract is being performed. Goals are published periodically in the Federal Register in notice form and such notices may be obtained from any Office of Federal Contract Compliance Programs office or any Federal procurement contracting officer. The

Contractor is expected to make substantially uniform progress toward its goals in each craft during the period specified.

1.5. Neither the provisions of any collective bargaining agreement, nor the failure by a union with whom the Contractor has a collective bargaining agreement, to refer either minorities or women will excuse the Contractor's obligations under these specifications, Executive Order 11246, or the regulations promulgated pursuant thereto.

1.6. In order for the nonworking training hours of apprentices and trainees to be counted in meeting the goals, such apprentices and trainees must be employed by the Contractor during the training period, and the Contractor must have made a commitment to employ the apprentices and trainees at the completion of their training, subject to the availability of employment opportunities. Trainees must be trained pursuant to training programs approved by the U. S. Department of Labor.

1.7. The Contractor will take specific affirmative actions to ensure equal employment opportunity. The evaluation of the Contractor's compliance with these specifications will be based upon its effort to achieve maximum results from its actions. The Contractor will document these efforts fully, and will implement affirmative action steps at least as extensive as the following:

1.7.1. Ensure and maintain a working environment free of harassment, intimidation, and coercion at all sites, and in all facilities at which the Contractor's employees are assigned to work. The Contractor, where possible, will assign two or more women to each construction project. The Contractor will specifically ensure that all foremen, superintendents, and other on-site supervisory personnel are aware of and carry out the Contractor's obligation to maintain such a working environment, with specific attention to minority or female individuals working at such sites or in such facilities.

1.7.2. Establish and maintain a current list of minority and female recruitment sources, provide written notification to minority and female recruitment sources and to community organizations when the Contractor or its unions have employment opportunities available, and maintain a record of the organizations' responses.

1.7.3. Maintain a current file of the names, addresses and telephone numbers of each minority and female off-the-street applicant and minority or female referral from a union, a recruitment source or community organization and of what action was taken with respect to each such individual. If such individual was sent to the union hiring hall for referral and was not referred back to the Contractor by the union or, if referred, not employed by the Contractor, this will be documented in the file with the reason therefor, along with whatever additional actions the Contractor may have taken.

1.7.4. Provide immediate written notification to the Director when the union or unions with which the Contractor has a collective bargaining agreement has not referred to the Contractor a minority person or woman sent by the Contractor, or when the Contractor has other information that the union referral Process has impeded the Contractor's efforts to meet its obligations.

1.7.5. Develop on-the-job training opportunities and/or participate in training programs for the area which expressly include minorities and women, including upgrading programs and apprenticeship and trainee programs relevant to the Contractor's employment needs, especially those programs funded or approved by the Department of Labor. The Contractor will provide notice of these programs to the sources compiled under 7b above.

1.7.6. Disseminate the Contractor's EEO policy by providing notice of the policy to unions and training programs and requesting their cooperation in assisting the Contractor in meeting its EEO obligations; by including it in any policy manual and Collective bargaining agreement; by publicizing it in the company newspaper, annual report, etc.; by specific review of the policy with all management personnel and with all minority and female employees at least once a year; and by posting the company EEO policy on bulletin boards accessible to all employees at each location where construction work is performed.

1.7.7. Review, at least annually, the company's EEO policy and affirmative action obligations under these specifications with all employees having any responsibility for hiring, assignment, layoff, termination or other

employment decisions including specific review of these items with on-site supervisory personnel such as Superintendents, General Foremen, etc., before the initiation of construction work at any job site. A written record must be made and maintained identifying the time and place of these meetings, persons attending, subject matter discussed, and disposition of the subject matter.

1.7.8. Disseminate the Contractor's EEO policy externally by including it in any advertising in the news media, specifically including minority and female news media, and providing written notification to and discussing the Contractor's EEO policy with other Contractors and Subcontractors with whom the Contractor does or anticipates doing business.

1.7.9. Direct its recruitment efforts, both oral and written, to minority, female and community organizations, to schools with minority and female students and to minority and female recruitment and training organizations serving the Contractor's recruitment area and employment needs. Not later than one month before the date for the acceptance of applications for apprenticeship or other training by any recruitment source, the Contractor will send written notification to organizations such as the above, describing the openings, screening procedures, and tests to be used in the selection process.

1.7.10. Encourage present minority and female employees to recruit other minority persons and women and, where reasonable, provide after school, summer and vacation employment to minority and female youth both on the site and in other areas of a Contractor's workforce.

1.7.11. Validate all tests and other selection requirements where there is an obligation to do so under 41 CFR Part 60-3.

1.7.12. Conduct, at least annually, an inventory and evaluation at least of all minority and female personnel for promotional opportunities and encourage these employees to seek or to prepare for, through appropriate training, etc., such opportunities.

1.7.13. Ensure that seniority practices, job classifications, work assignments and other personnel practices, do not have a discriminatory effect by continually monitoring all personnel and employment-related activities to ensure that the EEO policy and the Contractor's obligations under these specifications are being carried out.

1.7.14. Ensure that all facilities and company activities are non-segregated except that separate or single-user toilet and necessary changing facilities will be provided to assure privacy between the sexes.

1.7.15. Document and maintain a record of all solicitations of offers for subcontracts from minority and female construction contractors and suppliers, including circulation of solicitations to minority and female contractor associations and other business associations.

1.7.16. Conduct a review, at least annually, of all supervisors' adherence to and performance under the Contractor's EEO policies and affirmative action obligations.

1.8. Contractors are encouraged to participate in voluntary associations which assist in fulfilling one or more of their affirmative action obligations (Section 7.1. through Section 7.16.). The efforts of a contractor association, joint contractor-union, contractor-community, or other similar group of which the Contractor is a member and participant, may be asserted as fulfilling any one or more of its obligations under Section 7.1. through Section 7.16. of these Specifications provided that the Contractor actively participates in the group, makes every effort to assure that the group has a positive impact on the employment of minorities and women in the industry, ensures that the concrete benefits of the program are reflected in the Contractor's minority and female workforce participation, makes a good faith effort to meet its individual goals and timetables, and can provide access to documentation which demonstrates the effectiveness of actions taken on behalf of the Contractor. The obligation to comply, however, is the Contractor's and failure of such a group to fulfill an obligation will not be a defense for the Contractor's noncompliance.

1.9. A single goal for minorities and a separate single goal for women have been established. The Contractor, however, is required to provide equal employment opportunity and to take affirmative action for all minority groups, both male and female, and all women, both minority and non-minority. Consequently, the Contractor

may be in violation of the Executive Order if a particular group is employed in a substantially disparate manner (for example, even though the Contractor has achieved its goals for women generally, the Contractor may be in violation of the Executive Order if a specific minority group of women is underutilized).

1.10. The Contractor shall not use the goals and timetables or affirmative action standards to discriminate against any person because of race, color, religion, sex, or national origin.

1.11. The Contractor will not enter into any Subcontract with any person or firm debarred from Government Contracts pursuant to Executive Order 11246.

1.12. The Contractor will carry out such sanctions and penalties for violation of these specifications and of the Equal Opportunity Clause, including suspension, termination and cancellation of existing subcontracts as may be imposed or ordered pursuant to Executive Order 11246, as amended, and its implementing regulations, by the Office of Federal Contract Compliance Programs. Any Contractor who fails to carry out such sanctions and penalties will be in violation of these specifications and Executive Order 11246, as amended.

1.13. The Contractor, in fulfilling its obligations under these specifications, will implement specific affirmative action steps, at least as extensive as those standards prescribed in paragraph 7 of these specifications, so as to achieve maximum results from its efforts to ensure equal employment opportunity. If the Contractor fails to comply with the requirements of the Executive Order, the implementing regulations, or these specifications, the Director will proceed in accordance with 41 CFR 60-4.8.

1.14. The Contractor will designate a responsible official to monitor all employment-related activity to ensure that the company EEO policy is being carried out, to submit reports relating to the provisions hereof as may be required by the Government and to keep records. Records must at least include for each employee the name, address, telephone numbers, construction trade, union affiliation if any, employee identification number when assigned, social security number, race, sex, status (e.g., mechanic, apprentice, trainee, helper, or laborer), dates of changes in status, hours worked per week in the indicated trade, rate of pay, and locations at which the work was performed. Records must be maintained in an easily understandable and retrievable form; however, to the degree that existing records satisfy this requirement, Contractors shall not be required to maintain separate records.

1.15. Nothing herein provided will be construed as a limitation upon the application of other laws which establish different standards of compliance or upon the application of requirements for the hiring of local or other area residents (e.g., those under the Public Works Employment Act of 1977 and the Community Development Block Grant Program).

1.16. In addition to the reporting requirements set forth elsewhere in this Contract, the Contractor and the subcontractors holding subcontracts, not including material suppliers, of $10,000 or more, will submit for every month of July during which work is performed, employment data as contained under Form PR 1391 (Appendix C to 23 CFR, Part 230), and in accordance with the included instructions.

Special Provision to Item 000
On-the-Job Training Program

1. DESCRIPTION

The primary objective of this Special Provision is the training and advancement of minorities, women and economically disadvantaged persons toward journeyworker status. Accordingly, make every effort to enroll minority, women and economically disadvantaged persons to the extent that such persons are available within a reasonable area of recruitment. This training commitment is not intended, and will not be used to discriminate against any applicant for training, whether or not he/she is a member of a minority group.

2. TRAINEE ASSIGNMENT

Training assignments are based on the past volume of state-let highway construction contracts awarded with the Department. Contractors meeting the selection criteria will be notified of their training assignment at the beginning of the reporting year by the Department's Office of Civil Rights.

3. PROGRAM REQUIREMENTS

Fulfill all of the requirements of the On-the-Job Training Program including the maintenance of records and submittal of periodic reports documenting program performance. Trainees will be paid at least 60% of the appropriate minimum journeyworker's rate specified in the Contract for the first half of the training period, 75% for the third quarter, and 90% for the last quarter, respectively.

4. REIMBURSEMENT

If requested, Contractors may be reimbursed $0.80 per training hour at no additional cost to the Department. Training may occur on this project, all other Department contracts, or local-administered federal-aid projects with concurrence of the local government entity. However, reimbursement for training is not available on projects to the extent that such projects that do not contain federal funds.

5. COMPLIANCE

The Contractor will have fulfilled the contractual responsibilities by having provided acceptable training to the number of trainees specified in their goal assignment. Noncompliance may be cause for corrective and appropriate measures pursuant to Article 8.7., "Abandonment of Work or Default of Contract," which may be used to comply with the sanctions for noncompliance pursuant to 23 CFR Part 230.

Special Provision to Item 000
Americans with Disabilities Act Curb Ramp Workshop

Before starting work, schedule and attend a mandatory preconstruction Americans with Disabilities Act curb ramp workshop. The workshop will be administered by the Department, will be four hours or less, and will be held during normal working hours at an approved location in proximity to the project.

Supervisory personnel responsible for control of the work must attend the workshop.

The Department will provide workshop facilitators and facilities. No direct compensation will be made for fulfilling these requirements, as this workshop is considered subsidiary to the Items of the Contract.

Special Provision 000
Important Notice to Contractors

As of June 21, 2024, utilities within the project limits have not been cleared. The Department anticipates clearance by the dates listed below. Unless otherwise stated, clearance of these obstructions will be performed by their owners. Estimated clearance dates are not anticipated to interfere with the Contractor's operations. In the event the clearance dates are not met, requests for additional compensation or time will be made in accordance with the standard specifications.

The Contractor is invited to review the mapped information of obstructions on file with the Engineer.

UTILITY			
Utility Owner	**Approximate Location**	**Estimated Clearance Date**	**Effect on Construction**
CPS Energy	STA 169+62–187+97 LT/RT	January 3, 2025	None
AT&T	STA 173+25–173+49 RT	June 12, 2029	None
Level 3 (Lumen)	STA 173+25–173+49 RT	June 12, 2029	None
Spectrum	STA 173+25–173+49 RT	June 12, 2029	None
Google Fiber Texas	STA 173+25–173+49 RT	June 12, 2029	None
CPS Energy	STA 169+62–187+97 LT/RT	June 12, 2029	None
AT&T	STA 169+62–187+97 LT	June 12, 2029	None
AT&T TCA (LNS)	STA 169+62–187+97 LT	June 12, 2029	None
Spectrum	STA 169+62–187+97 LT	June 12, 2029	None
Astound (Grande)	STA 169+62–187+97 LT	June 12, 2029	None
Zayo	STA 169+62–187+97 LT	June 12, 2029	None

Special Provision 000
Certificate of Interested Parties (Form 1295)

Submit a notarized Form 1295, "Certificate of Interested Parties," in the following instances:

- at Contract execution for Contracts awarded by the Commission;
- at Contract execution for Contracts awarded by the District Engineer or Chief Engineer with an award amount of $1,000,000 or more; at any time an existing Contract awarded by the District Engineer or Chief Engineer increases in value to $1,000,000 or more due to changes in the Contract; at any time there is an increase of $1,000,000 or more to an existing Contract (change orders, extensions, and renewals); or
- at any time there is a change to the information in Form 1295, when the form was filed for an existing Contract.

Form 1295 and instructions on completing and filing the form are available on the Texas Ethics Commission website.

Special Provision 000
Important Notice to Contractors

For Dollar Amount of Original Contract		Dollar Amount of Daily Contract Administration Liquidated Damages per Working Day
From More Than	To and including	
0	1,000,000	618
1,000,000	3,000,000	832
3,000,000	5,000,000	940
5,000,000	15,000,000	1317
15,000,000	25,000,000	1718
25,000,000	50,000,000	2411
50,000,000	Over 50,000,000	4265

In addition to the amount shown in Table 1, the Liquidated Damages will be increased by the amount shown in Item 8 of the General Notes for Road User Cost (RUC), when applicable.

Special Provision 000

Cargo Preference Act Requirements in Federal Aid Contracts

1. DESCRIPTION

All recipients of federal financial assistance are required to comply with the U.S. Department of Transportation's (DOT) Cargo Preference Act Requirements, 46 CFR Part 381, Use of United States-Flag Vessels.

This requirement applies to material or equipment that is acquired specifically for a Federal-aid highway project. It is not applicable to goods or materials that come into inventories independent of a Federal Highway Administration (FHWA) funded contract.

When oceanic shipments are necessary for materials or equipment acquired for a specific Federal-aid construction project, the contractor agrees to:

- Utilize privately owned United States-flag commercial vessels to ship at least 50 percent of the gross tonnage (computed separately for dry bulk carriers, dry cargo liners, and tankers) involved, whenever shipping any equipment, material, or commodities pursuant to this contract, to the extent such vessels are available at fair and reasonable rates for United States-flag commercial vessels.

- Furnish a legible copy of a rated, on-board commercial ocean bill-of-lading in English for each shipment of cargo described in paragraph (b) (1) of 46 CFR Part 381 Section 7, "Federal Grant, Guaranty, Loan and Advance of Funds Agreements," within 20 days following the date of loading for shipments originating within the United States or within 30 working days following the date of loading for shipments originating outside the United States, to both the Engineer (through the prime contractor in the case of subcontractor bills-of-lading) and to the Division of National Cargo, Office of Market Development, Maritime Administration, Washington, DC 20590.

- Insert the substance of the provisions of this clause in all subcontracts issued pursuant to this contract.

Special Provision to Item 000

Disadvantaged Business Enterprise in Federal-Aid Contracts

1. DESCRIPTION

The purpose of this Special Provision is to carry out the U.S. Department of Transportation's (DOT) policy of ensuring nondiscrimination in the award and administration of DOT-assisted Contracts and creating a level playing field on which firms owned and controlled by individuals who are determined to be socially and economically disadvantaged can compete fairly for DOT-assisted Contracts.

2. DISADVANTAGED BUSINESS ENTERPRISE IN FEDERAL-AID CONTRACTS

2.1. **Policy.** It is the policy of the DOT and the Texas Department of Transportation (Department) that DBEs, as defined in 49 CFR Part 26, Subpart A, and the Department's DBE Program, will have the opportunity to participate in the performance of Contracts financed in whole or in part with federal funds. The DBE requirements of 49 CFR Part 26, and the Department's DBE Program, apply to this Contract as follows.

The Contractor will solicit DBEs through reasonable and available means, as defined in 49 CFR Part 26, Appendix A, and the Department's DBE Program, or show a good faith effort to meet the DBE goal for this Contract.

The Contractor, subrecipient, or subcontractor will not discriminate on the basis of race, color, national origin, or sex in the performance of this Contract. Carry out applicable requirements of 49 CFR Part 26 in the award and administration of DOT-assisted Contracts. Failure to carry out these requirements is a material breach of this Contract, which may result in the termination of this Contract or such other remedy as the Department deems appropriate.

The requirements of this Special Provision must be physically included in any subcontract.

By signing the Contract proposal, the Bidder is certifying that the DBE goal as stated in the proposal will be met by obtaining commitments from eligible DBEs or that the Bidder will provide acceptable evidence of good faith effort to meet the commitment.

2.2. **Definitions.**

2.2.1. **Administrative Reconsideration.** A process by which the low bidder may request reconsideration when the Department determines the good faith effort (GFE) requirements have not been met.

2.2.2. **Commercially Useful Function (CUF).** A CUF occurs when a DBE has the responsibility for the execution of the work and carrying out such responsibilities by actually performing, managing, and supervising the work.

2.2.3. **Disadvantaged Business Enterprise (DBE).** A for-profit small business certified through the Texas Unified Certification Program in accordance with 49 CFR Part 26, that is at least 51% owned by one or more socially and economically disadvantaged individuals, or in the case of a publicly owned business, in which is at least 51% of the stock is owned by one or more socially and economically disadvantaged individuals, and whose management and daily business operations are controlled by one or more of the individuals who own it.

2.2.4. **DBE Joint Venture.** An association of a DBE firm and one or more other firms to carry out a single business enterprise for profit for which purpose they combine their property, capital, efforts, skills, and knowledge, and

in which the DBE is responsible for a distinct, clearly defined portion of the work of the Contract and whose share in the capital contribution, control, management, risks, and profits of the joint venture are commensurate with its ownership interest.

2.2.5. **DOT.** The U.S. Department of Transportation, including the Office of the Secretary, the Federal Highway Administration (FHWA), the Federal Transit Administration (FTA), and the Federal Aviation Administration (FAA).

2.2.6. **Federal-Aid Contract.** Any Contract between the Department and a Contractor that is paid for in whole or in part with DOT financial assistance.

2.2.7. **Good Faith Effort.** All necessary and reasonable steps to achieve the contract goal which, by their scope, intensity, and appropriateness to the objective, could reasonably be expected to obtain sufficient DBE participation, even if not fully successful. Good faith efforts are evaluated prior to award and throughout performance of the Contract. For guidance on good faith efforts, see 49 CFR Part 26, Appendix A.

2.2.8. **North American Industry Classification System (NAICS).** A designation that best describes the primary business of a firm. The NAICS is described in the North American Industry Classification Manual—United States, which is available on the Internet at the U.S. Census Bureau website: http://www.census.gov/eos/www/naics/.

2.2.9. **Race-Conscious.** A measure or program that is focused specifically on assisting only DBEs, including women-owned businesses.

2.2.10. **Race-Neutral DBE Participation.** Any participation by a DBE through customary competitive procurement procedures.

2.2.11. **Texas Unified Certification Program (TUCP) Directory.** An online directory listing all DBEs currently certified by the TUCP. The Directory identifies DBE firms whose participation on a Contract may be counted toward achievement of the assigned DBE Contract goal.

2.3. **Contractor's Responsibilities.**

2.3.1. **DBE Liaison Officer**. Designate a DBE liaison officer who will administer the Contractor's DBE program and who will be responsible for maintenance of records of efforts and contacts made to subcontract with DBEs.

2.3.2. **Compliance Tracking System (CTS)**. This Contract is subject to electronic Contract compliance tracking. Contractors and DBEs are required to provide any noted and requested Contract compliance-related data electronically in the Department's tracking system. This includes commitments, payments, substitutions, and good faith efforts. Contractors and DBEs are responsible for responding by any noted response date or due date to any instructions or request for information, and to check the system on a regular basis. A Contractor is responsible for ensuring all DBEs have completed all requested items and that their contact information is accurate and up-to-date. The Department may require additional information related to the Contract to be provided electronically through the system at any time before, during, or after contract award. The system is web-based and can be accessed at the following Internet address: https://txdot.txdotcms.com/.

In its sole discretion, the Department may require that contract compliance tracking data be submitted by Contractors and DBEs in an alternative format prescribed by the Department.

2.3.3. **Apparent Low Bidder.** The apparent low bidder must submit DBE commitments to satisfy the DBE goal or submit good faith effort Form 2603 and supporting documentation demonstrating why the goal could not be achieved, in whole or part, no later than 5 calendar days after bid opening. The means of transmittal and the risk of timely receipt of the information will be the bidder's responsibility and no extension of the 5-calendar-day timeframe will be allowed for any reason.

2.3.4. **DBE Contractor.** A DBE Contractor may receive credit toward the DBE goal for work performed by its own forces and work subcontracted to DBEs. In the event a DBE subcontracts to a non-DBE, that information must be reported monthly.

2.3.5. **DBE Committal.** Only those DBEs certified by the TUCP are eligible to be used for goal attainment. The Department maintains the TUCP DBE Directory. The Directory can be accessed at the following Internet address: https://txdot.txdotcms.com/FrontEnd/VendorSearchPublic.asp?TN=txdot&XID=2340.

A DBE must be certified on the day the commitment is considered and at time of subcontract execution. It is the Contractor's responsibility to ensure firms identified for participation are approved certified DBE firms.

The Bidder is responsible to ensure that all submittals are checked for accuracy. Any and all omissions, deletions, and/or errors that may affect the end result of the commitment package are the sole liabilities of the bidder.

Commitments in excess of the goal are considered race-neutral commitments.

2.3.6. **Good Faith Effort Requirements.** A Contractor who cannot meet the Contract goal, in whole or in part, must make adequate good faith efforts to obtain DBE participation as so stated and defined in 49 CFR Part 26, Appendix A.

2.3.6.1. **Administrative Reconsideration.** If the Department determines that the apparent low bidder has failed to satisfy the good faith efforts requirement, the Department will notify the Bidder of the failure and will give the Bidder an opportunity to provide written documentation or argument concerning the issue of whether it met the goal or made adequate good faith efforts to do so..

The Bidder must request an administrative reconsideration of that determination within 3 days of the date of receipt of the notice. The request must be submitted directly to the Texas Department of Transportation, Civil Rights Division, 125 East 11th Street, Austin, Texas 78701-2483.

If a request for administrative reconsideration is not filed within the period specified the determination made is final and further administrative appeal is barred.

If a reconsideration request is timely received, the reconsideration decision will be made by the Department's DBE liaison officer or, if the DBE liaison officer took part in the original determination, the Department's executive director will appoint a department employee to perform the administrative reconsideration. The employee will hold a senior leadership position and will report directly to the executive director.

The meeting or written documentation must be provided or held within 7 days of the date the request was submitted.

The Department will provide to the Bidder a written decision if the Bidder did or did not make adequate good faith efforts to meet the Contract goal. The reconsideration decision is final and is not administratively appealed to DOT.

2.3.7. **Determination of DBE Participation.** The work performed by the DBE must be reasonably construed to be included in the work area and NAICS work code identified by the Contractor in the approved commitment.

Participation by a DBE on a Contract will not be counted toward DBE goals until the amount of the participation has been paid to the DBE.

Payments made to a DBE that was not on the original commitment may be counted toward the Contract goal if that DBE was certified as a DBE before the execution of the subcontract and has performed a Commercially Useful Function.

The total amount paid to the DBE for work performed with its own forces is counted toward the DBE goal. When a DBE subcontracts part of the work of its Contract to another firm, the value of the subcontracted work may be counted toward DBE goals only if the subcontractor is itself a DBE.

DBE Goal credit for the DBE subcontractors leasing of equipment or purchasing of supplies from the Contractor or its affiliates is not allowed. Project materials or supplies acquired from an affiliate of the Contractor cannot directly or indirectly (second or lower tier subcontractor) be used for DBE goal credit.

If a DBE firm is declared ineligible due to DBE decertification after the execution of the DBE's subcontract, the DBE firm may complete the work and the DBE firm's participation will be counted toward the Contract goal. If the DBE firm is decertified before the DBE firm has signed a subcontract, the Contractor is obligated to replace the ineligible DBE firm or demonstrate that it has made good faith efforts to do so.

The Contractor may count 100% of its expenditure to a DBE manufacturer. According to 49 CFR 26.55(e)(1)(i), a DBE manufacturer is a firm that operates or maintains a factory or establishment that produces, on the premises, the materials, supplies, articles, or equipment required under the Contract and of the general character described by the specifications.

The Contractor may count only 60% of its expenditure to a DBE regular dealer. According to 49 CFR 26.55(e)(2)(i), a DBE regular dealer is a firm that owns, operates, or maintains a store, warehouse, or other establishment in which the materials, supplies, articles, or equipment of the general character described by the specifications and required under the Contract are bought, kept in stock, and regularly sold or leased to the public in the usual course of business. A firm may be a regular dealer in such bulk items as petroleum products, steel, cement, gravel, stone, or asphalt without owning, operating, or maintaining a place of business if the firm both owns and operates distribution equipment for the products. Any supplementing of regular dealers' own distribution equipment must be by a long-term lease agreement and not on an ad hoc or contract-by-contract basis. A long-term lease with a third-party transportation company is not eligible for 60% goal credit.

With respect to materials or supplies purchased from a DBE that is neither a manufacturer nor a regular dealer, the Contractor may count the entire amount of fees or commissions charged for assistance in the procurement of the materials and supplies, or fees or transportation charges for the delivery of materials or supplies required on a job site.

A Contractor may count toward its DBE goal a portion of the total value of the Contract amount paid to a DBE joint venture equal to the distinct, clearly defined portion of the work of the Contract performed by the DBE.

2.3.8. **Commercially Useful Function.** It is the Contractor's obligation to ensure that each DBE used on federal-assisted contracts performs a commercially useful function on the Contract.

The Department will monitor performance during the Contract to ensure each DBE is performing a CUF.

Under the terms established in 49 CFR 26.55, a DBE performs a CUF when it is responsible for execution of the work of the Contract and is carrying out its responsibilities by actually performing, managing, and supervising the work involved.

With respect to material and supplies used on the Contract, a DBE must be responsible for negotiating price, determining quality and quantity, ordering the material, installing the material, if applicable, and paying for the material itself.

With respect to trucking, the DBE trucking firm must own and operate at least one fully licensed, insured, and operational truck used on the Contract. The DBE may lease trucks from another DBE firm, including an owner-operator who is certified as a DBE. The DBE who leases trucks from another DBE receives credit for the total value of the transportation services the lessee DBE provides on the Contract. The DBE may also lease trucks from a non-DBE firm, including from an owner-operator. The DBE that leases trucks equipped with drivers from a non-DBE is entitled to credit for the total value of transportation services provided by non-DBE leased trucks equipped with drivers not to exceed the value of transportation services on the Contract

provided by DBE-owned trucks or leased trucks with DBE employee drivers. Additional participation by non-DBE owned trucks equipped with drivers receives credit only for the fee or commission it receives as a result of the lease arrangement.

A DBE does not perform a CUF when its role is limited to that of an extra participant in a transaction, Contract, or project through which funds are passed in order to obtain the appearance of DBE participation. The Department will evaluate similar transactions involving non-DBEs in order to determine whether a DBE is an extra participant.

If a DBE does not perform or exercise responsibility for at least 30% of the total cost of its Contract with its own work force, or the DBE subcontracts a greater portion of the work than would be expected on the basis of normal industry practice for the type of work involved, the Department will presume that the DBE is not performing a CUF.

If the Department determines that a DBE is not performing a CUF, no work performed by such DBE will count as eligible participation. The denial period of time may occur before or after a determination has been made by the Department.

In case of the denial of credit for non-performance of a CUF, the Contractor will be required to provide a substitute DBE to meet the Contract goal or provide an adequate good faith effort when applicable.

2.3.8.1. **Rebuttal of a Finding of No Commercially Useful Function.** Consistent with the provisions of 49 CFR 26.55(c)(4)&(5), before the Department makes a final finding that no CUF has been performed by a DBE, the Department will notify the DBE and provide the DBE the opportunity to provide rebuttal information.

CUF determinations are not subject to administrative appeal to DOT.

2.3.9. **Joint Check.** The use of joint checks between a Contractor and a DBE is allowed with Department approval. To obtain approval, the Contractor must submit a completed Form 2178, “DBE Joint Check Approval,” to the Department.

The Department will closely monitor the use of joint checks to ensure that such a practice does not erode the independence of the DBE nor inhibit the DBE’s ability to perform a CUF. When joint checks are utilized, DBE credit toward the Contract goal will be allowed only when the subcontractor is performing a CUF in accordance with 49 CFR 26.55(c)(1).

Long-term or open-ended joint checking arrangements may be a basis for further scrutiny and may result in the lack of participation towards the Contract goal requirement if DBE independence cannot be established.

Joint checks will not be allowed simply for the convenience of the Contractor.

If the proper procedures are not followed or the Department determines that the arrangements result in a lack of independence for the DBE involved, no credit for the DBE’s participation as it relates to the material cost will be used toward the Contract goal requirement, and the Contractor will need to make up the difference elsewhere on the project.

2.3.10. **DBE Termination and Substitution.** No DBE named in the commitment submitted under Section 2.3.5. will be terminated for convenience, in whole or part, without the Department’s approval. This includes, but is not limited to, instances in which a Contractor seeks to perform work originally designated for a DBE subcontractor with its own forces or those of an affiliate, a non-DBE firm, or with another DBE firm.

Unless consent is provided, the Contractor will not be entitled to any payment for work or material unless it is performed or supplied by the listed DBE.

The Contractor, prior to submitting its request to terminate, must first give written notice to the DBE of its intent to terminate and the reason for the termination. The Contractor will copy the Department on the Notice of Intent to terminate.

The DBE has 5 calendar days to respond to the Contractor's notice and will advise the Contractor and the Department of the reasons, if any, why it objects to the proposed termination of its subcontract and why the Department should not approve the prime Contractor's request for termination.

The Department may provide a shorter response time if required in a particular case as a matter of public necessity.

The Department will consider both the Contractor's request and DBE's stated position prior to approving the request. The Department may provide a written approval only if it agrees, for reasons stated in its concurrence document, that the Contractor has good cause to terminate the DBE. If the Department does not approve the request, the Contractor must continue to use the committed DBE firm in accordance with the Contract. For guidance on what good cause includes, see 49 CFR 26.53.

Good cause does not exist if the Contractor seeks to terminate, reduce, or substitute a DBE it relied upon to obtain the Contract so that the Contractor can self-perform the work for which the DBE firm was engaged.

When a DBE subcontractor is terminated, make good faith efforts to find, as a substitute for the original DBE, another DBE to perform, at least to the extent needed to meet the established Contract goal, the work that the original DBE was to have performed under the Contract.

Submit the completed Form 2228, "DBE Termination Substitution Request," within seven (7) days, which may be extended for an additional 7 days if necessary at the request of the Contractor. The Department will provide a written determination to the Contractor stating whether or not good faith efforts have been demonstrated. If the Department determines that good faith efforts were not demonstrated, the Contractor will have the opportunity to appeal the determination to the Civil Rights Division.

2.3.11. **Reports and Records.** By the 15th of each month and after work begins, report payments to meet the DBE goal and for DBE race-neutral participation on projects with or without goals. These payment reports will be required until all DBE subcontracting or material supply activity is completed. Negative payment reports are required when no activity has occurred in a monthly period.

Notify the Area Engineer if payment to any DBE subcontractor is withheld or reduced.

Before receiving final payment from the Department, the Contractor must indicate a final payment on the compliance tracking system. The final payment is a summary of all payments made to the DBEs on the project.

All records must be retained for a period of 3 years following completion of the Contract work, and must be available at reasonable times and places for inspection by authorized representatives of the Department or the DOT. Provide copies of subcontracts or agreements and other documentation upon request.

2.3.12. **Failure to Comply.** If the Department determines the Contractor has failed to demonstrate good faith efforts to meet the assigned goal, the Contractor will be given an opportunity for reconsideration by the Department.

A Contractor's failure to comply with the requirements of this Special Provision will constitute a material breach of this Contract. In such a case, the Department reserves the right to terminate the Contract; to deduct the amount of DBE goal not accomplished by DBEs from the money due or to become due the Contractor; or to secure a refund, not as a penalty but as liquidated damages, to the Department or such other remedy or remedies as the Department deems appropriate.

2.3.13. **Investigations.** The Department may conduct reviews or investigations of participants as necessary. All participants, including, but not limited to, DBEs and complainants using DBE Subcontractors to meet the

Contract goal, are required to cooperate fully and promptly with compliance reviews, investigations, and other requests for information.

2.3.14. **Falsification and Misrepresentation.** If the Department determines that a Contractor or subcontractor was a knowing and willing participant in any intended or actual subcontracting arrangement contrived to artificially inflate DBE participation or any other business arrangement determined by the Department to be unallowable, or if the Contractor engages in repeated violations, falsification, or misrepresentation, the Department may:

- refuse to count any fraudulent or misrepresented DBE participation;
- withhold progress payments to the Contractor commensurate with the violation;
- reduce the Contractor's prequalification status;
- refer the matter to the Office of Inspector General of the US Department of Transportation for investigation; and/or
- seek any other available contractual remedy.

Special Provision Item 000
Important Notice to Contractors

The Contractor's attention is directed to the fact that there are experience requirements associated with the Intelligent Transportation Systems (ITS) items contained on this project. The Contractor or its subcontractor must provide information to the Engineer that they meet these requirements with the initial submittals for the associated bid items and before installing or testing ITS items. Following are the ITS items and requirements that must be met if the item is on this project.

Category A. Pulling Fiber Optic Cable.

Contractor or subcontractor must meet the following experience requirements:

- three years continuous existence offering services in the installation of fiber optic cable through an outdoor conduit system and terminating in ground boxes, field cabinets or enclosures, or buildings; and
- three completed projects where the personnel pulled fiber optic cable, minimum 5-mi. in length, through an outdoor conduit system for each project. The completed fiber optic cable systems must have been in continuous satisfactory operation for a minimum of 1 yr.

Category B. Splicing and Testing of Fiber Optic Cable.

Contractor or subcontractor must meet the following experience requirements:

- three years continuous existence offering services in the fields of fusion splicing and testing of fiber optic cable installed through a conduit system and terminating in ground boxes, field cabinets or enclosures, or buildings. Experience must include the following:
  - termination of a minimum of 48 fibers within a fiber distribution frame,
  - optical time-domain reflectometer (OTDR) testing and measurement of end-to-end attenuation of single mode and multimode fibers,
  - system troubleshooting and maintenance,
  - training of personnel in system maintenance,
  - use of water-tight splice enclosures, and
  - fusion splicing of fiber optic cable which meet the tolerable dB losses listed in Table 1 below; and

Table 1
Sample Table

Mode	dB Loss Range
Single mode	0.05–0.10
Multimode	0.20–0.30

- three completed projects where the personnel performed fiber optic cable splicing and terminations, system testing, system troubleshooting and maintenance during the course of the project and provided training on system maintenance. Each project must have consisted of a minimum 5-mi. length of fiber optic cable. The completed fiber optic cable systems must have been in continuous satisfactory operation for a minimum of 1 yr.

Category C. System Integration.

Contractor or subcontractor must meet the following experience requirements:

- three years of providing system integration on wire line and wireless projects including, but not limited to, programming of layer-2 Ethernet switches, integrating into existing systems and coordination with traffic management centers; and

- three completed projects requiring system integration and configuration of hardware including but not limited to Ethernet switches, video encoders and decoders, and radios.

Category D. Dynamic Message Sign (DMS) Installation.

Contractor or subcontractor must meet the following experience requirements:

- three years continuous existence offering services in the installation of DMS signs; and
- three completed projects consisting of a minimum of two signs in each project where the personnel installed, integrated, and tested DMS on outdoor, permanently mounted overhead structures and related sign control equipment. The completed sign system installations must have been in continuous satisfactory operation for a minimum of 1 yr.; and
- one project (may be one of the three projects in the preceding paragraph) in which the personnel worked in cooperation with technical representatives of the equipment supplier to perform the installation, integration, or acceptance testing of the work. The Contractor will not be required to furnish equipment on this project from the same supplier who was referenced in the qualification documentation.

Category E. Closed Circuit Television (CCTV) Equipment Installation.

Contractor or subcontractor must meet the following experience requirements:

- three years continuous existence offering services in the installation of CCTV camera systems;
- three completed projects consisting of a minimum of five cameras in each project where the personnel installed, tested, and integrated CCTV cameras on outdoor, permanently mounted structures and related camera control and transmission equipment. The completed CCTV camera system installations must have been in continuous satisfactory operation for a minimum of 1 yr.; and
- one project (may be one of the three projects in the preceding paragraph) in which the personnel worked in cooperation with technical representatives of the equipment supplier to perform installation, integration, or acceptance testing of the work. The Contractor will not be required to furnish equipment on this project from the same supplier who was referenced in the qualification documentation.

Category F. Wireless Communications.

Contractor or subcontractor must meet the following experience requirements:

- three years continuous existence offering services in the installation of wireless communications. Experience must include the following:
  - conducting radio installation studies, which include signal noise studies, spectrum analysis, antenna gain and radio power calculations, system attenuation, and measurement of standing wave ratios;
  - Installation, troubleshooting, and repair of broadband radio systems, which include equipment installation, configuration of radios, antenna calibration, and cabling; and
  - Installation, troubleshooting, and repair of interconnected Ethernet networks (LAN and WAN), which include cabling, switch or router configuration, and network analysis; and
- three projects consisting of wireless communications installation, troubleshooting, and repair. Each project must include transmitting signals over a minimum of 1-mi. distance and installation of a minimum of three devices; and
- one project (may be one of the three projects in the preceding paragraph) in which the personnel worked in cooperation with technical representatives of the equipment supplier to perform installation, integration, or acceptance testing of the work. The Contractor will not be required to furnish equipment on this project from the same supplier who was referenced in the qualification documentation.

Category G. Radar Detection Systems.

Contractor or subcontractor must meet the following experience requirements:

- three years continuous existence offering services in the installation of radar detection systems. Experience must include the following:
  - freeway and arterial management,
  - forward fire and side fire applications,
  - single zone and dual beam detection, and
  - equipment setup, testing, and troubleshooting; and
- three projects consisting of installation, configuration, and setup of radar detection systems; and
- one project (may be one of the three projects in the preceding paragraph) in which the personnel worked in cooperation with technical representatives of the equipment supplier to perform installation, integration, or acceptance testing of the work. The Contractor will not be required to furnish equipment on this project from the same supplier who was referenced in the qualification documentation.

Should the Contractor have subcontractors which meet the above requirements, and should these subcontractors be unable to complete the ITS items contained within the project, the Contractor must resubmit qualification material on alternate subcontractors for approval before the applicable category of work can be continued.

Special Provision 000
Notice of Contractor Performance Evaluations

1. GENERAL

In accordance with Texas Transportation Code §223.012, the Engineer will evaluate Contractor performance based on quality, safety, and timeliness of the project.

2. DEFINITIONS

2.1. **Project Recovery Plan (PRP)**—a formal, enforceable plan developed by the Contractor, in consultation with the District, that documents the cause of noted quality, safety, and timeliness issues and specifies how the Contractor proposes to correct project-specific performance deficiencies.

In accordance with Title 43, Texas Administrative Code (TAC), §9.23, the District will request a PRP if the Contractor's performance on a project is below the Department's acceptable standards and will monitor the Contractor's compliance with the established plan.

2.2. **Corrective Action Plan (CAP)**—a formal, enforceable plan developed by the Contractor, and proposed for adoption by the Construction or Maintenance Division, that documents the cause of noted quality, safety, and timeliness issues and specifies how the Contractor proposes to correct statewide performance deficiencies.

In accordance with 43 TAC §9.23, the Division will request a CAP if the average of the Contractor's statewide final evaluation scores falls below the Department's acceptable standards for the review period and will monitor the Contractor's compliance with the established plan.

3. CONTRACTOR EVALUATIONS

In accordance with Title 43, Texas Administrative Code (TAC) §9.23, the Engineer will schedule evaluations at the following intervals, at minimum:

- Interim evaluations—at or within 30 days after the anniversary of the notice to proceed, for Contracts extending beyond 1 yr., and
- Final evaluation—upon project closeout.

In case of a takeover agreement, neither the Surety nor its performing Contractor will be evaluated.

In addition to regularly scheduled evaluations, the Engineer may schedule an interim evaluation at any time to formally communicate issues with quality, safety, or timeliness. Upon request, work with the Engineer to develop a PRP to document expectations for correcting deficiencies.

Comply with the PRP as directed. Failure to comply with the PRP may result in additional remedial actions available to the Engineer under Item 5, "Control of the Work." Failure to meet a PRP to the Engineer's satisfaction may result in immediate referral to the Performance Review Committee for consideration of further action against the Contractor.

The Engineer will consider and document any events outside the Contractor's control that contributed to the failure to meet performance standards or comply with a PRP, including consideration of sufficient time.

Follow the escalation ladder if there is a disagreement regarding an evaluation or disposition of a PRP. The Contractor may submit additional documentation pertaining to the dispute. The District Engineer's decision

on a Contractor's evaluation score and recommendation of action required in a PRP or follow up for non-compliance is final.

4. DIVISION OVERSIGHT

Upon request of the Construction or Maintenance Division, develop and submit for Division approval a proposed CAP to document expectations for correcting deficiencies in the performance of projects statewide.

Comply with the CAP as directed. The CAP may be modified at any time up to completion or resolution after written approval of the premise of change from the Division. Failure to meet an adopted or revised adopted CAP to the Division's satisfaction within 120 days will result in immediate referral to the Performance Review Committee for consideration of further action against the Contractor.

The Division will consider and document any events outside the Contractor's control that contributed to the failure to meet performance standards or comply with a CAP, including consideration of sufficient time and associated costs as appropriate.

5. PERFORMANCE REVIEW COMMITTEE

The Performance Review Committee, in accordance with 43 TAC §9.24, will review at minimum all final evaluations, history of compliance with PRPs, any adopted CAPs including agreed modifications, any information about events outside a Contractor's control contributing to the Contractor's performance, and any documentation submitted by the Contractor and may recommend one or more of the following actions:

- take no action,
- reduce the Contractor's bidding capacity,
- prohibit the Contractor from bidding on one or more projects,
- immediately suspend the Contractor from bidding for a specified period of time, by reducing the Contractor's bidding capacity to zero, or
- prohibit the Contractor from being awarded a Contract on which they are the apparent low bidder.

The Deputy Executive Director will determine any further action against the Contractor.

6. APPEALS PROCESS

In accordance with 43 TAC §9.25, the Contractor may appeal remedial actions determined by the Deputy Executive Director.

Special Provision to Item 2
Instructions to Bidders

Item 2, "Instructions to Bidders," of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Article 2.3., "Issuing Proposal Forms," second paragraph, is supplemented by the following.

The Department will not issue a proposal form if one or more of the following apply:

- the Bidder or affiliate of the Bidder that was originally determined as the apparent low Bidder on a project, but was deemed nonresponsive for failure to submit a DBE commitment as specified in Article 2.14., "Disadvantaged Business Enterprise (DBE)," is prohibited from rebidding that specific project.

Article 2.7., "Nonresponsive Bid," is supplemented by the following:

The Department will not accept a nonresponsive bid. A bid that has one or more of the deficiencies listed below is considered nonresponsive:

- the Bidder failed to submit a DBE commitment as specified in Article 2.14., "Disadvantaged Business Enterprise (DBE)."

Article 2.14., "Disadvantaged Business Enterprise (DBE)," is added.

The apparent low bidder must submit DBE commitment information on federally funded projects with DBE goals within 5 calendar days (as defined in 49 CFR Part 26, Subpart A) of bid opening. For a submission that meets the 5-day requirement, administrative corrections will be allowed.

If the apparent low Bidder fails to submit their DBE information within the specified timeframe, they will be deemed nonresponsive and the proposal guaranty will become the property of the State, not as a penalty, but as liquidated damages. The Bidder forfeiting the proposal guaranty will not be considered in future proposals for the same work unless there has been a substantial change in the design of the work. The Department may recommend that the Commission:

- reject all bids, or
- award the Contract to the new apparent low Bidder, if the new apparent low Bidder submits DBE information within one calendar day of notification by the Department.

If the new apparent low Bidder is unable to submit the required DBE information within one calendar day:

- the new apparent low Bidder will not be deemed nonresponsive,
- the new apparent low Bidder's guaranty will not be forfeited,
- the Department will reject all bids, and
- the new apparent low Bidder will remain eligible to receive future proposals for the same project.

Special Provision to Item 2
Instructions to Bidders

Item 2, "Instructions to Bidders" of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Article 3., "Issuing Proposal Forms," is supplemented by the following:

The Electronic State Business Daily (ESBD), the Integrated Contractor Exchange (iCX) system, and the project proposal are the official sources of advertisement and bidding information for the State and Local Lettings. Bidders should bid the project using the information found therein, including any addenda. These sources take precedence over information from other sources, including TxDOT webpages, which are unofficial and intended for informational purposes only.

Special Provision to Item 2
Instructions to Bidders

Item 2, "Instructions to Bidders," of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Section 2.8.2., "Proposal Guaranty," third paragraph is replaced by the following.

It is the Bidder's responsibility to ensure the electronic bid bond is issued in the name or Department vendor identification numbers of the Bidder or Bidders.

Special Provision to Item 2
Instructions to Bidders

Item 2, "Instructions to Bidders," of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Article 2.3., "Issuing Proposal Forms," is supplemented by the following:

- the Bidder or affiliate of the Bidder that was originally determined as the apparent low Bidder on a project but was deemed nonresponsive for failure to register or participate in the Department of Homeland Security's (DHS) E-Verify system as specified in Article 2.15., "Department of Homeland Security (DHS) E-Verify System," is prohibited from rebidding that specific project.

Article 2.7., "Nonresponsive Bid," is supplemented by the following:

- the Bidder failed to participate in the Department of Homeland Security's (DHS) as specified in Article 2.15., "Department of Homeland Security (DHS) E-Verify System."

Article 2.15., "Department of Homeland Security (DHS) E-Verify System," is added.

The Department will not award a Contract to a Contractor that is not registered in the DHS E-Verify system. Remain active in E-Verify throughout the life of the Contract. In addition, in accordance with paragraph six of Article 8.2., "Subcontracting," include this requirement in all subcontracts and require that subcontractors remain active in E-Verify until their work is completed.

If the apparent low Bidder does not appear in the DHS E-Verify system before award, the Contractor must submit documentation showing that they are compliant within 5 calendar days after bid opening. A Contractor that fails to comply or respond within the deadline will be declared nonresponsive. The Bidder forfeiting the proposal guaranty will not be considered in future proposals for the same work unless there has been a substantial change in the scope of the work.

The Department may recommend that the Commission:

- reject all bids, or
- award the Contract to the new apparent low Bidder, if the Department is able to verify the Bidder's participation in the DHS E-Verify system.

If the Department is unable to verify the new apparent low Bidder's participation in the DHS E-Verify system:

- the new apparent low Bidder will not be deemed nonresponsive,
- the new apparent low Bidder's guaranty will not be forfeited,
- the Department will reject all bids,
- the new apparent low Bidder will remain eligible to receive future proposals for the same project, and
- the proposal guaranty of the original low bidder will become the property of the State, not as a penalty, but as liquidated damages.

Special Provision to Item 3
Award and Execution Contract

Item 3, Award and Execution of Contract," of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Section 4.3, "Insurance." The first sentence is voided and replaced by the following:

For construction and building Contracts, submit a certificate of insurance showing coverages in accordance with Contract requirements. For routine maintenance Contracts, refer to Article 8, "Beginning of Work."

Article 8, "Beginning of Work." The first sentence is supplemented by the following:

For a routine maintenance Contract, do not begin work until a certificate of insurance showing coverages in accordance with the Contract requirements is provided and accepted.

Special Provision to Item 3
Award and Execution of Contract

Item 3, "Award and Execution of Contract" of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Section 4.3 "Insurance" is being amended by the following:

Table 2
Insurance Requirements

Type of Insurance	Amount of Coverage
Commercial General Liability Insurance	Not Less Than: $600,000 each occurrence
Business Automobile Policy	Not Less Than: $600,000 combined single limit
Workers' Compensation	Not Less Than: Statutory
All Risk Builder's Risk Insurance (For building-facilities contracts only)	100% of Contract Price

Special Provision to Item 5
Control of the Work

Item 5, "Control of the Work," of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Article 5.1, "Authority of Engineer," is voided and replaced by the following.

The Engineer has the authority to observe, test, inspect, approve, and accept the work. The Engineer decides all questions about the quality and acceptability of materials, work performed, work progress, Contract interpretations, and acceptable Contract fulfillment. The Engineer has the authority to enforce and make effective these decisions.

The Engineer acts as a referee in all questions arising under the terms of the Contract. The Engineer's decisions will be final and binding.

The Engineer will pursue and document actions against the Contractor as warranted to address Contract performance issues. Contract remedies include, but are not limited to, the following:

- conducting interim performance evaluations requiring a Project Recovery Plan, in accordance with Title 43, Texas Administrative Code (TAC) §9.23,
- requiring the Contractor to remove and replace defective work, or reducing payment for defective work,
- removing an individual from the project,
- suspending the work without suspending working day charges,
- assessing standard liquidated damages to recover the Department's administrative costs, including additional project-specific liquidated damages when specified in the Contract in accordance with 43 TAC §9.22,
- withholding estimates,
- declaring the Contractor to be in default of the Contract, and
- in case of a Contractor's failure to meet a Project Recovery Plan, referring the issue directly to the Performance Review Committee for consideration of further action against the Contractor in accordance with 43 TAC §9.24.

The Engineer will consider and document any events outside the Contractor's control that contributed to the failure to meet performance standards, including consideration of sufficient time.

Follow the issue escalation ladder if there is disagreement regarding the application of Contract remedies.

Special Provision to Item 5
Control of the Work

Item 5, “Control of the Work” of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Article 5.4, “Coordination of Plans, Specifications, and Special Provisions,” the last sentence of the last paragraph is replaced by the following:

Failure to promptly notify the Engineer will constitute a waiver of all contract claims against the Department for misunderstandings or ambiguities that result from the errors, omissions, or discrepancies.

Special Provision to Item 6
Control of Materials

For this project, Item 6, "Control of Materials," of the Standard Specifications, is hereby amended with respect to the clauses cited below, and no other clauses or requirements of this Item are waived or changed hereby.

Article 4., "Sampling, Testing, and Inspection," is supplemented by the following:

Meet with the Engineer and choose either the Department or a Department-selected Commercial Lab (CL) for conducting the subset of project-level sampling and testing shown in Table 1, "Select Guide Schedule Sampling and Testing." Selection may be made on a test by test basis. CLs will meet the testing turnaround times shown (includes test time and time for travel/sampling and reporting) and in all cases issue test reports as soon as possible.

If the Contractor chooses a Department-selected CL for any Table 1 sampling and testing:

- notify the Engineer, District Lab, and the CL of project scheduling that may require CL testing;
- provide the Engineer, District Lab, and CL at least 24 hours' notice by phone and e-mail;
- reimburse the Department for CL Table 1 testing using the contract fee schedule for the CL (including mileage and travel/standby time) at the minimum guide schedule testing frequencies;
- reimburse the Department for CL Table 1 testing above the minimum guide schedule frequencies for retesting when minimum frequency testing results in failures to meet specification limits;
- agree with the Engineer and CL upon a policy regarding notification for testing services;
- give any cancellation notice to the Engineer, District Lab, and CL by phone and e-mail;
- reimburse the Department a $150 cancellation fee to cover technician time and mileage charges for previously scheduled work cancelled without adequate notice, which resulted in mobilization of technician and/or equipment by the CL; and
- all CL charges will be reimbursed to the Department by a deduction from the Contractor's monthly pay estimate.

If the CL does not meet the Table 1 turnaround times, testing charge to the Contractor will be reduced by 50% for the first late day and an additional 5% for each succeeding late day.

Approved CL project testing above the minimum testing frequencies in the Guide Schedule of Sampling and Testing, and not as the result of failing tests, will be paid by the Department.

Other project-level Guide Schedule sampling and testing not shown on Table 1 will be the responsibility of the Department.

Table 1
Select Guide Schedule Sampling and Testing (Note 1)

TxDOT Test	Test Description	Turn-Around Time (Calendar days)
SOILS/BASE		
Tex-101-E	Preparation of Soil and Flexible Base Materials for Testing (included in other tests)	
Tex-104-E	Liquid Limit of Soils (included in 106-E)	
Tex-105-E	Plastic Limit of Soils (included in 106-E)	
Tex-106-E	Calculating the Plasticity Index of Soils	7
Tex-110-E	Particle Size Analysis of Soils	6
Tex-113-E	Moisture-Density Relationship of Base Materials	7
Tex-114-E	Moisture-Density Relationship of Subgrade and Embankment Soil	7
Tex-115-E	Field Method for In-Place Density of Soils and Base Materials	2
Tex-116-E	Ball Mill Method for the Disintegration of Flexible Base Material	5
Tex-117-E, Part II	Triaxial Compression Tests For Disturbed Soils and Base Materials (Part II)	6
Tex-113-E **w/** Tex-117-E	Moisture-Density Relationship of Base Materials **with** Triaxial Compression Tests For Disturbed Soils and Base Materials (Part II)	10
Tex-140-E	Measuring Thickness of Pavement Layer	2
Tex-145-E	Determining Sulfate Content in Soils - Colorimetric Method	4
HOT MIX ASPHALT		
Tex-200-F	Sieve Analysis of Fine and Coarse Aggregate (dry, from ignition oven with known correction factors)	1 (Note 2)
Tex-203-F	Sand Equivalent Test	3
Tex-206-F, **w/** Tex-207-F, Part I, **w/** Tex-227-F	**(Lab-Molded Density of Production Mixture – Texas Gyratory)** Method of Compacting Test Specimens of Bituminous Mixtures **with** Density of Compacted Bituminous Mixtures, Part I - Bulk Specific Gravity of Compacted Bituminous Mixtures, **with** Theoretical Maximum Specific Gravity of Bituminous Mixtures	1 (Note 2)
Tex-207-F, Part I **&/or** Part VI	**(In-Place Air Voids of Roadway Cores)** Density of Compacted Bituminous Mixtures, Part I- Bulk Specific Gravity of Compacted Bituminous Mixtures **&/or** Part VI - Bulk Specific Gravity of Compacted Bituminous Mixtures Using the Vacuum Method	1 (Note 2)
Tex-207-F, Part V	Density of Compacted Bituminous Mixtures, Part V- Determining Mat Segregation using a Density-Testing Gauge	3
Tex-207-F, Part VII	Density of Compacted Bituminous Mixtures, Part VII - Determining Longitudinal Joint Density using a Density-Testing Gauge	4
Tex-212-F	Moisture Content of Bituminous Mixtures	3
Tex-217-F	Deleterious Material and Decantation Test for Coarse Aggregate	4
Tex-221-F	Sampling Aggregate for Bituminous Mixtures, Surface Treatments, and LRA (included in other tests)	
Tex-222-F	Sampling Bituminous Mixtures (included in other tests)	
Tex-224-F	Determination of Flakiness Index	3
Tex-226-F	Indirect Tensile Strength Test (production mix)	4
Tex-235-F	Determining Draindown Characteristics in Bituminous Materials	3
Tex-236-F (Correction Factors)	Asphalt Content from Asphalt Paving Mixtures by the Ignition Method (Determining Correction Factors)	4
Tex-236-F	Asphalt Content from Asphalt Paving Mixtures by the Ignition Method (Production Mixture)	1 (Note 2)
Tex-241-F **w/** Tex-207-F, Part I, **w/** Tex-227-F	**(Lab-Molded Density of Production Mixture – Superpave Gyratory)** Superpave Gyratory Compacting of Specimens of Bituminous Mixtures (production mixture) **with** Density of Compacted Bituminous Mixtures, Part I- Part I - Bulk Specific Gravity of Compacted Bituminous Mixtures, **with** Theoretical Maximum Specific Gravity of Bituminous Mixtures	1 (Note 2)
Tex-242-F	Hamburg Wheel-Tracking Test (production mix, molded samples)	3
Tex-244-F	Thermal Profile of Hot Mix Asphalt	1
Tex-246-F	Permeability of Water Flow of Hot Mix Asphalt	3
Tex-280-F	Flat and Elongated Particles	3
Tex-530-C	Effect of Water on Bituminous Paving Mixtures (production mix)	4

AGGREGATES		
Tex-400-A	Sampling Flexible Base, Stone, Gravel, Sand, and Mineral Aggregates	3
Tex-410-A	Abrasion of Coarse Aggregate Using the Los Angeles Machine	5
Tex-411-A	Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate	12
Tex-461-A	Degradation of Coarse Aggregate by Micro-Deval Abrasion	5
CHEMICAL		
Tex-612-J	Acid Insoluble Residue for Fine Aggregate	4
GENERAL		
HMA Production Specialist [TxAPA – Level 1-A] ($/hr)		
HMA Roadway Specialist [TxAPA – Level 1-B] ($/hr)		
Technician Travel/Standby Time ($/hr)		
Per Diem ($/day – meals and lodging)		
Mileage Rate ($/mile from closest CL location)		

Note 1– Turn-Around Time includes test time and time for travel/sampling and reporting.
Note 2 – These tests require turn-around times meeting the governing specifications. Provide test results within the stated turn-around time. CL is allowed one additional day to provide the signed and sealed report.

Special Provision to Item 6
Control of Materials

Item 6, "Control of Materials" of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Article 6.10., "Hazardous Materials," is voided and replaced by the following:

Comply with the requirements of Article 7.12., "Responsibility for Hazardous Materials."

Notify the Engineer immediately when a visual observation or odor indicates that materials on sites owned or controlled by the Department may contain hazardous materials. Except as noted herein, the Department is responsible for testing, removing, and disposing of hazardous materials not introduced by the Contractor. The Engineer may suspend work wholly or in part during the testing, removing, or disposing of hazardous materials, except in the case where hazardous materials are introduced by the Contractor.

Use materials that are free of hazardous materials. Notify the Engineer immediately if materials are suspected to contain hazardous materials. If materials delivered to the project by the Contractor are suspected to contain hazardous materials, have an approved commercial laboratory test the materials for the presence of hazardous materials as approved. Remove, remediate, and dispose of any of these materials found to contain hazardous materials. The work required to comply with this section will be at the Contractor's expense if materials are found to contain hazardous materials. Working day charges will not be suspended and extensions of working days will not be granted for activities related to handling hazardous material introduced by the Contractor. If suspected materials are not found to contain hazardous materials, the Department will reimburse the Contractor for hazardous materials testing and will adjust working day charges if the Contractor can show that this work impacted the critical path.

10.1. Painted Steel Requirements. Coatings on existing steel contain hazardous materials unless otherwise shown on the plans. Remove paint and dispose of steel coated with paint containing hazardous materials is in accordance with the following:

10.1.1. Removing Paint From Steel For contracts that are specifically for painting steel, Item 446, "Field Cleaning and Painting Steel" will be included as a pay item. Perform work in accordance with that item.

For projects where paint must be removed to allow for the dismantling of steel or to perform other work, the Department will provide for a separate contractor (third party) to remove paint containing hazardous materials prior to or during the Contract. Remove paint covering existing steel shown not to contain hazardous materials in accordance with Item 446, "Field Cleaning and Painting Steel."

10.1.2. Removal and Disposal of Painted Steel. For steel able to be dismantled by unbolting, paint removal will not be performed by the Department. The Department will remove paint, at locations shown on the plans or as agreed, for the Contractor's cutting and dismantling purposes. Utilize Department cleaned locations for dismantling when provided or provide own means of dismantling at other locations.

Painted steel to be retained by the Department will be shown on the plans. For painted steel that contains hazardous materials, dispose of the painted steel at a steel recycling or smelting facility unless otherwise shown on the plans. Maintain and make available to the Engineer invoices and other records obtained from the facility showing the received weight of the steel and the facility name. Dispose of steel that does not contain hazardous material coatings in accordance with federal, state and local regulations.

10.2. Asbestos Requirements. The plans will indicate locations or elements where asbestos containing materials (ACM) are known to be present. Where ACM is known to exist or where previously unknown ACM has been found, the Department will arrange for abatement by a separate contractor prior to or during the Contract. Notify the Engineer of proposed dates of demolition or removal of structural elements with ACM at least 60 days before beginning work to allow the Department sufficient time for abatement.

The Department of State Health Services (DSHS), Asbestos Programs Branch, is responsible for administering the requirements of the National Emissions Standards for Hazardous Air Pollutants, 40 CFR Part 61, Subpart M and the Texas Asbestos Health Protection Rules (TAHPR). Based on EPA guidance and regulatory background information, bridges are considered to be a regulated “facility” under NESHAP. Therefore, federal standards for demolition and renovation apply.

The Department is required to notify the DSHS at least 10 working days (by postmarked date) before initiating demolition or renovation of each structure or load bearing member shown on the plans. If the actual demolition or renovation date is changed or delayed, notify the Engineer in writing of the revised dates in sufficient time to allow for the Department’s notification to DSHS to be postmarked at least 10 days in advance of the actual work.

Failure to provide the above information may require the temporary suspension of work under Article 8.4., “Temporary Suspension of Work or Working Day Charges,” due to reasons under the control of the Contractor. The Department retains the right to determine the actual advance notice needed for the change in date to address post office business days and staff availability.

10.3. Lead Abatement. Provide traffic control as shown on the plans, and coordinate and cooperate with the third party and the Department for managing or removing hazardous materials. Work for the traffic control shown on the plans and coordination work will not be paid for directly but will be subsidiary to pertinent Items.

Special Provision to Item 6
Control of Materials

Item 6, "Control of Materials" of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Section 1.1. "Buy America.," This section is voided and replaced by the following:

1.1. **Buy America**. Comply with the latest provisions of Build America, Buy America Act (BABA Act) of the Bipartisan Infrastructure Law and applicable CFR, which restrict funds being made available from Federal financial assistance programs unless all the iron products, steel products, manufactured products, and construction materials used in the project are produced in the United States. Use iron or steel products, manufactured products, or construction materials produced in the United States for all permanently installed materials and products except when defined in Section 1.1.5., "Buy America Exceptions."

A material is solely classified based on its status at the time it is brought to the work site as either an iron or steel product, construction material, manufactured product, or Section 70917(c) material. Refer to the Buy America Material Classification Sheet found in the general notes or txdot.gov for additional clarification on material classification.

1.1.1. **Iron or Steel**. Iron or steel products means articles, materials, or supplies that consist of iron or steel or a combination of both. For iron or steel products, manufacturing includes any process that modifies the chemical content, physical shape or size, or final finish of a product. The manufacturing process begins with initial melting and mixing and continues through fabrication (cutting, drilling, welding, bending, etc.) and coating (paint, galvanizing, epoxy, etc.).

For iron or steel products submit a notarized original FORM D-9-USA-1 (Department Form 1818) with the proper attachments for verification of compliance.

1.1.2. **Section 70917(c) Materials**. Section 70917(c) materials mean cement and cementitious material; aggregates such as stone, sand, or gravel; or aggregate binding agents or additives. Section 70917(c) materials do not require domestic sourcing or Buy America certification.

1.1.3. **Construction Materials**. Construction materials are classified as articles, materials, or supplies that consist of only one of the items listed in bullets below. Minor additions (as determined by plans or Engineer) to any of the items listed is still a construction material.

- non-ferrous metals,
- plastic and polymer-based products (including polyvinyl chloride, composite building materials, and polymers used in fiber optic cables),
- glass (including optic glass),
- fiber optic cable (including drop cable),
- optical fiber,
- lumber,
- engineered wood, or
- drywall.

For construction materials, submit a Construction Material Buy America Certification Form (Department Form 2806) for verification of compliance that all manufacturing processes, as required, occurred in the

United States. Each construction material has specific certification requirements stated below. Provide additional documentation as requested.

Details shown on the plans provide additional clarification on Buy America requirements.

For non-ferrous metals, certification requires all manufacturing processes, from initial smelting or melting through final shaping, coating, and assembly, occurred in the United States.

For plastic and polymer-based products (including polyvinyl chloride, composite building materials, and polymers used in fiber optic cables), certification requires all manufacturing processes, from initial combination of constituent plastic or polymer-based inputs, or, where applicable, constituent composite materials, until the item is in its final form, occurred in the United States.

For glass (including optic glass), certification requires all manufacturing processes, from initial batching and melting of raw materials through annealing, cooling, and cutting, occurred in the United States.

For fiber optic cable (including drop cable), certification requires all manufacturing processes, from the initial ribboning (if applicable), through buffering, fiber stranding and jacketing, occurred in the United States. All manufacturing processes also include the standards for glass and optical fiber, but not for non-ferrous metals, plastic and polymer-based products, or any others.

For optical fiber, certification requires all manufacturing processes, from the initial preform fabrication stage through the completion of the draw, occurred in the United States.

For lumber, certification requires all manufacturing processes, from initial debarking through treatment and planing, occurred in the United States.

For engineered wood, certification requires all manufacturing processes from the initial combination of constituent materials until the wood product is in its final form, occurred in the United States.

For drywall, certification requires all manufacturing processes, from initial blending of mined or synthetic gypsum plaster and additives through cutting and drying of sandwiched panels, occurred in the United States.

1.1.4. **Manufactured Products**. Materials classified as a manufactured product are currently waived from Buy America requirements by an FHWA general waiver and are not required to be domestically sourced. However, iron or steel products incorporated into manufactured products must meet iron and steel compliance requirements.

1.1.5. **Buy America Exceptions**. Use of iron, steel, construction materials, and manufactured products manufactured in the United States is required unless the material meets an exception below.

- A waiver exists exempting the material from Buy America compliance.
- The total value of the non-compliant products (other than iron or steel products) is no more than the lesser of $1,000,000 or 5% of Total Applicable Costs for the project. Total Applicable Cost means the actual cost of all materials requiring Buy America compliance including iron, steel, or other materials that are within the scope of existing waivers. Contractor must provide documentation showing under threshold in advance for Engineer's consideration.
- The total value of foreign iron and steel products, including delivery, does not exceed 0.1% of the total Contract cost or $2,500, whichever is greater. Contractor must provide documentation showing under threshold in advance for Engineer's consideration.
- Foreign steel may be allowed when the Contract contains an alternate item for a foreign source iron or steel product and the Contract is awarded based on the alternate item.

- The materials are temporarily installed or are supplies, tools and equipment not incorporated into the project. Temporarily installed means the materials and products must be removed at the end of the project or may be removed at the contractor's convenience with Engineers approval.

Special Provision to Item 7
Legal Relations and Responsibilities

Item 7, "Legal Relations and Responsibilities," of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Section 7.7.2., "Texas Pollutant Discharge Elimination System (TPDES) Permits and Storm Water Pollution Prevention Plans (SWP3)," is voided and replaced by the following:

7.2. Texas Pollution Discharge Elimination System (TPDES) Permits and Storm Water Pollution Prevention Plans (SWP3).

7.2.1. Projects with less than one acre of soil disturbance including required associated project specific locations (PSL's) per TPDES GP TXR 150000.

No posting or filing will be required for soil disturbances within the right of way. Adhere to the requirements of the SWP3.

7.2.2. Projects with one acre but less than five acres of soil disturbance including required associated PSL's per TPDES GP TXR 150000.

The Department will be considered a primary operator for Operational Control Over Plans and Specifications as defined in TPDES GP TXR 150000 for construction activity in the right of way. The Department will post a small site notice along with other requirements as defined in TPDES GP TXR 150000 as the entity of having operational control over plans and specifications for work shown on the plans in the right of way.

The Contractor will be considered a Primary Operator for Day-to-Day Operational Control as defined in TPDES GP TXR 150000 for construction activity in the right of way. In addition to the Department's actions, the Contractor will post a small site notice along with other requirements as defined in TPDES GP TXR 150000 as the entity of having day-to-day operational control of the work shown on the plans in the right of way. This is in addition to the Contractor being responsible for TPDES GP TXR 150000 requirements for on- right of way and off- right of way PSL's. Adhere to all requirements of the SWP3 as shown on the plans. The Contractor will be responsible for Implement the SWP3 for the project site in accordance with the plans and specifications, TPDES General Permit TXR150000, and as directed.

7.2.3. Projects with 5 acres or more of soil disturbance including required associated PSL's per TPDES GP TXR 150000.

The Department will be considered a primary operator for Operational Control Over Plans and Specifications as defined in TPDES GP TXR 150000 for construction activities in the right of way. The Department will post a large site notice, file a notice of intent (NOI), notice of change (NOC), if applicable, and a notice of termination (NOT) along with other requirements per TPDES GP TXR 150000 as the entity having operational control over plans and specifications for work shown on the plans in the right of way.

The Contractor will be considered a primary operator for Day-to-Day Operational Control as defined in TPDES GP TXR 150000 for construction activities in the right of way. In addition to the Department's actions, the Contractor shall file a NOI, NOC, if applicable, and NOT and post a large site notice along with other requirements as the entity of having day-to-day operational control of the work shown on the plans in the right of way. This is in addition to the Contractor

being responsible for TPDES GP TXR 150000 requirements for on- right of way and off- right of way PSL's. Adhere to all requirements of the SWP3 as shown on the plans.

Special Provision to Item 7
Legal Relations and Responsibilities

Item 7, "Legal Relations and Responsibilities" of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Section 19.1., Minimum Wage Requirements for Federally Funded Contracts. The second paragraph is voided and replaced by the following:

Submit electronic payroll records to the Engineer using the Department's payroll system.

Section 19.2., Minimum Wage Requirements for State Funded Contracts. The second paragraph is voided and replaced by the following:

Submit electronic payroll records to the Engineer using the Department's payroll system.

Special Provision to Item 7
Legal Relations and Responsibilities

Item 7, "Legal Relations and Responsibilities," of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Section 7.2.4., "Public Safety and Convenience." The first paragraph is deleted and replaced by the following.

Ensure the safety and convenience of the public and property as provided in the Contract and as directed. Keep existing roadways open to traffic or construct and maintain detours and temporary structures for safe public travel. Manage construction to minimize disruption to traffic. Maintain the roadway in a good and passable condition, including proper drainage and provide for ingress and egress to adjacent property.

If the construction of the project requires the closing of a highway, as directed, coordinate the closure with the Engineer and work to ensure all lanes and ramps possible are available during peak traffic periods before, during, and after significant traffic generator events to avoid any adverse economic impact on the municipalities during:

- dates or events as shown on the plans, and
- other dates as directed.

Special Provision to Item 007
Legal Relations and Responsibilities

Item 7, "Legal Relations and Responsibilities," of the Standard Specifications is amended with respect to the clauses cited below.

Section 2.6., "Barricades, Signs, and Traffic Handling," the first paragraph is voided and replaced by the following:

2.6. **Barricades, Signs, and Traffic Handling.** Comply with the requirements of Item 502 "Barricades, Signs, and Traffic Handling," and as directed. Provide traffic control devices that conform to the details shown on the plans, the TMUTCD, and the Department's Compliant Work Zone Traffic Control Device List maintained by the Traffic Safety Division. When authorized or directed, provide additional signs or traffic control devices not required by the plans.

Section 2.6.1., "Contractor Responsible Person and Alternative," is voided and replaced by the following:

2.6.1. **Contractor Responsible Person and Alternative.** Designate in writing, a Contractor's Responsible Person (CRP) and an alternate to be the representative of the Contractor who is responsible for taking or directing corrective measures regarding the traffic control. The CRP or alternate must be accessible by phone 24 hr. per day and able to respond when notified. The CRP and alternate must comply with the requirements of Section 2.6.5., "Training."

Section 2.6.2, "Flaggers," the first paragraph is voided and replaced by the following:

2.6.2. **Flaggers.** Designate in writing, a flagger instructor who will serve as a flagging supervisor and is responsible for training and assuring that all flaggers are qualified to perform flagging duties. Certify to the Engineer that all flaggers will be trained and make available upon request a list of flaggers trained to perform flagging duties.

Section 2.6.5, "Training," is voided and replaced by the following:

2.6.5. **Training.** Train workers involved with the traffic control using Department-approved training as shown on the "Traffic Control Training" Material Producer List.

Coordinate enrollment, pay associated fees, and successfully complete Department-approved training or Contractor-developed training. Training is valid for the period prescribed by the provider. Except for law enforcement personnel training, refresher training is required every 4 yr. from the date of completion unless otherwise specified by the course provider. The Engineer may require training at a frequency instead of the period prescribed based on the Department's needs. Training and associated fees will not be measured or paid for directly but are considered subsidiary to pertinent Items.

Certify to the Engineer that workers involved in traffic control and other work zone personnel have been trained and make available upon request a copy of the certification of completion to the Engineer. Ensure the following is included in the certification of completion:

- name of provider and course title,
- name of participant,
- date of completion, and
- date of expiration.

Where Contractor-developed training or a Department-approved training course does not produce a certification, maintain a log of attendees. Make the log available upon request. Ensure the log is legible and includes the following:

- printed name and signature of participant,
- name and title of trainer, and
- date of training.

2.6.5.1. **Contractor-developed Training.** Develop and deliver Contractor-developed training meeting the minimum requirements established by the Department. The outline for this training must be submitted to the Engineer for approval at the preconstruction meeting. The CRP or designated alternate may deliver the training instead of the Department-approved training. The work performed and materials furnished to develop and deliver the training will not be measured or paid for directly but will be considered subsidiary to pertinent Items.

2.6.5.1.1. **Flagger Training Minimum Requirements.** A Contractor's certified flagging instructor is permitted to train other flaggers.

2.6.5.1.2. **Optional Contractor-developed Training for Other Work Zone Personnel.** For other work zone personnel, the Contractor may provide training meeting the curriculum shown below instead of Department-approved training.

Minimum curriculum for Contractor-provided training is as follows:

Contractor-developed training must provide information on the use of personnel protection equipment, occupational hazards and health risks, and other pertinent topics related to traffic management. The type and amount of training will depend on the job duties and responsibilities. Develop training applicable to the work being performed. Develop training to include the following topics.

- The Life You Save May Be Your Own (or other similar company safety motto).
- Purpose of the training.
  - It's the Law.
  - To make work zones safer for workers and motorist.
  - To understand what is needed for traffic control.
  - To save lives including your own.
- Personal and Co-Worker Safety.
  - **High Visibility Safety Apparel.** Discuss compliant requirements; inspect regularly for fading and reduced reflective properties; if night operations are required, discuss the additional and appropriate required apparel in addition to special night work risks; if moving operations are underway, discuss appropriate safety measures specific to the situation and traffic control plan.
  - **Blind Areas.** A blind area is the area around a vehicle or piece of construction equipment not visible to the operators, either by line of sight or indirectly by mirrors. Discuss the "Circle of Safety" around equipment and vehicles; use of spotters; maintain eye contact with equipment operators; and use of hand signals.
  - **Runovers and Backovers.** Remain alert at all times; keep a safe distance from traffic; avoid turning your back to traffic and if you must then use a spotter; and stay behind protective barriers, whenever possible. Note: It is not safe to sit on or lean against a concrete barrier, these barriers can deflect four plus feet when struck by a vehicle.
  - Look out for each other, warn co-workers.
  - Be courteous to motorists.
  - Do not run across active roadways.
  - Workers must obey traffic laws and drive courteously while operating vehicles in the work zones.
  - Workers must be made aware of company distracted driving policies.
- **Night Time Operations.** Focus should be placed on projects with a nighttime element.

- **Traffic Control Training.** Basics of Traffic Control.
  - Identify work zone traffic control supervisor and other appropriate persons to report issues to when they arise.
  - Emphasize that work zone traffic control devices must be in clean and in undamaged condition. If devices have been hit but not damaged, put back in their correct place and report to traffic control supervisor. If devices have been damaged, replace with new one and report to traffic control supervisor. If devices are dirty, faded or have missing or damaged reflective tape clean or replace and report to traffic control supervisor. Show examples of non-acceptable device conditions. Discuss various types of traffic control devices to be used and where spacing requirements can be found.
  - **Channelizing Devices and Barricades with Slanted Stripes.** Stripes are to slant in the direction you want traffic to stay or move to; demonstrate this with a device.
  - **Traffic Queuing.** Workers must be made aware of traffic queuing and the dangers created by it. Workers must be instructed to immediately notify the traffic control supervisor and other supervisory personnel if traffic is queuing beyond advance warning sign and devices or construction limits.
  - **Signs.** Signs must be straight and not leaning. Report problems to the traffic control supervisor or other as designated for immediate repair. Covered signs must be fully covered. If covers are damaged or out of place, report to traffic control supervisor or other as designated.

Special Provision to Item 7
Legal Relations and Responsibilities

Item 7, "Legal Relations and Responsibilities" of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Article 7.20., "Security Incidents," is added**.**

20.1. **Reporting of Security Incidents.** Immediately notify the Department's Cyber Security Operations Center (CSOC) via the Report Cybersecurity Incident Page on www.txdot.gov, of any potential cybersecurity incident or breach involving Department data**.** A breach of system security is the unauthorized acquisition of computerized data that compromises the security, confidentiality, or integrity of sensitive personal information maintained by a person, including data that is encrypted if the person accessing the data has the key required to decrypt the data.

20.2. **Liability for costs incurred.** The Department reserves the right to hold the Contractor liable for all costs incurred by the Department to resolve a security incident introduced by the Contractor, their Subcontractors, or their Suppliers.

Special Provision to Item 8
Prosecution and Progress

Item 8, "Prosecution and Progress" of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

This item is supplemented by the following:

9. **Incentive Using Road-User Cost or Contract Administration Liquidated Damage Values and Disincentive Using Road-User Cost.** This special provision is for the application of incentives and disincentives as follows:

- incentives for early Contract completion using contract administration liquidated damage or substantial completion of work ahead of time using daily road-user cost values as basis and
- disincentives for late substantial completion of work using daily road-user costs.

Incentive provisions, based on contract administration liquidated damages, will apply when shown on the plans. Incentive provisions, based on road-user cost, will apply when shown on the plans. Disincentive provisions, based on road-user cost, will apply when road-user cost incentive provisions are shown on the plans. The disincentive provisions, based on road-user cost, will also apply when shown separately on the plans (without an associated road-user cost incentive). Definitions are as follows:

- Contract Completion - The final acceptance date (day) unless performance, establishment and maintenance periods occur. In the case of performance, establishment and maintenance periods, completion shall be considered when all work is complete and accepted except for performance, establishment and maintenance periods, with time computed to the suspension of time charges for the acceptance process.
- Substantial Completion of Work - The date (day) when all project work (or the work for a specified milestone or phase) requiring lane or shoulder closures or obstructions is completed, and traffic is following the lane arrangement as shown on the plans for the finished roadway (or the specified milestone or phase of work); all pavement construction and resurfacing are complete; and traffic control devices and pavement markings are in their final position (or as called for on the plans for the specified milestone of work). The Engineer may make an exception for permanent pavement markings provided the lack of markings does not cause a disruption to traffic flow or an unsafe condition for the traveling public, and work zone pavement markings are in place.

When A + B Bidding provisions are included in the Contract, the B working days bid will be considered as the time allowed for completion, contract or substantial as applicable. In addition, the plans will show either the number of working days or a specific date for the purposes of computing substantial completion incentives or disincentives.

Time charge adjustments will be made in accordance with the schedule required to meet Article 8.1, "Prosecution of Work" and Article 8.5, "Project Schedules," the proposal, and the plans. For Contracts with milestone dates, time charges for the completion incentives and disincentives will not be adjusted for weather, weekends, holidays, or other unforeseeable events not under the control or responsibility of the Department. However, time charges for completion incentives or disincentives may be adjusted by the Engineer when;

- work, under the control of the Department, such as extension of limits or changes in scope, change the actual duration of completion,

- delays occur due to unadjusted utilities or unclear right-or-way when clearance is not the responsibility of the Contractor, or
- catastrophic events occur, such as a declared state of emergency or natural disaster, if the event directly affects the Contractor's prosecution.

9.1. **Incentives.** When shown on the plans and in accordance with the Contract, the Department will pay an incentive for the early Contract completion or substantial completion of work under the number of working days stipulated in the Contract. The maximum number of working days used in computing the credit will be 30 days for each milestone and Contract completion incentive unless otherwise shown in the Contract. The amount of the credit will be added to money due or to become due to the Contractor.

9.1.1. **Early Contract Completion Incentive.** The incentive will be based on the difference between the actual early Contract completion days and the Contract completion days in the Contract. The difference will then be multiplied by the daily contract administration liquidated damage value shown in the proposal.

9.1.2. **Early Substantial Completion of Work Incentive.** The incentive will be based on the differences between the actual early substantial completion of work and the Contract days allowed to substantially complete the work (or the specified milestone or phase of work). The difference will then be multiplied by the daily road-user cost values specified for substantial Contract completion (or road-user cost specified for the corresponding milestone or phase of work).

9.2. **Disincentives for Failure to Substantially Complete Work on Time.** When shown on the plans and in accordance with the Contract, failure to substantially complete the work (or specified milestone or phase of work) within the established number of working days will result in the assessment of disincentives using the daily road-user cost shown on the plans for each working day in excess of those allowed. The road-user cost disincentive deductions will be in addition to any Contract administration liquidated damages, in accordance with Article 8.6, "Failure to Complete Work on Time." The amount of the disincentive will be deducted from money due or to become due to the Contractor. The road-user cost disincentives will be assessed not as a penalty, but for added expense incurred by the traveling public.

Special Provision to Item 8
Prosecution and Progress

Item 8, "Prosecution and Progress" of the Standard Specification is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Article 8.2., "Subcontracting," is supplemented by the following paragraph, which is added as paragraph six to this article:

The Contractor certifies by signing the Contract that the Contractor will not enter into any subcontract with a subcontractor that is not registered in the Department of Homeland Security's (DHS) E-Verify system. Require that all subcontractors working on the project register and require that all subcontractors remain active in the DHS E-Verify system until their work is complete on the project.

Special Provision to Item 8
Prosecution and Progress

Item 8, "Prosecution and Progress" of the Standard Specifications is amended with respect to the clause cited below. No other clauses or requirements of this Item are waived or changed.

Article 8.7.2., "Wrongful Default," is revised and replaced by the following:

If it is determined after the Contractor is declared in default, that the Contractor was not in default, the rights and obligations of all parties will be the same as if termination had been issued for the convenience of the public as provided in Article 8.8 "Termination of Contract."

Special Provision to Item 8
Prosecution and Progress

Item 8, "Prosecution and Progress," of the Standard Specifications, is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Article 8.6., "Failure to Complete Work on Time," is supplemented by the following:

8.6.1. Lane Closure Assessment Fees.

Monetary assessment, as shown on the plans, will be made against the Contractor for any lane closure or obstruction that overlaps into the peak hour traffic for each time increment defined on the plans or portion thereof, per lane, regardless of the length of lane closure or obstruction.

8.6.1.1. Definition of Terms. For this Contract, the following definitions apply:

8.6.1.1.1. Time increment. Any continuous defined increment of time period or portion thereof for a period beginning at that point when lanes are closed or obstructed by the Contractor's operations.

8.6.1.1.2. Assessment Fee. The amount shown on the proposal for each defined time increment, representing the average cost of interference and inconvenience to the road user for each lane closed or obstructed during peak hour traffic. The Engineer may allow a proportional fee assessment for closures that do not involve an entire defined time increment.

8.6.1.1.3. Closure or Obstruction. When the Contractor's operations result in a reduced lane width of the travel way or shoulder less than that specified on the plan documents.

8.6.1.1.4. Peak Hour Traffic Times. Schedule of days and times described in the General Notes, when lane closures or obstructions are not allowed.

8.6.1.2. Fee Calculation and Collection. The assessment fee will be deducted from the amount due to the Contractor on the monthly construction estimate, and thus retained by the Department. The Engineer will determine the time of overlap of lane closures or obstructions for calculating the assessment fee. The assessment fee is based on road user costs and is assessed not as a penalty, but for added expense incurred by the traveling public.

Special Provision to Item 8
Prosecution and Progress

Item 8, "Prosecution and Progress" of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Article 3., "Computation of Contract Time for Completion." The second paragraph is voided and replaced by the following:

The development of the conceptual time determination is intended to establish the number of working days on the Contract. Upon request, the Engineer will provide the conceptual time determination schedule to the Contractor for informational purposes only. The schedule assumes generic resources, production rates, sequences of construction, and average weather conditions based on historic data. Schedule labor, equipment, procurement of materials, subcontractor work, and all other necessary means to prosecute the work within the number of working days specified by the Contract.

Special Provision to Item 8
Prosecution and Progress

Item 8, "Prosecution and Progress," of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Article 8.1., "Prosecution of Work." The article is voided and replaced by the following.

Begin work within 90 calendar days after the authorization date to begin work. Prosecute the work continuously to completion within the working days specified. Unless otherwise shown on the plans, work may be prosecuted in concurrent phases if no changes are required to the traffic control plan or if a revised traffic control plan is approved. Notify the Engineer at least 24 hr. before beginning work or before beginning any new operation. Do not start new operations to the detriment of work already begun. Minimize interference to traffic.

For Contracts with callout work and work orders, begin work in the right of way within the specified time and continuously prosecute the work until completion.

Special Provision to Item 009
Measurement and Payment

Item 009 "Measurement and Payment" of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Article 9.5., "PROGRESS PAYMENTS" is supplemented with the following:

It is the Department's desire to pay a Contractor for work through the last working day of the month; however, the use of early cut-off dates for monthly estimates and MOH is a project management practice to manage workload at the Area Office level. Approval for using early cut-off dates is at the District's discretion. The earliest cut-off date for estimates is the 25th of the month.

Article 9.6., "PAYMENT FOR MATERIAL ON HAND (MOH)" first paragraph is amended as follows:

If payment for MOH is desired, request compensation for the invoice cost of acceptable nonperishable materials that have not been used in the work before the request, and that have been delivered to the work location or are in acceptable storage places. Nonperishable materials are those that do not have a shelf life or whose characteristics do not materially change when exposed to the elements. Include only materials that have been sampled, tested, approved, or certified, and are ready for incorporation into the work. Only materials which are completely constructed or fabricated on the Contractor's order for a specific Contract and are so marked and on which an approved test report has been issued are eligible. Payment for MOH may include the following types of items: concrete traffic barrier, precast concrete box culverts, concrete piling, reinforced concrete pipe, and illumination poles. Any repairs required after fabricated materials have been approved for storage will require approval of the Engineer before being made and will be made at the Contractor's expense. Include only those materials and products, when cumulated under an individual item or similar bid items, that have an invoice cost of at least $1,000 in the request for MOH payment (e.g. For MOH eligibility, various sizes of conductor are considered similar bid items and may be cumulated to meet the threshold; for small roadside signs, the sign supports, mounting bolts, and the sign face is considered one bid item or similar bid items for more than one pay item for sign supports.) Requests for MOH are to be submitted at least two days before but not later than the estimate cutoff date unless otherwise agreed. If there is a need to request MOH after the established cut-off date, the district can make accommodation as the need arises. This needed accommodation is to be the exception, though, and not the rule.

Special Provision to Item 9
Measurement and Payment

Item 9, "Measurement and Payment" of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Section 7.1.4.3., "Standby Equipment Costs," is voided and replaced by the following:

7.1.4.3. **Standby Equipment Costs.** Payment for standby equipment will be made in accordance with Section 9.7.1.4., "Equipment." The 15% markup will be paid when standby is associated with extra work but will not be paid when standby is associated with damages.

Section 7.1.4.3.1., "Contractor-Owned Equipment," is voided and replaced by the following:

7.1.4.3.1. **Contractor-Owned Equipment**. For Contractor-owned equipment:

- Standby will be paid at 50% of the monthly Rental Rate Blue Book rate after the regional and age adjustment factors have been applied. Operating costs will not be allowed. Calculate the standby rate as follows.

  Standby rate = (FHWA hourly rate - operating costs) × 50%

- If an hourly rate is needed, divide the monthly Rental Rate Blue Book rate by 176.
- No more than 8 hr. of standby will be paid during a 24-hr. day period, nor more than 40 hr. per week.
- Standby costs will not be allowed during periods when the equipment would have otherwise been idle.

Special Provision to Item 247
Flexible Base

Item 247, "Flexible Base," of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Section 247.2.1., "Aggregate." This Section is voided and replaced by the following.

Furnish aggregate of the type and grade shown on the plans and meeting the requirements shown in Table 1. Each source must meet Table 1 requirements for liquid limit, plasticity index, and wet ball mill for the grade specified. Do not use additives, such as but not limited to cement, emulsion, foamed asphalt, or lime, to modify aggregates to meet the requirements of Table 1, unless otherwise shown on the plans.

Unless otherwise shown on the plans, the unconfined compressive strength is waived when the flexible base material meets the #200 sieve requirement.

Table 1
Material Requirements

Property	Test Method	Grade 1–2[3]	Grade 3	Grade 4	Grade 5[3]
Master gradation sieve size (cumulative % retained)	Tex-110-E	–	–	As shown on the plans	–
2-1/2"		0	0		0
1-3/4"		0–10	0–10		0–5
7/8"		10–35	–		10–35
3/8"		30–65	–		35–65
#4		45–75	45–75		45–75
#40		65–90	50–85		70–90
#200[1, 2]		85–95	–		–
Liquid limit, % Max	Tex-104-E	40	40		35
Plasticity index, Max	Tex-106-E	10	12		10
Plasticity index, Min		As shown on the plans	As shown on the plans		As shown on the plans
Wet ball mill, % Max	Tex-116-E	40	–		40
Wet ball mill, % Max increase passing the #40 sieve		20	–		20
Min compressive strength[2], psi	Tex-117-E	–	–		–
lateral pressure 0 psi		35	–		–
lateral pressure 3 psi		–	–		90
lateral pressure 15 psi		175	–		175

1. The #200 sieve test is only required to meet the waiver of the unconfined compressive strength. The #200 sieve test requirement is only applicable to stockpile samples from Section 247.2.4.
2. Compressive strength and #200 sieve test requirements are waived when the flexible base is mixed with or without existing material and treated with cement, emulsion, foamed asphalt, or lime, unless otherwise shown on the plans.
3. Grade 3 may be substituted for Grade 1–2 or Grade 5 when the flexible base is mixed with or without existing material and treated with cement, emulsion, foamed asphalt, or lime, as approved. The Grade 3 flexible base must meet the wet ball mill requirements of Grade 1–2 or Grade 5.

Section 247.2.1.2.4., "Type D." The third sentence is voided and replaced by the following.

Crushed concrete must meet the requirements in Section 247.2.1.3., "Recycled Material," and be managed in a way to provide for uniform quality.

Section 247.2.1.3., "Recycled Material." This Section is voided and replaced by the following.

Reclaimed asphalt pavement (RAP) and other recycled materials may be used as shown on the plans. Request approval to blend two or more sources of recycled materials. When RAP is allowed, do not exceed 20% RAP by weight, unless otherwise shown on the plans. The percentage limitations for other recycled materials are as shown on the plans.

Provide recycled materials, other than RAP, that have a maximum sulfate content of 3,000 ppm when tested in accordance with Tex-145-E. Certify accordance with DMS-11000, "Evaluating and Using Nonhazardous Recyclable Materials Guidelines." In addition, recycled materials must be free of reinforcing steel and other objectionable material and have at most 1.5% deleterious material when tested in accordance with Tex-413-A. The liquid limit, plasticity index, wet ball mill, and compressive strength for all recycled materials are waived. When using RAP, crush RAP so that 100% passes the 2-in. sieve and does not exceed a maximum percent loss from decantation of 5.0% when tested in accordance with Tex-406-A. Test RAP without removing the asphalt. The final product must meet the requirements shown in Table 1 for the grade specified, except when the Department requires a specific amount of Department-furnished RAP be added to the blend, unless otherwise shown on the plans.

The Contractor is responsible for uniformly blending the recycled material with the flexible base material to build a stockpile to meet the percentages required. Any Contractor-furnished surplus of recycled materials must remain the property of the Contractor. Remove Contractor-owned recycled materials from the project, and dispose of them in conformance with federal, state, and local regulations before project acceptance.

Section 247.2.4., "Stockpile Approval." This Section is added.

Stockpile is approved when the Engineer's test results meet the material requirements shown in Table 1.

Section 247.2.4.1., "Sampling." This Section is added.

The Contractor and the Engineer will sample flexible base from completed stockpiles in accordance with Tex-100-A. Personnel conducting sampling must be certified by the Department-approved soils and base certification program.

Sampling stockpiles may be located at the production site or at the project location. The Contractor must witness the Engineer's sampling and sample the stockpile for their own testing, and label as deemed necessary.

Sample the stockpile for the Engineer as shown on the plans. When the Contractor samples the stockpile for the Engineer, the Engineer will witness the sampling of material designated for the Engineer and the Materials and Tests Division (MTD). The Engineer will label their sampling containers as "Engineer" and "MTD," or as deemed necessary.

The Engineer will take immediate possession of the sample containers for the Engineer and MTD. The Engineer will maintain custody of the samples until all testing and reporting are completed.

Section 247.2.4.2., "Referee Testing." This Section is added.

Referee testing is applicable for stockpile testing only. MTD is the referee laboratory. MTD may designate a laboratory from the Department's MPL for *Commercial Laboratories Approved for Flexible Base Referee Requests* as the referee laboratory as deemed necessary. The designated laboratory must not perform any testing under this Item for the Engineer or Contractor.

The Contractor may request referee testing when the Engineer's test results fail to meet any of the material requirements shown in Table 1 and when the Contractor's sample from Section 247.2.4.1., "Sampling," for the same failing Department test passes. The tests must be performed by a laboratory on the Department's MPL for *Commercial Laboratories Approved for Flexible Base Referee Requests*. Submit the request by email within 5 working days after receiving failing test results from the Engineer. Include completed test reports passing the applicable requirements shown in Table 1 in the email.

Record and submit completed test reports electronically on Department-provided templates in their original format meeting the applicable material requirements shown in Table 1. Use Department-provided templates to record and calculate all test data. The Engineer and the Contractor will provide any available test results to the other party when requested.

Section 247.4.3., "Compaction." The first paragraph is voided and replaced by the following.

Compact using density control unless otherwise shown on the plans. Multiple lifts are permitted as shown on the plans or approved. Bring each layer to the moisture content directed. When necessary, sprinkle the material in accordance with Item 204, "Sprinkling." Maintain moisture during compaction within ±2.0% of the optimum moisture content as determined in accordance with Tex-113-E.

Section 247.4.3.2., "Density Control." This Section is voided and replaced by the following.

Compact to at least 100% of the maximum dry density and within ±2.0% of the optimum moisture content as determined in accordance with Tex-113-E, unless otherwise shown on the plans. Provide the Engineer with the beginning and ending station numbers of the area completed for testing. The Engineer will determine roadway density and moisture content of completed sections in accordance with Tex-115-E, Part I. The Engineer will determine random locations for testing in accordance with Tex-115-E, Part IV. Do not achieve density by drying the material after compaction.

When the density is less than 100% of the maximum dry density, the Engineer may perform additional testing to determine the extent of the area to correct. The Engineer may accept the section if no more than one of the five most recent density tests is below the specified density and the failing test is no more than 3 pcf below the specified density.

Section 247.4.3.3., "Miscellaneous and Small Areas." This Section is added.

Miscellaneous areas are those that typically involve handwork or discontinuous paving operations, such as temporary detours, driveways, mailbox turnouts, crossovers, gores, spot level-up areas, and other similar areas. Miscellaneous and small areas are not subject to random sampling procedure but may be tested as directed.

Section 247.4.6., "Ride Quality." This Section is voided and replaced by the following.

Measurement of ride quality only applies to the final travel lanes that receive a one- or two-course surface treatment for the final riding surface, unless otherwise shown on the plans. Measure the ride quality of the base course either before or after the application of the prime coat, as directed, and before placement of the surface treatment. Use a certified profiler operator on the Department's MPL. When requested, furnish the Engineer with documentation for the person certified to operate the profiler.

Provide all profile data to the Engineer in electronic data files within 3 days of measuring the ride quality using the format specified in Tex-1001-S. The Engineer will use Department software to evaluate longitudinal profiles to determine areas requiring corrective action. Correct 0.1-mi. sections with an average international roughness index (IRI) value greater than 100 in. per mile to an IRI value of 100 in. per mile or less, unless otherwise shown on the plans. Re-profile and correct sections that fail to maintain ride quality before the placement of the surface treatment, as directed. Unless ride deterioration is due to environmental impact, traffic, or other incidents outside the Contractor's control, perform this work at no additional expense to the Department, as approved.

Special Provision to Item 300
Asphalt, Oils, and Emulsions

Item 300, “Asphalt, Oils, and Emulsions” of the Standard Specifications is replaced by Special Specification 3096, “Asphalts, Oils, and Emulsions.” All Item 300 Special Provisions are no longer available, beginning with the April 2022 letting.

Special Provision to Item 302
Aggregates for Surface Treatments

Item 302, "Aggregates for Seal Coats," of the Standard Specifications, is hereby amended with respect to the clauses cited below, and no other clauses or requirements of this Item are waived or changed hereby.

Section 2.1., "Aggregate." Tables 2 and 3 are voided and replaced by the following.

Table 2
Aggregate Gradation Requirements (Cumulative % Retained[1])

Sieve	Grade								
	1	2	3S[2]	3		4S[2]	4	5S[2]	5
				Non-Lightweight	Lightweight				
1"	-	-	-	-	-	-	-	-	-
7/8"	0–2	0	-	-	-	-	-	-	-
3/4"	20–35	0–2	0	0	0	-	-	-	-
5/8"	85–100	20–40	0–5	0–5	0–2	0	0	-	-
1/2"	-	80–100	55–85	20–40	10–25	0–5	0–5	0	0
3/8"	95–100	95–100	95–100	80–100	60–80	60–85	20–40	0–5	0–5
1/4"	-	-	-	95–100	95–100	-	-	65–85	-
#4	-	-	-	-	-	95–100	95–100	95–100	50–80
#8	99–100	99–100	99–100	98–100	98–100	98–100	98–100	98–100	98–100

1. Round test results to the nearest whole number.
2. Single-size gradation.

Table 3
Aggregate Quality Requirements

Property	Test Method	Requirement[1]	
		Minimum	Maximum
SAC	AQMP	As shown on the plans	
Deleterious Material[2], %	Tex-217-F, Part I	-	2.0
Decantation, %	Tex-406-A	-	1.5
Flakiness Index, %	Tex-224-F	-	17
Gradation	Tex-200-F, Part I	Table 2 Requirements	
Los Angeles Abrasion, %	Tex-410-A	-	35
Magnesium Sulfate Soundness, 5 Cycle, %	Tex-411-A	-	25
Micro-Deval Abrasion, %	Tex-461-A	Note 3	
Coarse Aggregate Angularity[4], 2 Crushed Faces, %	Tex-460-A, Part I	85	-
Additional Requirements for Lightweight Aggregate			
Dry Loose Unit Wt., lb./cu. ft.	Tex-404-A	35	60
Pressure Slaking, %	Tex-431-A	-	6.0
Freeze-Thaw Loss, %	Tex-432-A	-	10.0
Water Absorption, 24hr., %	Tex-433-A	-	12.0

1. Material requirements are listed below, unless otherwise shown on the plans.
2. Not required for lightweight aggregate.
3. Used to estimate the magnesium sulfate soundness loss in accordance with Section 2.1.1.
4. Only required for crushed gravel.

Section 2.1.1., "Micro-Deval Abrasion," is added.

The Engineer will perform a minimum of one Micro-Deval abrasion test in accordance with Tex-461-A for each coarse aggregate source per project that has a Rated Source Soundness Magnesium (RSSM) loss value greater than 15 as listed in the BRSQC. The Engineer may waive all Micro-Deval testing based on a satisfactory test history of the same aggregate source.

The Engineer will estimate the magnesium sulfate soundness loss for each coarse aggregate source, when tested, using the following formula.

$Mg_{est.} = (RSSM)(MD_{act.}/RSMD)$

where:
$Mg_{est.}$ = magnesium sulfate soundness loss
$MD_{act.}$ = actual Micro-Deval percent loss
RSMD = Rated Source Micro-Deval

When the estimated magnesium sulfate soundness loss is greater than the maximum magnesium sulfate soundness loss specified, the coarse aggregate source will not be allowed for use unless otherwise approved by the Engineer. The Engineer may require additional testing before granting approval.

Section 2.2., "Precoating." The third paragraph is voided and replaced by the following.

The Engineer retains the right to remove precoat material from aggregate samples in accordance with Tex-210-F, or as recommended by the Construction Division, and test the aggregate to verify compliance with Table 2 and Table 3 requirements. Gradation testing may be performed with precoat intact.

Section 2.3., "Sampling," is added.

Personnel who conduct sampling and witnessing of sampling must be certified by the Department-approved certification program. Supply the Engineer with a list of certified personnel and copies of their current certificates before beginning construction and when personnel changes are made. At any time during the project, the Engineer may perform production tests as deemed necessary in accordance with Item 5, "Control of the Work."

The Engineer will sample aggregate from stockpiles located at the production site, intermediate distribution site, or project location in accordance with Tex-221-F, Section 3.2.3. The Engineer will split each sample into 2 equal portions in accordance with Tex-200-F, Section 3.3, and label these portions "Engineer" and "Contractor" or "Supplier." Witness the sampling and splitting, and take immediate possession of the samples labeled "Contractor" or "Supplier".

Section 2.4., "Reporting and Responsibilities," is added.

The Engineer will provide test results to the Contractor and Supplier within 10 working days from the date the stockpile was sampled for sources listed on the Department's Bituminous Rated Source Quality Catalog (BRSQC), unless otherwise directed. The Engineer will provide test results for the LA Abrasion (Tex-410-A) and Magnesium Sulfate Soundness (Tex-411-A) tests within 30 calendar days for sources not listed on the BRSQC, or for sources not meeting the requirements of Section 2.1.1., "Micro-Deval Abrasion." The Engineer will report to the other party within 24 hours when any test result does not meet the requirements listed in Table 2 or Table 3.

Special Provision to Item 316
Seal Coat

Item 316, "Seal Coat" of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Section 4.8, "Asphalt Placement" is supplemented by the following:

4.8.5. Collect all samples in accordance with Tex-500-C, "Sampling Bituminous Materials, Pre-Molded Joint Fillers, and Joint Sealers" from the distributor and with witness by the Engineer.

At least once per project, collect split samples of each binder grade and source used. The Engineer will submit one split sample to MTD for testing and retain the other split sample.

In addition, collect one sample of each binder grade and source used on the project for each production day. The Engineer will retain these samples.

The Engineer will keep all retained samples for one yr., for hot-applied binders and cutback asphalts; or for two mo., for emulsified asphalts. The Engineer may submit retained samples to MTD for testing as necessary or as requested by MTD.

Special Provision to Item 334
Hot-Mix Cold-Laid Asphalt Concrete Pavement

Item 334, "Hot-Mix Cold-Laid Asphalt Concrete Pavement," of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed hereby.

Section 334.4.1.2., "Job-Mix Formula Approval." Table 5 is voided and replaced by the following:

Table 5
Laboratory Mixture Design Properties

Property	Test Method	Requirement
Target laboratory-molded density, %[1]	Tex-207-F	94.0 ± 1.5
Hveem stability, Min	Tex-208-F	35
Cantabro loss, %, Max	Tex-245-F	10
Hydrocarbon-volatile content, %, Max	Tex-213-F	0.6
Moisture content, %, Max[2]	Tex-212-F	1.0
Boil test, %, Max[3]	Tex-530-C	10

1. Unless otherwise shown on the plans.
2. Unless otherwise approved.
3. Limit may be increased or eliminated when approved.

Special Provision to Item 340
Dense-Graded Hot-Mix (Small Quantity)

Item 340, “Dense-Graded Hot-Mix (Small Quantity)” of the Standard Specifications is replaced by Special Specification 3076, “Dense-Graded Hot-Mix Asphalt,” Section 4.9.4., “Exempt Production.” All Item 340 Special Provisions and bid codes are no longer available, beginning with the February 2022 letting.

Special Provision to Item 341
Dense-Graded Hot-Mix Asphalt

Item 341, “Dense-Graded Hot-Mix Asphalt” of the Standard Specifications is replaced by Special Specification 3076, “Dense-Graded Hot-Mix Asphalt.” All Item 341 Special Provisions and bid codes are no longer available, beginning with the February 2020 letting.

Special Provision to Item 342
Permeable Friction Course (PFC)

Item 342, “Permeable Friction Course (PFC)” of the Standard Specifications is replaced by Special Specification 3079, “Permeable Friction Course.” All Item 342 Special Provisions and bid codes are no longer available, beginning with the April 2022 letting.

Special Provision to Item 344
Superpave Mixtures

Item 344, “Superpave Mixtures” of the Standard Specifications is replaced by Special Specification 3077, “Superpave Mixtures.” All Item 344 Special Provisions and bid codes are no longer available, beginning with the February 2020 letting.

Special Provision to Item 346
Stone-Matrix Asphalt

Item 346, “Stone-Matrix Asphalt” of the Standard Specifications is replaced by Special Specification 3080, “Stone-Mix Asphalt.” All Item 346 Special Provisions and bid codes are no longer available, beginning with the April 2022 letting.

Special Provision to Item 347
Thin Overlay Mixture (TOM)

Item 347, “Thin Overlay Mixture (TOM)” of the Standard Specifications is replaced by Special Specification 3081, “Thin Overlay Mixture (TOM). All Item 347 Special Provisions and bid codes are no longer available, beginning with the April 2022 letting.

Special Provision to Item 348
Thin Bonded Friction Courses

Item 348, “Thin Bonded Friction Courses” of the Standard Specifications is replaced by Special Specification 3082, “Thin Bonded Friction Courses.” All Item 348 Special Provisions and bid codes are no longer available, beginning with the April 2022 letting.

Special Provision to Item 360
Concrete Pavement

Item 360, "Concrete Pavement" of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Section 360.2.1., "Materials," the third paragraph is voided and replaced by the following:

For continuously reinforced concrete pavements, use a coarse aggregate with a rated coefficient of thermal expansion of not more than 5.5×10^{-6} in./in./°F as listed in the Department's *Concrete Rated Source Quality Catalog*.

Section 360.4.8.3., "Surface Texture," the second paragraph is voided and replaced by the following:

A metal-tine texture finish is required unless otherwise shown on the plans. Provide transverse or longitudinal tining unless otherwise shown on the plans. Immediately following the carpet drag, apply a single coat of evaporation retardant, if needed, at the rate recommended by the manufacturer. Provide the metal-tine finish immediately after the concrete surface has set enough for consistent tining. Operate the metal-tine device to obtain grooves approximately 3/16 in. deep, with a minimum depth of 1/8 in., and approximately 1/12 in. wide. Do not overlap a previously tined area. Use manual methods to achieve similar results on ramps, small or irregular areas, and narrow width sections of pavements. Repair damage to the edge of the slab and joints immediately after texturing. Do not tine pavement that will be overlaid or that is scheduled for blanket diamond grinding or shot blasting.

Special Provision to Item 420
Concrete Substructure

Item 420, “Concrete Substructures” of the Standard Specifications is amended with respect to the clause cited below. No other clauses or requirements of this Item are waived or changed.

Article 420.6., “Payment.” The first paragraph is replaced by the following:

The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for the class of concrete and element identified and by the special designation when appropriate. This price is full compensation for furnishing, hauling, and mixing concrete materials; furnishing, bending, fabricating, splicing, welding and placing the required reinforcement; clips, blocks, metal spacers, ties, wire, or other materials used for fastening reinforcement in place; placing, finishing, and curing concrete; mass placement controls; applying ordinary surface finish; furnishing and placing drains, metal flashing strips, and expansion-joint material; excavation, subgrade preparation; and forms and falsework, equipment, labor, tools, and incidentals.

Special Provision to Item 421
Hydraulic Cement Concrete

Item 421, "Hydraulic Cement Concrete" of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Article 421.2., "Materials," the second sentence of the first paragraph is voided and replaced by the following.

Provide aggregates from sources listed in the Department's Concrete Rated Source Quality Catalog (CRSQC).

Article 421.2.2., Supplementary Cementing Materials (SCM), is voided and replaced with the following.

Supplementary Cementitious Materials (SCM).

- **Coal Ash**. Furnish sources of fly ash, , Modified fly ash (MFA), harvested coal ash, and Ground Bottom Ash (GBA) conforming to DMS-4610, "Coal Ash."
- **Slag Cement**. Furnish Slag Cement in accordance with DMS-4620, "Slag Cement."
- **Silica Fume**. Furnish silica fume in accordance with DMS-4630, "Silica Fume."
- **Natural Pozzolans**. Furnish Natural Pozzolans in accordance with DMS-4635, "Natural Pozzolans."

Article 421.3.1.3., "Agitators and Truck and Stationary Mixers," the first paragraph is voided and replaced by the following.

Provide stationary and truck mixers capable of combining the ingredients of the concrete into a thoroughly mixed and uniform mass and capable of discharging the concrete so that the requirements of Tex-472-A are met.

Article 421.3.1.3., "Agitators and Truck and Stationary Mixers," is supplemented with the following.

Truck mixers with automated water and chemical admixture measurement and slump and slump flow monitoring equipment meeting the requirement of ASTM C94 will be allowed. Provide data every 6 mo. substantiating the accuracy of slump, slump flow, temperature, water, and chemical admixture measurements. The slump measured by the automated system must be within 1 in. of the slump measured in accordance with Tex-415-A. The concrete temperature measured by the automated system must be within 1°F of concrete temperature measured in accordance with Tex-422-A. The Engineer will not use the automated measurements for acceptance.

Article 421.4.2., "Mix Design Proportioning," Table 8 is voided and replaced by the following.

Table 8
Concrete Classes

Class of Concrete	Design Strength,[1] Min f'_c (psi)	Max w/cm Ratio	Coarse Aggregate Grades[2,3,4]	Cement Types	Mix Design Options	Exceptions to Mix Design Options	General Usage[5]
A	3,000	0.60	1–4, 8	I, II, I/II, IL, IP, IS, IT, V	1, 2, 4, & 7	When the cementitious material content does not exceed 520 lb./cu. yd., any coal ash or natural pozzolan listed in the MPL may be used at a cement replacement of 20% to 50%.	Curb, gutter, curb & gutter, conc. retards, sidewalks, driveways, back-up walls, anchors, non-reinforced drilled shafts
B	2,000	0.60	2–7				Riprap, traffic signal controller foundations, small roadside signs, and anchors
C[6]	3,600	0.45	1–6	I, II, I/II, IP, IL, IS, IT, V	1–8		Drilled shafts, bridge substructure, traffic rail, culverts except top slab of direct traffic culverts, headwalls, wing walls, inlets, manholes, traffic barrier
E	3,000	0.50	2–5	I, II, I/II, IL, IP, IS, IT, V	1–8	When the cementitious material content does not exceed 520 lb./cu. yd., any coal ash or natural pozzolan listed in the MPL may be used at a cement replacement of 20% to 50%.	Seal concrete
F[6]	Note[7]	0.45	2–5	I, II, I/II, IP, IL, IS, IT, V			Railroad structures; occasionally for bridge piers, columns, bents, post-tension members
H[6]	Note[7]	0.45	3–6	I, II, I/II, III, IP, IL, IS, IT, V	1–4, 8	Mix design options 1-8 allowed for cast-in-place concrete and the following precast elements unless otherwise stated in the plans: ■ Bridge Deck Panels, ■ Retaining Wall Systems, ■ Coping, ■ Sound Walls, ■ Wall Columns, ■ Traffic Rail, ■ Traffic Barrier, ■ Long/Arch Span Culverts, and ■ precast concrete products included in Item 462, "Concrete Box Culverts and Drains, Item 464, "Reinforced Concrete Pipe," and Item 465, "Junction Boxes, Manholes, and Inlets." Do not use Type III cement in mass placement concrete. Up to 20% of blended cement may be replaced with listed SCMs when Option 4 is used for precast concrete. Options 6, & 7 allowed for cast-in-place Class H concrete.	Precast concrete, post-tension members
S[6]	4,000	0.45	2–5	I, II, I/II, IP, IL, IS, IT, V	1–8		Bridge slabs, top slabs of direct traffic culverts, approach slabs

Class of Concrete	Design Strength,[1] Min f'_c (psi)	Max w/cm Ratio	Coarse Aggregate Grades[2,3,4]	Cement Types	Mix Design Options	Exceptions to Mix Design Options	General Usage[5]
P	See Item 360, "Concrete Pavement."	0.50	2–3	I, II, I/II, IL, IP, IS, IT, V	1–8	When the cementitious material content does not exceed 520 lb./cu. yd., any coal ash or natural pozzolan listed in the MPL's may be used at a cement replacement of 20% to 50%.	Concrete pavement
CO[6]	4,600	0.40	6	I, II, I/II, IP, IL, IS, IT, V	1–8		Bridge deck concrete overlay
LMC[6]	4,000	0.40	6–8				Latex-modified concrete overlay
SS[6]	3,600	0.45	4–6		1-8	Use a Min cementitious material content of 658 lb./cu. yd. of concrete. Limit the alkali loading to 4.0 lbs./cu. yd. or less when using Option 7.	Slurry displacement shafts, underwater drilled shafts
K[6]	Note[7]	0.40	Note[7]	I, II, I/II, III IP, IL, IS, IT, V	1-8		Note[7]
HES	Note[7]	0.45	Note[7]	I, IL, II, I/II, III		Mix design options do not apply. 700 lb. of cementitious material per cubic yard limit does not apply.	Concrete pavement, concrete pavement repair
"X" (HPC) [6,8,9]	Note[10]	0.45	Note[10]	I, II, I/II, III IP, IL, IS, IT, V	1–4, & 8	Max coal ash replacement for Option 3 may be increased to 50%. Up to 20% of a blended cement may be replaced with listed SCMs for Option 4. Do not use Option 8 for precast concrete.	
"X" (SRC) [6,8,9]	Note[10]	0.45	Note[10]	I/II, II, IP, IL (MS or HS), IS, IT (MS or HS), V	1–4, & 7	When using coal ash, only use coal ashes allowed for SRC as listed in the Coal Ash MPL. Type III-MS may be used where allowed. Type I, Type IL, and Type III cements may be used when natural pozzolans are used or when coal ashes allowed for SRC as listed in the Coal Ash MPL are used, and with a Max w/cm of 0.40. Up to 20% of blended cement may be replaced with listed SCMs when Option 4 is used for precast concrete. Use Option 7 for precast concrete where allowed.	

1. Design strength must be attained within 56 days.
2. Do not use Grade 1 coarse aggregate except in massive foundations with 4 in. Min clear spacing between reinforcing steel bars, unless otherwise permitted. Do not use Grade 1 aggregate in drilled shafts.
3. Use Grade 8 aggregate in extruded curbs unless otherwise approved.
4. Other grades of coarse aggregate maybe used in non-structural concrete classes when allowed by the Engineer.
5. For information only.
6. Structural concrete classes.
7. As shown on the plans or specified.
8. "X" denotes class of concrete shown on the plans or specified.
9. (HPC): High Performance Concrete, (SRC): Sulfate Resistant Concrete.
10. Same as class of concrete shown on the plans.

Article 421.4.2.2., "Aggregates," is supplemented by the following.

Use the following equation to determine if the aggregate combination meets the sand equivalency requirement when blending fine aggregate or using an intermediate aggregate:

$$\frac{(SE_1 \times P_1)+(SE_2 \times P_2)+(SE_{ia} \times P_{ia})}{100} \geq 80\%$$

where:
SE_1 = sand equivalency (%) of fine aggregate 1
SE_2 = sand equivalency (%) of fine aggregate 2
SE_{ia} = sand equivalency (%) of intermediate aggregate passing the 3/8 in. sieve
P_1 = percent by weight of fine aggregate 1 of the fine aggregate blend
P_2 = percent by weight of fine aggregate 2 of the fine aggregate blend
P_{ia} = percent by weight of intermediate aggregate passing the 3/8 in. sieve

Article 421.4.2.3., Chemical Admixtures," the second paragraph is voided and replaced with the following.

Use a 30% calcium nitrite solution when a corrosion-inhibiting admixture is required. Dose the admixture at the rate of gallons of admixture per cubic yard of concrete shown on the plans. Use set retarding admixtures, as needed, to control setting time to ensure concrete containing corrosion inhibiting admixtures remain workable for the entire duration of the concrete placement. Perform setting time testing and slump loss testing during trial batch testing.

Article 421.4.2.5., "Slump," the second paragraph is voided and not replaced. Table 9 is voided and replaced with below:

Table 9
Placement Slump Requirements

General Usage	Placement Slump Range,[1,2] in.
Walls (over 9 in. thick), caps, columns, piers	3 – 7
Bridge slabs, top slabs of direct traffic culverts, approach slabs, concrete overlays, latex-modified concrete for bridge deck overlays	3 – 6
Inlets, manholes, walls (less than 9 in. thick), bridge railing, culverts, concrete traffic barrier, concrete pavement (formed)	4 – 6
Precast concrete	4 – 9
Underwater concrete placements	6 – 8-1/2
Drilled shafts, slurry displaced and underwater drilled shafts	See Item 416, "Drilled Shaft Foundations."
Curb, gutter, curb and gutter, concrete retards, sidewalk, driveways, seal concrete, anchors, riprap, small roadside sign foundations, concrete pavement repair, concrete repair	As approved

1. Max slump values may be increase above these values shown using chemical admixtures, provided the admixture treated concrete has the same or lower water-to-cementitious ratio and does not exhibit segregation or excessive bleeding. Request approval to increase slump limits in advance for proper evaluation by the Engineer.
2. For fiber reinforced concrete, perform slump before addition of fibers.

Article 421.4.2.6., "Mix Design Options," is voided and replaced with the following.

Option 1. Replace cement with at least the minimum dosage listed in the MPL for the coal ash or natural pozzolan used in the mixture. Do not replace more than 50% of the cement. Conduct Option 8 testing as listed on the MPL.

Option 2. Replace 35% to 50% of the cement with slag cement.

Option 3. Replace 35% to 50% of the cement with a combination of coal ash, slag cement, natural pozzolan, or at least 3% silica fume; however, no more than 10% may be silica fume.

Option 4. Use Type IP, Type IS, or Type IT cement as allowed in Table 8 for each class of concrete. When replacing blended cements with additional SCM's, the replacement limits in Option 3 will apply to the final cementitious mixture. When using coal

ash or natural pozzolans not having a minimum dosage listed in the MPL in the final cementitious mixture, perform Option 8 testing.

Option 5. Option 5 is left intentionally blank.

Option 6. Use a lithium nitrate admixture at a minimum dosage determined by testing conducted in accordance with Tex-471-A. Before use of the mix, provide an annual certified test report signed and sealed by a licensed professional engineer, from a laboratory listed on the MPL, certified by the Materials and Tests Division as being capable of testing according to Tex-471-A.

Option 7. Ensure the total alkali contribution from the cement in the concrete does not exceed 3.5 lb. per cubic yard of concrete when using hydraulic cement not containing SCMs calculated as follows:

$$\text{lb. alkali per cu. yd.} = \frac{(\text{lb. cement per cu. yd.}) \times (\%\ Na_2O \text{ equivalent in cement})}{100}$$

In the above calculation, use the maximum cement alkali content reported on the cement mill certificate.

Option 8. Use Table 10 when deviating from Options 1–3 or when required by the Coal Ash MPL. Perform required testing annually and submit results to the Engineer. Laboratories performing ASTM C1260, ASTM C1567, and ASTM C1293 testing must be listed on the MPL. Before use of the mix, provide a certified test report signed and sealed by a licensed professional engineer demonstrating the proposed mixture in accordance with the requirements of Table 10.

Provide a certified test report signed and sealed by a licensed professional engineer, when HPC is required, and less than 20% of the cement is replaced with SCMs, demonstrating ASTM C1876 test results indicate the uniaxial resistivity of the concrete is greater than 15.6 kΩ-cm tested immediately after either of the following curing schedules:

- Moisture cure specimens 56 days at 73°F.
- Moisture cure specimens 7 days at 73°F followed by 21 days at 100°F.

Table 10
Option 8 Testing and Mix Design Requirements

Scenario	ASTM C1260 Result		Testing Requirements for Mix Design Materials or Prescriptive Mix Design Options
	Mix Design Fine Aggregate	Mix Design Coarse Aggregate	
A	> 0.10%	> 0.10%	Determine the dosage of SCMs needed to limit the 14-day expansion of each aggregate[1] to 0.10% when tested individually in accordance with ASTM C1567.
B	≤ 0.10%	≤ 0.10%	Use the Min replacement listed in the Coal Ash MPL, or when Option 8 is listed on the MPL, use a Min of 40% coal ash with a Max CaO[2] content of 25%, or use any ternary combination which replaces 35% to 50% of cement.
	≤ 0.10%	ASTM C1293 1 yr. Expansion ≤ 0.04%	Use a minimum of 20% of any coal ash; or Use any ternary combination which replaces 20% to 50% of cement.
C	≤ 0.10%	> 0.10%	Determine the dosage of SCMs needed to limit the 14-day expansion of coarse and intermediate[1] aggregate to ≤0.10% when tested individually in accordance with ASTM C1567.
D	> 0.10%	≤ 0.10%	Use the Min replacement listed in the Coal Ash MPL, or when Option 8 is listed on the MPL, use a Min of 40% coal ash with a Max CaO[2] content of 25%, or use any ternary combination which replaces 35% to 50% of cement.
	> 0.10%	ASTM C1293 1 yr. Expansion ≤ 0.04%	Determine the dosage of SCMs needed to limit the 14-day expansion of each fine aggregate to ≤0.10% when individually tested in accordance with ASTM C1567.

1. Intermediate size aggregates will fall under the requirements of mix design coarse aggregate.
2. Average the CaO content from the previous ten values as listed on the test certificate.

Article 421.4.2.7., "Optimized Aggregate Gradation (OAG) Concrete," the first sentence of the first paragraph is voided and replaced by the following.

The gradations requirements in Table 4 and Table 6 do not apply when OAG concrete is specified or used by the Contractor unless otherwise shown on the plans.

The fineness modulus for fine aggregate listed in Table 5, does not apply when OAG concrete is used,

Article 421.4.6.2., Delivering Concrete," the third paragraph is supplemented by the following.

When truck mixers are equipped with automated water or chemical admixture measurement and slump or slump flow monitoring equipment, the addition of water or chemical admixtures during transit is allowed. Reports generated by this equipment must be submitted to the Engineer daily.

Article 421.4.6.2., "Delivering Concrete," the fifth paragraph is voided and replaced with the following. Begin the discharge of concrete delivered in truck mixers within the times listed in Table 14. Concrete delivered after these times, and concrete that has not begun to discharge within these times will be rejected.

Article 421.4.8.3., "Testing of Fresh Concrete," is voided and replaced with the following.

Testing Concrete. The Engineer, unless specified in other Items or shown on the plans, will test the fresh and hardened concrete in accordance with the following methods:

- Slump. Tex-415-A;
- Air Content. Tex-414-A or Tex-416-A;
- Temperature. Tex-422-A;
- Making and Curing Strength Specimens. Tex-447-A;
- Compressive Strength. Tex-418-A;
- Flexural Strength. Tex-448-A; and
- Maturity. Tex-426-A.

Flexural strength and maturity specimens will not be made unless specified in other items or shown on the plans.

Concrete with slump less than minimum required after all addition of water withheld will be rejected, unless otherwise allowed by the Engineer. Concrete with slump exceeding maximum allowed may be used at the Contractor's option. If used, Engineer will make, test, and evaluate strength specimens as specified in Article 421.5., "Acceptance of Concrete." Acceptance of concrete not meeting air content or temperature requirements will be determined by Engineer. Fresh concrete exhibiting segregation and excessive bleeding will be rejected.

Article 421.4.8.3.1., "Job-Control Testing," is voided and not replaced.

Special Provision to Item 423
Retaining Walls

Item 423, “Retaining Walls” of the Standard Specifications is amended with respect to the clause cited below. No other clauses or requirements of this Item are waived or changed.

Article 2.1., “General” is supplemented with the following:

Construct permanent retaining walls approved for use in accordance with DMS 4800, “Proprietary Earth Retaining Wall System,” and on the Approved System list for Concrete Block Retaining Walls Systems and Mechanically Stabilized Earth Panel Type Systems.

Special Provision to Item 425
Precast Prestressed Concrete Structural Members

Item 425, "Precast Prestressed Concrete Structural Members" of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Section 2.3., "Prestressing Steel." The first bullet is voided and replaced with the following.

- Seven-wire steel strand meeting DMS-4500, "Steel Strand, Uncoated Seven-Wire Low Relaxation for Prestressed Concrete."

Section 2.3., "Prestressing Steel." The second paragraph is voided and replaced with the following.

Use 7-wire steel strand produced by a prequalified manufacturer on the list in the Department MPL maintained by the Materials and Tests Division. The Department may take samples in accordance with Tex-710-I to verify compliance with specification requirements.

Special Provision to Item 426
Post-Tensioning

Item 426, "Post-Tensioning" of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Section 2.1., "Prestressing Steel." The first bullet is voided and replaced with the following.

- Seven-wire steel strand meeting DMS-4500, "Steel Strand, Uncoated Seven-Wire Low Relaxation for Prestressed Concrete," or

Section 2.2., "Post-Tensioning System." The second bulleted item is voided and replaced with the following:

- Provide pre-packaged grouts in accordance with DMS-4670, "Grouts for Post-Tensioning." Do not use grouts that exceed the manufacturers' recommended shelf life or 6 mo. after date of manufacture, whichever is less.

Section 4.2., "Required Submittals." The section is voided and replaced with the following.

4.2. **Required Submittals.** Submit information required in this Section for post-tensioned elements, in addition to forming and falsework plans required by Item 420, "Concrete Substructures," and Item 424, "Precast Concrete Structural Members (Fabrication)." Include all necessary construction information in these submittals for cast-in-place and precast construction including, but not limited to the information required in this Section.

4.2.1. **Design Calculations**. Provide design procedures, coefficients, allowable stresses, tendon spacing, and clearances in accordance with the AASHTO LRFD *Bridge Design Specifications* and PTI/ASBI M50 unless otherwise shown on the plans. Submit enough calculations to support the proposed system and method of post-tensioning including friction loss diagrams. When the required jacking force for a particular type of tendon, duct, and configuration is furnished on the plans, design calculations are not required except to adjust for conditions different from those shown on the plans.

4.2.2. **Post-Tensioning Details**. Provide drawings with details that meet the requirements of PTI/ASBI M50 and this Specification.

4.2.3. **Grouting Plan**. Submit for approval written grouting procedures at least four weeks before the start of the element's construction. Include items required by PTI M55.

Include the names of people responsible for PT installation and grouting operations, with the foreman of each grouting crew certified as a PTI Level 2 Bonded PT Field Specialist and ASBI Certified Grouting Technician.

4.2.4. **Stressing Safety Plan**. Provide a plan to protect the public, workers, and Department personnel on and around the vicinity where post-tensioning operations are occurring.

Submit for approval, a detailed safety plan which identifies potential risk associated with post-tensioning operations, including but not limited to:

- tendon alignment,
- temporary shoring,
- ram operations, and
- stand anchorage.

Section 4.3., "Design Calculations." The section is voided and replaced with the following.

4.3. **Packaging, Storing, and Handling of Post-Tensioning Components**. Package, store, and handle post-tensioning steel, grout, duct, and other accessories in accordance with PTI/ASBI M50 and PTI M55 unless otherwise indicated. Acceptance and rejection criteria for strand will follow PTI/ASBI M50 and PTI M55.

The following exceptions apply:

- grout storage onsite will be limited to 30 days unless approval by the Engineer is given in advance of material delivery,
- install grout caps and ensure vents are closed at all times so that water and other contaminants cannot enter the duct before strand installation, and
- do not flush ducts at any time.

Section 4.4., "Packaging, Storing, and Handling of Post-Tensioning Components." The section is voided and replaced with the following.

4.4. **Duct and Prestressing Steel Installation for Post-Tensioning**. Follow PTI/ASBI M50 for duct and prestressing steel installation procedures and requirements unless otherwise specified. Verify that concrete strength requirements on the plans are met for stressing and staged loading of post-tensioned structural elements.

Stress the tendons within seven days of installing the strand in the ducts unless otherwise approved in advance. Follow the tensioning procedure noted in the approved post-tensioning details.

Section 4.5., "Duct and Prestressing Steel Installation for Post-Tensioning." The section is voided and replaced with the following.

4.5. **Grouting**. Grout in accordance with PTI M55.

Grout within 14 days of tendon stressing unless otherwise specified or approved. Obtain approval to extend the grouting time before stressing tendons.

Do not allow the grout temperature to exceed 85°F during mixing and pumping. Do not grout when the ambient temperature is below 35°F. Field-test the grout in accordance with Table 1 during grout installation. Perform field-testing by trained personnel at the Contractor's expense while witnessed by the Engineer. Pump at the lowest pressure possible that will maintain a continuous flow of grout.

Table1
Requirements for Field-Testing of Grout

Test	Frequency	Requirement
Schupak Pressure Bleed Test (ASTM C1741)	1 per day	Per DMS-4670
Fluidity test (Tex-437-A, Method 2)	2 every 2 hr. 2 min. per day	per DMS-4670
Compressive Strength test (3" × 6" cylinders)	1 per day	per DMS-4670
Mud Balance test (Tex-130-E, Part II)[1, 2]	2 per day	per PTI M55

1. Take one sample from the mixer and one sample from the farthest duct outlet.
2. Verify wet density is within the range established by the department.

Section 4.6., "Grouting." The section is voided and not replaced.

Article 5., "MEASUREMENT AND PAYMENT." The section is voided and replaced with the following.

5. **MEASUREMENT**

This Item will be measured by the each PT element or member. An element or member is defined by one of the following individual components.

- PT Cap

- PT Column
- PT Bent
- Other elements shown in the plans.

The PT may extend into other elements which is subsidiary to the main element being post-tensioned.

6. **PAYMENT**

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "PT" for the member type shown on the plans. This price is full compensation for submittals, mock-ups, prestressing steel, post-tensioning, ducts, grout fittings, grout, end anchorages, bearing plates, equipment, labor, materials, tools, and incidentals. Materials furnished for testing will not be paid for directly.

Post-tensioning of precast members, tensioned at a fabrication plant, will not be paid for directly but will be subsidiary to pertinent Items.

Special Provision to Item 427
Surface Finishes for Concrete

Item 427, "Surface Finishes for Concrete" of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Article 427.2.1 "Coatings," is supplemented with the following:

Epoxy Waterproofing. Provide Type X Epoxy per DMS-6100 "Epoxies and Adhesives." Match color of coating with Federal Standard 595C color 35630, concrete gray, unless otherwise shown on the plans.

Article 427.4.2.2 "Application," is supplemented with the following:

Epoxy Waterproofing. Mix epoxy per manufacturer's instructions. Apply the coating on a dry surface at a maximum application rate of 100 sq. ft per gallon. Apply a thin uniform film of mixed epoxy to the substrate by the use of a short nap roller or brush. The epoxy may be sprayed following the thinning requirements of the manufacturer. No more than 15% reduction is permitted.

Match the color of the applied coating with the color standard shown on the plans. Apply when ambient temperature is between 50°F and 100°F.

Article 427.6 "Payment," the second paragraph is voided and replaced in its entirety with:

When a surface finish for concrete is specified as a pay item, the work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Adhesive Grout Finish," "Concrete Paint Finish," "Opaque Sealer Finish," "Silicone Resin Paint Finish," "Epoxy Waterproof Finish," or "Blast Finish." This price is full compensation for materials; cleaning and preparing surfaces; application of materials; and equipment, labor, tools, and incidentals.

Special Provision to Item 434
Bridge Bearings

Item 434, "Bridge Bearings" of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Section 434.2.1., "Plain and Laminated Elastomeric Bearings," is voided and replaced with the following:

Manufacturers of plain and laminated elastomeric bearing pads must be approved in accordance with DMS-7365, "Qualification Procedure for Elastomeric Bridge Bearing Pad Manufacturers." The Materials and Tests Division (MTD) maintains a list of approved elastomeric bridge bearing pad manufacturers.

Manufacturers that produce laminated elastomeric bearings with a top steel plate or special components (steel guide bars and bottom plate) must comply with AASHTO's NTPEP Committee Work Plan for Evaluation of Plain and Laminated Elastomeric Bridge Bearing Manufacturers. DMS-7365 does not apply to manufacturers of bridge bearings where the laminated elastomeric bearing pad is a component of the completed bearing assembly.

Section 434.2.1.1., "Elastomer," is voided and replaced with the following:

Provide elastomer for bearings formulated from previously unvulcanized 100% virgin polychloroprene rubber polymers meeting the physical properties, heat resistance, and compression set requirements of AASHTO M 251, Table X1.1, unless otherwise shown on the plans. Do not provide bearings containing previously vulcanized synthetic rubber or other synthetic rubber-like polymers. Perform material tests on the finished product in accordance with the applicable test methods. Do not use standard laboratory test slabs for this purpose. Prepare test specimens from the finished product in accordance with ASTM D3183.

Obtain approval for each elastomer formulation before use on Department projects. Submit certified test results to MTD to prequalify and obtain approval of a particular formulation. Show actual test values obtained and the required values for the physical properties, heat resistance, and compression set of the elastomer when tested for compliance with the minimum requirements of AASHTO M 251, Table X1.1.

Forward samples (freight prepaid) to MTD, or their contracted testing laboratory when directed.

Submit only elastomer of the type or types to be supplied. Submit prequalification samples consisting of 2 finished bearing pads typical of the formulation and workmanship for Department projects. Submit 2 samples of each type when laminated and plain bearing pads are required. Laminated sample bearing pads may represent both plain bearing pads and laminated bearing pads for an elastomer formulation.

Plain sample bearing pads must measure 9 in. × 19 in. × 1 in. Laminated sample bearing pads must measure 9 in. × 14 in. × 1-1/2 in. with the following number of steel laminates:

- 50 durometer—3 steel laminates,
- 60 durometer—2 steel laminates, and
- 70 durometer—2 steel laminates.

Bond strength testing of laminated prequalification samples will be performed by the Department in accordance with Tex-601-J, Part I—"Bond Strength Test Method 1". The tested sample must achieve a minimum bond strength of 40 lbf/in. of width. Presence of chlorinated compounds (neoprene) in the elastomer will be verified by the Department in accordance with Tex-601-J, Part III—Chlorinated Compound Test Method 3.

Costs associated with testing elastomer formulations failing to conform to the requirements of this Item are borne by the bearing manufacturer. This cost will be assessed at the rate established by MTD at the time of testing.

Certify that the submitted samples are of the same basic elastomer formulation and of equivalent cure as the finished products to be furnished on Department projects.

Complete prequalification testing will be performed for each formulation at least once every 2 yr. and when necessary.

Section 434.2.1.2., "Steel Laminates," is voided and replaced with the following:

Provide steel laminates, for laminated bearing pads, of commercial grade steel strip or sheet with a thickness of 0.105 ±0.015 in.

Section 434.2.2.1.2., "Laminated Elastomeric Bearing Pad and Steel Plate," the first paragraph is amended to include the following sentence:

Bearing manufacturers that produce the laminated elastomeric bearing pad component of a sliding elastomeric bearing must comply with AASHTO's NTPEP Committee Work Plan for Evaluation of Plain and Laminated Elastomeric Bridge Bearing Manufacturers.

Section 434.3.1., "Plain and Laminated Elastomeric Bearings," is voided and replaced with the following:

Electronically submit shop drawings for the complete assembly before fabrication of laminated elastomeric bearings with or without steel top plates or special components in accordance with the plans and Item 441, "Steel Structures." Provide a bearing layout with the shop drawings.

Mold together components of a laminated bearing pad to form an integral unit free of voids or separations in the elastomer or between the elastomer and the steel laminates or plates, unless otherwise shown on the plans. Provide well-vulcanized elastomer between the laminates or plates and on the outer surfaces of the bearing pad that is uniform and integral and resists separation by mechanical means into separate, definite, well-defined elastomeric layers. Evidence of this layered construction, either at the outer surfaces or within the bearing pad, will be cause for rejection. Repair of damaged elastomer on sides of laminated bearing pads is not allowed for product acceptance. Repair of damaged elastomer on top or bottom surfaces of laminated bearing pads is allowed when approved.

Cover edges of steel laminates with 1/8 in. to 1/4 in. of elastomer except exposure of the laminates will be permitted at approved laminate restraining devices and around holes entirely enclosed in the finished structure. Position laminates within 1/8 in. of plan location.

Plain bearing pads may be molded individually, cut from previously molded strips or slabs molded to the full thickness of the finished bearing pads, or extruded and cut to length. The finish of cut surfaces must be ANSI 250, or smoother. The finished bearing pads must have no voids or separations detectable either at the bearing surfaces or within the bearing pad. Plain elastomeric bearing pads must be well vulcanized, uniform, and integral units of such construction that the bearing pad is incapable of being separated by any mechanical means into separate, definite, well-defined elastomeric layers. Evidence of layered construction either at the outer surfaces or within the bearing pad will be cause for rejection.

The permissible variation from the dimensions and configuration shown on the plans for both plain and laminated bearing pads will be as listed in AASHTO M 251, Table 2. Flash tolerance, finish, and appearance must meet the requirements of the latest edition of the Rubber Handbook published by the US Tire Manufacturer's Association, RMA F3 and T.063 for molded bearings, and RMA F2 for extruded bearings.

Perform required welding in accordance with Item 441, "Steel Structures." Manufacture guide bars, when required, so adjacent top and bottom bar surfaces are parallel to within 1/16 in. in the assembled position. The tolerance for diameter of anchor bolt holes is +1/8 in., −0. The maximum deviation for flatness of steel plates is 1/16 in. in any 24 in. or as shown on the plans.

Section 434.3.1.1., "Marking," the first paragraph is voided and replaced with the following:

Mark the bearing type on the surface of each bearing as shown on the plans. The marking must remain legible until placement in the structure. Permanently mark, in addition, laminated bearings with:

- manufacturer's name or trademark,
- lot number, and
- date of manufacture (month-year).

Section 434.3.1.2., "Testing and Acceptance," is voided and replaced with the following:

Perform testing, inspection, and acceptance of plain and laminated elastomeric bearing pads in accordance with DMS-7365, "Qualification Procedure for Elastomeric Bridge Bearing Pad Manufacturers."

For laminated elastomeric bearings with a steel top plate or special components (steel guide bars and bottom plate), apply a compression load of 2,250 psi or a stress approved by the Engineer to each bearing. Provide calibrated equipment per ASTM E4 for this compression testing. Each bearing will be acceptable if there is no visible evidence of bond failure or other damage and if the finished bearing meets other pertinent portions of this Item. Samples may be taken if the quality of production becomes questionable.

Section 434.3.2.2.1., "Lower Component," is voided and replaced with the following:

Manufacture one additional bearing lower component per project for testing purposes. Notify MTD, which will sample a bearing lower component at random from the lot, after bearings have been manufactured for a project. Forward selected samples (freight prepaid) to MTD, or to their contracted testing laboratory when directed. Lower component samples will be tested to the following:

- Tex-601-J, Part II—"Adhesion Test Method 2." Adhesion between the PTFE material and steel plate must meet a minimum 20 lb. per inch of width;
- Tex-601-J, Part III—"Chlorinated Compound Test Method 3." Laminated bearing pad elastomer must contain chlorinated compounds (neoprene); and
- PTFE physical properties in accordance with Table 1, with the exception of Melting Point Testing (ASTM D4894).

Costs associated with testing sliding elastomeric bearing lower component project samples failing to conform to these requirements are borne by the bearings manufacturer. This cost will be assessed at the rate established by Construction Division at the time of testing.

Section 434.3.3.2., "Testing and Acceptance." The last paragraph is voided.

Special Provision to Item 440
Reinforcement for Concrete

Item 440, "Reinforcement for Concrete," of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Article 440.2., "Materials," is supplemented with the following.

2.7. **Welded Deformed Bar Mat Reinforcement.** Provide welded deformed bar mats in accordance with ASTM A184 except as otherwise noted in this Specification. Fabricate welded bar mats from deformed steel bars in accordance with ASTM A706 by securely connecting every intersection with a process of electrical resistance welding that employs the principle of fusion combined with pressure. The bars must be assembled by automatic machines or by other suitable mechanical means that will assure accurate spacing and alignment of all bars of the finished product.

2.14. **Zinc-Coated, Hot-Dip Galvanized Class I or Class II Steel Reinforcement.** Provide zinc-coated, hot-dip galvanized Class I or Class II steel reinforcement in accordance with ASTM A767, Grade 60 or Grade 75, when shown on the plans and as allowed.

2.15. **Continuously Hot-Dip Galvanized Reinforcement (CGR).** Provide CGR in accordance with ASTM A1094 steel reinforcement, Grade 60 or Grade 75, when shown on the plans and as allowed.

Section 440.2.1., "Approved Mills." The second paragraph is voided and not replaced.

Section 440.2.5., "Weldable Reinforcing Steel," is supplemented with the following.

All welding operations must be performed before hot-dip galvanizing.

Section 440.2.8., "Mechanical Couplers," is voided and replaced with the following.

Use couplers of the type specified in DMS-4510, "Mechanical Couplers for Reinforcing Steel," Section 4510.6.1., "General Requirements," when mechanical splices in reinforcing steel bars are shown on the plans.

Furnish only couplers pre-qualified in accordance with DMS-4510, "Mechanical Couplers for Reinforcing Steel." Ensure sleeve-wedge type couplers are not used on coated reinforcing. Sample mechanical couplers in accordance with Tex-743-I for testing before use on individual projects. Test the mechanical couplers for every project in which mechanical couplers are used in accordance with Tex-744-I. Furnish couplers only at locations shown on the plans.

Furnish couplers for stainless reinforcing steel with the same alloy designation as the reinforcing steel.

Provide hot-dip or mechanically galvanized couplers when splicing galvanized reinforcing or CGR.

Section 440.2.11., "Low Carbon/Chromium Reinforcing Steel." The first sentence is voided and replaced by the following.

Provide deformed steel bars in accordance with ASTM A1035, Grade 100, Type CS, when low-carbon, chromium-reinforcing steel is required on the plans. Type CM will be permitted only if specified on the plans.

Section 440.3.1., "Bending," is supplemented with the following.

Do not bend hot-dip galvanized reinforcement. Only minor positioning adjustments are permitted.

Bending of CGR is permitted after galvanizing.

Section 440.3.5., "Placing." The following will be added to the fourth paragraph.

Use Class 1 or Class 1A supports with CGR. Provide epoxy- or plastic-coated tie wires and clips for use with epoxy-coated reinforcing steel.

Section 440.3.6.3., "Repairing Coating," is supplemented with the following:

Repair damaged galvanized surfaces in accordance with Section 445.3.5.2., "Repair Processes."

Special Provision to Item 441
Steel Structures

Item 441, "Steel Structures" of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Section 441.2.2., Approved Electrodes and Flux-Electrode Combinations," is voided and replaced with the following:

Use only electrodes and flux-electrode combinations conforming to AWS A5 specifications, and pertinent classifications for the applicable welding processes. When requested, submit a current Certificate of Conformance (COC) containing all test results as required by the applicable AWS A5 specification and welding code. Provide proof of Buy America compliance for welding consumables when requested. For bridge main member fabrication, submit the COC annually.

Section 441.2.3., "High-Strength Bolts," is revised and replaced by the following:

Use fasteners that meet Item 447, "Structural Bolting." Use galvanized fasteners on field connections of bridge members when ASTM F3125-Grade A325 bolts are specified, and steel is painted.

Section 441.3.1.5.1., "Plants," The second and third paragraphs are voided and replaced with the following:

Fabrication plants that produce the following non-bridge steel members must be approved in accordance with DMS-7380, "Steel Non-Bridge Member Fabrication Plant Qualification."

- Item 610, "Roadway Illumination Poles"
- Item 613, "High Mast Illumination Poles"
- Item 614, "High Mast Rings and Support Assemblies"
- Item 650, "Overhead Sign Support Structures"
- Item 654, "Sign Walkways"
- Item 686, "Traffic Signal Poles"
- Special Specification 6064, "Intelligent Transportation System (ITS) Poles."

The Materials and Tests Division (MTD) maintains a list of approved non-bridge fabrication plants on the Department MPL that produce these members.

Section 441.3.1.6.1., "Erection Drawings," the third paragraph is voided and replaced with the following:

Perform erection engineering evaluation of the structural adequacy and stability of constructing the bridge system for each step of the steel erection.

Section 441.3.1.5.3., "Nondestructive Testing (NDT)," is voided and replaced with the following:

Personnel performing NDT must be qualified in accordance with the applicable AWS code and the employer's Written Practice. Level III personnel who qualifies Level I and Level II technicians must be certified by ASNT for which the NDT Level III is qualified. In addition, NDT technicians must pass hands-on tests that MTD administers. This will remain current provided they continue to perform testing on Department materials as evidenced by test reports requiring their signature. A technician who fails any of the hands-on tests must wait 3 mo. or as approved otherwise before retesting. Qualification to perform NDT will be revoked when the technician's employment is terminated or when the technician goes 6 mo. without performing a test on a Department project. The technician must pass a new hands-on test to be re-certified. Testing of similar weld joints for non-Department projects may be considered by the Engineer instead of re-testing provided enough documentation is submitted with the signature of the project's Engineer. These requirements also apply to testing agencies, and individual third-party contractors.

Section 441.3.1.5.4., "Welding Procedure Specification Qualification Testing," is voided and replaced by the following:

For Fabricators qualified in accordance with DMS-7370, DMS-7380, or DMS-7395, laboratories performing procedure qualification testing for welding procedure specifications (WPSs) must be accredited by a nationally recognized agency that performs testing in accordance with ISO/International Electrotechnical Commission (IEC) 17025 in the mechanical field of testing.

Section 441.3.1.9., "Material Identification," is amended to include the following paragraph:

Low-stress stencil marks must have a radius instead of a sharp point. Acceptable stencils include dot, vibration, and rounded-V stencils. Label these stencils so that they are easily distinguishable from other stencils that are not low-stress.

Section 441.3.2.4.1., "Flange Tilt," the last sentence is voided and replaced with the following:

Minor jacking that does not deform the material will be permitted.

Section 441.3.2.5.3., "Magnetic Particle Testing," is voided and replaced with the following:

Use alternating current (AC) when using the yoke method unless otherwise approved. Welds may be further evaluated with half-wave rectified DC for subsurface indications. Centerline cracking may be detected with aluminum prod method when approved.

Section 441.3.5.8., "Hammering," is added to state the following:

Do not perform hammering on any portion of the member that causes the material to permanently deform. Avoid damage to the material by measures such as use of brass or aluminum hammers or by padding the area to be hammered.

Section 441.3.8.1., "Shop Painting," is amended to include with the following paragraph:

Measure the anchor profile after blast cleaning at random locations along the thermal cut surfaces. If specified anchor profile is not achieved over the entire flame cut surface, grind the edges and re-blast to achieve the required anchor pattern.

Section 441.3.9., "Handling and Storage of Materials," The second sentence of the second paragraph is replaced by the following:

Keep materials clean and avoid damaging of the applied coating.

Special Provision to Item 442
Metal for Structures

Item 442, "Metal for Structures" of the Standard Specifications is amended with respect to the clause cited below. No other clauses or requirements of this Item are waived or changed.

Section 442.2.1.3.3., "Fasteners." The first sentence of the first paragraph is replaced by the following:

Fasteners. Provide high-strength bolts that meet ASTM F3125-Grade A325 unless otherwise shown on the plans.

Section 442.2.1.3.3., "Fasteners." The third paragraph is deleted and not replaced.

Special Provision to Item 446
Field Cleaning and Painting Steel

For this project, Item 446, "Field Cleaning and Painting Steel," of the Standard Specifications, is hereby amended with respect to the clauses cited below, and no other clauses or requirements of this Item are waived or changed hereby.

Section 446.4.1., "Qualification," the first and second paragraphs are voided and replaced by the following:

> Submit to the Engineer documentation verifying SSPC QP 1 or NACE NIICAP AS-1 certification for work requiring the removal or application of coatings. Additionally, submit to the Engineer documentation verifying SSPC QP 2 Cat A or NACE NIICAP AS-2 certification when work requires removal of coatings containing hazardous materials. Maintain certifications throughout the project. No work may be performed without current and active certifications unless otherwise shown on the plans. The Engineer may waive certification requirements for minor, touch-up repair work and coating steel members repaired in accordance with Item 784, "Steel Member Repair."
>
> The Engineer may waive certification requirements, when stated on the plans, for the purpose of qualification in either contractor certification program if the project has been accepted as a qualification project as part of the process for obtaining SSPC QP1 Cat A or NACE NIICAP AS-1 certification. Submit certification applications and proof of acceptance before beginning work or provide SSPC QP 7 certification when required on the plans.

Section 446.4.7.3.2., "Classes of Cleaning," is amended with the following:

> Prepare all surfaces of painted steel members subsequently exposed from structural operations, such as deck removal or steel repair, in accordance with this Item. Prevent loose or damaged paint from entering the environment.

Special Provision to Item 447
Structural Bolting

Item 447, "Structural Bolting" of the Standard Specifications is amended with respect to the clause cited below. No other clauses or requirements of this Item are waived or changed.

Article 447.2.2., "Bolt Assemblies." The first paragraph is replaced by the following:

Bolt Assemblies. Provide ASTM F3125 bolts and nuts and washers meeting the type, grade, and finish requirements in Table 1, unless otherwise shown in the plans.

Article 447.2.2., "Bolt Assemblies." The second paragraph is replaced by the following:

Use Grade A325 or Grade A490 Type 3 plain (uncoated) bolts for weathering steel as indicated and Grade A325 Type 1 galvanized bolts for coated steel, unless otherwise shown on the plans.

Article 447.2.2., "Bolt Assemblies." Table 1 is replaced by the following:

Table 1
ASTM Type, Finish, and Grade for Structural Bolts, Nuts, and Washers

	Bolt[1] Grade	Bolt Type	Bolt Finish	ASTM A563 Nut Grade and Finish	ASTM F436 Washer Type and Finish
Heavy-Hex Bolts[1]	A325	1	Galvanized	DH,[2] galvanized and lubricated	1; galvanized
	A325	3	Plain	C3 and DH3; plain	3; plain
	A490	3	Plain	DH3; plain	3; plain
Tension-Control Bolts[1]	F1852	1	Galvanized	DH,[2] galvanized and lubricated	1; galvanized
	F1852	3	Plain	C3 and DH3; plain	3; plain
	F2280	3	Plain	DH3; plain	3; plain

1. ASTM F3125 High Strength Structural Bolts
2. ASTM A194 Heavy Hex Grade 2H nuts may be substituted.

Article 447.2.6., "Fitup Bolts and Erection Pins." The first paragraph is replaced by the following:

Fitup Bolts and Erection Pins. Provide heavy-hex fitup bolts of the same diameter as the connection bolts. Do not use washer-type indicating devices for fitups. Do not reuse galvanized bolts or Grade A490 bolts that have been used as fitup bolts. Provide a sufficient number of erection or drift pins, 1/32 in. larger than the bolt diameter.

Article 447.4.3., "General." The second sentence of the third paragraph is replaced by the following:

Install hardened washers under both the nut and bolt head of Grade A490 bolts when the outer plies being fastened have a yield strength less than 40 ksi.

Article 447.4.3., "General." Table 2 is replaced by the following:

Table 2
Bolt Tension

Nominal Bolt Size, in.	Minimum Tension (kips)	
	Grade A325 Bolts	Grade A490 Bolts
½	12	15
5/8	19	24
¾	28	35
7/8	39	49
1	51	64
1-1/8	56	80
1-1/4	71	102
1-3/8	85	121
1-1/2	103	148

Article 447.4.5.2., "Install Bolts." The second paragraph is replaced by the following:

Fully tighten a minimum number of bolts as directed until the plies are in full contact if snugging does not bring the plies of the joint into full contact. Mark these bolts as fitup bolts. Use a non-galvanized Grade A325 bolt of the same diameter as a fitup bolt in connections requiring the use of galvanized Grade A325 bolts. Re-snug all remaining bolts.

Article 447.4.5.3., "Tension Bolts." The first paragraph is replaced by the following:

Tension Bolts. Loosen all fitup bolts after tensioning all the other bolts in the connection. Ungalvanized Grade A325 bolts used as fitup bolts may be reused in a connection using this type of bolt. Replace all galvanized bolts and Grade A490 bolts used as fitup bolts. Tension these remaining untensioned bolts in accordance with this paragraph. Ensure the element not turned by the wrench (bolt head or nut) does not rotate.

Article 447.4.5.4., "Bolt Reuse." The first paragraph is replaced by the following:

Bolt Reuse. Do not reuse Grade A490 or galvanized Grade A325 bolts. Ungalvanized Grade A325 bolts may be reused one time if the threads have not been damaged. Re-tensioning previously tensioned bolts loosened by the tensioning of adjacent bolts is not considered to be reuse.

Special Provision to Item 448
Structural Field Welding

Item 448, "Structural Field Welding" of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Article 448.2., "Materials," the third paragraph is voided and replaced with the following:

Use only electrodes and flux-electrode combinations conforming to AWS A5 specifications and pertinent classifications for the applicable welding processes. When requested, submit a current Certificate of Conformance (COC) containing acceptable wording indicating Buy America compliance and all tests required by the applicable AWS specifications and welding codes. Tests must be conducted on electrodes of the same class, size, and brand; and manufactured by the same process and with the same materials as the electrodes to be furnished.

Special Provision to Item 449
Anchor Bolts

Item 449, "Anchor Bolts" of the Standard Specifications is amended with respect to the clause cited below. No other clauses or requirements of this Item are waived or changed.

Section 449.2.1., "Bolts and Nuts." Table 1 is replaced by the following:

Table 1
Bolt and Nut Standards

Specified Anchor Bolt Category	Bolt Standards	Nut Standards
Mild steel	ASTM A307 Gr. A, F1554 Gr. 36, or A36	ASTM A563
Medium-strength, mild steel	ASTM F1554 Gr. 55 with supplementary requirement S1	ASTM A194 Gr. 2 or A563 Gr. D or better
High-strength steel	ASTM F3125-Grade A325 or ASTM A449[1]	ASTM A194 or A563, heavy hex
Alloy steel	ASTM A193 Gr. B7 or F1554 Gr. 105	ASTM A194 Gr. 2H or A563 Gr. DH, heavy hex

1. **If headed bolts are specified, ASTM A449 bolts must be heavy hex head.**

Section 449.3.3.1,"Anchor Bolt Thread Lubricant Coating," The first sentence of the first paragraph is voided and replaced by the following.

Coat anchor bolt threads before installing nuts with an electrically conducting lubricant compound described in Section 449.3.3.2.1., "Definitions," for traffic signal poles, roadway illumination poles, high mast illumination poles, intelligent transportation system poles, overhead sign support structures, and steel electrical service supports.

Section 449.3.3.2,"Anchor Bolt Tightening Procedure," The first sentence of the first paragraph is voided and replaced by the following.

Tighten anchor bolts for traffic signal poles, shoe base and concrete traffic barrier base roadway illumination poles, high mast illumination poles, intelligent transportation system poles, and overhead sign support structures in accordance with this Section.

Special Provision to Item 450
Railing

Item 450, "Railing" of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Section 450.3.1.2., "Fabrication," is supplemented with the following.

Fabrication plants that produce metal railing (steel and aluminum) must be approved in accordance with DMS-7395, "Metal Railing Fabrication Plant Qualification." This required approval does not include fabricators of chain link fence. The Materials and Tests Division maintains a MPL of approved fabrication plants of metal railing.

Permanently mark each metal railing post base plate, at a visible location when erected, with the fabrication plant's insignia or trademark. For fabricated rail panels, provide this permanent mark on one post base plate, per panel.

Special Provision to Item 462
Concrete Box Culverts and Drains

Item 462, "Concrete Box Culverts and Drains," of the Standard Specifications, is hereby amended with respect to the clauses cited below, and no other clauses or requirements of this Item are waived or changed hereby.

Section 2.1., "General." The last paragraph is voided and replaced with the following:

Furnish material for precast formed and machine-made box culverts in accordance with DMS-7305, "Fabrication and Qualification Procedure for Multi-Project Fabrication Plants of Precast Concrete Drainage Structures."

Sections 2.2.2., "Formed Precast," and 2.2.3., "Machine-Made Precast," are voided and replaced by the following.

2.2.2 **Precast.** Precast formed and machine –made box culvert fabrication plants must be approved in accordance with DMS-7305, "Fabrication and Qualification Procedure for Multi-Project Fabrication Plants of Precast Concrete Drainage Structures." The Construction Division maintains a list of approved precast box culvert fabrication plants on the Department's MPL. Fabricate precast boxes in accordance with DMS-7305, "Fabrication and Qualification Procedure for Multi-Project Fabrication Plants of Precast Concrete Drainage Structures."

Sections 2.3.2., "Formed Precast," and 2.3.3., "Machine-Made Precast," are voided and replaced by the following.

2.3.2 **Precast.** Make, cure, and test compressive test specimens for precast formed and machine –made box culverts in accordance with DMS-7305, "Fabrication and Qualification Procedure for Multi-Project Fabrication Plants of Precast Concrete Drainage Structures.

Section 2.5., "Marking," the first paragraph is voided and replaced with the following.

Marking. Clearly mark each precast unit with the following:

- Name or trademark of fabricator and plant location;
- ASTM designation and product designation (when applicable);
- Date of manufacture,
- Box size,
- Minimum and maximum fill heights,
- Designation "TX" for precast units fabricated per DMS-7305,
- Fabricator's designated approval stamp for each approved unit,
- Designation "SR" for boxes meeting sulfate-resistant concrete plan requirements (when applicable), and
- Precast drainage structures used for jacking and boring (when applicable).

Section 2.6., "Tolerances." The section is voided and replaced with the following.

Ensure precast sections meet the permissible variations listed in ASTM C1577.

Ensure that the sides of a section at each end do not vary from being perpendicular to the top and bottom by more than 1/2 in. when measured diagonally between opposite interior corners. Deviations from this tolerance will be acceptable if the sections can be fitted at the plant and the joint opening at any point does not exceed 1 in. Use match-marks for proper installation on sections that have been accepted in this manner.

Ensure wall and slab thicknesses are not less than shown on the plans except for occasional deficiencies not greater than 3/16 in. or 5%, whichever is greater. If proper jointing is not affected, thicknesses in excess of plan requirements are acceptable.

Section 2.7., "Defects and Repair." The section is voided and replaced with the following:

Fine cracks on the surface of members that do not extend to the plane of the nearest reinforcement are acceptable unless the cracks are numerous and extensive. Repair cracks that extend into the plane of the reinforcing steel in accordance with the Department's Concrete Repair Manual. The Engineer may accept boxes with repairs that are sound, properly finished, and cured in conformance with pertinent specifications. Discontinue further production of precast sections until corrections are made and proper curing is provided when fine cracks on the surface indicate poor curing practices.

Repair precast boxes in accordance with DMS-7305, "Fabrication and Qualification Procedure for Multi-Project Fabrication Plants of Precast Concrete Drainage Structures."

Section 2.8., "Storage and Shipment." This section is voided and replaced with the following:

2.8 **Storage and Shipment.** Store precast sections on a level surface. Do not place any load on the sections until design strength is reached and curing is complete. Store and ship precast boxes in accordance with DMS-7305, "Fabrication and Qualification Production for Multi-Project Fabrication Plants of Precast Concrete Drainage Structures.

Special Provision to Item 464
Reinforced Concrete Pipe

Item 464, "Reinforced Concrete Pipe," of the Standard Specifications, is hereby amended with respect to the clauses cited below, and no other clauses or requirements of this Item are waived or changed hereby.

Section 2.1., "Fabrication." The section is voided and replaced with the following.

Fabrication plants must be approved by the Materials and Tests Division in accordance with DMS-7305, "Fabrication and Qualification Procedure for Multi-Project Fabrication Plants of Precast Concrete Drainage Structures," before furnishing precast reinforced concrete pipe for Departmental projects. The Department's MPL has a list of approved reinforced concrete pipe plants.

Furnish material and fabricate reinforced concrete pipe in accordance with DMS-7305, "Fabrication and Qualification Procedure for Multi-Project Fabrication Plants of Precast Concrete Drainage Structures."

Section 2.3., "Marking." The first paragraph is voided and replaced with the following.

Furnish each section of reinforced concrete pipe marked with the following information specified in DMS-7305, "Fabrication and Qualification Procedure for Multi-Project Fabrication Plants of Precast Concrete Drainage Structures."

- Class or D-Load of pipe,
- ASTM designation,
- Date of manufacture,
- Pipe size,
- Name or trademark of fabricator and plant location,
- Designation "TX" for precast units fabricated per DMS-7305;
- Designated fabricator's approval stamp for each approved unit,
- Pipe to be used for jacking and boring (when applicable), and
- Designation "SR" for pipe meeting sulfate-resistant concrete plan requirements (when applicable).

Section 2.5., "Causes for Rejection." The section is voided and replaced with the following.

Individual sections of pipe may be rejected for any of the conditions stated in the Annex of DMS-7305, "Fabrication and Qualification Procedure for Multi-Project Fabrication Plants of Precast Concrete Drainage Structures."

Section 2.6., "Repairs." The section is voided and replaced with the following:

Make repairs, if necessary, as stated in the Annex of DMS-7305, "Fabrication and Qualification Procedure for Multi-Project Fabrication Plants of Precast Concrete Drainage Structures."

Special Provision to Item 465
Junction Boxes, Manholes, and Inlets

Item 465, "Junction Boxes, Manholes, and Inlets," of the Standard Specifications, is hereby amended with respect to the clauses cited below, and no other clauses or requirements of this Item are waived or changed hereby.

Section 2.1., "Concrete," The section is voided and replaced with the following.

Furnish concrete per DMS-7305 for formed and machine-made precast junction boxes, manholes, and inlets. Furnish Class C concrete for cast-in-place junction boxes, manholes, and inlets unless otherwise shown on the plans.

Section 3.1., "Precast Junction Boxes, Manholes, and Inlets," The section is voided and replaced with the following.

Construct formed and machine-made precast junction boxes, manholes, and inlets in accordance with DMS-7305, "Fabrication and Qualification Procedure for Multi-Project Fabrication Plants of Precast Concrete Drainage Structures" and the Contract Plans, except as otherwise noted in this Item.

Multi-project fabrication plants as defined in Item 424 "Precast Concrete Structural Members (Fabrication)," that produce junction boxes, manholes, and inlets will be approved by the Materials and Tests Division in accordance with DMS-7305, "Fabrication and Qualification Procedure for Multi-Project Fabrication Plants of Precast Concrete Drainage Structures." The Department's MPL has a list of approved multi-project fabrication plants.

Section 3.1.1., "Lifting Holes," The section is voided and not replaced.

Section 3.1.2., "Marking." The section is voided and replaced with the following.

Marking. Clearly mark each precast junction box, manhole, and inlet unit with the following information:

- name or trademark of fabricator and plant location;
- product designation;
- ASTM designation (if applicable);
- date of manufacture;
- designation "TX" for precast units fabricated per DMS-7305;
- designated fabricator's approval stamp for each approved unit; and
- designation "SR" for product meeting sulfate-resistant concrete plan requirements (when applicable).

Special Provision to Item 502
Barricades, Signs and Traffic Handling

Item 502, "Barricades, Signs and Traffic Handling" of the Standard Specifications, is hereby amended with respect to the clauses cited below, and no other clauses or requirements of this Item are waived or changed hereby.

Article 502.1., "Description," is supplemented by the following:

Temporary work-zone (TWZ) traffic control devices manufactured after December 31, 2019, must have been successfully tested to the crashworthiness requirements of the 2016 edition of the Manual for Assessing Safety Hardware (MASH). Such devices manufactured on or before this date and successfully tested to NCHRP Report 350 or the 2009 edition of MASH may continue to be used throughout their normal service lives. An exception to the manufacture date applies when, based on the project's date of letting, a category of MASH-2016 compliant TWZ traffic control devices are not approved, or are not self-certified after the December 31, 2019, date. In such case, devices that meet NCHRP-350 or MASH-2009 may be used regardless of the manufacture date.

Such TWZ traffic control devices include: portable sign supports, barricades, portable traffic barriers designated exclusively for use in temporary work zones, crash cushions designated exclusively for use in temporary work zones, longitudinal channelizers, truck and trailer mounted attenuators. Category I Devices (i.e., lightweight devices) such as cones, tubular markers and drums without lights or signs attached however, may be self-certified by the vendor or provider, with documentation provided to Department or as are shown on Department's Compliant Work Zone Traffic Control Device List.

Article 502.4., "Payment," is supplemented by the following:

Truck mounted attenuators and trailer attenuators will be paid for under Special Specification, "Truck Mounted Attenuator (TMA) and Trailer Attenuator (TA)." Portable Changeable Message Signs will be paid for under Special Specification, "Portable Changeable Message Sign." Portable Traffic Signals will be paid for under Special Specification, "Portable Traffic Signals."

Special Provision to Item 506

Temporary Erosion, Sedimentation, and Environmental Controls

Item 506, "Temporary Erosion, Sedimentation, and Environmental Controls," of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Article 506.1., "Description." The second paragraph is voided and replaced by the following.

Contractor is considered primary operator to have day-to-day operational control as defined in TPDES GP TXR150000.

1.1. For projects with soil disturbance of less than 1 acre, no submittal to TCEQ will be required but Contractor will follow SWP3. For projects with soil disturbance of 1acre to less than 5 acres a small site notice will be posted at the site. For projects with soil disturbance of 5 acres or more a Notice of Intent (NOI) is required and a large site notice posted at site. Postings will be in accordance with TPDES GP TXR150000. Postings not associated with project specific locations will be in same location as Department's postings.

1.2. Notice of Intent (NOI). Submit a NOI, if applicable, with the TCEQ under the TPDES GP TXR150000 at least 7 days prior to commencement of construction activities at the project site. Provide a signed copy to the Engineer and any other MS4 operators at the time of submittal. The Department will submit their NOI prior to contractor submission and will provide a copy for Contractor's use in completing the Contractor's NOI form.

1.3. Notice of Change (NOC). Upon concurrence of the Engineer, submit a NOC, if applicable, to the TCEQ within 14 days of discovery of a change or revision to the NOI as required by the TPDES GP TXR150000. Provide a signed copy of the NOC to the Engineer and any other MS4 operators at the time of submittal.

1.4. Notice of Termination (NOT). Upon concurrence of the Engineer, submit a NOT, if applicable, to the TCEQ within 30 days of the Engineer's approval that 70% native background vegetative cover is met or equivalent permanent stabilization have been employed in accordance with the TPDES GP TXR 150000. Provide a signed copy of the NOT to the Engineer and any other MS4 operators at the time of submittal.

Section 506.3.1, "Contractor Responsible Person Environmental (CRPE) Qualifications and Responsibilities," is supplemented by the following:

3.1. Contractor Responsible Person Environmental (CRPE) Qualifications and Responsibilities. Provide and designate in writing at the preconstruction conference a CRPE and alternate CRPE who have overall responsibility for the storm water management program. The CRPE will implement stormwater and erosion control practices; will oversee and observe stormwater control measure monitoring and management; will monitor the project site daily and produce daily monitoring reports as long as there are BMPs in place or soil disturbing activities are evident to ensure compliance with the SWP3 and TPDES General Permit TXR150000. Daily monitor reports shall be maintained and made available upon request. During time suspensions when work is not occurring or on contract non-work days, daily inspections are not required unless a rain event has occurred. The CRPE will provide recommendations on how to improve the effectiveness of control measures. Attend the Department's preconstruction conference for the project. Ensure training is completed as identified in Section 506.3.3., "Training," by all applicable personnel before employees work on the project. Document and maintain and make available upon request, a list, signed by the CRPE, of all applicable Contractor and subcontractor employees who have completed the training. Include the employee's name, the training course name, and date the employee completed the training.

Section 506.3.3., "Training," is supplemented by the following:

Training is provided by the Department at no cost to the Contractor and is valid for 3 yr. from the date of completion. The Engineer may require the following training at a frequency less than 3 yr. based on environmental needs:

- "Environmental Management System: Awareness Training for the Contractor" (English and Spanish) (Approximate running time 20 min.), and
- "Storm Water: Environmental Requirements During Construction" (English and Spanish) (Approximate running time 20 min.).

The Contractor responsible person environmental (CRPE), alternate CRPE designated for emergencies, Contractor's superintendent, Contractor, and subcontractor lead personnel involved in soil disturbing or SWP3 activities must enroll in and complete the training listed below and maintain and make available upon request the certificate of completion. Training is provided by a third party and is valid for 3 yr. from the date shown on the Certificate of Completion. Coordinate enrollment as prescribed by the Department and pay associated fees for the following training:

- "Revegetation During Construction,"
- "Construction General Permit Compliance," and
- "Construction Stage Gate Checklist (CSGC)."

Training and associated fee will not be measured or paid for directly but are subsidiary to this Item.

Special Provision to Item 520
Weighing and Measuring Equipment

Item 520, "Weighing and Measuring Equipment" of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Article 520.2., "Equipment." The third paragraph is voided and replaced by the following.

Calibrate truck scales using weights certified by the Texas Department of Agriculture (TDA) or an equivalent agency as approved. Provide a written calibration report from a scale mechanic for truck scale calibrations. Cease plant operations during the checking operation. Do not use inaccurate or inadequate scales. Bring performance errors as close to zero as practicable when adjusting equipment.

Article 520.2., "Equipment." The fourth paragraph is amended to include the following:

At the Contractors option, an electronic ticket delivery system (e-ticketing) may be used instead of printed tickets. The use of e-ticketing will require written approval of the Engineer. At a minimum, the approved system will:

- Provide electronic, real-time e-tickets meeting the requirements of the applicable bid items;
- Automatically generate e-tickets using software and hardware fully integrated with the automated scale system used to weigh the material, and be designed in such a way that data input cannot be altered by the Contractor or the Engineer;
- Provide the Engineer access to the e-ticketing data in real-time with a web-based or app-based system compatible with iOS;
- Provide offline capabilities to prevent data loss if power or connectivity is lost;
- Require both the Contractor and the Engineer to accept or reject the e-ticket and provide the ability to record the information required by the applicable bid items, as well as any comments. Record the time of the approval/rejection and include it in the summary spreadsheet described below. Provide each party the capability to edit their respective actions and any entered information;

The Contractor may discontinue use of the e-ticket system and provide printed tickets as needed to meet the requirements of the applicable bid items.

Special Provision to Item 540
Metal Beam Guard Fence

Item 540, "Metal Beam Guard Fence" of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Article 540.4.7, "Measurement," is voided and replaced with the following:

> **Long Span System**. Measurement will be by each long span system, complete in place. Each long span system will be from the first CRT to the last CRT in the system.

Special Provision to Item 636
Signs

Item 636, "Signs" of the Standard Specifications, is hereby amended with respect to the clauses cited below, and no other clauses or requirements of this Item are waived or changed hereby.

Section 636.3.1, "Fabrication." is deleted.

Section 636.3.1.2, "Sheeting Application." The last sentence of the fourth paragraph is voided and replaced by the following.

Do not splice sheeting or overlay films for signs fabricated with ink or with colored transparent films.

Special Provision to Item 643
Sign Identification Decals

Item 643, "Sign Identification Decals," of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Article 2. "Materials." The sign identification decal design shown in Figure 1 and the description for each row in Table 1 are supplemented by the following.

Texas Department of Transportation												
C	**Fabrication Date**										**T**	**1**
J	F	M	A	M	J	J	A	S	O	N	D	**2**
	201		202		203		204		205			**3**
	0	1	2	3	4	5	6	7	8	9		**4**
Sheeting MFR - Substrate												
A	B	C	D	E	F	G	H	J	K	L	M	**5**
Film MFR												
A	B	C	D	E	F	G	H	J	K	L	M	**6**
Sheeting MFR - Legend												
A	B	C	D	E	F	G	H	J	K	L	M	**7**
Installation Date												
				0	1	2	3					**8**
	0	1	2	3	4	5	6	7	8	9		**9**
J	F	M	A	M	J	J	A	S	O	N	D	**10**
	201		202		203		204		205			**11**
	0	1	2	3	4	5	6	7	8	9		**12**
Name of Sign Fabricator **Physical Address** **City, State, Zip Code**												**13**

Figure 1
Decal Design (Row numbers explained in Table 1)

Table 1
Decal Description

Row Explanation
1 – Sign fabricator
2 – Month fabricated
3 – First 3 digits of year fabricated
4 – Last digit of year fabricated
5 – Manufacturer of the sheeting applied to the substrate
6 – Film (colored transparent or non-reflective black) manufacturer
7 – Manufacturer of the sheeting for the legend
8 – Tens digit of date installed
9 - Ones digit of date installed
10 – Month installed
11 – First 3 digits of year installed
12 – Last digit of year installed
13 – Name of sign fabricator and physical location of sign shop

Special Provision to Item 654
Sign Walkways

Item 654," Sign Walkways" of the Standard Specifications, is hereby amended with respect to the clauses cited below, and no other clauses or requirements of this Item are waived or changed hereby.

Section 654.3.2, "Fabrication." The following language is added after the first paragraph.

Fabrication plants that produce sign walkways must be approved in accordance with DMS-7380, "Steel Non-Bridge Member Fabrication Plant Qualification." The Construction Division maintains a list of approved sign walkway fabrication plants on the Department's Material Producers List.

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Special Provision to Item 656
Foundations for Traffic Control Devices

Item 656, "Foundations for Traffic Control Devices" of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Article 3. "Construction.," the first paragraph is supplemented by the following:

Ensure the top of the foundation and anchor bolts meet specified requirements in relation to the final grade.

Special Provision to Item 666
Retroreflectorized Pavement Markings

Item 666, "Retroreflectorized Pavement Markings," of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Section 2.3., "Glass Traffic Beads." The first paragraph is voided and replaced by the following:

Furnish drop-on glass beads in accordance with DMS-8290, "Glass Traffic Beads," or as approved. Furnish a double-drop of Type II and Type III drop-on glass beads for longitudinal pavement markings where each type bead is applied separately in equal portions (by weight), unless otherwise approved. Apply the Type III beads before applying the Type II beads. Furnish Type II beads for work zone pavement markings and transverse markings or symbols.

Section 4.3.1., "Type I Markings.," is supplemented by the following:

4.3.1.3. Spot Striping. Perform spot striping on a callout basis with a minimum callout quantity as shown on the plans.

Section 4.3.2., "Type II Markings.," is supplemented by the following:

4.3.2.1. Spot Striping. Perform spot striping on a callout basis with a minimum callout quantity as shown on the plans.

Section 4.4., "Retroreflectivity Requirements.," is voided and replaced by the following.

Type I markings for Contracts totaling more than 20,000 ft. of pavement markings must meet the following minimum retroreflectivity values for all longitudinal edgeline, centerline or no passing barrier-line, and lane line markings when measured any time after 3 days, but not later than 10 days after application.

- White markings: 250 millicandelas per square meter per lux (mcd/m^2/lx)
- Yellow markings: 175 mcd/m^2/lx

Retroreflectivity requirements for Type I markings are not required for Contracts with less than 20,000 ft. of pavement markings or Contracts with callout work, unless otherwise shown on the plans.

Section 4.5., "Retroreflectivity Measurements.," is voided and replaced by the following:

Use a mobile retroreflectometer to measure retroreflectivity for Contracts totaling more than 50,000 ft. of pavement markings, unless otherwise shown on the plans. For Contracts with less than 50,000 ft. of pavement markings, mobile or portable retroreflectometers may be used at the Contractor's discretion. Coordinate with and obtain authorization from the Engineer before starting any retroreflectivity data collection.

Section 4.5.1., "Mobile Retroreflectometer Measurements." The last paragraph is voided and replaced by the following.

Restripe again at the Contractor's expense with a minimum of 0.060 in. (60 mils) of Type I marking material if the average of these measurements falls below the minimum retroreflectivity requirements. Take measurements every 0.1 miles a minimum of 10 days after this third application within that mile segment for that series of markings. If the markings do not meet minimum retroreflectivity after this third application, the Engineer may require removal of all existing markings, a new application as initially specified, and a repeat of the application process until minimum retroreflectivity requirements are met.

Section 4.5.2., "Portable Retroreflectometer Measurements." The first and second paragraphs are voided and replaced by the following.

Provide portable measurement averages for every 1.0 mile unless otherwise specified or approved. Take a minimum of 20 measurements for each 1-mi. section of roadway for each series of markings (e.g., edgeline, center skip line, each line of a double line) and direction of traffic flow when using a portable reflectometer. Measure each line in both directions for centerlines on two-way roadways (i.e., measure both double solid lines in both directions and measure all center skip lines in both directions). The spacing between each measurement must be at least 100 ft. The Engineer may decrease the mileage frequency for measurements if the previous measurements provide satisfactory results. The Engineer may require the original number of measurements if concerns arise.

Restripe at the Contractor's expense with a minimum of 0.060 in. (60 mils) of Type I marking material if the averages of these measurements fail. Take a minimum of 10 more measurements after 10 days of this second application within that mile segment for that series of markings. Restripe again at the Contractor's expense with a minimum of 0.060 in. (60 mils) of Type I marking material if the average of these measurements falls below the minimum retroreflectivity requirements. If the markings do not meet minimum retroreflectivity after this third application, the Engineer may require removal of all existing markings, a new application as initially specified, and a repeat of the application process until minimum retroreflectivity requirements are met.

Section 4.6. "Performance Period." The first sentence is voided and replaced by the following:

All longitudinal markings must meet the minimum retroreflectivity requirements within the time frame specified. All markings must meet all other performance requirements of this specification for at least 30 calendar days after installation.

Article 6. "Payment." The first two paragraphs are voided and replaced by the following.

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Pavement Sealer" of the size specified; "Retroreflectorized Pavement Markings" of the type and color specified and the shape, width, size, and thickness (Type I markings only) specified, as applicable; "Retroreflectorized Pavement Markings with Retroreflective Requirements" of the types, colors, sizes, widths, and thicknesses specified; "Retroreflectorized Profile Pavement Markings" of the various types, colors, shapes, sizes, and widths specified; or "Reflectorized Pavement Marking (Call Out)" of the shape, width, size, and thickness (Type I markings only) specified, as applicable; or "Pavement Sealer (Call Out)" of the size specified.

This price is full compensation for materials, application of pavement markings, equipment, labor, tools, and incidentals.

Special Provision to Item 680
Highway Traffic Signals

Item 680, “Highway Traffic Signals” of the Standard Specifications is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Article 680.3.1.1.2,”Conduit,” The fourth sentence of the first paragraph is voided and replaced by the following.

Seal the ends of each conduit with approved sealant, after all cables and conductors are installed.

Special Provision to Special Specification 3096 Asphalts, Oils, and Emulsions

Special Specification 3096, "Asphalts, Oils, and Emulsions," is amended with respect to the clause cited below. No other clause or requirements of this Item are waived or changed.

Section 3096.2.2., Table 3 Polymer-Modified Asphalt Cement has been voided and replaced by the following:

Table 3
Polymer-Modified Asphalt Cement

Property	Test Procedure	Polymer-Modified Viscosity Grade											
		AC-12-5TR		NT-HA[1]		AC-15P		AC-20XP		AC-10-2TR		AC-20-5TR	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Polymer		TR		–		SBS		SBS		TR		TR	
Polymer content, % (solids basis)	Tex-533-C or Tex-553-C	5.0	–	–	–	3.0	–	–	–	2.0	–	5.0	–
Dynamic shear, G*/sin δ, 82°C, 10 rad/s, kPa	T 315	–	–	1.0	–	–	–	–	–	–	–	–	–
Dynamic shear, G*/sin δ, 64°C, 10 rad/s, kPa	T 315	–	–	–	–	–	–	1.0	–	–	–	1.0	–
Dynamic shear, G*/sin δ, 58°C, 10 rad/s, kPa	T 315	1.0	–	–	–	–	–	–	–	1.0	–	–	–
Viscosity													
140°F, poise	T 202	1,200	–	–	–	1,500	–	2,000	–	1,000	–	2,000	–
275°F, poise	T 202	–	–	–	–	–	8.0	–	–	–	8.0	–	10.0
275°F, Pa-s	T 316	–	–	–	4.0	–	–	–	–	–	–	–	–
Penetration, 77°F, 100 g, 5 sec.	T 49	110	150	–	25	100	150	75	115	95	130	75	115
Elastic recovery, 50°F, %	Tex-539-C	55				55	–	55	–	30	–	55	–
Polymer separation	Tex-540-C	None		–		None		None		None		None	
Flash point, C.O.C., °F	T 48	425		425		425	–	425	–	425	–	425	–
Tests on residue from RTFOT aging and pressure aging:	T 240 and R 28												
Creep stiffness	T 313												
S, -18°C, MPa		–	300	–	–	–	300	–	300	–	300	–	300
m-value, -18°C		0.300	–	–	–	0.300	–	0.300	–	0.300	–	0.300	–

1. This is a hot-applied TRAIL product.

Section 3096.2.5., Diluted Emulsions tables has been added.

Diluted Emulsions. Provide emulsified asphalt that is homogeneous, does not separate after thorough mixing, and meets the requirements for the specified type and grade in Tables 12A, and 12B, where the suffixes 50/50, 40/60, and 30/70 mean 50% emulsion diluted with 50% water; 40% emulsion diluted with 60% water, and 30% emulsion diluted with 70% water, respectively. For example, CSS-1H 40/60 means 40% CSS-1H diluted with 60% water and AE-P 30/70 means 30% AE-P diluted with 70% water.

Table 12A
Diluted CSS-1H

Property	Test Procedure	Type-Grade					
		Diluted Slow-Setting					
		CSS-1H 50/50		CSS-1H 40/60		CSS-1H 30/70	
		Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol 77°F, sec.	T 72	Report Only		Report Only		Report Only	
Distillation test:							
Residue by distillation, % by wt.	T 59	30	–	24	–	18	–
Oil distillate, % by volume of emulsion		–	0.5	–	0.5	–	0.5
Tests on residue from distillation:							
Penetration, 77°F, 100 g, 5 sec.	T 49	40	110	40	110	40	110
Solubility, %	T 44	97.5	–	97.5	–	97.5	–
Ductility, 77°F, 5 cm/min., cm	T 51	80	–	80	–	80	–

Table 12B
Diluted AE-P

Property	Test Procedure	Type–Grade					
		Diluted Slow-Setting					
		AE-P 50/50		AE-P 40/60		AE-P 30/70	
		Min	Max	Min	Min	Max	Min
Viscosity, Saybolt Furol 122°F, sec.	T 72	Report Only		Report Only		Report Only	
Asphalt emulsion distillation to 500°F followed by Cutback asphalt distillation of residue to 680°F:	T 59 & T 78						
Residue after both distillations, % by wt.		20	–	16	–	12	–
Total oil distillate from both distillations, % by volume of emulsion		12.5	20	10.0	16	7.5	12
Tests on residue after all distillations:							
Solubility, %	T 44	97.5	–	97.5	–	97.5	–
Float test, 122°F, sec.	T 50	50	200	50	200	50	200

Special Provision to Special Specification 6064
Intelligent Transportation System (ITS) Pole with Cabinet

Special Specification 6064, "Intelligent Transportation System (ITS) Pole with Cabinet" is amended with respect to the clauses cited below. No other clauses or requirements of this Item are waived or changed.

Section 6064.3.1., "Anchor Bolts." The second sentence is voided and replaced with the following:

Galvanize these items in accordance with Item 445, "Galvanizing."

Section 6064.3.2., "ITS Poles." Voided and replaced with the following:

ITS Poles. Fabricate ITS poles in accordance with the details shown on the plans, this Item, and Item 441, "Steel Structures." Alternate designs are not acceptable unless approved by the Department.

Provide properly fitting components. Provide round, octagonal (8-sided), or dodecagonal (12-sided) pole shafts tapered to the heights shown on the plans.

Permanently mark, at a visible location when erected, ITS pole base plates with the design wind speed. Locate the handholes, as shown on the plans, opposite of the direction of traffic flow.

Permanently mark, at a visible location when erected, ITS pole base plates with the fabrication plant's insignia. Place the mark on the pole base plate adjacent to the handhole access compartment.

Provide circumferential welds only at the ends of the shaft. Provide no more than two longitudinal seam welds in shaft sections. Provide 100% penetration within 6 in. of circumferential base welds and 60% minimum penetration at other locations along the longitudinal seam welds, unless otherwise specified. Use a welding technique that minimizes acid entrapment during later galvanizing. Hot-dip galvanize all fabricated parts in accordance with Item 445, "Galvanizing."

Perform at least 10% ultrasonic testing (UT) of longitudinal seam welds on the pole shafts. Use a Department approved UT procedure to ensure 60% or 85% minimum penetration where specified. Perform testing at a minimum of three locations on each shaft section (at both ends and middle). The minimum length of each test area must be 10 in. If minimum penetration is not achieved in any of the tested areas, test an additional 24 in. beyond the originally selected test areas requiring 60% or 85% penetration. Test the entire shaft seam weld if any locations within the additional 24 in. test areas does not achieve 60% or 85% penetration. Repair the deficient areas with a Department approved repair procedure and retest.

Fabricate air terminal and bracket assembly to serve as a lightning arrestor in accordance with ITS pole air terminal details and IEEE standards for lightning protection. Bond air terminal with air terminal bracket via clad weld or other approved bolted connection.

Special Provision to Special Specification 6185
Truck Mounted Attenuator (TMA) and Trailer Attenuator (TA)

Item 6185, "Truck Mounted Attenuator (TMA) and Trailer Attenuator (TA)" of the Standard Specifications, is hereby amended with respect to the clauses cited below, and no other clauses or requirements of this Item are waived or changed hereby.

Article 4. "Measurement", is voided and replaced by the following:

4.1. **Truck Mounted Attenuator/Trailer Attenuator (Stationary).** This Item will be measured by the day. TMA/TAs must be set up in a work area and operational before a calendar day can be considered measureable. A day will be measured for each TMA/TA set up and operational on the worksite.

4.2. **Truck Mounted Attenuator/Trailer Attenuator (Mobile Operation).** This Item will be measured by the hour or by the day. The time begins once the TMA/TA is ready for operation at the predetermined site and stops when notified by the Engineer. When measurement by the hour is specified, a minimum of 4 hr. will be paid each day for each operating TMA/TA used in a mobile operation. When measurement by the day is specified, a day will be measured for each TMA/TA set up and operational on the worksite.

Special Specification 3002
Spray Applied Underseal Membrane

1. DESCRIPTION

Construct an underseal membrane composed of a warm spray-applied polymer-modified emulsion meeting the requirements of Table 1. The membrane is applied through a spray-paver and is covered immediately with a mixture of aggregate, asphalt binder, and additives mixed hot in a mixing plant.

Table 1
Polymer-Modified Emulsions Requirements

Test on Emulsion	Test Method	Min	Max
Viscosity @ 77°F, SSF	Tex-513-C	20	100
Storage Stability[1], %	Tex-521-C		1
Demulsibility[2] Anionic emulsions — 35 ml of 0.02 N CaCl2, % Cationic emulsions — 35 ml 0.8% sodium dioctyl sulfosuccinate, %	Tex-521-C	55	
Sieve Test[3], %	Tex-521-C		0.05
Distillation Test[4] Residue by distillation, % by wt. Oil portion of distillate, % by vol.	Tex-521-C	 63	 0.5
Test on Residue from Distillation	**Test Method**	**Min**	**Max**
Elastic Recovery @ 50°F, 50 mm/min., %	Tex-539-C	60	
Penetration @ 77°F, 100 g, 5 sec, 0.1 mm	Tex-502-C	100	150

1. After standing undisturbed for 24 hr., the surface must be smooth, must not exhibit a white or milky colored substance, and must be a homogeneous color throughout.
2. Material must meet demulsibility test for emulsions.
3. May be required by the Engineer only when the emulsion cannot be easily applied in the field.
4. The temperature on the lower thermometer should be brought slowly to 350°F ±10°F and maintained at this temperature for 20 min. The total distillation should be complete in 60 ±5 min. from the first application of heat.

2. EQUIPMENT

2.1. **Spray Paver.** In addition to the requirements of Item 320, "Equipment for Asphalt Concrete Pavement," furnish a spray paver that will spray the membrane and apply the type and grade of mix shown on the plans and level the surface of the pavement layer in a single pass. Configure the spray paver so that the mixture is placed no more than 5 sec. after the membrane is applied.

2.2. **Membrane Storage Tank and Distribution System**. Equip the spray paver with an insulated storage tank having a minimum capacity of 900 gal., unless otherwise approved. Provide a metered mechanical pressure sprayer on the spray paver to apply the membrane at the specified rate. Locate the spray bar on the spray paver so that the membrane is applied immediately in front of the screed unit. Provide a read out device on the spray paver to monitor the membrane application rate.

Unless otherwise directed, furnish a volumetric calibration and strap stick for the tank in accordance with Tex-922-K, Part I. Calibrate the tank within the previous 5 yr. of the date first used on the project. The Engineer may verify calibration accuracy in accordance with Tex-922-K, Part II.

3. CONSTRUCTION METHODS

3.1. **Surface Preparation.** Remove existing raised pavement markers. Repair any damage incurred by removal as directed. Remove dirt, dust, or other harmful material before sealing. When shown on the plans, remove vegetation and blade pavement edges.

3.2. **Membrane Placement.** Unless otherwise directed, uniformly apply the membrane at a rate between 0.15 and 0.25 gal. per square yard. The Engineer may adjust the application rate, taking into consideration the existing pavement surface conditions. Spray the membrane using a metered mechanical pressure spray bar at a temperature between 140°F to 180°F. Monitor the membrane application rate and adjust the rate when needed or when directed. If required, verify that the spray bar is capable of applying the membrane at a uniform rate across the entire paving width as directed. Do not let the wheels or other parts of the paving machine contact the freshly applied membrane. Apply a uniform membrane coat to all contact surfaces and all joints as shown on the plans. Prevent splattering of the membrane when placed adjacent to curb, gutter, and other structures.

3.3. **Quality Control.** Perform the quality control tests listed in Table 2. If operational tolerances in Table 2 are exceeded, adjust processes or cease production when directed. The Engineer may perform independent tests to confirm contractor compliance and may require testing differences or failing results to be resolved before resuming production.

3.4. **Membrane Sampling.** Obtain a 1-qt. sample of the polymer-modified emulsion for each lot of mixture produced. The Engineer will witness the sampling of polymer-modified emulsion. Take the sample from the emulsion tank located on the paving machine, but not from the emulsion spraybar. Obtain the sample at approximately the same time the mixture random sample is obtained. Take all samples in accordance with Tex-500-C, Part III. Label the can with the corresponding lot and sublot numbers, and immediately deliver the sample to the Engineer. The Engineer will randomly choose at least 1 sample per project and test it to verify compliance with Table 1.

Table 2
Operational Tolerance and Minimum Testing Frequency

Test Description	Test Method	Minimum Testing Frequency	Operational Tolerance
Membrane Application Rate	Tex-247-F	1 per day	±0.02
Emulsion Membrane Sampling[1]	Tex-500-C	1 per day (sample only)	Table 1

1. The Engineer may reduce or waive the sampling and testing requirements based on a satisfactory history.

4. MEASUREMENT

Unless otherwise noted on the plans, underseal membrane material will be measured by one of the following methods:

4.1. **Volume.** Underseal membrane material will be measured at the applied temperature by strapping the tank before and after road application and determining the net volume in gallons from the distributor's calibrated strap stick. The Engineer will witness all strapping operations for volume determination.

If the meter and readout device is accurate within 1.5% of the strapped asphalt volume, the Engineer may allow use of the meter and readout to determine asphalt volume used and application rate.

The Engineer may require redetermination of meter readout at any time and will require volume determinations by strapping if the meter is not accurate to within 1.5% of strapped volume.

4.2. **Weight**. Underseal membrane material will be measured in tons using certified scales meeting the requirements of Item 320, "Equipment for Asphalt Concrete Pavement," unless otherwise approved. The transporting truck must have a seal attached to the driving device and other openings. The Engineer may require random checking on public scales, at the Contractor's expense, to verify weight accuracy.

Upon completion or temporary suspension, any remaining membrane material will be weighed by a certified public weigher or measured by volume in a calibrated tank, and the quantity converted to tons at the measured temperature. The quantity to be measured will be the number of tons received, minus the number of tons remaining after all directed work is complete, and minus the amount used for other Items.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided above will be paid for at the unit bid price for "Membrane Underseal." These prices are full compensation for all materials, equipment, labor, tools, and incidentals necessary to complete the work.

Special Specification 3076
Dense-Graded Hot-Mix Asphalt

1. DESCRIPTION

Construct a hot-mix asphalt (HMA) pavement layer composed of a compacted, dense-graded mixture of aggregate and asphalt binder mixed hot in a mixing plant. Payment adjustments will apply to HMA placed under this specification unless the HMA is deemed exempt in accordance with Section 3076.4.9.4., "Exempt Production."

2. MATERIALS

Furnish uncontaminated materials of uniform quality that meet the requirements of the plans and specifications.

Notify the Engineer of all material sources and before changing any material source or formulation. The Engineer will verify that the specification requirements are met when the Contractor makes a source or formulation change, and may require a new laboratory mixture design, trial batch, or both. The Engineer may sample and test project materials at any time during the project to verify specification compliance in accordance with Item 6, "Control of Materials."

2.1. **Aggregate**. Furnish aggregates from sources that conform to the requirements shown in Table 1 and as specified in this Section. Aggregate requirements in this Section, including those shown in Table 1, may be modified or eliminated when shown on the plans. Additional aggregate requirements may be specified when shown on the plans. Provide aggregate stockpiles that meet the definitions in this Section for coarse, intermediate, or fine aggregate. Aggregate from reclaimed asphalt pavement (RAP) is not required to meet Table 1 requirements unless otherwise shown on the plans. Supply aggregates that meet the definitions in Tex-100-E for crushed gravel or crushed stone. The Engineer will designate the plant or the quarry as the sampling location. Provide samples from materials produced for the project. The Engineer will establish the Surface Aggregate Classification (SAC) and perform Los Angeles abrasion, magnesium sulfate soundness, and Micro-Deval tests. Perform all other aggregate quality tests listed in Table 1. Document all test results on the mixture design report. The Engineer may perform tests on independent or split samples to verify Contractor test results. Stockpile aggregates for each source and type separately. Determine aggregate gradations for mixture design and production testing based on the washed sieve analysis given in Tex-200-F, Part II.

2.1.1. **Coarse Aggregate**. Coarse aggregate stockpiles must have no more than 20% material passing the No. 8 sieve. Aggregates from sources listed in the Department's *Bituminous Rated Source Quality Catalog* (BRSQC) are preapproved for use. Use only the rated values for hot-mix listed in the BRSQC. Rated values for surface treatment (ST) do not apply to coarse aggregate sources used in hot-mix asphalt.

For sources not listed on the Department's BRSQC:

- build an individual stockpile for each material;
- request the Department test the stockpile for specification compliance; and
- once approved, do not add material to the stockpile unless otherwise approved.

Provide aggregate from non-listed sources only when tested by the Engineer and approved before use. Allow 30 calendar days for the Engineer to sample, test, and report results for non-listed sources.

Provide coarse aggregate with at least the minimum SAC shown on the plans. SAC requirements only apply to aggregates used on the surface of travel lanes. SAC requirements apply to aggregates used on surfaces other than travel lanes when shown on the plans. The SAC for sources on the Department's *Aggregate Quality Monitoring Program* (AQMP) (Tex-499-A) is listed in the BRSQC.

2.1.1.1. **Blending Class A and Class B Aggregates**. Class B aggregate meeting all other requirements in Table 1 may be blended with a Class A aggregate to meet requirements for Class A materials, unless otherwise shown on the plans. Ensure that at least 50% by weight, or volume if required, of the material retained on the No. 4 sieve comes from the Class A aggregate source when blending Class A and B aggregates to meet a Class A requirement unless otherwise shown on the plans. Blend by volume if the bulk specific gravities of the Class A and B aggregates differ by more than 0.300. Coarse aggregate from RAP and Recycled Asphalt Shingles (RAS) will be considered as Class B aggregate for blending purposes.

The Engineer may perform tests at any time during production, when the Contractor blends Class A and B aggregates to meet a Class A requirement, to ensure that at least 50% by weight, or volume if required, of the material retained on the No. 4 sieve comes from the Class A aggregate source. The Engineer will use the Department's mix design template, when electing to verify conformance, to calculate the percent of Class A aggregate retained on the No. 4 sieve by inputting the bin percentages shown from readouts in the control room at the time of production and stockpile gradations measured at the time of production. The Engineer may determine the gradations based on either washed or dry sieve analysis from samples obtained from individual aggregate cold feed bins or aggregate stockpiles. The Engineer may perform spot checks using the gradations supplied by the Contractor on the mixture design report as an input for the template; however, a failing spot check will require confirmation with a stockpile gradation determined by the Engineer.

2.1.1.2. **Micro-Deval Abrasion**. The Engineer will perform a minimum of one Micro-Deval abrasion test in accordance with Tex-461-A for each coarse aggregate source used in the mixture design that has a Rated Source Soundness Magnesium (RSSM) loss value greater than 15 as listed in the BRSQC. The Engineer will perform testing before the start of production and may perform additional testing at any time during production. The Engineer may obtain the coarse aggregate samples from each coarse aggregate source or may require the Contractor to obtain the samples. The Engineer may waive all Micro-Deval testing based on a satisfactory test history of the same aggregate source.

The Engineer will estimate the magnesium sulfate soundness loss for each coarse aggregate source, when tested, using the following formula:

$$Mg_{est.} = (RSSM)(MD_{act.}/RSMD)$$

where:
$Mg_{est.}$ = magnesium sulfate soundness loss
$MD_{act.}$ = actual Micro-Deval percent loss
RSMD = Rated Source Micro-Deval

When the estimated magnesium sulfate soundness loss is greater than the maximum magnesium sulfate soundness loss specified, the coarse aggregate source will not be allowed for use unless otherwise approved. The Engineer will consult the Soils and Aggregates Section of the Materials and Tests Division, and additional testing may be required before granting approval.

2.1.2. **Intermediate Aggregate**. Aggregates not meeting the definition of coarse or fine aggregate will be defined as intermediate aggregate. Supply intermediate aggregates, when used that are free from organic impurities. The Engineer may test the intermediate aggregate in accordance with Tex-408-A to verify the material is free from organic impurities. Supply intermediate aggregate from coarse aggregate sources, when used that meet the requirements shown in Table 1 unless otherwise approved.

Test the stockpile if 10% or more of the stockpile is retained on the No. 4 sieve, and verify that it meets the requirements in Table 1 for crushed face count (Tex-460-A) and flat and elongated particles (Tex-280-F).

2.1.3. **Fine Aggregate**. Fine aggregates consist of manufactured sands, screenings, and field sands. Fine aggregate stockpiles must meet the gradation requirements in Table 2. Supply fine aggregates that are free from organic impurities. The Engineer may test the fine aggregate in accordance with Tex-408-A to verify the material is free from organic impurities. Unless otherwise shown on the plans, up to 10% of the total aggregate may be field sand or other uncrushed fine aggregate. Use fine aggregate, with the exception of field sand, from coarse aggregate sources that meet the requirements shown in Table 1 unless otherwise approved.

Test the stockpile if 10% or more of the stockpile is retained on the No. 4 sieve and verify that it meets the requirements in Table 1 for crushed face count (Tex-460-A) and flat and elongated particles (Tex-280-F).

Table 1
Aggregate Quality Requirements

Property	Test Method	Requirement
Coarse Aggregate		
SAC	Tex-499-A (AQMP)	As shown on the plans
Deleterious material, %, Max	Tex-217-F, Part I	1.5
Decantation, %, Max	Tex-217-F, Part II	1.5
Micro-Deval abrasion, %	Tex-461-A	Note 1
Los Angeles abrasion, %, Max	Tex-410-A	40
Magnesium sulfate soundness, 5 cycles, %, Max	Tex-411-A	30
Crushed face count,[2] %, Min	Tex-460-A, Part I	85
Flat and elongated particles @ 5:1, %, Max	Tex-280-F	10
Fine Aggregate		
Linear shrinkage, %, Max	Tex-107-E	3
Sand equivalent, %, Min	Tex-203-F	45

1. Used to estimate the magnesium sulfate soundness loss in accordance with Section 3076.2.1.1.2., "Micro-Deval Abrasion."
2. Only applies to crushed gravel.

Table 2
Gradation Requirements for Fine Aggregate

Sieve Size	% Passing by Weight or Volume
3/8"	100
#8	70–100
#200	0–30

2.2. **Mineral Filler**. Mineral filler consists of finely divided mineral matter such as agricultural lime, crusher fines, hydrated lime, or fly ash. Mineral filler is allowed unless otherwise shown on the plans. Use no more than 2% hydrated lime or fly ash unless otherwise shown on the plans. Use no more than 1% hydrated lime if a substitute binder is used unless otherwise shown on the plans or allowed. Test all mineral fillers except hydrated lime and fly ash in accordance with Tex-107-E to ensure specification compliance. The plans may require or disallow specific mineral fillers. Provide mineral filler, when used, that:

- is sufficiently dry, free-flowing, and free from clumps and foreign matter as determined by the Engineer;
- does not exceed 3% linear shrinkage when tested in accordance with Tex-107-E; and
- meets the gradation requirements in Table 3, unless otherwise shown on the plans.

Table 3
Gradation Requirements for Mineral Filler

Sieve Size	% Passing by Weight or Volume
#8	100
#200	55–100

2.3. **Baghouse Fines**. Fines collected by the baghouse or other dust-collecting equipment may be reintroduced into the mixing drum.

2.4. **Asphalt Binder**. Furnish the type and grade of performance-graded (PG) asphalt specified on the plans.

2.5. **Tack Coat**. Furnish CSS-1H, SS-1H, or a PG binder with a minimum high-temperature grade of PG 58 for tack coat binder in accordance with Item 300, "Asphalts, Oils, and Emulsions." Specialized tack coat materials listed on the Department's MPL are allowed or required when shown on the plans. Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use.

2.6. **Additives**. Use the type and rate of additive specified when shown on the plans. Additives that facilitate mixing, compaction, or improve the quality of the mixture are allowed when approved. Provide the Engineer with documentation such as the bill of lading showing the quantity of additives used in the project unless otherwise directed.

2.6.1. **Lime and Liquid Antistripping Agent**. When lime or a liquid antistripping agent is used, add in accordance with Item 301, "Asphalt Antistripping Agents." Do not add lime directly into the mixing drum of any plant where lime is removed through the exhaust stream unless the plant has a baghouse or dust collection system that reintroduces the lime into the drum.

2.6.2. **Warm Mix Asphalt (WMA)**. Warm Mix Asphalt (WMA) is defined as HMA that is produced within a target temperature discharge range of 215°F and 275°F using approved WMA additives or processes from the Department's MPL.

WMA is allowed for use on all projects and is required when shown on the plans. When WMA is required, the maximum placement or target discharge temperature for WMA will be set at a value below 275°F.

Department-approved WMA additives or processes may be used to facilitate mixing and compaction of HMA produced at target discharge temperatures above 275°F; however, such mixtures will not be defined as WMA.

2.6.3. **Compaction Aid.** Compaction Aid is defined as a chemical warm mix additive that is used to produce an asphalt mixture at a discharge temperature greater than 275°F.

Compaction Aid is allowed for use on all projects and is required when shown on the plans.

2.7. **Recycled Materials**. Use of RAP and RAS is permitted unless otherwise shown on the plans. Use of RAS is restricted to only intermediate and base mixes unless otherwise shown on the plans. Do not exceed the maximum allowable percentages of RAP and RAS shown in Table 4. The allowable percentages shown in Table 4 may be decreased or increased when shown on the plans. Determine the asphalt binder content and gradation of the RAP and RAS stockpiles for mixture design purposes in accordance with Tex-236-F, Part I. The Engineer may verify the asphalt binder content of the stockpiles at any time during production. Perform other tests on RAP and RAS when shown on the plans. Asphalt binder from RAP and RAS is designated as recycled asphalt binder. Calculate and ensure that the ratio of the recycled asphalt binder to total binder does not exceed the percentages shown in Table 5 during mixture design and HMA production when RAP or RAS is used. Use a separate cold feed bin for each stockpile of RAP and RAS during HMA production.

Surface, intermediate, and base mixes referenced in Tables 4 and 5 are defined as follows:

- **Surface**. The final HMA lift placed at the top of the pavement structure or placed directly below mixtures produced in accordance with Items 316, 342, 347, or 348;
- **Intermediate**. Mixtures placed below an HMA surface mix and less than or equal to 8.0 in. from the riding surface; and
- **Base**. Mixtures placed greater than 8.0 in. from the riding surface. Unless otherwise shown on the plans, mixtures used for bond breaker are defined as base mixtures.

2.7.1. **RAP**. RAP is salvaged, milled, pulverized, broken, or crushed asphalt pavement. Fractionated RAP is defined as a stockpile that contains RAP material with a minimum of 95.0% passing the 3/8-in. or 1/2-in. sieve, before burning in the ignition oven, unless otherwise approved. The Engineer may allow the Contractor to use an alternate to the 3/8-in. or 1/2-in. screen to fractionate the RAP.

Use of Contractor-owned RAP including HMA plant waste is permitted unless otherwise shown on the plans. Department-owned RAP stockpiles are available for the Contractor's use when the stockpile locations are shown on the plans. If Department-owned RAP is available for the Contractor's use, the Contractor may use Contractor-owned fractionated RAP and replace it with an equal quantity of Department-owned RAP. Department-owned RAP generated through required work on the Contract is available for the Contractor's use when shown on the plans. Perform any necessary tests to ensure Contractor- or Department-owned RAP is appropriate for use. The Department will not perform any tests or assume any liability for the quality of the Department-owned RAP unless otherwise shown on the plans. The Contractor will retain ownership of RAP generated on the project when shown on the plans.

Do not use Department- or Contractor-owned RAP contaminated with dirt or other objectionable materials. Do not use Department- or Contractor-owned RAP if the decantation value exceeds 5% and the plasticity index is greater than 8. Test the stockpiled RAP for decantation in accordance with Tex-406-A, Part I. Determine the plasticity index in accordance with Tex-106-E if the decantation value exceeds 5%. The decantation and plasticity index requirements do not apply to RAP samples with asphalt removed by extraction or ignition.

Do not intermingle Contractor-owned RAP stockpiles with Department-owned RAP stockpiles. Remove unused Contractor-owned RAP material from the project site upon completion of the project. Return unused Department-owned RAP to the designated stockpile location.

Table 4
Maximum Allowable Amounts of RAP[1]

Maximum Allowable Fractionated RAP (%)		
Surface	**Intermediate**	**Base**
15.0	25.0	30.0

1. Must also meet the recycled binder to total binder ratio shown in Table 5.

2.7.2. **RAS**. Use of post-manufactured RAS or post-consumer RAS (tear-offs) is not permitted in surface mixtures unless otherwise shown on the plans. RAS may be used in intermediate and base mixtures unless otherwise shown on the plans. Up to 3% RAS may be used separately or as a replacement for fractionated RAP in accordance with Table 4 and Table 5. RAS is defined as processed asphalt shingle material from manufacturing of asphalt roofing shingles or from re-roofing residential structures. Post-manufactured RAS is processed manufacturer's shingle scrap by-product. Post-consumer RAS is processed shingle scrap removed from residential structures. Comply with all regulatory requirements stipulated for RAS by the TCEQ. RAS may be used separately or in conjunction with RAP.

Process the RAS by ambient grinding or granulating such that 100% of the particles pass the 3/8 in. sieve when tested in accordance with Tex-200-F, Part I. Perform a sieve analysis on processed RAS material before extraction (or ignition) of the asphalt binder.

Add sand meeting the requirements of Table 1 and Table 2 or fine RAP to RAS stockpiles if needed to keep the processed material workable. Any stockpile that contains RAS will be considered a RAS stockpile and be limited to no more than 3.0% of the HMA mixture in accordance with Table 4.

Certify compliance of the RAS with DMS-11000, "Evaluating and Using Nonhazardous Recyclable Materials Guidelines." Treat RAS as an established nonhazardous recyclable material if it has not come into contact with any hazardous materials. Use RAS from shingle sources on the Department's MPL. Remove substantially all materials before use that are not part of the shingle, such as wood, paper, metal, plastic, and felt paper. Determine the deleterious content of RAS material for mixture design purposes in accordance with Tex-217-F, Part III. Do not use RAS if deleterious materials are more than 0.5% of the stockpiled RAS unless otherwise approved. Submit a sample for approval before submitting the mixture design. The Department will perform the testing for deleterious material of RAS to determine specification compliance.

2.8. **Substitute Binders**. Unless otherwise shown on the plans, the Contractor may use a substitute PG binder listed in Table 5 instead of the PG binder originally specified, if using recycled materials, and if the substitute PG binder and mixture made with the substitute PG binder meet the following:

- the substitute binder meets the specification requirements for the substitute binder grade in accordance with Section 300.2.10., "Performance-Graded Binders;" and
- the mixture has less than 10.0 mm of rutting on the Hamburg Wheel test (Tex-242-F) after the number of passes required for the originally specified binder. Use of substitute PG binders may only be allowed at the discretion of the Engineer if the Hamburg Wheel test results are between 10.0 mm and 12.5 mm.

Table 5
Allowable Substitute PG Binders and Maximum Recycled Binder Ratios

Originally Specified PG Binder	Allowable Substitute PG Binder for Surface Mixes	Allowable Substitute PG Binder for Intermediate and Base Mixes	Maximum Ratio of Recycled Binder[1] to Total Binder (%)		
			Surface	Intermediate	Base
76-22[4,5]	70-22	70-22	10.0	20.0	25.0
70-22[2,5]	N/A	64-22	10.0	20.0	25.0
64-22[2,3]	N/A	N/A	10.0	20.0	25.0
76-28[4,5]	70-28	70-28	10.0	20.0	25.0
70-28[2,5]	N/A	64-28	10.0	20.0	25.0
64-28[2,3]	N/A	N/A	10.0	20.0	25.0

1. Combined recycled binder from RAP and RAS. RAS is not permitted in surface mixtures unless otherwise shown on the plans.
2. Binder substitution is not allowed for surface mixtures.
3. Binder substitution is not allowed for intermediate and base mixtures.
4. Use no more than 10.0% recycled binder in surface mixtures when using this originally specified PG binder.
5. Use no more than 20.0% recycled binder when using this originally specified PG binder for intermediate mixtures. Use no more than 25.0% recycled binder when using this originally specified PG binder for base mixtures.

3. EQUIPMENT

Provide required or necessary equipment in accordance with Item 320, "Equipment for Asphalt Concrete Pavement."

4. CONSTRUCTION

Produce, haul, place, and compact the specified paving mixture. In addition to tests required by the specification, Contractors may perform other QC tests as deemed necessary. At any time during the project, the Engineer may perform production and placement tests as deemed necessary in accordance with Item 5, "Control of the Work." Schedule and participate in a mandatory pre-paving meeting with the Engineer on or before the first day of paving unless otherwise shown on the plans.

4.1. **Certification**. Personnel certified by the Department-approved hot-mix asphalt certification program must conduct all mixture designs, sampling, and testing in accordance with Table 6. Supply the Engineer with a list of certified personnel and copies of their current certificates before beginning production and when personnel changes are made. Provide a mixture design developed and signed by a Level 2 certified specialist. Provide Level 1A certified specialists at the plant during production operations. Provide Level 1B certified specialists to conduct placement tests. Provide AGG101 certified specialists for aggregate testing.

Table 6
Test Methods, Test Responsibility, and Minimum Certification Levels

Test Description	Test Method	Contractor	Engineer	Level[1]
1. Aggregate and Recycled Material Testing				
Sampling	Tex-221-F	✓	✓	1A/AGG101
Dry sieve	Tex-200-F, Part I	✓	✓	1A/AGG101
Washed sieve	Tex-200-F, Part II	✓	✓	1A/AGG101
Deleterious material	Tex-217-F, Parts I & III	✓	✓	AGG101
Decantation	Tex-217-F, Part II	✓	✓	AGG101
Los Angeles abrasion	Tex-410-A		✓	TxDOT
Magnesium sulfate soundness	Tex-411-A		✓	TxDOT
Micro-Deval abrasion	Tex-461-A		✓	AGG101
Crushed face count	Tex-460-A	✓	✓	AGG101
Flat and elongated particles	Tex-280-F	✓	✓	AGG101
Linear shrinkage	Tex-107-E	✓	✓	AGG101
Sand equivalent	Tex-203-F	✓	✓	AGG101
Organic impurities	Tex-408-A	✓	✓	AGG101
2. Asphalt Binder & Tack Coat Sampling				
Asphalt binder sampling	Tex-500-C, Part II	✓	✓	1A/1B
Tack coat sampling	Tex-500-C, Part III	✓	✓	1A/1B
3. Mix Design & Verification				
Design and JMF changes	Tex-204-F	✓	✓	2
Mixing	Tex-205-F	✓	✓	2
Molding (TGC)	Tex-206-F	✓	✓	1A
Molding (SGC)	Tex-241-F	✓	✓	1A
Laboratory-molded density	Tex-207-F, Parts I & VI	✓	✓	1A
Rice gravity	Tex-227-F, Part II	✓	✓	1A
Ignition oven correction factors[2]	Tex-236-F, Part II	✓	✓	2
Indirect tensile strength	Tex-226-F	✓	✓	1A
Hamburg Wheel test	Tex-242-F	✓	✓	1A
Boil test	Tex-530-C	✓	✓	1A
4. Production Testing				
Selecting production random numbers	Tex-225-F, Part I		✓	1A
Mixture sampling	Tex-222-F	✓	✓	1A/1B
Molding (TGC)	Tex-206-F	✓	✓	1A
Molding (SGC)	Tex-241-F	✓	✓	1A
Laboratory-molded density	Tex-207-F, Parts I & VI	✓	✓	1A
Rice gravity	Tex-227-F, Part II	✓	✓	1A
Gradation & asphalt binder content[2]	Tex-236-F, Part I	✓	✓	1A
Control charts	Tex-233-F	✓	✓	1A
Moisture content	Tex-212-F, Part II	✓	✓	1A/AGG101
Hamburg Wheel test	Tex-242-F	✓	✓	1A
Micro-Deval abrasion	Tex-461-A		✓	AGG101
Boil test	Tex-530-C	✓	✓	1A
Abson recovery	Tex-211-F		✓	TxDOT
5. Placement Testing				
Selecting placement random numbers	Tex-225-F, Part II		✓	1B
Trimming roadway cores	Tex-251-F, Parts I & II	✓	✓	1A/1B
In-place air voids	Tex-207-F, Parts I & VI	✓	✓	1A
In-place density (nuclear method)	Tex-207-F, Part III	✓		1B
Establish rolling pattern	Tex-207-F, Part IV	✓		1B
Control charts	Tex-233-F	✓	✓	1A
Ride quality measurement	Tex-1001-S	✓	✓	Note 3
Segregation (density profile)	Tex-207-F, Part V	✓	✓	1B
Longitudinal joint density	Tex-207-F, Part VII	✓	✓	1B
Thermal profile	Tex-244-F	✓	✓	1B
Shear Bond Strength Test	Tex-249-F		✓	TxDOT

1. Level 1A, 1B, AGG101, and 2 are certification levels provided by the Hot Mix Asphalt Center certification program.
2. Refer to Section 3076.4.9.2.3., "Production Testing," for exceptions to using an ignition oven.
3. Profiler and operator are required to be certified at the Texas A&M Transportation Institute facility when Surface Test Type B is specified.

4.2. **Reporting and Responsibilities**. Use Department-provided templates to record and calculate all test data, including mixture design, production and placement QC/QA, control charts, thermal profiles, segregation density profiles, and longitudinal joint density. Obtain the current version of the templates at http://www.txdot.gov/inside-txdot/forms-publications/consultants-contractors/forms/site-manager.html or from the Engineer. The Engineer and the Contractor will provide any available test results to the other party when requested. The maximum allowable time for the Contractor and Engineer to exchange test data is as given in Table 7 unless otherwise approved. The Engineer and the Contractor will immediately report to the other party any test result that requires suspension of production or placement, a payment adjustment less than 1.000, or that fails to meet the specification requirements. Record and electronically submit all test results and pertinent information on Department-provided templates.

Subsequent sublots placed after test results are available to the Contractor, which require suspension of operations, may be considered unauthorized work. Unauthorized work will be accepted or rejected at the discretion of the Engineer in accordance with Article 5.3., "Conformity with Plans, Specifications, and Special Provisions."

Table 7
Reporting Schedule

Description	Reported By	Reported To	To Be Reported Within
Production Quality Control			
Gradation[1]	Contractor	Engineer	1 working day of completion of the sublot
Asphalt binder content[1]			
Laboratory-molded density[2]			
Moisture content[3]			
Boil test[3]			
Production Quality Assurance			
Gradation[3]	Engineer	Contractor	1 working day of completion of the sublot
Asphalt binder content[3]			
Laboratory-molded density[1]			
Hamburg Wheel test[4]			
Boil test[3]			
Binder tests[4]			
Placement Quality Control			
In-place air voids[2]	Contractor	Engineer	1 working day of completion of the lot
Segregation[1]			
Longitudinal joint density[1]			
Thermal profile[1]			
Placement Quality Assurance			
In-place air voids[1]	Engineer	Contractor	1 working day after receiving the trimmed cores[5]
Segregation[3]			1 working day of completion of the lot
Longitudinal joint density[3]			
Thermal profile[3]			
Aging ratio[4]			
Payment adjustment summary	Engineer	Contractor	2 working days of performing all required tests and receiving Contractor test data

1. These tests are required on every sublot.
2. Optional test. When performed on split samples, report the results as soon as they become available.
3. To be performed at the frequency specified in Table 16 or as shown on the plans.
4. To be reported as soon as the results become available.
5. 2 days are allowed if cores cannot be dried to constant weight within 1 day.

The Engineer will use the Department-provided template to calculate all payment adjustment factors for the lot. Sublot samples may be discarded after the Engineer and Contractor sign off on the payment adjustment summary documentation for the lot.

Use the procedures described in Tex-233-F to plot the results of all quality control (QC) and quality assurance (QA) testing. Update the control charts as soon as test results for each sublot become available. Make the control charts readily accessible at the field laboratory. The Engineer may suspend production for failure to update control charts.

4.3. **Quality Control Plan (QCP)**. Develop and follow the QCP in detail. Obtain approval for changes to the QCP made during the project. The Engineer may suspend operations if the Contractor fails to comply with the QCP.

Submit a written QCP before the mandatory pre-paving meeting. Receive approval of the QCP before beginning production. Include the following items in the QCP:

4.3.1. **Project Personnel**. For project personnel, include:

- a list of individuals responsible for QC with authority to take corrective action;
- current contact information for each individual listed; and
- current copies of certification documents for individuals performing specified QC functions.

4.3.2. **Material Delivery and Storage**. For material delivery and storage, include:

- the sequence of material processing, delivery, and minimum quantities to assure continuous plant operations;
- aggregate stockpiling procedures to avoid contamination and segregation;
- frequency, type, and timing of aggregate stockpile testing to assure conformance of material requirements before mixture production; and
- procedure for monitoring the quality and variability of asphalt binder.

4.3.3. **Production**. For production, include:

- loader operation procedures to avoid contamination in cold bins;
- procedures for calibrating and controlling cold feeds;
- procedures to eliminate debris or oversized material;
- procedures for adding and verifying rates of each applicable mixture component (e.g., aggregate, asphalt binder, RAP, RAS, lime, liquid antistrip, WMA);
- procedures for reporting job control test results; and
- procedures to avoid segregation and drain-down in the silo.

4.3.4. **Loading and Transporting**. For loading and transporting, include:

- type and application method for release agents; and
- truck loading procedures to avoid segregation.

4.3.5. **Placement and Compaction**. For placement and compaction, include:

- proposed agenda for mandatory pre-paving meeting, including date and location;
- proposed paving plan (e.g., paving widths, joint offsets, and lift thicknesses);
- type and application method for release agents in the paver and on rollers, shovels, lutes, and other utensils;
- procedures for the transfer of mixture into the paver, while avoiding segregation and preventing material spillage;
- process to balance production, delivery, paving, and compaction to achieve continuous placement operations and good ride quality;
- paver operations (e.g., operation of wings, height of mixture in auger chamber) to avoid physical and thermal segregation and other surface irregularities; and
- procedures to construct quality longitudinal and transverse joints.

4.4. **Mixture Design**.

4.4.1. **Design Requirements**. The Contractor will design the mixture using a Superpave Gyratory Compactor (SGC). A Texas Gyratory Compactor (TGC) may be used when shown on the plans. Use the dense-graded design procedure provided in Tex-204-F. Design the mixture to meet the requirements listed in Tables 1, 2, 3, 4, 5, 8, 9, and 10.

4.4.1.1. **Design Number of Gyrations (Ndesign) When The SGC Is Used**. Design the mixture at 50 gyrations (Ndesign). Use a target laboratory-molded density of 96.0% to design the mixture; however, adjustments can be made to the Ndesign value as noted in Table 9. The Ndesign level may be reduced to at least 35 gyrations at the Contractor's discretion.

Use an approved laboratory from the Department's MPL to perform the Hamburg Wheel test, and provide results with the mixture design, or provide the laboratory mixture and request that the Department perform the Hamburg Wheel test. The Engineer will be allowed 10 working days to provide the Contractor with Hamburg Wheel test results on the laboratory mixture design.

The Engineer will provide the mixture design when shown on the plans. The Contractor may submit a new mixture design at any time during the project. The Engineer will verify and approve all mixture designs (JMF1) before the Contractor can begin production.

Provide the Engineer with a mixture design report using the Department-provided template. Include the following items in the report:

- the combined aggregate gradation, source, specific gravity, and percent of each material used;
- asphalt binder content and aggregate gradation of RAP and RAS stockpiles;
- the target laboratory-molded density (or Ndesign level when using the SGC);
- results of all applicable tests;
- the mixing and molding temperatures;
- the signature of the Level 2 person or persons that performed the design;
- the date the mixture design was performed; and
- a unique identification number for the mixture design.

Table 8
Master Gradation Limits (% Passing by Weight or Volume) and VMA Requirements

Sieve Size	B Fine Base	C Coarse Surface	D Fine Surface	F Fine Mixture
2"	–	–	–	–
1-1/2"	100.0[1]	–	–	–
1"	98.0–100.0	100.0[1]	–	–
3/4"	84.0–98.0	95.0–100.0	100.0[1]	–
1/2"	–	–	98.0–100.0	100.0[1]
3/8"	60.0–80.0	70.0–85.0	85.0–100.0	98.0–100.0
#4	40.0–60.0	43.0–63.0	50.0–70.0	70.0–90.0
#8	29.0–43.0	32.0–44.0	35.0–46.0	38.0–48.0
#30	13.0–28.0	14.0–28.0	15.0–29.0	12.0–27.0
#50	6.0–20.0	7.0–21.0	7.0–20.0	6.0–19.0
#200	2.0–7.0	2.0–7.0	2.0–7.0	2.0–7.0
Design VMA, % Minimum				
–	13.0	14.0	15.0	16.0
Production (Plant-Produced) VMA, % Minimum				
–	12.5	13.5	14.5	15.5

1. Defined as maximum sieve size. No tolerance allowed.

Table 9
Laboratory Mixture Design Properties

Mixture Property	Test Method	Requirement
Target laboratory-molded density, % (SGC)	Tex-207-F	96.0
Design gyrations (Ndesign for SGC)	Tex-241-F	50[1]
Indirect tensile strength (dry), psi	Tex-226-F	85–200[2]
Boil test[3]	Tex-530-C	–

1. Adjust within a range of 35–100 gyrations when shown on the plans or specification or when mutually agreed between the Engineer and Contractor.
2. The Engineer may allow the IDT strength to exceed 200 psi if the corresponding Hamburg Wheel rut depth is greater than 3.0 mm and less than 12.5 mm.
3. Used to establish baseline for comparison to production results. May be waived when approved.

Table 10
Hamburg Wheel Test Requirements

High-Temperature Binder Grade	Test Method	Minimum # of Passes @ 12.5 mm[1] Rut Depth, Tested @ 50°C
PG 64 or lower	Tex-242-F	10,000[2]
PG 70		15,000[3]
PG 76 or higher		20,000

1. When the rut depth at the required minimum number of passes is less than 3 mm, the Engineer may require the Contractor to increase the target laboratory-molded density (TGC) by 0.5% to no more than 97.5% or lower the Ndesign level (SGC) to at least 35 gyrations.
2. May be decreased to at least 5,000 passes when shown on the plans.
3. May be decreased to at least 10,000 passes when shown on the plans.

4.4.1.2. **Target Laboratory-Molded Density When The TGC Is Used**. Design the mixture at a 96.5% target laboratory-molded density. Increase the target laboratory-molded density to 97.0% or 97.5% at the Contractor's discretion or when shown on the plans or specification.

4.4.2. **Job-Mix Formula Approval**. The job-mix formula (JMF) is the combined aggregate gradation, target laboratory-molded density (or Ndesign level), and target asphalt percentage used to establish target values for hot-mix production. JMF1 is the original laboratory mixture design used to produce the trial batch. When WMA is used, JMF1 may be designed and submitted to the Engineer without including the WMA additive. When WMA is used, document the additive or process used and recommended rate on the JMF1 submittal. The Engineer and the Contractor will verify JMF1 based on plant-produced mixture from the trial batch unless otherwise approved. The Engineer may accept an existing mixture design previously used on a Department project and may waive the trial batch to verify JMF1. The Department may require the Contractor to reimburse the Department for verification tests if more than 2 trial batches per design are required.

4.4.2.1. **Contractor's Responsibilities**.

4.4.2.1.1. **Providing Gyratory Compactor**. Use a SGC calibrated in accordance with Tex-241-F to design the mixture in accordance with Tex-204-F, Part IV, for molding production samples. Locate the SGC, if used, at the Engineer's field laboratory and make the SGC available to the Engineer for use in molding production samples. Furnish a TGC calibrated in accordance with Tex-914-K when shown on the plans to design the mixture in accordance with Tex-204-F, Part I, for molding production samples.

4.4.2.1.2. **Gyratory Compactor Correlation Factors**. Use Tex-206-F, Part II, to perform a gyratory compactor correlation when the Engineer uses a different gyratory compactor. Apply the correlation factor to all subsequent production test results.

4.4.2.1.3. **Submitting JMF1**. Furnish a mix design report (JMF1) with representative samples of all component materials and request approval to produce the trial batch. Provide approximately 10,000 g of the design mixture if opting to have the Department perform the Hamburg Wheel test on the laboratory mixture, and request that the Department perform the test.

4.4.2.1.4. **Supplying Aggregates**. Provide approximately 40 lb. of each aggregate stockpile unless otherwise directed.

4.4.2.1.5. **Supplying Asphalt**. Provide at least 1 gal. of the asphalt material and enough quantities of any additives proposed for use.

4.4.2.1.6. **Ignition Oven Correction Factors**. Determine the aggregate and asphalt correction factors from the ignition oven in accordance with Tex-236-F, Part II. Provide correction factors that are not more than 12 months old. Provide the Engineer with split samples of the mixtures before the trial batch production, including all additives (except water), and blank samples used to determine the correction factors for the ignition oven used for QA testing during production. Correction factors established from a previously approved mixture design may be used for the current mixture design if the mixture design and ignition oven are the same as previously used, unless otherwise directed.

4.4.2.1.7. **Boil Test**. Perform the test and retain the tested sample from Tex-530-C until completion of the project or as directed. Use this sample for comparison purposes during production. The Engineer may waive the requirement for the boil test.

4.4.2.1.8. **Trial Batch Production**. Provide a plant-produced trial batch upon receiving conditional approval of JMF1 and authorization to produce a trial batch, including the WMA additive or process if applicable, for verification testing of JMF1 and development of JMF2. Produce a trial batch mixture that meets the requirements in Table 4, Table 5, and Table 11. The Engineer may accept test results from recent production of the same mixture instead of a new trial batch.

4.4.2.1.9. **Trial Batch Production Equipment**. Use only equipment and materials proposed for use on the project to produce the trial batch.

4.4.2.1.10. **Trial Batch Quantity**. Produce enough quantity of the trial batch to ensure that the mixture meets the specification requirements.

4.4.2.1.11. **Number of Trial Batches**. Produce trial batches as necessary to obtain a mixture that meets the specification requirements.

4.4.2.1.12. **Trial Batch Sampling**. Obtain a representative sample of the trial batch and split it into 3 equal portions in accordance with Tex-222-F. Label these portions as “Contractor,” “Engineer,” and “Referee.” Deliver samples to the appropriate laboratory as directed.

4.4.2.1.13. **Trial Batch Testing**. Test the trial batch to ensure the mixture produced using the proposed JMF1 meets the mixture requirements in Table 11. Ensure the trial batch mixture is also in compliance with the Hamburg Wheel requirement in Table 10. Use a Department-approved laboratory to perform the Hamburg Wheel test on the trial batch mixture or request that the Department perform the Hamburg Wheel test. The Engineer will be allowed 10 working days to provide the Contractor with Hamburg Wheel test results on the trial batch. Provide the Engineer with a copy of the trial batch test results.

4.4.2.1.14. **Development of JMF2**. Evaluate the trial batch test results after the Engineer grants full approval of JMF1 based on results from the trial batch, determine the optimum mixture proportions, and submit as JMF2. Adjust the asphalt binder content or gradation to achieve the specified target laboratory-molded density. The asphalt binder content established for JMF2 is not required to be within any tolerance of the optimum asphalt binder content established for JMF1; however, mixture produced using JMF2 must meet the voids in mineral aggregates (VMA) requirements for production shown in Table 8. If the optimum asphalt binder content for JMF2 is more than 0.5% lower than the optimum asphalt binder content for JMF1, the Engineer may perform or require the Contractor to perform Tex-226-F on Lot 1 production to confirm the indirect tensile strength does not exceed 200 psi. Verify that JMF2 meets the mixture requirements in Table 5.

4.4.2.1.15. **Mixture Production**. Use JMF2 to produce Lot 1 as described in Section 3076.4.9.3.1.1., “Lot 1 Placement,” after receiving approval for JMF2 and a passing result from the Department’s or a Department-approved

laboratory's Hamburg Wheel test on the trial batch. If desired, proceed to Lot 1 production, once JMF2 is approved, at the Contractor's risk without receiving the results from the Department's Hamburg Wheel test on the trial batch.

Notify the Engineer if electing to proceed without Hamburg Wheel test results from the trial batch. Note that the Engineer may require up to the entire sublot of any mixture failing the Hamburg Wheel test to be removed and replaced at the Contractor's expense.

4.4.2.1.16. **Development of JMF3**. Evaluate the test results from Lot 1, determine the optimum mixture proportions, and submit as JMF3 for use in Lot 2.

4.4.2.1.17. **JMF Adjustments**. If JMF adjustments are necessary to achieve the specified requirements, make the adjustments before beginning a new lot. The adjusted JMF must:

- be provided to the Engineer in writing before the start of a new lot;
- be numbered in sequence to the previous JMF;
- meet the mixture requirements in Table 4 and Table 5;
- meet the master gradation limits shown in Table 8; and
- be within the operational tolerances of JMF2 listed in Table 11.

4.4.2.1.18. **Requesting Referee Testing**. Use referee testing, if needed, in accordance with Section 3076.4.9.1., "Referee Testing," to resolve testing differences with the Engineer.

Table 11
Operational Tolerances

Description	Test Method	Allowable Difference Between Trial Batch and JMF1 Target	Allowable Difference from Current JMF Target	Allowable Difference between Contractor and Engineer[1]
Individual % retained for #8 sieve and larger	Tex-200-F or Tex-236-F	Must be Within Master Grading Limits in Table 8	±5.0[2,3]	±5.0
Individual % retained for sieves smaller than #8 and larger than #200			±3.0[2,3]	±3.0
% passing the #200 sieve			±2.0[2,3]	±1.6
Asphalt binder content, %	Tex-236-F	±0.5	±0.3[3]	±0.3
Laboratory-molded density, %	Tex-207-F	±1.0	±1.0	±1.0
In-place air voids, %		N/A	N/A	±1.0
Laboratory-molded bulk specific gravity		N/A	N/A	±0.020
VMA, %, min	Tex-204-F	Note[4]	Note[4]	N/A
Theoretical maximum specific (Rice) gravity	Tex-227-F	N/A	N/A	±0.020

1. Contractor may request referee testing only when values exceed these tolerances.
2. When within these tolerances, mixture production gradations may fall outside the master grading limits; however, the % passing the #200 will be considered out of tolerance when outside the master grading limits.
3. Only applies to mixture produced for Lot 1 and higher.
4. Test and verify that Table 8 requirements are met.

4.4.2.2. **Engineer's Responsibilities**.

4.4.2.2.1. **Gyratory Compactor**. For SGC mixtures designed in accordance with Tex-204-F, Part IV, the Engineer will use a Department SGC, calibrated in accordance with Tex-241-F, to mold samples for laboratory mixture design verification. For molding trial batch and production specimens, the Engineer will use the Contractor-provided SGC at the field laboratory or provide and use a Department SGC at an alternate location. The Engineer will make the Contractor-provided SGC in the Department field laboratory available to the Contractor for molding verification samples.

For TGC mixtures designed in accordance with Tex-204-F, Part I, the Engineer will use a Department TGC, calibrated in accordance with Tex-914-K, to mold samples for trial batch and production testing. The Engineer will make the Department TGC and the Department field laboratory available to the Contractor for molding verification samples, if requested by the Contractor.

4.4.2.2.2. **Conditional Approval of JMF1 and Authorizing Trial Batch**. The Engineer will review and verify conformance of the following information within 2 working days of receipt:

- the Contractor's mix design report (JMF1);
- the Contractor-provided Hamburg Wheel test results;
- all required materials including aggregates, asphalt, additives, and recycled materials; and
- the mixture specifications.

The Engineer will grant the Contractor conditional approval of JMF1 if the information provided on the paper copy of JMF1 indicates that the Contractor's mixture design meets the specifications. When the Contractor does not provide Hamburg Wheel test results with laboratory mixture design, 10 working days are allowed for conditional approval of JMF1. The Engineer will base full approval of JMF1 on the test results on mixture from the trial batch.

Unless waived, the Engineer will determine the Micro-Deval abrasion loss in accordance with Section 3076.2.1.1.2., "Micro-Deval Abrasion." If the Engineer's test results are pending after two working days, conditional approval of JMF1 will still be granted within two working days of receiving JMF1. When the Engineer's test results become available, they will be used for specification compliance.

After conditionally approving JMF1, including either Contractor- or Department-supplied Hamburg Wheel test results, the Contractor is authorized to produce a trial batch.

4.4.2.2.3. **Hamburg Wheel Testing of JMF1**. If the Contractor requests the option to have the Department perform the Hamburg Wheel test on the laboratory mixture, the Engineer will mold samples in accordance with Tex-242-F to verify compliance with the Hamburg Wheel test requirement in Table 10.

4.4.2.2.4. **Ignition Oven Correction Factors**. The Engineer will use the split samples provided by the Contractor to determine the aggregate and asphalt correction factors for the ignition oven used for QA testing during production in accordance with Tex-236-F, Part II. Provide correction factors that are not more than 12 months old.

4.4.2.2.5. **Testing the Trial Batch**. Within 1 full working day, the Engineer will sample and test the trial batch to ensure that the mixture meets the requirements in Table 11. If the Contractor requests the option to have the Department perform the Hamburg Wheel test on the trial batch mixture, the Engineer will mold samples in accordance with Tex-242-F to verify compliance with the Hamburg Wheel test requirement in Table 10.

The Engineer will have the option to perform the following tests on the trial batch:

- Tex-226-F, to verify that the indirect tensile strength meets the requirement shown in Table 9; and
- Tex-530-C, to retain and use for comparison purposes during production.

4.4.2.2.6. **Full Approval of JMF1**. The Engineer will grant full approval of JMF1 and authorize the Contractor to proceed with developing JMF2 if the Engineer's results for the trial batch meet the requirements in Table 11. The Engineer will notify the Contractor that an additional trial batch is required if the trial batch does not meet these requirements.

4.4.2.2.7. **Approval of JMF2**. The Engineer will approve JMF2 within one working day if the mixture meets the requirements in Table 5 and the gradation meets the master grading limits shown in Table 8. The asphalt binder content established for JMF2 is not required to be within any tolerance of the optimum asphalt binder content established for JMF1; however, mixture produced using JMF2 must meet the VMA requirements shown in Table 8. If the optimum asphalt binder content for JMF2 is more than 0.5% lower than the optimum asphalt binder content for JMF1, the Engineer may perform or require the Contractor to perform Tex-226-F on Lot 1 production to confirm the indirect tensile strength does not exceed 200 psi.

4.4.2.2.8. **Approval of Lot 1 Production**. The Engineer will authorize the Contractor to proceed with Lot 1 production (using JMF2) as soon as a passing result is achieved from the Department's or a Department-approved laboratory's Hamburg Wheel test on the trial batch. The Contractor may proceed at its own risk with Lot 1 production without the results from the Hamburg Wheel test on the trial batch.

If the Department's or Department-approved laboratory's sample from the trial batch fails the Hamburg Wheel test, the Engineer will suspend production until further Hamburg Wheel tests meet the specified values. The Engineer may require up to the entire sublot of any mixture failing the Hamburg Wheel test be removed and replaced at the Contractor's expense.

4.4.2.2.9. **Approval of JMF3 and Subsequent JMF Changes**. JMF3 and subsequent JMF changes are approved if they meet the mixture requirements shown in Table 4, Table 5, and the master grading limits shown in Table 8, and are within the operational tolerances of JMF2 shown in Table 11.

4.5. **Production Operations**. Perform a new trial batch when the plant or plant location is changed. Take corrective action and receive approval to proceed after any production suspension for noncompliance to the specification. Submit a new mix design and perform a new trial batch when the asphalt binder content of:

- any RAP stockpile used in the mix is more than 0.5% higher than the value shown on the mixture design report; or
- RAS stockpile used in the mix is more than 2.0% higher than the value shown on the mixture design report.

4.5.1. **Storage and Heating of Materials**. Do not heat the asphalt binder above the temperatures specified in Item 300, "Asphalts, Oils, and Emulsions," or outside the manufacturer's recommended values. Provide the Engineer with daily records of asphalt binder and hot-mix asphalt discharge temperatures (in legible and discernible increments) in accordance with Item 320, "Equipment for Asphalt Concrete Pavement," unless otherwise directed. Do not store mixture for a period long enough to affect the quality of the mixture, nor in any case longer than 12 hr. unless otherwise approved.

4.5.2. **Mixing and Discharge of Materials**. Notify the Engineer of the target discharge temperature and produce the mixture within 25°F of the target. Monitor the temperature of the material in the truck before shipping to ensure that it does not exceed the maximum production temperatures listed in Table 12 (or 275°F for WMA). The Department will not pay for or allow placement of any mixture produced above the maximum production temperatures listed in Table 12.

Table 12
Maximum Production Temperature

High-Temperature Binder Grade[1]	Maximum Production Temperature
PG 64	325˚F
PG 70	335˚F
PG 76	345˚F

1. The high-temperature binder grade refers to the high-temperature grade of the virgin asphalt binder used to produce the mixture.

Produce WMA within the target discharge temperature range of 215°F and 275°F when WMA is required. Take corrective action any time the discharge temperature of the WMA exceeds the target discharge range. The Engineer may suspend production operations if the Contractor's corrective action is not successful at controlling the production temperature within the target discharge range. Note that when WMA is produced, it may be necessary to adjust burners to ensure complete combustion such that no burner fuel residue remains in the mixture.

Control the mixing time and temperature so that substantially all moisture is removed from the mixture before discharging from the plant. Determine the moisture content, if requested, by oven-drying in accordance with

Tex-212-F, Part II, and verify that the mixture contains no more than 0.2% of moisture by weight. Obtain the sample immediately after discharging the mixture into the truck, and perform the test promptly.

4.6. **Hauling Operations**. Clean all truck beds before use to ensure that mixture is not contaminated. Use a release agent shown on the Department's MPL to coat the inside bed of the truck when necessary.

Use equipment for hauling as defined in Section 3076.4.7.3.3., "Hauling Equipment." Use other hauling equipment only when allowed.

4.7. **Placement Operations**. Collect haul tickets from each load of mixture delivered to the project and provide the Department's copy to the Engineer approximately every hour, or as directed. Use a hand-held thermal camera or infrared thermometer, when a thermal imaging system is not used, to measure and record the internal temperature of the mixture as discharged from the truck or Material Transfer Device (MTD) before or as the mix enters the paver and an approximate station number or GPS coordinates on each ticket. Calculate the daily yield and cumulative yield for the specified lift and provide to the Engineer at the end of paving operations for each day unless otherwise directed. The Engineer may suspend production if the Contractor fails to produce and provide haul tickets and yield calculations by the end of paving operations for each day.

Prepare the surface by removing raised pavement markers and objectionable material such as moisture, dirt, sand, leaves, and other loose impediments from the surface before placing mixture. Remove vegetation from pavement edges. Place the mixture to meet the typical section requirements and produce a smooth, finished surface with a uniform appearance and texture. Offset longitudinal joints of successive courses of hot-mix by at least 6 in. Place mixture so that longitudinal joints on the surface course coincide with lane lines and are not placed in the wheel path, or as directed. Ensure that all finished surfaces will drain properly. Place the mixture at the rate or thickness shown on the plans. The Engineer will use the guidelines in Table 13 to determine the compacted lift thickness of each layer when multiple lifts are required. The thickness determined is based on the rate of 110 lb./sq. yd. for each inch of pavement unless otherwise shown on the plans.

Table 13
Compacted Lift Thickness and Required Core Height

Mixture Type	Compacted Lift Thickness Guidelines		Minimum Untrimmed Core Height (in.) Eligible for Testing
	Minimum (in.)	Maximum (in.)	
B	2.50	5.00	1.75
C	2.00	4.00	1.50
D	1.50	3.00	1.25
F	1.25	2.50	1.25

4.7.1. **Weather Conditions**.

4.7.1.1. **When Using a Thermal Imaging System**. Place mixture when the roadway surface is dry and the roadway surface temperature is at or above the temperatures listed in Table 14A. The Engineer may restrict the Contractor from paving surface mixtures if the ambient temperature is likely to drop below 32°F within 12 hr. of paving. Place mixtures only when weather conditions and moisture conditions of the roadway surface are suitable as determined by the Engineer. Provide output data from the thermal imaging system to demonstrate to the Engineer that no recurring severe thermal segregation exists in accordance with Section 3076.4.7.3.1.2., "Thermal Imaging System."

Table 14A
Minimum Pavement Surface Temperatures

High-Temperature Binder Grade[1]	Minimum Pavement Surface Temperatures (°F)	
	Subsurface Layers or Night Paving Operations	Surface Layers Placed in Daylight Operations
PG 64	35	40
PG 70	45[2]	50[2]
PG 76	45[2]	50[2]

1. The high-temperature binder grade refers to the high-temperature grade of the virgin asphalt binder used to produce the mixture.
2. Contractors may pave at temperatures 10°F lower than these values when a chemical WMA additive is used as a compaction aid in the mixture or when using WMA.

4.7.1.2. **When Not Using a Thermal Imaging System**. When using a thermal camera instead of the thermal imaging system, place mixture when the roadway surface temperature is at or above the temperatures listed in Table 14B unless otherwise approved or as shown on the plans. Measure the roadway surface temperature with a hand-held thermal camera or infrared thermometer. The Engineer may allow mixture placement to begin before the roadway surface reaches the required temperature if conditions are such that the roadway surface will reach the required temperature within 2 hr. of beginning placement operations. Place mixtures only when weather conditions and moisture conditions of the roadway surface are suitable as determined by the Engineer. The Engineer may restrict the Contractor from paving if the ambient temperature is likely to drop below 32°F within 12 hr. of paving.

Table 14B
Minimum Pavement Surface Temperatures

High-Temperature Binder Grade[1]	Minimum Pavement Surface Temperatures (°F)	
	Subsurface Layers or Night Paving Operations	Surface Layers Placed in Daylight Operations
PG 64	45	50
PG 70	55[2]	60[2]
PG 76	60[2]	60[2]

1. The high-temperature binder grade refers to the high-temperature grade of the virgin asphalt binder used to produce the mixture.
2. Contractors may pave at temperatures 10°F lower than these values when a chemical WMA additive is used as a compaction aid in the mixture, when using WMA, or utilizing a paving process with equipment that eliminates thermal segregation. In such cases, for each sublot and in the presence of the Engineer, use a hand-held thermal camera operated in accordance with Tex-244-F to demonstrate to the satisfaction of the Engineer that the uncompacted mat has no more than 10°F of thermal segregation.

4.7.2. **Tack Coat**.

4.7.2.1. **Application.** Clean the surface before placing the tack coat. The Engineer will set the rate between 0.04 and 0.10 gal. of residual asphalt per square yard of surface area. Apply a uniform tack coat at the specified rate unless otherwise directed. Apply the tack coat in a uniform manner to avoid streaks and other irregular patterns. Apply the tack coat to all surfaces that will come in contact with the subsequent HMA placement, unless otherwise directed. Allow adequate time for emulsion to break completely before placing any material. Prevent splattering of tack coat when placed adjacent to curb, gutter, and structures. Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use.

4.7.2.2. **Sampling.** The Engineer will obtain at least one sample of the tack coat binder per project in accordance with Tex-500-C, Part III, and test it to verify compliance with Item 300, “Asphalts, Oils, and Emulsions.” The Engineer will notify the Contractor when the sampling will occur and will witness the collection of the sample from the asphalt distributor immediately before use.

For emulsions, the Engineer may test as often as necessary to ensure the residual of the emulsion is greater than or equal to the specification requirement in Item 300, “Asphalts, Oils, and Emulsions.”

4.7.3. **Lay-Down Operations**. Use the placement temperatures in Table 15 to establish the minimum placement temperature of the mixture delivered to the paver.

Table 15
Minimum Mixture Placement Temperature

High-Temperature Binder Grade[1]	Minimum Placement Temperature (Before Entering Paver)[2,3]
PG 64	260˚F
PG 70	270˚F
PG 76	280˚F

1. The high-temperature binder grade refers to the high-temperature grade of the virgin asphalt binder used to produce the mixture.
2. Minimum placement temperatures may be reduced 10°F if using a chemical WMA additive as a compaction aid.
3. When using WMA, the minimum placement temperature is 215°F.

4.7.3.1. **Thermal Profile**. Use a hand-held thermal camera or a thermal imaging system to obtain a continuous thermal profile in accordance with Tex-244-F. Thermal profiles are not applicable in areas described in Section 3076.4.9.3.1.4., "Miscellaneous Areas."

4.7.3.1.1. **Thermal Segregation**.

4.7.3.1.1.1. **Moderate**. Any areas that have a temperature differential greater than 25°F, but not exceeding 50°F, are deemed as moderate thermal segregation.

4.7.3.1.1.2. **Severe**. Any areas that have a temperature differential greater than 50°F are deemed as severe thermal segregation.

4.7.3.1.2. **Thermal Imaging System**. Review the output results when a thermal imaging system is used, and provide the automated report described in Tex-244-F to the Engineer daily unless otherwise directed. Modify the paving process as necessary to eliminate any recurring (moderate or severe) thermal segregation identified by the thermal imaging system. The Engineer may suspend paving operations if the Contractor cannot successfully modify the paving process to eliminate recurring severe thermal segregation. Density profiles are not required and not applicable when using a thermal imaging system. Provide the Engineer with electronic copies of all daily data files that can be used with the thermal imaging system software to generate temperature profile plots daily or upon completion of the project or as requested by the Engineer.

4.7.3.1.3. **Thermal Camera**. When using a thermal camera instead of the thermal imaging system, take immediate corrective action to eliminate recurring moderate thermal segregation when a hand-held thermal camera is used. Evaluate areas with moderate thermal segregation by performing density profiles in accordance with Section 3076.4.9.3.3.2., "Segregation (Density Profile)." Provide the Engineer with the thermal profile of every sublot within one working day of the completion of each lot. When requested by the Engineer, provide the thermal images generated using the thermal camera. Report the results of each thermal profile in accordance with Section 3076.4.2., "Reporting and Responsibilities." The Engineer will use a hand-held thermal camera to obtain a thermal profile at least once per project. No production or placement payment adjustments greater than 1.000 will be paid for any sublot that contains severe thermal segregation. Suspend operations and take immediate corrective action to eliminate severe thermal segregation unless otherwise directed. Resume operations when the Engineer determines that subsequent production will meet the requirements of this Section. Evaluate areas with severe thermal segregation by performing density profiles in accordance with Section 3076.4.9.3.3.2., "Segregation (Density Profile)." Remove and replace the material in any areas that have both severe thermal segregation and a failing result for Segregation (Density Profile) unless otherwise directed. The sublot in question may receive a production and placement payment adjustment greater than 1.000, if applicable, when the defective material is successfully removed and replaced.

4.7.3.2. **Windrow Operations**. Operate windrow pickup equipment so that when hot-mix is placed in windrows, substantially all the mixture deposited on the roadbed is picked up and loaded into the paver.

4.7.3.3. **Hauling Equipment**. Use belly dumps, live bottom, or end dump trucks to haul and transfer mixture; however, with exception of paving miscellaneous areas, end dump trucks are only allowed when used in conjunction with an MTD with remixing capability or when a thermal imaging system is used unless otherwise allowed.

4.7.3.4. **Screed Heaters**. Turn off screed heaters to prevent overheating of the mat if the paver stops for more than 5 min. The Engineer may evaluate the suspect area in accordance with Section 3076.4.9.3.3.4., "Recovered Asphalt Dynamic Shear Rheometer (DSR)," if the screed heater remains on for more than 5 min. while the paver is stopped.

4.8. **Compaction**. Compact the pavement uniformly to contain between 3.8% and 8.5% in-place air voids. Take immediate corrective action to bring the operation within 3.8% and 8.5% when the in-place air voids exceed the range of these tolerances. The Engineer will allow paving to resume when the proposed corrective action is likely to yield between 3.8% and 8.5% in-place air voids.

Obtain cores in areas placed under Exempt Production, as directed, at locations determined by the Engineer. The Engineer may test these cores and suspend operations or require removal and replacement if the in-place air voids are less than 2.7% or more than 9.9%. Areas defined in Section 3076.4.9.3.1.4., "Miscellaneous Areas," are not subject to in-place air void determination.

Furnish the type, size, and number of rollers required for compaction as approved. Use additional rollers as required to remove any roller marks. Use only water or an approved release agent on rollers, tamps, and other compaction equipment unless otherwise directed.

Use the control strip method shown in Tex-207-F, Part IV, on the first day of production to establish the rolling pattern that will produce the desired in-place air voids unless otherwise directed.

Use tamps to thoroughly compact the edges of the pavement along curbs, headers, and similar structures and in locations that will not allow thorough compaction with rollers. The Engineer may require rolling with a trench roller on widened areas, in trenches, and in other limited areas.

Complete all compaction operations before the pavement temperature drops below 160°F unless otherwise allowed. The Engineer may allow compaction with a light finish roller operated in static mode for pavement temperatures below 160°F.

Allow the compacted pavement to cool to 160°F or lower before opening to traffic unless otherwise directed. Sprinkle the finished mat with water or limewater, when directed, to expedite opening the roadway to traffic.

4.9. **Acceptance Plan**. Payment adjustments for the material will be in accordance with Article 3076.6., "Payment."

Sample and test the hot-mix on a lot and sublot basis. Suspend production until test results or other information indicates to the satisfaction of the Engineer that the next material produced or placed will result in payment factors of at least 1.000, if the production payment factor given in Section 3076.6.1., "Production Payment Adjustment Factors," for two consecutive lots or the placement pay factor given in Section 3076.6.2., "Placement Payment Adjustment Factors," for two consecutive lots is below 1.000.

4.9.1. **Referee Testing**. The Materials and Tests Division is the referee laboratory. The Contractor may request referee testing if a "remove and replace" condition is determined based on the Engineer's test results, or if the differences between Contractor and Engineer test results exceed the maximum allowable difference shown in Table 11 and the differences cannot be resolved. The Contractor may also request referee testing if the Engineer's test results require suspension of production and the Contractor's test results are within specification limits. Make the request within five working days after receiving test results and cores from the Engineer. Referee tests will be performed only on the sublot in question and only for the particular tests in question. Allow 10 working days from the time the referee laboratory receives the samples for test results to

be reported. The Department may require the Contractor to reimburse the Department for referee tests if more than three referee tests per project are required and the Engineer's test results are closer to the referee test results than the Contractor's test results.

The Materials and Tests Division will determine the laboratory-molded density based on the molded specific gravity and the maximum theoretical specific gravity of the referee sample. The in-place air voids will be determined based on the bulk specific gravity of the cores, as determined by the referee laboratory and the Engineer's average maximum theoretical specific gravity for the lot. With the exception of "remove and replace" conditions, referee test results are final and will establish payment adjustment factors for the sublot in question. The Contractor may decline referee testing and accept the Engineer's test results when the placement payment adjustment factor for any sublot results in a "remove and replace" condition. Placement sublots subject to be removed and replaced will be further evaluated in accordance with Section 3076.6.2.2., "Placement Sublots Subject to Removal and Replacement."

4.9.2. **Production Acceptance**.

4.9.2.1. **Production Lot**. A production lot consists of four equal sublots. The default quantity for Lot 1 is 1,000 tons; however, when requested by the Contractor, the Engineer may increase the quantity for Lot 1 to no more than 4,000 tons. The Engineer will select subsequent lot sizes based on the anticipated daily production such that approximately three to four sublots are produced each day. The lot size will be between 1,000 tons and 4,000 tons. The Engineer may change the lot size before the Contractor begins any lot.

If the optimum asphalt binder content for JMF2 is more than 0.5% lower than the optimum asphalt binder content for JMF1, the Engineer may perform or require the Contractor to perform Tex-226-F on Lot 1 to confirm the indirect tensile strength does not exceed 200 psi. Take corrective action to bring the mixture within specification compliance if the indirect tensile strength exceeds 200 psi unless otherwise directed.

4.9.2.1.1. **Incomplete Production Lots**. If a lot is begun but cannot be completed, such as on the last day of production or in other circumstances deemed appropriate, the Engineer may close the lot. Adjust the payment for the incomplete lot in accordance with Section 3076.6.1., "Production Payment Adjustment Factors." Close all lots within five working days unless otherwise allowed.

4.9.2.2. **Production Sampling**.

4.9.2.2.1. **Mixture Sampling**. Obtain hot-mix samples from trucks at the plant in accordance with Tex-222-F. The sampler will split each sample into three equal portions in accordance with Tex-200-F and label these portions as "Contractor," "Engineer," and "Referee." The Engineer will perform or witness the sample splitting and take immediate possession of the samples labeled "Engineer" and "Referee." The Engineer will maintain the custody of the samples labeled "Engineer" and "Referee" until the Department's testing is completed.

4.9.2.2.1.1. **Random Sample**. At the beginning of the project, the Engineer will select random numbers for all production sublots. Determine sample locations in accordance with Tex-225-F. Take one sample for each sublot at the randomly selected location. The Engineer will perform or witness the sampling of production sublots.

4.9.2.2.1.2. **Blind Sample**. For one sublot per lot, the Engineer will obtain and test a "blind" sample instead of the random sample collected by the Contractor. Test either the "blind" or the random sample; however, referee testing (if applicable) will be based on a comparison of results from the "blind" sample. The location of the Engineer's "blind" sample will not be disclosed to the Contractor. The Engineer's "blind" sample may be randomly selected in accordance with Tex-225-F for any sublot or selected at the discretion of the Engineer. The Engineer will use the Contractor's split sample for sublots not sampled by the Engineer.

4.9.2.2.2. **Informational Shear Bond Strength Testing.** Select one random sublot from Lot 2 or higher for shear bond strength testing. Obtain full depth cores in accordance with Tex-249-F. Label the cores with the Control Section Job (CSJ), producer of the tack coat, mix type, shot rate, lot, and sublot number and provide to the

Engineer. The Engineer will ship the cores to the Materials and Tests Division or district laboratory for shear bond strength testing. Results from these tests will not be used for specification compliance.

4.9.2.2.3. **Asphalt Binder Sampling**. Obtain a 1-qt. sample of the asphalt binder witnessed by the Engineer for each lot of mixture produced. The Contractor will notify the Engineer when the sampling will occur. Obtain the sample at approximately the same time the mixture random sample is obtained. Sample from a port located immediately upstream from the mixing drum or pug mill and upstream from the introduction of any additives in accordance with Tex-500-C, Part II. Label the can with the corresponding lot and sublot numbers, producer, producer facility location, grade, district, date sampled, and project information including highway and CSJ. The Engineer will retain these samples for one year. The Engineer may also obtain independent samples. If obtaining an independent asphalt binder sample and upon request of the Contractor, the Engineer will split a sample of the asphalt binder with the Contractor.

At least once per project, the Engineer will collect split samples of each binder grade and source used. The Engineer will submit one split sample to MTD to verify compliance with Item 300, “Asphalts, Oils, and Emulsions” and will retain the other split sample for one year.

4.9.2.3. **Production Testing**. The Contractor and Engineer must perform production tests in accordance with Table 16. The Contractor has the option to verify the Engineer’s test results on split samples provided by the Engineer. Determine compliance with operational tolerances listed in Table 11 for all sublots.

Take immediate corrective action if the Engineer’s laboratory-molded density on any sublot is less than 95.0% or greater than 97.0% to bring the mixture within these tolerances. The Engineer may suspend operations if the Contractor’s corrective actions do not produce acceptable results. The Engineer will allow production to resume when the proposed corrective action is likely to yield acceptable results.

The Engineer may allow alternate methods for determining the asphalt binder content and aggregate gradation if the aggregate mineralogy is such that Tex-236-F, Part I does not yield reliable results. Provide evidence that results from Tex-236-F, Part I are not reliable before requesting permission to use an alternate method unless otherwise directed. Use the applicable test procedure as directed if an alternate test method is allowed.

Table 16
Production and Placement Testing Frequency

Description	Test Method	Minimum Contractor Testing Frequency	Minimum Engineer Testing Frequency
Individual % retained for #8 sieve and larger	Tex-200-F or Tex-236-F	1 per sublot	1 per 12 sublots[1]
Individual % retained for sieves smaller than #8 and larger than #200			
% passing the #200 sieve			
Laboratory-molded density	Tex-207-F	N/A	1 per sublot[1]
Laboratory-molded bulk specific gravity			
In-place air voids			
VMA	Tex-204-F		
Segregation (density profile)[2]	Tex-207-F, Part V	1 per sublot	1 per project
Longitudinal joint density	Tex-207-F, Part VII		
Moisture content	Tex-212-F, Part II	When directed	
Theoretical maximum specific (Rice) gravity	Tex-227-F	N/A	1 per sublot[1]
Asphalt binder content	Tex-236-F	1 per sublot	1 per lot[1]
Hamburg Wheel test	Tex-242-F	N/A	1 per project
Recycled Asphalt Shingles (RAS)[3]	Tex-217-F, Part III	N/A	
Thermal profile[2]	Tex-244-F	1 per sublot	
Asphalt binder sampling and testing	Tex-500-C, Part II	1 per lot (sample only)[4]	
Tack coat sampling and testing	Tex-500-C, Part III	N/A	
Boil test[5]	Tex-530-C	1 per lot	
Shear Bond Strength Test[6]	Tex-249-F	1 per project (sample only)	

1. For production defined in Section 3076.4.9.4., "Exempt Production," the Engineer will test one per day if 100 tons or more are produced. For Exempt Production, no testing is required when less than 100 tons are produced.
2. Not required when a thermal imaging system is used.
3. Testing performed by the Materials and Tests Division or designated laboratory.
4. Obtain witnessed by the Engineer. The Engineer will retain these samples for one year.
5. The Engineer may reduce or waive the sampling and testing requirements based on a satisfactory test history.
6. Testing performed by the Materials and Tests Division or District for informational purposes only.

4.9.2.4. **Operational Tolerances**. Control the production process within the operational tolerances listed in Table 11. When production is suspended, the Engineer will allow production to resume when test results or other information indicates the next mixture produced will be within the operational tolerances.

4.9.2.4.1. **Gradation**. Suspend operation and take corrective action if any aggregate is retained on the maximum sieve size shown in Table 8. A sublot is defined as out of tolerance if either the Engineer's or the Contractor's test results are out of operational tolerance. Suspend production when test results for gradation exceed the operational tolerances in Table 11 for three consecutive sublots on the same sieve or four consecutive sublots on any sieve unless otherwise directed. The consecutive sublots may be from more than one lot.

4.9.2.4.2. **Asphalt Binder Content**. A sublot is defined as out of operational tolerance if either the Engineer's or the Contractor's test results exceed the values listed in Table 11. No production or placement payment adjustments greater than 1.000 will be paid for any sublot that is out of operational tolerance for asphalt binder content. Suspend production and shipment of the mixture if the Engineer's or the Contractor's asphalt binder content deviates from the current JMF by more than 0.5% for any sublot.

4.9.2.4.3. **Voids in Mineral Aggregates (VMA)**. The Engineer will determine the VMA for every sublot. For sublots when the Engineer does not determine asphalt binder content, the Engineer will use the asphalt binder content results from QC testing performed by the Contractor to determine VMA.

Take immediate corrective action if the VMA value for any sublot is less than the minimum VMA requirement for production listed in Table 8. Suspend production and shipment of the mixture if the Engineer's VMA results on two consecutive sublots are below the minimum VMA requirement for production listed in Table 8. No production or placement payment adjustments greater than 1.000 will be paid for any sublot that does not

meet the minimum VMA requirement for production listed in Table 8 based on the Engineer's VMA determination.

Suspend production and shipment of the mixture if the Engineer's VMA result is more than 0.5% below the minimum VMA requirement for production listed in Table 8. In addition to suspending production, the Engineer may require removal and replacement or may allow the sublot to be left in place without payment.

4.9.2.4.4. **Hamburg Wheel Test**. The Engineer may perform a Hamburg Wheel test at any time during production, including when the boil test indicates a change in quality from the materials submitted for JMF1. In addition to testing production samples, the Engineer may obtain cores and perform Hamburg Wheel tests on any areas of the roadway where rutting is observed. Suspend production until further Hamburg Wheel tests meet the specified values when the production or core samples fail the Hamburg Wheel test criteria in Table 10. Core samples, if taken, will be obtained from the center of the finished mat or other areas excluding the vehicle wheel paths. The Engineer may require up to the entire sublot of any mixture failing the Hamburg Wheel test to be removed and replaced at the Contractor's expense.

If the Department's or Department approved laboratory's Hamburg Wheel test results in a "remove and replace" condition, the Contractor may request that the Department confirm the results by re-testing the failing material. The Materials and Tests Division will perform the Hamburg Wheel tests and determine the final disposition of the material in question based on the Department's test results.

4.9.2.5. **Individual Loads of Hot-Mix**. The Engineer can reject individual truckloads of hot-mix. When a load of hot-mix is rejected for reasons other than temperature, contamination, or excessive uncoated particles, the Contractor may request that the rejected load be tested. Make this request within 4 hr. of rejection. The Engineer will sample and test the mixture. If test results are within the operational tolerances shown in Table 11, payment will be made for the load. If test results are not within operational tolerances, no payment will be made for the load.

4.9.3. **Placement Acceptance**.

4.9.3.1. **Placement Lot**. A placement lot consists of four placement sublots. A placement sublot consists of the area placed during a production sublot.

4.9.3.1.1. **Lot 1 Placement**. Placement payment adjustments greater than 1.000 for Lot 1 will be in accordance with Section 3076.6.2., "Placement Payment Adjustment Factors"; however, no placement adjustment less than 1.000 will be assessed for any sublot placed in Lot 1 when the in-place air voids are greater than or equal to 2.7% and less than or equal to 9.9%. Remove and replace any sublot with in-place air voids less than 2.7% or greater than 9.9%.

4.9.3.1.2. **Incomplete Placement Lots**. An incomplete placement lot consists of the area placed as described in Section 3076.4.9.2.1.1., "Incomplete Production Lots," excluding areas defined in Section 3076.4.9.3.1.4., "Miscellaneous Areas." Placement sampling is required if the random sample plan for production resulted in a sample being obtained from an incomplete production sublot.

4.9.3.1.3. **Shoulders, Ramps, Etc**. Shoulders, ramps, intersections, acceleration lanes, deceleration lanes, and turn lanes are subject to in-place air void determination and payment adjustments unless designated on the plans as not eligible for in-place air void determination. Intersections may be considered miscellaneous areas when determined by the Engineer.

4.9.3.1.4. **Miscellaneous Areas**. Miscellaneous areas include areas that typically involve significant handwork or discontinuous paving operations, such as temporary detours, driveways, mailbox turnouts, crossovers, gores, spot level-up areas, and other similar areas. Temporary detours are subject to in-place air void determination when shown on the plans. Miscellaneous areas also include level-ups and thin overlays when the layer thickness specified on the plans is less than the minimum untrimmed core height eligible for testing shown in Table 13. The specified layer thickness is based on the rate of 110 lb./sq. yd. for each inch of

pavement unless another rate is shown on the plans. When "level up" is listed as part of the item bid description code, a payment adjustment factor of 1.000 will be assigned for all placement sublots as described in Article 3076.6, "Payment." Miscellaneous areas are not eligible for random placement sampling locations. Compact miscellaneous areas in accordance with Section 3076.4.8., "Compaction." Miscellaneous areas are not subject to in-place air void determination, thermal profiles testing, segregation (density profiles), or longitudinal joint density evaluations.

4.9.3.2. **Placement Sampling**. The Engineer will select random numbers for all placement sublots at the beginning of the project. The Engineer will provide the Contractor with the placement random numbers immediately after the sublot is completed. Mark the roadway location at the completion of each sublot and record the station number. Determine one random sample location for each placement sublot in accordance with Tex-225-F. Adjust the random sample location by no more than necessary to achieve a 2-ft. clearance if the location is within 2 ft. of a joint or pavement edge.

Shoulders, ramps, intersections, acceleration lanes, deceleration lanes, and turn lanes are always eligible for selection as a random sample location; however, if a random sample location falls on one of these areas and the area is designated on the plans as not subject to in-place air void determination, cores will not be taken for the sublot and a 1.000 pay factor will be assigned to that sublot.

Provide the equipment and means to obtain and trim roadway cores on site. On-site is defined as in close proximity to where the cores are taken. Obtain the cores within one working day of the time the placement sublot is completed unless otherwise approved. Obtain two 6-in. diameter cores side-by-side from within 1 ft. of the random location provided for the placement sublot. For Type D and Type F mixtures, 4-in. diameter cores are allowed. Mark the cores for identification, measure and record the untrimmed core height, and provide the information to the Engineer. The Engineer will witness the coring operation and measurement of the core thickness. Visually inspect each core and verify that the current paving layer is bonded to the underlying layer. Take corrective action if an adequate bond does not exist between the current and underlying layer to ensure that an adequate bond will be achieved during subsequent placement operations.

Trim the cores immediately after obtaining the cores from the roadway in accordance with Tex-251-F if the core heights meet the minimum untrimmed value listed in Table 13. Trim the cores on site in the presence of the Engineer. Use a permanent marker or paint pen to record the lot and sublot numbers on each core as well as the designation as Core A or B. The Engineer may require additional information to be marked on the core and may choose to sign or initial the core. The Engineer will take custody of the cores immediately after witnessing the trimming of the cores and will retain custody of the cores until the Department's testing is completed. Before turning the trimmed cores over to the Engineer, the Contractor may wrap the trimmed cores or secure them in a manner that will reduce the risk of possible damage occurring during transport by the Engineer. After testing, the Engineer will return the cores to the Contractor.

The Engineer may have the cores transported back to the Department's laboratory at the HMA plant via the Contractor's haul truck or other designated vehicle. In such cases where the cores will be out of the Engineer's possession during transport, the Engineer will use Department-provided security bags and the Roadway Core Custody protocol located at http://www.txdot.gov/business/specifications.htm to provide a secure means and process that protects the integrity of the cores during transport.

Decide whether to include the pair of cores in the air void determination for that sublot if the core height before trimming is less than the minimum untrimmed value shown in Table 13. Trim the cores as described above before delivering to the Engineer if electing to have the cores included in the air void determination. Deliver untrimmed cores to the Engineer and inform the Engineer of the decision to not have the cores included in air void determination if electing to not have the cores included in air void determination. The placement pay factor for the sublot will be 1.000 if cores will not be included in air void determination.

Instead of the Contractor trimming the cores on site immediately after coring, the Engineer and the Contractor may mutually agree to have the trimming operations performed at an alternate location such as a field laboratory or other similar location. In such cases, the Engineer will take possession of the cores

immediately after they are obtained from the roadway and will retain custody of the cores until testing is completed. Either the Department or Contractor representative may perform trimming of the cores. The Engineer will witness all trimming operations in cases where the Contractor representative performs the trimming operation.

Dry the core holes and tack the sides and bottom immediately after obtaining the cores. Fill the hole with the same type of mixture and properly compact the mixture. Repair core holes with other methods when approved.

4.9.3.3. **Placement Testing**. Perform placement tests in accordance with Table 16. After the Engineer returns the cores, the Contractor may test the cores to verify the Engineer's test results for in-place air voids. The allowable differences between the Contractor's and Engineer's test results are listed in Table 11.

4.9.3.3.1. **In-Place Air Voids**. The Engineer will measure in-place air voids in accordance with Tex-207-F and Tex-227-F. Before drying to a constant weight, cores may be pre-dried using a CoreDry or similar vacuum device to remove excess moisture. The Engineer will average the values obtained for all sublots in the production lot to determine the theoretical maximum specific gravity. The Engineer will use the average air void content for in-place air voids.

The Engineer will use the vacuum method to seal the core if required by Tex-207-F. The Engineer will use the test results from the unsealed core to determine the placement payment adjustment factor if the sealed core yields a higher specific gravity than the unsealed core. After determining the in-place air void content, the Engineer will return the cores and provide test results to the Contractor.

4.9.3.3.2. **Segregation (Density Profile)**. Test for segregation using density profiles in accordance with Tex-207-F, Part V when using a thermal camera insead of the thermal imaging system. Density profiles are not required and are not applicable when using a thermal imaging system. Density profiles are not applicable in areas described in Section 3076.4.9.3.1.4., "Miscellaneous Areas."

Perform a minimum of one density profile per sublot. Perform additional density profiles when any of the following conditions occur, unless otherwise approved:

- the paver stops due to lack of material being delivered to the paving operations and the temperature of the uncompacted mat before the initial break down rolling is less than the temperatures shown in Table 17;
- areas that are identified by either the Contractor or the Engineer with thermal segregation;,
- any visibly segregated areas that exist.

Table 17
Mimimum Uncompacted Mat Temperature Requiring a Segregation Profile

High-Temperature Binder Grade[1]	Minimum Temperature of the Uncompacted Mat Allowed Before Initial Break Down Rolling[2,3,4]
PG 64	<250˚F
PG 70	<260˚F
PG 76	<270˚F

1. The high-temperature binder grade refers to the high-temperature grade of the virgin asphalt binder used to produce the mixture.
2. Segregation profiles are required in areas with moderate and severe thermal segregation as described in Section 3076.4.7.3.1.3.
3. Minimum uncompacted mat temperature requiring a segregation profile may be reduced 10°F if using a chemical WMA additive as a compaction aid.
4. When using WMA, the minimum uncompacted mat temperature requiring a segregation profile is 215°F.

Provide the Engineer with the density profile of every sublot in the lot within one working day of the completion of each lot. Report the results of each density profile in accordance with Section 3076.4.2., "Reporting and Responsibilities."

The density profile is considered failing if it exceeds the tolerances in Table 18. No production or placement payment adjustments greater than 1.000 will be paid for any sublot that contains a failing density profile. When a hand-held thermal camera is used instead of a thermal imaging system, the Engineer will measure the density profile at least once per project. The Engineer's density profile results will be used when available. The Engineer may require the Contractor to remove and replace the area in question if the area fails the density profile and has surface irregularities as defined in Section 3076.4.9.3.3.5., "Irregularities." The sublot in question may receive a production and placement payment adjustment greater than 1.000, if applicable, when the defective material is successfully removed and replaced.

Investigate density profile failures and take corrective actions during production and placement to eliminate the segregation. Suspend production if 2 consecutive density profiles fail unless otherwise approved. Resume production after the Engineer approves changes to production or placement methods.

Table 18
Segregation (Density Profile) Acceptance Criteria

Mixture Type	Maximum Allowable Density Range (Highest to Lowest)	Maximum Allowable Density Range (Average to Lowest)
Type B	8.0 pcf	5.0 pcf
Type C, Type D & Type F	6.0 pcf	3.0 pcf

4.9.3.3.3. **Longitudinal Joint Density**.

4.9.3.3.3.1. **Informational Tests**. Perform joint density evaluations while establishing the rolling pattern and verify that the joint density is no more than 3.0 pcf below the density taken at or near the center of the mat. Adjust the rolling pattern, if needed, to achieve the desired joint density. Perform additional joint density evaluations, at least once per sublot, unless otherwise directed.

4.9.3.3.3.2. **Record Tests**. Perform a joint density evaluation for each sublot at each pavement edge that is or will become a longitudinal joint. Joint density evaluations are not applicable in areas described in Section 3076.4.9.3.1.4., "Miscellaneous Areas." Determine the joint density in accordance with Tex-207-F, Part VII. Record the joint density information and submit results on Department forms to the Engineer. The evaluation is considered failing if the joint density is more than 3.0 pcf below the density taken at the core random sample location and the correlated joint density is less than 90.0%. The Engineer will make independent joint density verification at least once per project and may make independent joint density verifications at the random sample locations. The Engineer's joint density test results will be used when available.

Provide the Engineer with the joint density of every sublot in the lot within one working day of the completion of each lot. Report the results of each joint density in accordance with Section 3076.4.2., "Reporting and Responsibilities."

Investigate joint density failures and take corrective actions during production and placement to improve the joint density. Suspend production if the evaluations on two consecutive sublots fail unless otherwise approved. Resume production after the Engineer approves changes to production or placement methods.

4.9.3.3.4. **Recovered Asphalt Dynamic Shear Rheometer (DSR)**. The Engineer may take production samples or cores from suspect areas of the project to determine recovered asphalt properties. Asphalt binders with an aging ratio greater than 3.5 do not meet the requirements for recovered asphalt properties and may be deemed defective when tested and evaluated by the Materials and Tests Division. The aging ratio is the DSR value of the extracted binder divided by the DSR value of the original unaged binder. Obtain DSR values in accordance with AASHTO T 315 at the specified high temperature performance grade of the asphalt. The Engineer may require removal and replacement of the defective material at the Contractor's expense. The asphalt binder will be recovered for testing from production samples or cores in accordance with Tex-211-F.

4.9.3.3.5. **Irregularities**. Identify and correct irregularities including segregation, rutting, raveling, flushing, fat spots, mat slippage, irregular color, irregular texture, roller marks, tears, gouges, streaks, uncoated aggregate particles, or broken aggregate particles. The Engineer may also identify irregularities, and in such cases, the Engineer will promptly notify the Contractor. If the Engineer determines that the irregularity will adversely affect pavement performance, the Engineer may require the Contractor to remove and replace (at the Contractor's expense) areas of the pavement that contain irregularities. The Engineer may also require the Contractor to remove and replace (at the Contractor's expense) areas where the mixture does not bond to the existing pavement.

If irregularities are detected, the Engineer may require the Contractor to immediately suspend operations or may allow the Contractor to continue operations for no more than one day while the Contractor is taking appropriate corrective action.

4.9.4. **Exempt Production**. The Engineer may deem the mixture as exempt production for the following conditions:

- anticipated daily production is less than 500 tons;
- total production for the project is less than 5,000 tons;
- when mutually agreed between the Engineer and the Contractor; or
- when shown on the plans.

For exempt production, the Contractor is relieved of all production and placement sampling and testing requirements, except for coring operations when required by the Engineer. The production and placement pay factors are 1.000 if the specification requirements listed below are met, all other specification requirements are met, and the Engineer performs acceptance tests for production and placement listed in Table 16 when 100 tons or more per day are produced.

- produce, haul, place, and compact the mixture in compliance with the specification and as directed;
- control mixture production to yield a laboratory-molded density that is within ±1.0% of the target laboratory-molded density as tested by the Engineer;
- compact the mixture in accordance with Section 3076.4.8., "Compaction;" and
- when a thermal imaging system is not used, the Engineer may perform segregation (density profiles) and thermal profiles in accordance with the specification.

4.9.5. **Ride Quality**. Measure ride quality in accordance with Item 585, "Ride Quality for Pavement Surfaces," unless otherwise shown on the plans.

5. MEASUREMENT

5.1. **Dense Graded Hot-Mix Asphalt.** Hot mix will be measured by the ton of composite hot-mix, which includes asphalt, aggregate, and additives. Measure the weight on scales in accordance with Item 520, "Weighing and Measuring Equipment."

5.2. **Tack Coat.** Tack coat will be measured at the applied temperature by strapping the tank before and after road application and determining the net volume in gallons from the calibrated distributor. The Engineer will witness all strapping operations for volume determination. All tack, including emulsions, will be measured by the gallon applied.

The Engineer may allow the use of a metering device to determine asphalt volume used and application rate if the device is accurate within 1.5% of the strapped volume.

6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under Section 3076.5.1, "Measurement," will be paid for at the unit bid price for "Dense Graded Hot-Mix Asphalt" of the mixture type, SAC, and binder specified. These prices are full compensation for surface preparation, materials, placement, equipment, labor, tools, and incidentals.

The work performed and materials furnished in accordance with this Item and measured as provided under Article 3076.5.2, "Measurement," will be paid for at the unit bid price for "Tack Coat" of the tack coat provided. These prices are full compensation for materials, placement, equipment, labor, tools, and incidentals. Payment adjustments will be applied as determined in this Item; however, a payment adjustment factor of 1.000 will be assigned for all placement sublots for "level ups" only when "level up" is listed as part of the item bid description code. A payment adjustment factor of 1.000 will be assigned to all production and placement sublots when "exempt" is listed as part of the item bid description code, and all testing requirements are met.

Payment for each sublot, including applicable payment adjustments greater than 1.000, will only be paid for sublots when the Contractor supplies the Engineer with the required documentation for production and placement QC/QA, thermal profiles, segregation density profiles, and longitudinal joint densities in accordance with Section 3076.4.2., "Reporting and Responsibilities." When a thermal imaging system is used, documentation is not required for thermal profiles or segregation density profiles on individual sublots; however, the thermal imaging system automated reports described in Tex-244-F are required.

Trial batches will not be paid for unless they are included in pavement work approved by the Department.

Payment adjustment for ride quality will be determined in accordance with Item 585, "Ride Quality for Pavement Surfaces."

6.1. **Production Payment Adjustment Factors**. The production payment adjustment factor is based on the laboratory-molded density using the Engineer's test results. The bulk specific gravities of the samples from each sublot will be divided by the Engineer's maximum theoretical specific gravity for the sublot. The individual sample densities for the sublot will be averaged to determine the production payment adjustment factor in accordance with Table 19 for each sublot, using the deviation from the target laboratory-molded density defined in Table 9. The production payment adjustment factor for completed lots will be the average of the payment adjustment factors for the four sublots sampled within that lot.

Table 19
Production Payment Adjustment Factors for Laboratory-Molded Density[1]

Absolute Deviation from Target Laboratory-Molded Density	Production Payment Adjustment Factor (Target Laboratory-Molded Density)
0.0	1.050
0.1	1.050
0.2	1.050
0.3	1.044
0.4	1.038
0.5	1.031
0.6	1.025
0.7	1.019
0.8	1.013
0.9	1.006
1.0	1.000
1.1	0.965
1.2	0.930
1.3	0.895
1.4	0.860
1.5	0.825
1.6	0.790
1.7	0.755
1.8	0.720
> 1.8	Remove and replace

1. If the Engineer's laboratory-molded density on any sublot is less than 95.0% or greater than 98.0%, take immediate corrective action to bring the mixture within these tolerances. The Engineer may suspend operations if the Contractor's corrective actions do not produce acceptable results. The Engineer will allow production to resume when the proposed corrective action is likely to yield acceptable results.

6.1.1. **Payment for Incomplete Production Lots**. Production payment adjustments for incomplete lots, described under Section 3076.4.9.2.1.1., "Incomplete Production Lots," will be calculated using the average production payment factors from all sublots sampled.

A production payment factor of 1.000 will be assigned to any lot when the random sampling plan did not result in collection of any samples within the first sublot.

6.1.2. **Production Sublots Subject to Removal and Replacement**. If after referee testing, the laboratory-molded density for any sublot results in a "remove and replace" condition as listed in Table 19, the Engineer may require removal and replacement or may allow the sublot to be left in place without payment. The Engineer may also accept the sublot in accordance with Section 3076.5.3.1., "Acceptance of Defective or Unauthorized Work." Replacement material meeting the requirements of this Item will be paid for in accordance with this Section.

6.2. **Placement Payment Adjustment Factors**. The placement payment adjustment factor is based on in-place air voids using the Engineer's test results. The bulk specific gravities of the cores from each sublot will be divided by the Engineer's average maximum theoretical specific gravity for the lot. The individual core densities for the sublot will be averaged to determine the placement payment adjustment factor in accordance with Table 20 for each sublot that requires in-place air void measurement. A placement payment adjustment factor of 1.000 will be assigned to the entire sublot when the random sample location falls in an area designated on the plans as not subject to in-place air void determination. A placement payment adjustment factor of 1.000 will be assigned to quantities placed in areas described in Section 3076.4.9.3.1.4., "Miscellaneous Areas." The placement payment adjustment factor for completed lots will be the average of the placement payment adjustment factors for up to four sublots within that lot.

Table 20
Placement Payment Adjustment Factors for In-Place Air Voids

In-Place Air Voids	Placement Pay Adjustment Factor	In-Place Air Voids	Placement Pay Adjustment Factor
< 2.7	Remove and Replace	6.4	1.042
2.7	0.710	6.5	1.040
2.8	0.740	6.6	1.038
2.9	0.770	6.7	1.036
3.0	0.800	6.8	1.034
3.1	0.830	6.9	1.032
3.2	0.860	7.0	1.030
3.3	0.890	7.1	1.028
3.4	0.920	7.2	1.026
3.5	0.950	7.3	1.024
3.6	0.980	7.4	1.022
3.7	0.998	7.5	1.020
3.8	1.002	7.6	1.018
3.9	1.006	7.7	1.016
4.0	1.010	7.8	1.014
4.1	1.014	7.9	1.012
4.2	1.018	8.0	1.010
4.3	1.022	8.1	1.008
4.4	1.026	8.2	1.006
4.5	1.030	8.3	1.004
4.6	1.034	8.4	1.002
4.7	1.038	8.5	1.000
4.8	1.042	8.6	0.998
4.9	1.046	8.7	0.996
5.0	1.050	8.8	0.994
5.1	1.050	8.9	0.992
5.2	1.050	9.0	0.990
5.3	1.050	9.1	0.960
5.4	1.050	9.2	0.930
5.5	1.050	9.3	0.900
5.6	1.050	9.4	0.870
5.7	1.050	9.5	0.840
5.8	1.050	9.6	0.810
5.9	1.050	9.7	0.780
6.0	1.050	9.8	0.750
6.1	1.048	9.9	0.720
6.2	1.046	> 9.9	Remove and Replace
6.3	1.044		

6.2.1. **Payment for Incomplete Placement Lots**. Payment adjustments for incomplete placement lots described under Section 3076.4.9.3.1.2., "Incomplete Placement Lots," will be calculated using the average of the placement payment factors from all sublots sampled and sublots where the random location falls in an area designated on the plans as not eligible for in-place air void determination.

If the random sampling plan results in production samples, but not in placement samples, the random core location and placement adjustment factor for the sublot will be determined by applying the placement random number to the length of the sublot placed.

If the random sampling plan results in placement samples, but not in production samples, no placement adjustment factor will apply for that sublot placed.

A placement payment adjustment factor of 1.000 will be assigned to any lot when the random sampling plan did not result in collection of any production samples.

6.2.2. **Placement Sublots Subject to Removal and Replacement**. If after referee testing, the placement payment adjustment factor for any sublot results in a "remove and replace" condition as listed in Table 20, the Engineer will choose the location of two cores to be taken within 3 ft. of the original failing core location. The Contractor will obtain the cores in the presence of the Engineer. The Engineer will take immediate possession of the untrimmed cores and submit the untrimmed cores to the Materials and Tests Division, where they will be trimmed if necessary and tested for bulk specific gravity within 10 working days of receipt.

The bulk specific gravity of the cores from each sublot will be divided by the Engineer's average maximum theoretical specific gravity for the lot. The individual core densities for the sublot will be averaged to determine the new payment adjustment factor of the sublot in question. If the new payment adjustment factor is 0.700 or greater, the new payment adjustment factor will apply to that sublot. If the new payment adjustment factor is less than 0.700, no payment will be made for the sublot. Remove and replace the failing sublot, or the Engineer may allow the sublot to be left in place without payment. The Engineer may also accept the sublot in accordance with Section 3076.5.3.1., "Acceptance of Defective or Unauthorized Work." Replacement material meeting the requirements of this Item will be paid for in accordance with this Section.

6.3. **Total Adjusted Pay Calculation**. Total adjusted pay (TAP) will be based on the applicable payment adjustment factors for production and placement for each lot.

$TAP = (A+B)/2$

where:
A = Bid price × production lot quantity × average payment adjustment factor for the production lot
B = Bid price × placement lot quantity × average payment adjustment factor for the placement lot + (bid price × quantity placed in miscellaneous areas × 1.000)

Production lot quantity = Quantity actually placed - quantity left in place without payment

Placement lot quantity = Quantity actually placed - quantity left in place without payment - quantity placed in miscellaneous areas

Special Specification 3077
Superpave Mixtures

1. DESCRIPTION

Construct a hot-mix asphalt (HMA) pavement layer composed of a compacted, Superpave (SP) mixture of aggregate and asphalt binder mixed hot in a mixing plant. Payment adjustments will apply to HMA placed under this specification unless the HMA is deemed exempt in accordance with Section 3077.4.9.4., "Exempt Production."

2. MATERIALS

Furnish uncontaminated materials of uniform quality that meet the requirements of the plans and specifications.

Notify the Engineer of all material sources and before changing any material source or formulation. The Engineer will verify that the specification requirements are met when the Contractor makes a source or formulation change and may require a new laboratory mixture design, trial batch, or both. The Engineer may sample and test project materials at any time during the project to verify specification compliance in accordance with Item 6, "Control of Materials."

2.1. **Aggregate**. Furnish aggregates from sources that conform to the requirements shown in Table 1 and as specified in this Section. Aggregate requirements in this Section, including those shown in Table 1, may be modified or eliminated when shown on the plans. Additional aggregate requirements may be specified when shown on the plans. Provide aggregate stockpiles that meet the definitions in this Section for coarse, intermediate, or fine aggregate. Aggregate from reclaimed asphalt pavement (RAP) is not required to meet Table 1 requirements unless otherwise shown on the plans. Supply aggregates that meet the definitions in Tex-100-E for crushed gravel or crushed stone. The Engineer will designate the plant or the quarry as the sampling location. Provide samples from materials produced for the project. The Engineer will establish the Surface Aggregate Classification (SAC) and perform Los Angeles abrasion, magnesium sulfate soundness, and Micro-Deval tests. Perform all other aggregate quality tests listed in Table 1. Document all test results on the mixture design report. The Engineer may perform tests on independent or split samples to verify Contractor test results. Stockpile aggregates for each source and type separately. Determine aggregate gradations for mixture design and production testing based on the washed sieve analysis given in Tex-200-F, Part II.

2.1.1. **Coarse Aggregate**. Coarse aggregate stockpiles must have no more than 20% material passing the No. 8 sieve. Aggregates from sources listed in the Department's *Bituminous Rated Source Quality Catalog* (BRSQC) are preapproved for use. Use only the rated values for hot-mix listed in the BRSQC. Rated values for surface treatment (ST) do not apply to coarse aggregate sources used in hot-mix asphalt.

For sources not listed on the Department's BRSQC:

- build an individual stockpile for each material;
- request the Department test the stockpile for specification compliance; and
- once approved, do not add material to the stockpile unless otherwise approved.

Provide aggregate from non-listed sources only when tested by the Engineer and approved before use. Allow 30 calendar days for the Engineer to sample, test, and report results for non-listed sources.

Provide coarse aggregate with at least the minimum SAC shown on the plans. SAC requirements only apply to aggregates used on the surface of travel lanes. SAC requirements apply to aggregates used on surfaces other than travel lanes when shown on the plans. The SAC for sources on the Department's *Aggregate Quality Monitoring Program* (AQMP) (Tex-499-A) is listed in the BRSQC.

2.1.1.1. **Blending Class A and Class B Aggregates**. Class B aggregate meeting all other requirements in Table 1 may be blended with a Class A aggregate to meet requirements for Class A materials, unless otherwise shown on the plans. Ensure that at least 50% by weight, or volume if required, of the material retained on the No. 4 sieve comes from the Class A aggregate source when blending Class A and B aggregates to meet a Class A requirement unless otherwise shown on the plans. Blend by volume if the bulk specific gravities of the Class A and B aggregates differ by more than 0.300. Coarse aggregate from RAP and Recycled Asphalt Shingles (RAS) will be considered as Class B aggregate for blending purposes.

The Engineer may perform tests at any time during production, when the Contractor blends Class A and B aggregates to meet a Class A requirement, to ensure that at least 50% by weight, or volume if required, of the material retained on the No. 4 sieve comes from the Class A aggregate source. The Engineer will use the Department's mix design template, when electing to verify conformance, to calculate the percent of Class A aggregate retained on the No. 4 sieve by inputting the bin percentages shown from readouts in the control room at the time of production and stockpile gradations measured at the time of production. The Engineer may determine the gradations based on either washed or dry sieve analysis from samples obtained from individual aggregate cold feed bins or aggregate stockpiles. The Engineer may perform spot checks using the gradations supplied by the Contractor on the mixture design report as an input for the template; however, a failing spot check will require confirmation with a stockpile gradation determined by the Engineer.

2.1.1.2. **Micro-Deval Abrasion**. The Engineer will perform a minimum of one Micro-Deval abrasion test in accordance with Tex-461-A for each coarse aggregate source used in the mixture design that has a Rated Source Soundness Magnesium (RSSM) loss value greater than 15 as listed in the BRSQC. The Engineer will perform testing before the start of production and may perform additional testing at any time during production. The Engineer may obtain the coarse aggregate samples from each coarse aggregate source or may require the Contractor to obtain the samples. The Engineer may waive all Micro-Deval testing based on a satisfactory test history of the same aggregate source.

The Engineer will estimate the magnesium sulfate soundness loss for each coarse aggregate source, when tested, using the following formula:

$$Mg_{est.} = (RSSM)(MD_{act.}/RSMD)$$

where:
$Mg_{est.}$ = magnesium sulfate soundness loss
$MD_{act.}$ = actual Micro-Deval percent loss
RSMD = Rated Source Micro-Deval

When the estimated magnesium sulfate soundness loss is greater than the maximum magnesium sulfate soundness loss specified, the coarse aggregate source will not be allowed for use unless otherwise approved. The Engineer will consult the Soils and Aggregates Section of the Materials and Tests Division, and additional testing may be required before granting approval.

2.1.2. **Intermediate Aggregate**. Aggregates not meeting the definition of coarse or fine aggregate will be defined as intermediate aggregate. Supply intermediate aggregates, when used that are free from organic impurities. The Engineer may test the intermediate aggregate in accordance with Tex-408-A to verify the material is free from organic impurities. Supply intermediate aggregate from coarse aggregate sources, when used that meet the requirements shown in Table 1 unless otherwise approved.

Test the stockpile if 10% or more of the stockpile is retained on the No. 4 sieve, and verify that it meets the requirements in Table 1 for crushed face count (Tex-460-A) and flat and elongated particles (Tex-280-F).

2.1.3. **Fine Aggregate**. Fine aggregates consist of manufactured sands, screenings, and field sands. Fine aggregate stockpiles must meet the gradation requirements in Table 2. Supply fine aggregates that are free from organic impurities. The Engineer may test the fine aggregate in accordance with Tex-408-A to verify the material is free from organic impurities. Unless otherwise shown on the plans, up to 10% of the total aggregate may be field sand or other uncrushed fine aggregate. Use fine aggregate, with the exception of field sand, from coarse aggregate sources that meet the requirements shown in Table 1 unless otherwise approved.

Test the stockpile if 10% or more of the stockpile is retained on the No. 4 sieve and verify that it meets the requirements in Table 1 for crushed face count (Tex-460-A) and flat and elongated particles (Tex-280-F).

Table 1
Aggregate Quality Requirements

Property	Test Method	Requirement
Coarse Aggregate		
SAC	Tex-499-A (AQMP)	As shown on the plans
Deleterious material, %, Max	Tex-217-F, Part I	1.0
Decantation, %, Max	Tex-217-F, Part II	1.5
Micro-Deval abrasion, %	Tex-461-A	Note 1
Los Angeles abrasion, %, Max	Tex-410-A	35[2]
Magnesium sulfate soundness, 5 cycles, %, Max	Tex-411-A	25[3]
Crushed face count,[4] %, Min	Tex-460-A, Part I	85
Flat and elongated particles @ 5:1, %, Max	Tex-280-F	10
Fine Aggregate		
Linear shrinkage, %, Max	Tex-107-E	3
Sand equivalent, %, Min	Tex-203-F	45

1. Used to estimate the magnesium sulfate soundness loss in accordance with Section 3077.2.1.1.2., "Micro-Deval Abrasion."
2. For base mixtures defined in Section 3077.2.7., "Recycled Materials," the Los Angeles abrasion may be increased to a maximum of 40%.
3. For base mixtures defined in Section 3077.2.7., "Recycled Materials," the magnesium sulfate soundness, five cycles, may be increased to a maximum of 30%.
4. Only applies to crushed gravel.

Table 2
Gradation Requirements for Fine Aggregate

Sieve Size	% Passing by Weight or Volume
3/8"	100
#8	70–100
#200	0–30

2.2. **Mineral Filler**. Mineral filler consists of finely divided mineral matter such as agricultural lime, crusher fines, hydrated lime, or fly ash. Mineral filler is allowed unless otherwise shown on the plans. Use no more than 2% hydrated lime or fly ash unless otherwise shown on the plans. Use no more than 1% hydrated lime if a substitute binder is used unless otherwise shown on the plans or allowed. Test all mineral fillers except hydrated lime and fly ash in accordance with Tex-107-E to ensure specification compliance. The plans may require or disallow specific mineral fillers. Provide mineral filler, when used, that:

- is sufficiently dry, free-flowing, and free from clumps and foreign matter as determined by the Engineer;
- does not exceed 3% linear shrinkage when tested in accordance with Tex-107-E; and
- meets the gradation requirements in Table 3, unless otherwise shown on the plans.

Table 3
Gradation Requirements for Mineral Filler

Sieve Size	% Passing by Weight or Volume
#8	100
#200	55–100

2.3. **Baghouse Fines**. Fines collected by the baghouse or other dust-collecting equipment may be reintroduced into the mixing drum.

2.4. **Asphalt Binder**. Furnish the type and grade of performance-graded (PG) asphalt specified on the plans.

2.5. **Tack Coat**. Furnish CSS-1H, SS-1H, or a PG binder with a minimum high-temperature grade of PG 58 for tack coat binder in accordance with Item 300, "Asphalts, Oils, and Emulsions." Specialized tack coat materials listed on the Department's MPL are allowed or required when shown on the plans. Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use.

2.6. **Additives**. Use the type and rate of additive specified when shown on the plans. Additives that facilitate mixing, compaction, or improve the quality of the mixture are allowed when approved. Provide the Engineer with documentation such as the bill of lading showing the quantity of additives used in the project unless otherwise directed.

2.6.1. **Lime and Liquid Antistripping Agent**. When lime or a liquid antistripping agent is used, add in accordance with Item 301, "Asphalt Antistripping Agents." Do not add lime directly into the mixing drum of any plant where lime is removed through the exhaust stream unless the plant has a baghouse or dust collection system that reintroduces the lime into the drum.

2.6.2. **Warm Mix Asphalt (WMA)**. Warm Mix Asphalt (WMA) is defined as HMA that is produced within a target temperature discharge range of 215°F and 275°F using approved WMA additives or processes from the Department's MPL.

WMA is allowed for use on all projects and is required when shown on the plans. When WMA is required, the maximum placement or target discharge temperature for WMA will be set at a value below 275°F.

Department-approved WMA additives or processes may be used to facilitate mixing and compaction of HMA produced at target discharge temperatures above 275°F; however, such mixtures will not be defined as WMA.

2.6.3. **Compaction Aid.** Compaction Aid is defined as a chemical warm mix additive that is used to produce an asphalt mixture at a discharge temperature greater than 275°F.

Compaction Aid is allowed for use on all projects and is required when shown on the plans.

2.7. **Recycled Materials**. Use of RAP and RAS is permitted unless otherwise shown on the plans. Use of RAS is restricted to only intermediate and base mixes unless otherwise shown on the plans. Do not exceed the maximum allowable percentages of RAP and RAS shown in Table 4. The allowable percentages shown in Table 4 may be decreased or increased when shown on the plans. Determine the asphalt binder content and gradation of the RAP and RAS stockpiles for mixture design purposes in accordance with Tex-236-F, Part I. The Engineer may verify the asphalt binder content of the stockpiles at any time during production. Perform other tests on RAP and RAS when shown on the plans. Asphalt binder from RAP and RAS is designated as recycled asphalt binder. Calculate and ensure that the ratio of the recycled asphalt binder to total binder does not exceed the percentages shown in Table 5 during mixture design and HMA production when RAP or RAS is used. Use a separate cold feed bin for each stockpile of RAP and RAS during HMA production.

Surface, intermediate, and base mixes referenced in Tables 4 and 5 are defined as follows:

- **Surface**. The final HMA lift placed at the top of the pavement structure or placed directly below mixtures produced in accordance with Items 316, 342, 347, or 348;
- **Intermediate**. Mixtures placed below an HMA surface mix and less than or equal to 8.0 in. from the riding surface; and
- **Base**. Mixtures placed greater than 8.0 in. from the riding surface. Unless otherwise shown on the plans, mixtures used for bond breaker are defined as base mixtures.

2.7.1. **RAP**. RAP is salvaged, milled, pulverized, broken, or crushed asphalt pavement. Fractionated RAP is defined as a stockpile that contains RAP material with a minimum of 95.0% passing the 3/8-in. or 1/2-in.

sieve, before burning in the ignition oven, unless otherwise approved. The Engineer may allow the Contractor to use an alternate to the 3/8-in. or 1/2-in. screen to fractionate the RAP.

Use of Contractor-owned RAP including HMA plant waste is permitted unless otherwise shown on the plans. Department-owned RAP stockpiles are available for the Contractor's use when the stockpile locations are shown on the plans. If Department-owned RAP is available for the Contractor's use, the Contractor may use Contractor-owned fractionated RAP and replace it with an equal quantity of Department-owned RAP. Department-owned RAP generated through required work on the Contract is available for the Contractor's use when shown on the plans. Perform any necessary tests to ensure Contractor- or Department-owned RAP is appropriate for use. The Department will not perform any tests or assume any liability for the quality of the Department-owned RAP unless otherwise shown on the plans. The Contractor will retain ownership of RAP generated on the project when shown on the plans.

Do not use Department- or Contractor-owned RAP contaminated with dirt or other objectionable materials. Do not use Department- or Contractor-owned RAP if the decantation value exceeds 5% and the plasticity index is greater than eight. Test the stockpiled RAP for decantation in accordance with Tex-406-A, Part I. Determine the plasticity index in accordance with Tex-106-E if the decantation value exceeds 5%. The decantation and plasticity index requirements do not apply to RAP samples with asphalt removed by extraction or ignition.

Do not intermingle Contractor-owned RAP stockpiles with Department-owned RAP stockpiles. Remove unused Contractor-owned RAP material from the project site upon completion of the project. Return unused Department-owned RAP to the designated stockpile location.

Table 4
Maximum Allowable Amounts of RAP[1]

Maximum Allowable Fractionated RAP (%)		
Surface	**Intermediate**	**Base**
20.0	30.0	35.0

1. Must also meet the recycled binder to total binder ratio shown in Table 5.

2.7.2. **RAS**. Use of post-manufactured RAS or post-consumer RAS (tear-offs) is not permitted in surface mixtures unless otherwise shown on the plans. RAS may be used in intermediate and base mixtures unless otherwise shown on the plans. Up to 3% RAS may be used separately or as a replacement for fractionated RAP in accordance with Table 4 and Table 5. RAS is defined as processed asphalt shingle material from manufacturing of asphalt roofing shingles or from re-roofing residential structures. Post-manufactured RAS is processed manufacturer's shingle scrap by-product. Post-consumer RAS is processed shingle scrap removed from residential structures. Comply with all regulatory requirements stipulated for RAS by the TCEQ. RAS may be used separately or in conjunction with RAP.

Process the RAS by ambient grinding or granulating such that 100% of the particles pass the 3/8 in. sieve when tested in accordance with Tex-200-F, Part I. Perform a sieve analysis on processed RAS material before extraction (or ignition) of the asphalt binder.

Add sand meeting the requirements of Table 1 and Table 2 or fine RAP to RAS stockpiles if needed to keep the processed material workable. Any stockpile that contains RAS will be considered a RAS stockpile and be limited to no more than 3.0% of the HMA mixture in accordance with Table 4.

Certify compliance of the RAS with DMS-11000, "Evaluating and Using Nonhazardous Recyclable Materials Guidelines." Treat RAS as an established nonhazardous recyclable material if it has not come into contact with any hazardous materials. Use RAS from shingle sources on the Department's MPL. Remove substantially all materials before use that are not part of the shingle, such as wood, paper, metal, plastic, and felt paper. Determine the deleterious content of RAS material for mixture design purposes in accordance with Tex-217-F, Part III. Do not use RAS if deleterious materials are more than 0.5% of the stockpiled RAS unless

otherwise approved. Submit a sample for approval before submitting the mixture design. The Department will perform the testing for deleterious material of RAS to determine specification compliance.

2.8. **Substitute Binders**. Unless otherwise shown on the plans, the Contractor may use a substitute PG binder listed in Table 5 instead of the PG binder originally specified if using recycled materials, and if the substitute PG binder and mixture made with the substitute PG binder meet the following:

- the substitute binder meets the specification requirements for the substitute binder grade in accordance with Section 300.2.10., "Performance-Graded Binders;" and
- the mixture has less than 10.0 mm of rutting on the Hamburg Wheel test (Tex-242-F) after the number of passes required for the originally specified binder. Use of substitute PG binders may only be allowed at the discretion of the Engineer if the Hamburg Wheel test results are between 10.0 mm and 12.5 mm.

Table 5
Allowable Substitute PG Binders and Maximum Recycled Binder Ratios

Originally Specified PG Binder	Allowable Substitute PG Binder for Surface Mixes	Allowable Substitute PG Binder for Intermediate and Base Mixes	Maximum Ratio of Recycled Binder[1] to Total Binder (%)		
			Surface	Intermediate	Base
76-22[4,5]	70-22	70-22	15.0	25.0	30.0
70-22[2,5]	N/A	64-22	15.0	25.0	30.0
64-22[2,3]	N/A	N/A	15.0	25.0	30.0
76-28[4,5]	70-28	70-28	15.0	25.0	30.0
70-28[2,5]	N/A	64-28	15.0	25.0	30.0
64-28[2,3]	N/A	N/A	15.0	25.0	30.0

1. Combined recycled binder from RAP and RAS. RAS is not permitted in surface mixtures unless otherwise shown on the plans.
2. Binder substitution is not allowed for surface mixtures.
3. Binder substitution is not allowed for intermediate and base mixtures.
4. Use no more than 15.0% recycled binder in surface mixtures when using this originally specified PG binder.
5. Use no more than 25.0% recycled binder when using this originally specified PG binder for intermediate mixtures. Use no more than 30.0% recycled binder when using this originally specified PG binder for base mixtures.

3. EQUIPMENT

Provide required or necessary equipment in accordance with Item 320, "Equipment for Asphalt Concrete Pavement."

4. CONSTRUCTION

Produce, haul, place, and compact the specified paving mixture. In addition to tests required by the specification, Contractors may perform other QC tests as deemed necessary. At any time during the project, the Engineer may perform production and placement tests as deemed necessary in accordance with Item 5, "Control of the Work." Schedule and participate in a mandatory pre-paving meeting with the Engineer on or before the first day of paving unless otherwise shown on the plans.

4.1. **Certification**. Personnel certified by the Department-approved hot-mix asphalt certification program must conduct all mixture designs, sampling, and testing in accordance with Table 6. Supply the Engineer with a list of certified personnel and copies of their current certificates before beginning production and when personnel

changes are made. Provide a mixture design developed and signed by a Level 2 certified specialist. Provide Level 1A certified specialists at the plant during production operations. Provide Level 1B certified specialists to conduct placement tests. Provide AGG101 certified specialists for aggregate testing.

Table 6
Test Methods, Test Responsibility, and Minimum Certification Levels

Test Description	Test Method	Contractor	Engineer	Level[1]
1. Aggregate and Recycled Material Testing				
Sampling	Tex-221-F	✓	✓	1A/AGG101
Dry sieve	Tex-200-F, Part I	✓	✓	1A/AGG101
Washed sieve	Tex-200-F, Part II	✓	✓	1A/AGG101
Deleterious material	Tex-217-F, Parts I & III	✓	✓	AGG101
Decantation	Tex-217-F, Part II	✓	✓	AGG101
Los Angeles abrasion	Tex-410-A		✓	TxDOT
Magnesium sulfate soundness	Tex-411-A		✓	TxDOT
Micro-Deval abrasion	Tex-461-A		✓	AGG101
Crushed face count	Tex-460-A	✓	✓	AGG101
Flat and elongated particles	Tex-280-F	✓	✓	AGG101
Linear shrinkage	Tex-107-E	✓	✓	AGG101
Sand equivalent	Tex-203-F	✓	✓	AGG101
Bulk specific gravity	Tex-201-F	✓	✓	AGG101
Unit weight	Tex-404-A	✓	✓	AGG101
Organic impurities	Tex-408-A	✓	✓	AGG101
2. Asphalt Binder & Tack Coat Sampling				
Asphalt binder sampling	Tex-500-C, Part II	✓	✓	1A/1B
Tack coat sampling	Tex-500-C, Part III	✓	✓	1A/1B
3. Mix Design & Verification				
Design and JMF changes	Tex-204-F	✓	✓	2
Mixing	Tex-205-F	✓	✓	2
Molding (SGC)	Tex-241-F	✓	✓	1A
Laboratory-molded density	Tex-207-F, Parts I & VI	✓	✓	1A
Rice gravity	Tex-227-F, Part II	✓	✓	1A
Ignition oven correction factors[2]	Tex-236-F, Part II	✓	✓	2
Indirect tensile strength	Tex-226-F	✓	✓	1A
Hamburg Wheel test	Tex-242-F	✓	✓	1A
Boil test	Tex-530-C	✓	✓	1A
4. Production Testing				
Selecting production random numbers	Tex-225-F, Part I		✓	1A
Mixture sampling	Tex-222-F	✓	✓	1A/1B
Molding (SGC)	Tex-241-F	✓	✓	1A
Laboratory-molded density	Tex-207-F, Parts I & VI	✓	✓	1A
Rice gravity	Tex-227-F, Part II	✓	✓	1A
Gradation & asphalt binder content[2]	Tex-236-F, Part I	✓	✓	1A
Control charts	Tex-233-F	✓	✓	1A
Moisture content	Tex-212-F, Part II	✓	✓	1A/AGG101
Hamburg Wheel test	Tex-242-F	✓	✓	1A
Micro-Deval abrasion	Tex-461-A		✓	AGG101
Boil test	Tex-530-C	✓	✓	1A
Abson recovery	Tex-211-F		✓	TxDOT
5. Placement Testing				
Selecting placement random numbers	Tex-225-F, Part II		✓	1B
Trimming roadway cores	Tex-251-F, Parts I & II	✓	✓	1A/1B
In-place air voids	Tex-207-F, Parts I & VI	✓	✓	1A
In-place density (nuclear method)	Tex-207-F, Part III	✓		1B
Establish rolling pattern	Tex-207-F, Part IV	✓		1B
Control charts	Tex-233-F	✓	✓	1A
Ride quality measurement	Tex-1001-S	✓	✓	Note 3
Segregation (density profile)	Tex-207-F, Part V	✓	✓	1B
Longitudinal joint density	Tex-207-F, Part VII	✓	✓	1B
Thermal profile	Tex-244-F	✓	✓	1B
Shear Bond Strength Test	Tex-249-F		✓	TxDOT

1. Level 1A, 1B, AGG101, and 2 are certification levels provided by the Hot Mix Asphalt Center certification program.
2. Refer to Section 3077.4.9.2.3., "Production Testing," for exceptions to using an ignition oven.
3. Profiler and operator are required to be certified at the Texas A&M Transportation Institute facility when Surface Test Type B is specified.

4.2. **Reporting and Responsibilities**. Use Department-provided templates to record and calculate all test data, including mixture design, production and placement QC/QA, control charts, thermal profiles, segregation density profiles, and longitudinal joint density. Obtain the current version of the templates at http://www.txdot.gov/inside-txdot/forms-publications/consultants-contractors/forms/site-manager.html or from the Engineer. The Engineer and the Contractor will provide any available test results to the other party when requested. The maximum allowable time for the Contractor and Engineer to exchange test data is as given in Table 7 unless otherwise approved. The Engineer and the Contractor will immediately report to the other party any test result that requires suspension of production or placement, a payment adjustment less than 1.000, or that fails to meet the specification requirements. Record and electronically submit all test results and pertinent information on Department-provided templates.

Subsequent sublots placed after test results are available to the Contractor, which require suspension of operations, may be considered unauthorized work. Unauthorized work will be accepted or rejected at the discretion of the Engineer in accordance with Article 5.3., "Conformity with Plans, Specifications, and Special Provisions."

Table 7
Reporting Schedule

Description	Reported By	Reported To	To Be Reported Within
Production Quality Control			
Gradation[1]	Contractor	Engineer	1 working day of completion of the sublot
Asphalt binder content[1]			
Laboratory-molded density[2]			
Moisture content[3]			
Boil test[3]			
Production Quality Assurance			
Gradation[3]	Engineer	Contractor	1 working day of completion of the sublot
Asphalt binder content[3]			
Laboratory-molded density[1]			
Hamburg Wheel test[4]			
Boil test[3]			
Binder tests[4]			
Placement Quality Control			
In-place air voids[2]	Contractor	Engineer	1 working day of completion of the lot
Segregation[1]			
Longitudinal joint density[1]			
Thermal profile[1]			
Placement Quality Assurance			
In-place air voids[1]	Engineer	Contractor	1 working day after receiving the trimmed cores[5]
Segregation[3]			1 working day of completion of the lot
Longitudinal joint density[3]			
Thermal profile[3]			
Aging ratio[4]			
Payment adjustment summary	Engineer	Contractor	2 working days of performing all required tests and receiving Contractor test data

1. These tests are required on every sublot.
2. Optional test. When performed on split samples, report the results as soon as they become available.
3. To be performed at the frequency specified in Table 17 or as shown on the plans.
4. To be reported as soon as the results become available.
5. Two days are allowed if cores cannot be dried to constant weight within 1 day.

The Engineer will use the Department-provided template to calculate all payment adjustment factors for the lot. Sublot samples may be discarded after the Engineer and Contractor sign off on the payment adjustment summary documentation for the lot.

Use the procedures described in Tex-233-F to plot the results of all quality control (QC) and quality assurance (QA) testing. Update the control charts as soon as test results for each sublot become available.

Make the control charts readily accessible at the field laboratory. The Engineer may suspend production for failure to update control charts.

4.3. **Quality Control Plan (QCP)**. Develop and follow the QCP in detail. Obtain approval for changes to the QCP made during the project. The Engineer may suspend operations if the Contractor fails to comply with the QCP.

Submit a written QCP before the mandatory pre-paving meeting. Receive approval of the QCP before beginning production. Include the following items in the QCP:

4.3.1. **Project Personnel**. For project personnel, include:

- a list of individuals responsible for QC with authority to take corrective action;
- current contact information for each individual listed; and
- current copies of certification documents for individuals performing specified QC functions.

4.3.2. **Material Delivery and Storage**. For material delivery and storage, include:

- the sequence of material processing, delivery, and minimum quantities to assure continuous plant operations;
- aggregate stockpiling procedures to avoid contamination and segregation;
- frequency, type, and timing of aggregate stockpile testing to assure conformance of material requirements before mixture production; and
- procedure for monitoring the quality and variability of asphalt binder.

4.3.3. **Production**. For production, include:

- loader operation procedures to avoid contamination in cold bins;
- procedures for calibrating and controlling cold feeds;
- procedures to eliminate debris or oversized material;
- procedures for adding and verifying rates of each applicable mixture component (e.g., aggregate, asphalt binder, RAP, RAS, lime, liquid antistrip, WMA);
- procedures for reporting job control test results; and
- procedures to avoid segregation and drain-down in the silo.

4.3.4. **Loading and Transporting**. For loading and transporting, include:

- type and application method for release agents; and
- truck loading procedures to avoid segregation.

4.3.5. **Placement and Compaction**. For placement and compaction, include:

- proposed agenda for mandatory pre-paving meeting, including date and location;
- proposed paving plan (e.g., paving widths, joint offsets, and lift thicknesses);
- type and application method for release agents in the paver and on rollers, shovels, lutes, and other utensils;
- procedures for the transfer of mixture into the paver, while avoiding segregation and preventing material spillage;
- process to balance production, delivery, paving, and compaction to achieve continuous placement operations and good ride quality;
- paver operations (e.g., operation of wings, height of mixture in auger chamber) to avoid physical and thermal segregation and other surface irregularities; and
- procedures to construct quality longitudinal and transverse joints.

4.4. **Mixture Design**.

4.4.1. **Design Requirements**. Use the SP design procedure provided in Tex-204-F, unless otherwise shown on the plans. Design the mixture to meet the requirements listed in Tables 1, 2, 3, 4, 5, 8, 9, 10, and 11.

Design the mixture at 50 gyrations (Ndesign). Use a target laboratory-molded density of 96.0% to design the mixture; however, adjustments can be made to the Ndesign value as noted in Table 10. The Ndesign level may be reduced to at least 35 gyrations at the Contractor's discretion.

Use an approved laboratory from the Department's MPL to perform the Hamburg Wheel test and provide results with the mixture design, or provide the laboratory mixture and request that the Department perform the Hamburg Wheel test. The Engineer will be allowed 10 working days to provide the Contractor with Hamburg Wheel test results on the laboratory mixture design.

The Engineer will provide the mixture design when shown on the plans. The Contractor may submit a new mixture design at any time during the project. The Engineer will verify and approve all mixture designs (JMF1) before the Contractor can begin production.

The aggregate gradation may pass below or through the reference zone shown in Table 9 unless otherwise shown on the plans. Design a mixture with a gradation that has stone-on-stone contact and passes below the reference zone shown in Table 9 when shown on the plans. Verify stone-on-stone contact using the method given in the SP design procedure in Tex-204-F, Part IV.

Provide the Engineer with a mixture design report using the Department-provided template. Include the following items in the report:

- the combined aggregate gradation, source, specific gravity, and percent of each material used;
- asphalt binder content and aggregate gradation of RAP and RAS stockpiles;
- the Ndesign level used;
- results of all applicable tests;
- the mixing and molding temperatures;
- the signature of the Level 2 person or persons that performed the design;
- the date the mixture design was performed; and
- a unique identification number for the mixture design.

Table 8
Master Gradation Limits (% Passing by Weight or Volume) and VMA Requirements

Sieve Size	SP-B Intermediate	SP-C Surface	SP-D Fine Mixture
2"	–	–	–
1-1/2"	100.0[1]	–	–
1"	98.0–100.0	100.0[1]	–
3/4"	90.0–100.0	98.0–100.0	100.0[1]
1/2"	Note[2]	90.0–100.0	98.0–100.0
3/8"	–	Note[2]	90.0–100.0
#4	23.0–90.0	28.0–90.0	32.0–90.0
#8	23.0–34.6	28.0–37.0	32.0–40.0
#16	2.0–28.3	2.0–31.6	2.0–37.6
#30	2.0–20.7	2.0–23.1	2.0–27.5
#50	2.0–13.7	2.0–15.5	2.0–18.7
#200	2.0–8.0	2.0–10.0	2.0–10.0
Design VMA, % Minimum			
–	14.0	15.0	16.0
Production (Plant-Produced) VMA, % Minimum			
–	13.5	14.5	15.5

1. Defined as maximum sieve size. No tolerance allowed.
2. Must retain at least 10% cumulative.

Table 9
Reference Zones (% Passing by Weight or Volume)

Sieve Size	SP-B Intermediate	SP-C Surface	SP-D Fine Mixture
2"	–	–	–
1-1/2"	–	–	–
1"	–	–	–
3/4"	–	–	–
1/2"	–	–	–
3/8"	–	–	–
#4	–	–	–
#8	34.6–34.6	39.1–39.1	47.2–47.2
#16	22.3–28.3	25.6–31.6	31.6–37.6
#30	16.7–20.7	19.1–23.1	23.5–27.5
#50	13.7–13.7	15.5–15.5	18.7–18.7
#200	–	–	–

Table 10
Laboratory Mixture Design Properties

Mixture Property	Test Method	Requirement
Target laboratory-molded density, %	Tex-207-F	96.0
Design gyrations (Ndesign)	Tex-241-F	50[1]
Indirect tensile strength (dry), psi	Tex-226-F	85–200[2]
Dust/asphalt binder ratio[3]	–	0.6–1.4
Boil test[4]	Tex-530-C	–

1. Adjust within a range of 35–100 gyrations when shown on the plans or specification or mutually agreed between the Engineer and Contractor.
2. The Engineer may allow the IDT strength to exceed 200 psi if the corresponding Hamburg Wheel rut depth is greater than 3.0 mm and less than 12.5 mm.
3. Defined as % passing #200 sieve divided by asphalt binder content.
4. Used to establish baseline for comparison to production results. May be waived when approved.

Table 11
Hamburg Wheel Test Requirements

High-Temperature Binder Grade	Test Method	Minimum # of Passes @ 12.5 mm[1] Rut Depth, Tested @ 50°C
PG 64 or lower	Tex-242-F	10,000[2]
PG 70		15,000[3]
PG 76 or higher		20,000

1. When the rut depth at the required minimum number of passes is less than 3 mm, the Engineer may require the Contractor to lower the Ndesign level to at least 35 gyrations.
2. May be decreased to at least 5,000 passes when shown on the plans.
3. May be decreased to at least 10,000 passes when shown on the plans.

4.4.2. **Job-Mix Formula Approval**. The job-mix formula (JMF) is the combined aggregate gradation, Ndesign level, and target asphalt percentage used to establish target values for hot-mix production. JMF1 is the original laboratory mixture design used to produce the trial batch. When WMA is used, JMF1 may be designed and submitted to the Engineer without including the WMA additive. When WMA is used, document the additive or process used and recommended rate on the JMF1 submittal. The Engineer and the Contractor will verify JMF1 based on plant-produced mixture from the trial batch unless otherwise approved. The Engineer may accept an existing mixture design previously used on a Department project and may waive the trial batch to verify JMF1. The Department may require the Contractor to reimburse the Department for verification tests if more than two trial batches per design are required.

4.4.2.1. **Contractor's Responsibilities**.

4.4.2.1.1. **Providing Superpave Gyratory Compactor (SGC)**. Furnish an SGC calibrated in accordance with Tex-241-F for molding production samples. Locate the SGC at the Engineer's field laboratory and make the SGC available to the Engineer for use in molding production samples.

4.4.2.1.2. **Gyratory Compactor Correlation Factors**. Use Tex-206-F, Part II, to perform a gyratory compactor correlation when the Engineer uses a different SGC. Apply the correlation factor to all subsequent production test results.

4.4.2.1.3. **Submitting JMF1**. Furnish a mix design report (JMF1) with representative samples of all component materials and request approval to produce the trial batch. Provide approximately 10,000 g of the design mixture if opting to have the Department perform the Hamburg Wheel test on the laboratory mixture, and request that the Department perform the test.

4.4.2.1.4. **Supplying Aggregates**. Provide approximately 40 lb. of each aggregate stockpile unless otherwise directed.

4.4.2.1.5. **Supplying Asphalt**. Provide at least 1 gal. of the asphalt material and enough quantities of any additives proposed for use.

4.4.2.1.6. **Ignition Oven Correction Factors**. Determine the aggregate and asphalt correction factors from the ignition oven in accordance with Tex-236-F, Part II. Provide correction factors that are not more than 12 months old. Provide the Engineer with split samples of the mixtures before the trial batch production, including all additives (except water), and blank samples used to determine the correction factors for the ignition oven used for QA testing during production. Correction factors established from a previously approved mixture design may be used for the current mixture design if the mixture design and ignition oven are the same as previously used, unless otherwise directed.

4.4.2.1.7. **Boil Test**. Perform the test and retain the tested sample from Tex-530-C until completion of the project or as directed. Use this sample for comparison purposes during production. The Engineer may waive the requirement for the boil test.

4.4.2.1.8. **Trial Batch Production**. Provide a plant-produced trial batch upon receiving conditional approval of JMF1 and authorization to produce a trial batch, including the WMA additive or process if applicable, for verification testing of JMF1 and development of JMF2. Produce a trial batch mixture that meets the requirements in Table 4, Table 5, and Table 12. The Engineer may accept test results from recent production of the same mixture instead of a new trial batch.

4.4.2.1.9. **Trial Batch Production Equipment**. Use only equipment and materials proposed for use on the project to produce the trial batch.

4.4.2.1.10. **Trial Batch Quantity**. Produce enough quantity of the trial batch to ensure that the mixture meets the specification requirements.

4.4.2.1.11. **Number of Trial Batches**. Produce trial batches as necessary to obtain a mixture that meets the specification requirements.

4.4.2.1.12. **Trial Batch Sampling**. Obtain a representative sample of the trial batch and split it into 3 equal portions in accordance with Tex-222-F. Label these portions as “Contractor,” “Engineer,” and “Referee.” Deliver samples to the appropriate laboratory as directed.

4.4.2.1.13. **Trial Batch Testing**. Test the trial batch to ensure the mixture produced using the proposed JMF1 meets the mixture requirements in Table 12. Ensure the trial batch mixture is also in compliance with the Hamburg Wheel-requirement in Table 11. Use a Department-approved laboratory to perform the Hamburg Wheel test on the trial batch mixture or request that the Department perform the Hamburg Wheel test.

The Engineer will be allowed 10 working days to provide the Contractor with Hamburg Wheel test results on the trial batch. Provide the Engineer with a copy of the trial batch test results.

4.4.2.1.14. **Development of JMF2**. Evaluate the trial batch test results after the Engineer grants full approval of JMF1 based on results from the trial batch, determine the optimum mixture proportions, and submit as JMF2.

Adjust the asphalt binder content or gradation to achieve the specified target laboratory-molded density. The asphalt binder content established for JMF2 is not required to be within any tolerance of the optimum asphalt binder content established for JMF1; however, mixture produced using JMF2 must meet the voids in mineral aggregates (VMA) requirements for production shown in Table 8. If the optimum asphalt binder content for JMF2 is more than 0.5% lower than the optimum asphalt binder content for JMF1, the Engineer may perform or require the Contractor to perform Tex-226-F on Lot 1 production to confirm the indirect tensile strength does not exceed 200 psi. Verify that JMF2 meets the mixture requirements in Table 4 and Table 5.

4.4.2.1.15. **Mixture Production**. Use JMF2 to produce Lot 1 as described in Section 3077.4.9.3.1.1., "Lot 1 Placement," after receiving approval for JMF2 and a passing result from the Department's or a Department-approved laboratory's Hamburg Wheel test on the trial batch. If desired, proceed to Lot 1 production, once JMF2 is approved, at the Contractor's risk without receiving the results from the Department's Hamburg Wheel test on the trial batch.

Notify the Engineer if electing to proceed without Hamburg Wheel test results from the trial batch. Note that the Engineer may require up to the entire sublot of any mixture failing the Hamburg Wheel test to be removed and replaced at the Contractor's expense.

4.4.2.1.16. **Development of JMF3**. Evaluate the test results from Lot 1, determine the optimum mixture proportions, and submit as JMF3 for use in Lot 2.

4.4.2.1.17. **JMF Adjustments**. If JMF adjustments are necessary to achieve the specified requirements, make the adjustment before beginning a new lot. The adjusted JMF must:

- be provided to the Engineer in writing before the start of a new lot;
- be numbered in sequence to the previous JMF;
- meet the mixture requirements in Table 4 and Table 5;
- meet the master gradation limits shown in Table 8; and
- be within the operational tolerances of JMF2 listed in Table 12.

4.4.2.1.18. **Requesting Referee Testing**. Use referee testing, if needed, in accordance with Section 3077.4.9.1., "Referee Testing," to resolve testing differences with the Engineer.

Table 12
Operational Tolerances

Description	Test Method	Allowable Difference Between Trial Batch and JMF1 Target	Allowable Difference from Current JMF Target	Allowable Difference between Contractor and Engineer[1]
Individual % retained for #8 sieve and larger	Tex-200-F or Tex-236-F	Must be Within Master Grading Limits in Table 8	±5.0[2,3]	±5.0
Individual % retained for sieves smaller than #8 and larger than #200			±3.0[2,3]	±3.0
% passing the #200 sieve			±2.0[2,3]	±1.6
Asphalt binder content, %	Tex-236-F	±0.5	±0.3[3]	±0.3
Dust/asphalt binder ratio[4]	–	Note 5	Note 5	N/A
Laboratory-molded density, %	Tex-207-F	±1.0	±1.0	±0.5
In-place air voids, %		N/A	N/A	±1.0
Laboratory-molded bulk specific gravity		N/A	N/A	±0.020
VMA, % min	Tex-204-F	Note 6	Note 6	N/A
Theoretical maximum specific (Rice) gravity	Tex-227-F	N/A	N/A	±0.020

1. Contractor may request referee testing only when values exceed these tolerances.
2. When within these tolerances, mixture production gradations may fall outside the master grading limits; however, the % passing the #200 will be considered out of tolerance when outside the master grading limits.
3. Only applies to mixture produced for Lot 1 and higher.
4. Defined as % passing #200 sieve divided by asphalt binder content.
5. Verify that Table 10 requirement is met.
6. Verify that Table 8 requirements are met.

4.4.2.2. **Engineer's Responsibilities**.

4.4.2.2.1. **Gyratory Compactor**. The Engineer will use a Department SGC, calibrated in accordance with Tex-241-F, to mold samples for laboratory mixture design verification. For molding trial batch and production specimens, the Engineer will use the Contractor-provided SGC at the field laboratory or provide and use a Department SGC at an alternate location. The Engineer will make the Contractor-provided SGC in the Department field laboratory available to the Contractor for molding verification samples.

4.4.2.2.2. **Conditional Approval of JMF1 and Authorizing Trial Batch**. The Engineer will review and verify conformance of the following information within two working days of receipt:

- the Contractor's mix design report (JMF1);
- the Contractor-provided Hamburg Wheel test results;
- all required materials including aggregates, asphalt, additives, and recycled materials; and
- the mixture specifications.

The Engineer will grant the Contractor conditional approval of JMF1 if the information provided on the paper copy of JMF1 indicates that the Contractor's mixture design meets the specifications. When the Contractor does not provide Hamburg Wheel test results with laboratory mixture design, 10 working days are allowed for conditional approval of JMF1. The Engineer will base full approval of JMF1 on the test results on mixture from the trial batch.

Unless waived, the Engineer will determine the Micro-Deval abrasion loss in accordance with Section 3077.2.1.1.2., "Micro-Deval Abrasion." If the Engineer's test results are pending after two working days, conditional approval of JMF1 will still be granted within 2 working days of receiving JMF1. When the Engineer's test results become available, they will be used for specification compliance.

After conditionally approving JMF1, including either Contractor- or Department-supplied Hamburg Wheel test results, the Contractor is authorized to produce a trial batch.

4.4.2.2.3. **Hamburg Wheel Testing of JMF1**. If the Contractor requests the option to have the Department perform the Hamburg Wheel test on the laboratory mixture, the Engineer will mold samples in accordance with Tex-242-F to verify compliance with the Hamburg Wheel test requirement in Table 11.

4.4.2.2.4. **Ignition Oven Correction Factors**. The Engineer will use the split samples provided by the Contractor to determine the aggregate and asphalt correction factors for the ignition oven used for QA testing during production in accordance with Tex-236-F, Part II. Provide correction factors that are not more than 12 months old.

4.4.2.2.5. **Testing the Trial Batch**. Within 1 full working day, the Engineer will sample and test the trial batch to ensure that the mixture meets the requirements in Table 12. If the Contractor requests the option to have the Department perform the Hamburg Wheel test on the trial batch mixture, the Engineer will mold samples in accordance with Tex-242-F to verify compliance with the Hamburg Wheel test requirement in Table 11.

The Engineer will have the option to perform the following tests on the trial batch:

- Tex-226-F, to verify that the indirect tensile strength meets the requirement shown in Table 10; and
- Tex-530-C, to retain and use for comparison purposes during production.

4.4.2.2.6. **Full Approval of JMF1**. The Engineer will grant full approval of JMF1 and authorize the Contractor to proceed with developing JMF2 if the Engineer's results for the trial batch meet the requirements in Table 12. The Engineer will notify the Contractor that an additional trial batch is required if the trial batch does not meet these requirements.

4.4.2.2.7. **Approval of JMF2**. The Engineer will approve JMF2 within one working day if the mixture meets the requirements in Table 5 and the gradation meets the master grading limits shown in Table 8. The asphalt binder content established for JMF2 is not required to be within any tolerance of the optimum asphalt binder content established for JMF1; however, mixture produced using JMF2 must meet the VMA requirements shown in Table 8. If the optimum asphalt binder content for JMF2 is more than 0.5% lower than the optimum asphalt binder content for JMF1, the Engineer may perform or require the Contractor to perform Tex-226-F on Lot 1 production to confirm the indirect tensile strength does not exceed 200 psi.

4.4.2.2.8. **Approval of Lot 1 Production**. The Engineer will authorize the Contractor to proceed with Lot 1 production (using JMF2) as soon as a passing result is achieved from the Department's or a Department-approved laboratory's Hamburg Wheel test on the trial batch. The Contractor may proceed at its own risk with Lot 1 production without the results from the Hamburg Wheel test on the trial batch.

If the Department's or Department-approved laboratory's sample from the trial batch fails the Hamburg Wheel test, the Engineer will suspend production until further Hamburg Wheel tests meet the specified values. The Engineer may require up to the entire sublot of any mixture failing the Hamburg Wheel test be removed and replaced at the Contractor's expense.

4.4.2.2.9. **Approval of JMF3 and Subsequent JMF Changes**. JMF3 and subsequent JMF changes are approved if they meet the mixture requirements shown in Table 4, Table 5, and the master grading limits shown in Table 8, and are within the operational tolerances of JMF2 shown in Table 12.

4.5. **Production Operations**. Perform a new trial batch when the plant or plant location is changed. Take corrective action and receive approval to proceed after any production suspension for noncompliance to the specification. Submit a new mix design and perform a new trial batch when the asphalt binder content of:

- any RAP stockpile used in the mix is more than 0.5% higher than the value shown on the mixture design report; or
- RAS stockpile used in the mix is more than 2.0% higher than the value shown on the mixture design report.

4.5.1. **Storage and Heating of Materials**. Do not heat the asphalt binder above the temperatures specified in Item 300, "Asphalts, Oils, and Emulsions," or outside the manufacturer's recommended values. Provide the Engineer with daily records of asphalt binder and hot-mix asphalt discharge temperatures (in legible and discernible increments) in accordance with Item 320, "Equipment for Asphalt Concrete Pavement," unless otherwise directed. Do not store mixture for a period long enough to affect the quality of the mixture, nor in any case longer than 12 hr. unless otherwise approved.

4.5.2. **Mixing and Discharge of Materials**. Notify the Engineer of the target discharge temperature and produce the mixture within 25°F of the target. Monitor the temperature of the material in the truck before shipping to ensure that it does not exceed the maximum production temperatures listed in Table 13 (or 275°F for WMA). The Department will not pay for or allow placement of any mixture produced above the maximum production temperatures listed in Table 13.

Table 13
Maximum Production Temperature

High-Temperature Binder Grade[1]	Maximum Production Temperature
PG 64	325˚F
PG 70	335˚F
PG 76	345˚F

1. The high-temperature binder grade refers to the high-temperature grade of the virgin asphalt binder used to produce the mixture.

Produce WMA within the target discharge temperature range of 215°F and 275°F when WMA is required. Take corrective action any time the discharge temperature of the WMA exceeds the target discharge range. The Engineer may suspend production operations if the Contractor's corrective action is not successful at controlling the production temperature within the target discharge range. Note that when WMA is produced, it may be necessary to adjust burners to ensure complete combustion such that no burner fuel residue remains in the mixture.

Control the mixing time and temperature so that substantially all moisture is removed from the mixture before discharging from the plant. Determine the moisture content, if requested, by oven-drying in accordance with Tex-212-F, Part II, and verify that the mixture contains no more than 0.2% of moisture by weight. Obtain the sample immediately after discharging the mixture into the truck, and perform the test promptly.

4.6. **Hauling Operations**. Clean all truck beds before use to ensure that mixture is not contaminated. Use a release agent shown on the Department's MPL to coat the inside bed of the truck when necessary.

Use equipment for hauling as defined in Section 3077.4.7.3.3., "Hauling Equipment." Use other hauling equipment only when allowed.

4.7. **Placement Operations**. Collect haul tickets from each load of mixture delivered to the project and provide the Department's copy to the Engineer approximately every hour or as directed. Use a hand-held thermal camera or infrared thermometer, when a thermal imaging system is not used, to measure and record the internal temperature of the mixture as discharged from the truck or Material Transfer Device (MTD) before or as the mix enters the paver and an approximate station number or GPS coordinates on each ticket. Calculate the daily yield and cumulative yield for the specified lift and provide to the Engineer at the end of paving operations for each day unless otherwise directed. The Engineer may suspend production if the Contractor fails to produce and provide haul tickets and yield calculations by the end of paving operations for each day.

Prepare the surface by removing raised pavement markers and objectionable material such as moisture, dirt, sand, leaves, and other loose impediments from the surface before placing mixture. Remove vegetation from pavement edges. Place the mixture to meet the typical section requirements and produce a smooth, finished surface with a uniform appearance and texture. Offset longitudinal joints of successive courses of hot-mix by at least 6 in. Place mixture so that longitudinal joints on the surface course coincide with lane lines and are not placed in the wheel path, or as directed. Ensure that all finished surfaces will drain properly. Place the

mixture at the rate or thickness shown on the plans. The Engineer will use the guidelines in Table 14 to determine the compacted lift thickness of each layer when multiple lifts are required. The thickness determined is based on the rate of 110 lb./sq. yd. for each inch of pavement unless otherwise shown on the plans.

Table 14
Compacted Lift Thickness and Required Core Height

Mixture Type	Compacted Lift Thickness Guidelines		Minimum Untrimmed Core Height (in.) Eligible for Testing
	Minimum (in.)	Maximum (in.)	
SP-B	2.50	4.0	2.00
SP-C	2.00	3.0	1.25
SP-D	1.25	2.0	1.25

4.7.1. **Weather Conditions**.

4.7.1.1. **When Using a Thermal Imaging System**. Place mixture when the roadway is dry and the roadway surface temperature is at or above the temperatures listed in Table 15A.The Engineer may restrict the Contractor from paving surface mixtures if the ambient temperature is likely to drop below 32°F within 12 hr. of paving. Place mixtures only when weather conditions and moisture conditions of the roadway surface are suitable as determined by the Engineer. Provide output data from the thermal imaging system to demonstrate to the Engineer that no recurring severe thermal segregation exists in accordance with Section 3077.4.7.3.1.2., "Thermal Imaging System."

Table 15A
Minimum Pavement Surface Temperatures

High-Temperature Binder Grade[1]	Minimum Pavement Surface Temperatures (°F)	
	Subsurface Layers or Night Paving Operations	Surface Layers Placed in Daylight Operations
PG 64	35	40
PG 70	45[2]	50[2]
PG 76	45[2]	50[2]

1. The high-temperature binder grade refers to the high-temperature grade of the virgin asphalt binder used to produce the mixture.
2. Contractors may pave at temperatures 10°F lower than these values when a chemical WMA additive is used as a compaction aid in the mixture or when using WMA.

4.7.1.2. **When Not Using a Thermal Imaging System**. When using a thermal camera instead of the thermal imaging system, place mixture when the roadway surface temperature is at or above the temperatures listed in Table 15B unless otherwise approved or as shown on the plans. Measure the roadway surface temperature with a hand-held thermal camera or infrared thermometer. The Engineer may allow mixture placement to begin before the roadway surface reaches the required temperature if conditions are such that the roadway surface will reach the required temperature within 2 hr. of beginning placement operations. Place mixtures only when weather conditions and moisture conditions of the roadway surface are suitable as determined by the Engineer. The Engineer may restrict the Contractor from paving if the ambient temperature is likely to drop below 32°F within 12 hr. of paving.

Table 15B
Minimum Pavement Surface Temperatures

High-Temperature Binder Grade[1]	Minimum Pavement Surface Temperatures (°F)	
	Subsurface Layers or Night Paving Operations	Surface Layers Placed in Daylight Operations
PG 64	45	50
PG 70	55[2]	60[2]
PG 76	60[2]	60[2]

1. The high-temperature binder grade refers to the high-temperature grade of the virgin asphalt binder used to produce the mixture.
2. Contractors may pave at temperatures 10°F lower than these values when a chemical WMA additive is used as a compaction aid in the mixture, when using WMA, or utilizing a paving process with equipment that eliminates thermal segregation. In such cases, for each sublot and in the presence of the Engineer, use a hand-held thermal camera operated in accordance with Tex-244-F to demonstrate to the satisfaction of the Engineer that the uncompacted mat has no more than 10°F of thermal segregation.

4.7.2. **Tack Coat**.

4.7.2.1. **Application.** Clean the surface before placing the tack coat. The Engineer will set the rate between 0.04 and 0.10 gal. of residual asphalt per square yard of surface area. Apply a uniform tack coat at the specified rate unless otherwise directed. Apply the tack coat in a uniform manner to avoid streaks and other irregular patterns. Apply the tack coat to all surfaces that will come in contact with the subsequent HMA placement, unless otherwise directed. Allow adequate time for emulsion to break completely before placing any material. Prevent splattering of tack coat when placed adjacent to curb, gutter, and structures. Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use.

4.7.2.2. **Sampling.** The Engineer will obtain at least one sample of the tack coat binder per project in accordance with Tex-500-C, Part III, and test it to verify compliance with Item 300, "Asphalts, Oils, and Emulsions." The Engineer will notify the Contractor when the sampling will occur and will witness the collection of the sample from the asphalt distributor immediately before use.

For emulsions, the Engineer may test as often as necessary to ensure the residual of the emulsion is greater than or equal to the specification requirement in Item 300, "Asphalts, Oils, and Emulsions."

4.7.3. **Lay-Down Operations**. Use the placement temperatures in Table 16 to establish the minimum placement temperature of mixture delivered to the paver.

Table 16
Minimum Mixture Placement Temperature

High-Temperature Binder Grade[1]	Minimum Placement Temperature (Before Entering Paver)[2,3]
PG 64	260˚F
PG 70	270˚F
PG 76	280˚F

1. The high-temperature binder grade refers to the high-temperature grade of the virgin asphalt binder used to produce the mixture.
2. Minimum placement temperatures may be reduced 10°F if using a chemical WMA additive as a compaction aid.
3. When using WMA, the minimum placement temperature is 215°F.

4.7.3.1. **Thermal Profile**. Use a hand-held thermal camera or a thermal imaging system to obtain a continuous thermal profile in accordance with Tex-244-F. Thermal profiles are not applicable in areas described in Section 3077.4.9.3.1.4., "Miscellaneous Areas."

4.7.3.1.1. **Thermal Segregation**.

4.7.3.1.1.1. **Moderate**. Any areas that have a temperature differential greater than 25°F, but not exceeding 50°F, are deemed as moderate thermal segregation.

4.7.3.1.1.2. **Severe**. Any areas that have a temperature differential greater than 50°F are deemed as severe thermal segregation.

4.7.3.1.2. **Thermal Imaging System**. Review the output results when a thermal imaging system is used, and provide the automated report described in Tex-244-F to the Engineer daily unless otherwise directed. Modify the paving process as necessary to eliminate any recurring (moderate or severe) thermal segregation identified by the thermal imaging system. The Engineer may suspend paving operations if the Contractor cannot successfully modify the paving process to eliminate recurring severe thermal segregation. Density profiles are not required and not applicable when using a thermal imaging system. Provide the Engineer with electronic copies of all daily data files that can be used with the thermal imaging system software to generate temperature profile plots daily or upon completion of the project or as requested by the Engineer.

4.7.3.1.3. **Thermal Camera**. When using a thermal camera instead of the thermal imaging system, take immediate corrective action to eliminate recurring moderate thermal segregation when a hand-held thermal camera is used. Evaluate areas with moderate thermal segregation by performing density profiles in accordance with Section 3077.4.9.3.3.2., "Segregation (Density Profile)." Provide the Engineer with the thermal profile of every sublot within one working day of the completion of each lot. When requested by the Engineer, provide the thermal images generated using the thermal camera. Report the results of each thermal profile in accordance with Section 3077.4.2., "Reporting and Responsibilities." The Engineer will use a hand-held thermal camera to obtain a thermal profile at least once per project. No production or placement payment adjustments greater than 1.000 will be paid for any sublot that contains severe thermal segregation. Suspend operations and take immediate corrective action to eliminate severe thermal segregation unless otherwise directed. Resume operations when the Engineer determines that subsequent production will meet the requirements of this Section. Evaluate areas with severe thermal segregation by performing density profiles in accordance with Section 3077.4.9.3.3.2., "Segregation (Density Profile)." Remove and replace the material in any areas that have both severe thermal segregation and a failing result for Segregation (Density Profile) unless otherwise directed. The sublot in question may receive a production and placement payment adjustment greater than 1.000, if applicable, when the defective material is successfully removed and replaced.

4.7.3.2. **Windrow Operations**. Operate windrow pickup equipment so that when hot-mix is placed in windrows, substantially all the mixture deposited on the roadbed is picked up and loaded into the paver.

4.7.3.3. **Hauling Equipment**. Use belly dumps, live bottom, or end dump trucks to haul and transfer mixture; however, with exception of paving miscellaneous areas, end dump trucks are only allowed when used in conjunction with an MTD with remixing capability or when a thermal imaging system is used unless otherwise allowed.

4.7.3.4. **Screed Heaters**. Turn off screed heaters to prevent overheating of the mat if the paver stops for more than 5 min. The Engineer may evaluate the suspect area in accordance with Section 3077.4.9.3.3.4., "Recovered Asphalt Dynamic Shear Rheometer (DSR)," if the screed heater remains on for more than 5 min. while the paver is stopped.

4.8. **Compaction**. Compact the pavement uniformly to contain between 3.7% and 7.5% in-place air voids. Take immediate corrective action to bring the operation within 3.7% and 7.5% when the in-place air voids exceed the range of these tolerances. The Engineer will allow paving to resume when the proposed corrective action is likely to yield between 3.7% and 7.5% in-place air voids.

Obtain cores in areas placed under Exempt Production, as directed, at locations determined by the Engineer. The Engineer may test these cores and suspend operations or require removal and replacement if the in-place air voids are less than 2.7% or more than 9.0%. Areas defined in Section 3077.4.9.3.1.4., "Miscellaneous Areas," are not subject to in-place air void determination.

Furnish the type, size, and number of rollers required for compaction as approved. Use additional rollers as required to remove any roller marks. Use only water or an approved release agent on rollers, tamps, and other compaction equipment unless otherwise directed.

Use the control strip method shown in Tex-207-F, Part IV, on the first day of production to establish the rolling pattern that will produce the desired in-place air voids unless otherwise directed.

Use tamps to thoroughly compact the edges of the pavement along curbs, headers, and similar structures and in locations that will not allow thorough compaction with rollers. The Engineer may require rolling with a trench roller on widened areas, in trenches, and in other limited areas.

Complete all compaction operations before the pavement temperature drops below 160°F unless otherwise allowed. The Engineer may allow compaction with a light finish roller operated in static mode for pavement temperatures below 160°F.

Allow the compacted pavement to cool to 160°F or lower before opening to traffic unless otherwise directed. Sprinkle the finished mat with water or limewater, when directed, to expedite opening the roadway to traffic.

4.9. **Acceptance Plan**. Payment adjustments for the material will be in accordance with Article 3077.6., "Payment."

Sample and test the hot-mix on a lot and sublot basis. Suspend production until test results or other information indicates to the satisfaction of the Engineer that the next material produced or placed will result in pay factors of at least 1.000 if the production pay factor given in Section 3077.6.1., "Production Payment Adjustment Factors," for two consecutive lots or the placement pay factor given in Section 3077.6.2., "Placement Payment Adjustment Factors," for two consecutive lots is below 1.000.

4.9.1. **Referee Testing**. The Materials and Tests Division is the referee laboratory. The Contractor may request referee testing if a "remove and replace" condition is determined based on the Engineer's test results, or if the differences between Contractor and Engineer test results exceed the maximum allowable difference shown in Table 12 and the differences cannot be resolved. The Contractor may also request referee testing if the Engineer's test results require suspension of production and the Contractor's test results are within specification limits. Make the request within 5 working days after receiving test results and cores from the Engineer. Referee tests will be performed only on the sublot in question and only for the particular tests in question. Allow 10 working days from the time the referee laboratory receives the samples for test results to be reported. The Department may require the Contractor to reimburse the Department for referee tests if more than three referee tests per project are required and the Engineer's test results are closer to the referee test results than the Contractor's test results.

The Materials and Tests Division will determine the laboratory-molded density based on the molded specific gravity and the maximum theoretical specific gravity of the referee sample. The in-place air voids will be determined based on the bulk specific gravity of the cores, as determined by the referee laboratory and the Engineer's average maximum theoretical specific gravity for the lot. With the exception of "remove and replace" conditions, referee test results are final and will establish payment adjustment factors for the sublot in question. The Contractor may decline referee testing and accept the Engineer's test results when the placement payment adjustment factor for any sublot results in a "remove and replace" condition. Placement sublots subject to be removed and replaced will be further evaluated in accordance with Section 3077.6.2.2., "Placement Sublots Subject to Removal and Replacement."

4.9.2. **Production Acceptance**.

4.9.2.1. **Production Lot**. A production lot consists of four equal sublots. The default quantity for Lot 1 is 1,000 tons; however, when requested by the Contractor, the Engineer may increase the quantity for Lot 1 to no more than 4,000 tons. The Engineer will select subsequent lot sizes based on the anticipated daily production such

that approximately three to four sublots are produced each day. The lot size will be between 1,000 tons and 4,000 tons. The Engineer may change the lot size before the Contractor begins any lot.

If the optimum asphalt binder content for JMF2 is more than 0.5% lower than the optimum asphalt binder content for JMF1, the Engineer may perform or require the Contractor to perform Tex-226-F on Lot 1 to confirm the indirect tensile strength does not exceed 200 psi. Take corrective action to bring the mixture within specification compliance if the indirect tensile strength exceeds 200 psi unless otherwise directed.

4.9.2.1.1. **Incomplete Production Lots**. If a lot is begun but cannot be completed, such as on the last day of production or in other circumstances deemed appropriate, the Engineer may close the lot. Adjust the payment for the incomplete lot in accordance with Section 3077.6.1., "Production Payment Adjustment Factors." Close all lots within five working days unless otherwise allowed.

4.9.2.2. **Production Sampling**.

4.9.2.2.1. **Mixture Sampling**. Obtain hot-mix samples from trucks at the plant in accordance with Tex-222-F. The sampler will split each sample into three equal portions in accordance with Tex-200-F and label these portions as "Contractor," "Engineer," and "Referee." The Engineer will perform or witness the sample splitting and take immediate possession of the samples labeled "Engineer" and "Referee." The Engineer will maintain the custody of the samples labeled "Engineer" and "Referee" until the Department's testing is completed.

4.9.2.2.1.1. **Random Sample**. At the beginning of the project, the Engineer will select random numbers for all production sublots. Determine sample locations in accordance with Tex-225-F. Take one sample for each sublot at the randomly selected location. The Engineer will perform or witness the sampling of production sublots.

4.9.2.2.1.2. **Blind Sample**. For one sublot per lot, the Engineer will obtain and test a "blind" sample instead of the random sample collected by the Contractor. Test either the "blind" or the random sample; however, referee testing (if applicable) will be based on a comparison of results from the "blind" sample. The location of the Engineer's "blind" sample will not be disclosed to the Contractor. The Engineer's "blind" sample may be randomly selected in accordance with Tex-225-F for any sublot or selected at the discretion of the Engineer. The Engineer will use the Contractor's split sample for sublots not sampled by the Engineer.

4.9.2.2.2. **Informational Shear Bond Strength Testing.** Select one random sublot from Lot 2 or higher for shear bond strength testing. Obtain full depth cores in accordance with Tex-249-F. Label the cores with the Control Section Job (CSJ), producer of the tack coat, mix type, shot rate, lot, and sublot number and provide to the Engineer. The Engineer will ship the cores to the Materials and Tests Division or district laboratory for shear bond strength testing. Results from these tests will not be used for specification compliance.

4.9.2.2.3. **Asphalt Binder Sampling**. Obtain a 1-qt. sample of the asphalt binder witnessed by the Engineer for each lot of mixture produced. The Contractor will notify the Engineer when the sampling will occur. Obtain the sample at approximately the same time the mixture random sample is obtained. Sample from a port located immediately upstream from the mixing drum or pug mill and upstream from the introduction of any additives in accordance with Tex-500-C, Part II. Label the can with the corresponding lot and sublot numbers, producer, producer facility location, grade, district, date sampled, and project information including highway and CSJ. The Engineer will retain these samples for one year. The Engineer may also obtain independent samples. If obtaining an independent asphalt binder sample and upon request of the Contractor, the Engineer will split a sample of the asphalt binder with the Contractor.

At least once per project, the Engineer will collect split samples of each binder grade and source used. The Engineer will submit one split sample to MTD to verify compliance with Item 300, "Asphalts, Oils, and Emulsions" and will retain the other split sample for one year.

4.9.2.3. **Production Testing**. The Contractor and Engineer must perform production tests in accordance with Table 17. The Contractor has the option to verify the Engineer's test results on split samples provided by the Engineer. Determine compliance with operational tolerances listed in Table 12 for all sublots.

Take immediate corrective action if the Engineer's laboratory-molded density on any sublot is less than 95.0% or greater than 97.0% to bring the mixture within these tolerances. The Engineer may suspend operations if the Contractor's corrective actions do not produce acceptable results. The Engineer will allow production to resume when the proposed corrective action is likely to yield acceptable results.

The Engineer may allow alternate methods for determining the asphalt binder content and aggregate gradation if the aggregate mineralogy is such that Tex-236-F, Part I does not yield reliable results. Provide evidence that results from Tex-236-F, Part I are not reliable before requesting permission to use an alternate method unless otherwise directed. Use the applicable test procedure as directed if an alternate test method is allowed.

Table 17
Production and Placement Testing Frequency

Description	Test Method	Minimum Contractor Testing Frequency	Minimum Engineer Testing Frequency
Individual % retained for #8 sieve and larger	Tex-200-F or Tex-236-F	1 per sublot	1 per 12 sublots[1]
Individual % retained for sieves smaller than #8 and larger than #200			
% passing the #200 sieve			
Laboratory-molded density	Tex-207-F	N/A	1 per sublot[1]
Laboratory-molded bulk specific gravity			
In-place air voids			
VMA	Tex-204-F		
Segregation (density profile)	Tex-207-F, Part V	1 per sublot[2]	1 per project
Longitudinal joint density	Tex-207-F, Part VII		
Moisture content	Tex-212-F, Part II	When directed	
Theoretical maximum specific (Rice) gravity	Tex-227-F	N/A	1 per sublot[1]
Asphalt binder content	Tex-236-F	1 per sublot	1 per lot[1]
Hamburg Wheel test	Tex-242-F	N/A	1 per project
Recycled Asphalt Shingles (RAS)[3]	Tex-217-F, Part III	N/A	
Thermal profile	Tex-244-F	1 per sublot[2]	
Asphalt binder sampling and testing	Tex-500-C, Part II	1 per lot (sample only)[4]	
Tack coat sampling and testing	Tex-500-C, Part III	N/A	
Boil test[5]	Tex-530-C	1 per lot	
Shear Bond Strength Test[6]	Tex-249-F	1 per project (sample only)	

1. For production defined in Section 3077.4.9.4., "Exempt Production," the Engineer will test one per day if 100 tons or more are produced. For Exempt Production, no testing is required when less than 100 tons are produced.
2. To be performed in the presence of the Engineer, unless otherwise approved. Not required when a thermal imaging system is used.
3. Testing performed by the Materials and Tests Division or designated laboratory.
4. Obtain samples witnessed by the Engineer. The Engineer will retain these samples for one year.
5. The Engineer may reduce or waive the sampling and testing requirements based on a satisfactory test history.
6. Testing performed by the Materials and Tests Division or District for informational purposes only.

4.9.2.4. **Operational Tolerances**. Control the production process within the operational tolerances listed in Table 12. When production is suspended, the Engineer will allow production to resume when test results or other information indicates the next mixture produced will be within the operational tolerances.

4.9.2.4.1. **Gradation**. Suspend operation and take corrective action if any aggregate is retained on the maximum sieve size shown in Table 8. A sublot is defined as out of tolerance if either the Engineer's or the Contractor's test results are out of operational tolerance. Suspend production when test results for gradation exceed the operational tolerances in Table 12 for three consecutive sublots on the same sieve or four consecutive sublots on any sieve unless otherwise directed. The consecutive sublots may be from more than one lot.

4.9.2.4.2. **Asphalt Binder Content**. A sublot is defined as out of operational tolerance if either the Engineer's or the Contractor's test results exceed the values listed in Table 12. No production or placement payment

adjustments greater than 1.000 will be paid for any sublot that is out of operational tolerance for asphalt binder content. Suspend production and shipment of the mixture if the Engineer's or the Contractor's asphalt binder content deviates from the current JMF by more than 0.5% for any sublot.

4.9.2.4.3. **Voids in Mineral Aggregates (VMA)**. The Engineer will determine the VMA for every sublot. For sublots when the Engineer does not determine asphalt binder content, the Engineer will use the asphalt binder content results from QC testing performed by the Contractor to determine VMA.

Take immediate corrective action if the VMA value for any sublot is less than the minimum VMA requirement for production listed in Table 8. Suspend production and shipment of the mixture if the Engineer's VMA results on two consecutive sublots are below the minimum VMA requirement for production listed in Table 8. No production or placement payment adjustments greater than 1.000 will be paid for any sublot that does not meet the minimum VMA requirement for production listed in Table 8 based on the Engineer's VMA determination.

Suspend production and shipment of the mixture if the Engineer's VMA result is more than 0.5% below the minimum VMA requirement for production listed in Table 8. In addition to suspending production, the Engineer may require removal and replacement or may allow the sublot to be left in place without payment.

4.9.2.4.4. **Hamburg Wheel Test**. The Engineer may perform a Hamburg Wheel test at any time during production, including when the boil test indicates a change in quality from the materials submitted for JMF1. In addition to testing production samples, the Engineer may obtain cores and perform Hamburg Wheel tests on any areas of the roadway where rutting is observed. Suspend production until further Hamburg Wheel tests meet the specified values when the production or core samples fail the Hamburg Wheel test criteria in Table 11. Core samples, if taken, will be obtained from the center of the finished mat or other areas excluding the vehicle wheel paths. The Engineer may require up to the entire sublot of any mixture failing the Hamburg Wheel test to be removed and replaced at the Contractor's expense.

If the Department's or Department approved laboratory's Hamburg Wheel test results in a "remove and replace" condition, the Contractor may request that the Department confirm the results by re-testing the failing material. The Materials and Tests Division will perform the Hamburg Wheel tests and determine the final disposition of the material in question based on the Department's test results.

4.9.2.5. **Individual Loads of Hot-Mix**. The Engineer can reject individual truckloads of hot-mix. When a load of hot-mix is rejected for reasons other than temperature, contamination, or excessive uncoated particles, the Contractor may request that the rejected load be tested. Make this request within 4 hr. of rejection. The Engineer will sample and test the mixture. If test results are within the operational tolerances shown in Table 12, payment will be made for the load. If test results are not within operational tolerances, no payment will be made for the load.

4.9.3. **Placement Acceptance**.

4.9.3.1. **Placement Lot**. A placement lot consists of four placement sublots. A placement sublot consists of the area placed during a production sublot.

4.9.3.1.1. **Lot 1 Placement**. Placement payment adjustments greater than 1.000 for Lot 1 will be in accordance with Section 3077.6.2., "Placement Payment Adjustment Factors;" however, no placement adjustment less than 1.000 will be assessed for any sublot placed in Lot 1 when the in-place air voids are greater than or equal to 2.7% and less than or equal to 9.0%. Remove and replace any sublot with in-place air voids less than 2.7% or greater than 9.0%.

4.9.3.1.2. **Incomplete Placement Lots**. An incomplete placement lot consists of the area placed as described in Section 3077.4.9.2.1.1., "Incomplete Production Lot," excluding areas defined in Section 3077.4.9.3.1.4., "Miscellaneous Areas." Placement sampling is required if the random sample plan for production resulted in a sample being obtained from an incomplete production sublot.

4.9.3.1.3. **Shoulders, Ramps, Etc**. Shoulders, ramps, intersections, acceleration lanes, deceleration lanes, and turn lanes are subject to in-place air void determination and payment adjustments unless designated on the plans as not eligible for in-place air void determination. Intersections may be considered miscellaneous areas when determined by the Engineer.

4.9.3.1.4. **Miscellaneous Areas**. Miscellaneous areas include areas that typically involve significant handwork or discontinuous paving operations, such as temporary detours, driveways, mailbox turnouts, crossovers, gores, spot level-up areas, and other similar areas. Temporary detours are subject to in-place air void determination when shown on the plans. Miscellaneous areas also include level-ups and thin overlays when the layer thickness specified on the plans is less than the minimum untrimmed core height eligible for testing shown in Table 14. The specified layer thickness is based on the rate of 110 lb./sq. yd. for each inch of pavement unless another rate is shown on the plans. When "level up" is listed as part of the item bid description code, a payment adjustment factor of 1.000 will be assigned for all placement sublots as described in Article3077.6, "Payment." Miscellaneous areas are not eligible for random placement sampling locations. Compact miscellaneous areas in accordance with Section 3077.4.8., "Compaction." Miscellaneous areas are not subject to in-place air void determination, thermal profiles testing, segregation (density profiles), or longitudinal joint density evaluations.

4.9.3.2. **Placement Sampling**. The Engineer will select random numbers for all placement sublots at the beginning of the project. The Engineer will provide the Contractor with the placement random numbers immediately after the sublot is completed. Mark the roadway location at the completion of each sublot and record the station number. Determine one random sample location for each placement sublot in accordance with Tex-225-F. Adjust the random sample location by no more than necessary to achieve a 2-ft. clearance if the location is within 2 ft. of a joint or pavement edge.

Shoulders, ramps, intersections, acceleration lanes, deceleration lanes, and turn lanes are always eligible for selection as a random sample location; however, if a random sample location falls on one of these areas and the area is designated on the plans as not subject to in-place air void determination, cores will not be taken for the sublot and a 1.000 pay factor will be assigned to that sublot.

Provide the equipment and means to obtain and trim roadway cores on-site. On-site is defined as in close proximity to where the cores are taken. Obtain the cores within one working day of the time the placement sublot is completed unless otherwise approved. Obtain two 6-in. diameter cores side-by-side from within 1 ft. of the random location provided for the placement sublot. For SP-C and SP-D mixtures, 4-in. diameter cores are allowed. Mark the cores for identification, measure and record the untrimmed core height, and provide the information to the Engineer. The Engineer will witness the coring operation and measurement of the core thickness. Visually inspect each core and verify that the current paving layer is bonded to the underlying layer. Take corrective action if an adequate bond does not exist between the current and underlying layer to ensure that an adequate bond will be achieved during subsequent placement operations.

Trim the cores immediately after obtaining the cores from the roadway in accordance with Tex-251-F if the core heights meet the minimum untrimmed value listed in Table 14. Trim the cores on-site in the presence of the Engineer. Use a permanent marker or paint pen to record the lot and sublot numbers on each core as well as the designation as Core A or B. The Engineer may require additional information to be marked on the core and may choose to sign or initial the core. The Engineer will take custody of the cores immediately after witnessing the trimming of the coresand will retain custody of the cores until the Department's testing is completed. Before turning the trimmed cores over to the Engineer, the Contractor may wrap the trimmed cores or secure them in a manner that will reduce the risk of possible damage occurring during transport by the Engineer. After testing, the Engineer will return the cores to the Contractor.

The Engineer may have the cores transported back to the Department's laboratory at the HMA plant via the Contractor's haul truck or other designated vehicle. In such cases where the cores will be out of the Engineer's possession during transport, the Engineer will use Department-provided security bags and the Roadway Core Custody protocol located at http://www.txdot.gov/business/specifications.htm to provide a secure means and process that protects the integrity of the cores during transport.

Decide whether to include the pair of cores in the air void determination for that sublot if the core height before trimming is less than the minimum untrimmed value shown in Table 14. Trim the cores as described above before delivering to the Engineer if electing to have the cores included in the air void determination. Deliver untrimmed cores to the Engineer and inform the Engineer of the decision to not have the cores included in air void determination if electing to not have the cores included in air void determination. The placement pay factor for the sublot will be 1.000 if cores will not be included in air void determination.

Instead of the Contractor trimming the cores on-site immediately after coring, the Engineer and the Contractor may mutually agree to have the trimming operations performed at an alternate location such as a field laboratory or other similar location. In such cases, the Engineer will take possession of the cores immediately after they are obtained from the roadway and will retain custody of the cores until testing is completed. Either the Department or Contractor representative may perform trimming of the cores. The Engineer will witness all trimming operations in cases where the Contractor representative performs the trimming operation.

Dry the core holes and tack the sides and bottom immediately after obtaining the cores. Fill the hole with the same type of mixture and properly compact the mixture. Repair core holes with other methods when approved.

4.9.3.3. **Placement Testing**. Perform placement tests in accordance with Table 17. After the Engineer returns the cores, the Contractor may test the cores to verify the Engineer's test results for in-place air voids. The allowable differences between the Contractor's and Engineer's test results are listed in Table 12.

4.9.3.3.1. **In-Place Air Voids**. The Engineer will measure in-place air voids in accordance with Tex-207-F and Tex-227-F. Before drying to a constant weight, cores may be pre-dried using a CoreDry or similar vacuum device to remove excess moisture. The Engineer will average the values obtained for all sublots in the production lot to determine the theoretical maximum specific gravity. The Engineer will use the average air void content for in-place air voids.

The Engineer will use the vacuum method to seal the core if required by Tex-207-F. The Engineer will use the test results from the unsealed core to determine the placement payment adjustment factor if the sealed core yields a higher specific gravity than the unsealed core. After determining the in-place air void content, the Engineer will return the cores and provide test results to the Contractor.

4.9.3.3.2. **Segregation (Density Profile**). Test for segregation using density profiles in accordance with Tex-207-F, Part V when using a thermal camera instead of the thermal imaging system. Density profiles are not required and are not applicable when using a thermal imaging system. Density profiles are not applicable in areas described in Section 3077.4.9.3.1.4., "Miscellaneous Areas."

Perform a minimum of one density profile per sublot. Perform additional density profiles when any of the following conditions occur, unless otherwise approved:

- the paver stops due to lack of material being delivered to the paving operations and the temperature of the uncompacted mat before the initial break down rolling is less than the temperatures shown in Table 18;
- areas that are identified by either the Contractor or the Engineer with thermal segregation;
- any visibly segregated areas that exist.

Table 18
Minimum Uncompacted Mat Temperature Requiring a Segregation Profile

High-Temperature Binder Grade[1]	Minimum Temperature of the Uncompacted Mat Allowed Before Initial Break Down Rolling[2,3,4]
PG 64	<250˚F
PG 70	<260˚F
PG 76	<270˚F

1. The high-temperature binder grade refers to the high-temperature grade of the virgin asphalt binder used to produce the mixture.
2. Segregation profiles are required in areas with moderate and severe thermal segregation as described in Section 3077.4.7.3.1.3.
3. Minimum uncompacted mat temperature requiring a segregation profile may be reduced 10°F if using a chemical WMA additive as a compaction aid.
4. When using WMA, the minimum uncompacted mat temperature requiring a segregation profile is 215°F.

Provide the Engineer with the density profile of every sublot in the lot within one working day of the completion of each lot. Report the results of each density profile in accordance with Section 3077.4.2., "Reporting and Responsibilities."

The density profile is considered failing if it exceeds the tolerances in Table 19. No production or placement payment adjustments greater than 1.000 will be paid for any sublot that contains a failing density profile. When a hand-held thermal camera is used instead of a thermal imaging system, the Engineer will measure the density profile at least once per project. The Engineer's density profile results will be used when available. The Engineer may require the Contractor to remove and replace the area in question if the area fails the density profile and has surface irregularities as defined in Section 3077.4.9.3.3.5., "Irregularities." The sublot in question may receive a production and placement payment adjustment greater than 1.000, if applicable, when the defective material is successfully removed and replaced.

Investigate density profile failures and take corrective actions during production and placement to eliminate the segregation. Suspend production if two consecutive density profiles fail unless otherwise approved. Resume production after the Engineer approves changes to production or placement methods.

Table 19
Segregation (Density Profile) Acceptance Criteria

Mixture Type	Maximum Allowable Density Range (Highest to Lowest)	Maximum Allowable Density Range (Average to Lowest)
SP-B	8.0 pcf	5.0 pcf
SP-C & SP-D	6.0 pcf	3.0 pcf

4.9.3.3.3. **Longitudinal Joint Density**.

4.9.3.3.3.1. **Informational Tests**. Perform joint density evaluations while establishing the rolling pattern and verify that the joint density is no more than 3.0 pcf below the density taken at or near the center of the mat. Adjust the rolling pattern, if needed, to achieve the desired joint density. Perform additional joint density evaluations at least once per sublot unless otherwise directed.

4.9.3.3.3.2. **Record Tests**. Perform a joint density evaluation for each sublot at each pavement edge that is or will become a longitudinal joint. Joint density evaluations are not applicable in areas described in Section 3077.4.9.3.1.4., "Miscellaneous Areas." Determine the joint density in accordance with Tex-207-F, Part VII. Record the joint density information and submit results on Department forms to the Engineer. The evaluation is considered failing if the joint density is more than 3.0 pcf below the density taken at the core random sample location and the correlated joint density is less than 90.0%. The Engineer will make independent joint density verification at least once per project and may make independent joint density

verifications at the random sample locations. The Engineer's joint density test results will be used when available.

Provide the Engineer with the joint density of every sublot in the lot within one working day of the completion of each lot. Report the results of each joint density in accordance with Section 3077.4.2., "Reporting and Responsibilities."

Investigate joint density failures and take corrective actions during production and placement to improve the joint density. Suspend production if the evaluations on two consecutive sublots fail unless otherwise approved. Resume production after the Engineer approves changes to production or placement methods.

4.9.3.3.4. **Recovered Asphalt Dynamic Shear Rheometer (DSR)**. The Engineer may take production samples or cores from suspect areas of the project to determine recovered asphalt properties. Asphalt binders with an aging ratio greater than 3.5 do not meet the requirements for recovered asphalt properties and may be deemed defective when tested and evaluated by the Materials and Tests Division. The aging ratio is the DSR value of the extracted binder divided by the DSR value of the original unaged binder. Obtain DSR values in accordance with AASHTO T 315 at the specified high temperature performance grade of the asphalt. The Engineer may require removal and replacement of the defective material at the Contractor's expense. The asphalt binder will be recovered for testing from production samples or cores in accordance with Tex-211-F.

4.9.3.3.5. **Irregularities**. Identify and correct irregularities including segregation, rutting, raveling, flushing, fat spots, mat slippage, irregular color, irregular texture, roller marks, tears, gouges, streaks, uncoated aggregate particles, or broken aggregate particles. The Engineer may also identify irregularities, and in such cases, the Engineer will promptly notify the Contractor. If the Engineer determines that the irregularity will adversely affect pavement performance, the Engineer may require the Contractor to remove and replace (at the Contractor's expense) areas of the pavement that contain irregularities. The Engineer may also require the Contractor to remove and replace (at the Contractor's expense) areas where the mixture does not bond to the existing pavement.

If irregularities are detected, the Engineer may require the Contractor to immediately suspend operations or may allow the Contractor to continue operations for no more than one day while the Contractor is taking appropriate corrective action.

4.9.4. **Exempt Production**. The Engineer may deem the mixture as exempt production for the following conditions:

- anticipated daily production is less than 500 tons;
- total production for the project is less than 5,000 tons;
- when mutually agreed between the Engineer and the Contractor; or
- when shown on the plans.

For exempt production, the Contractor is relieved of all production and placement QC/QA sampling and testing requirements, except for coring operations when required by the Engineer. The production and placement pay factors are 1.000 if the specification requirements listed below are met, all other specification requirements are met, and the Engineer performs acceptance tests for production and placement listed in Table 17 when 100 tons or more per day are produced:

- produce, haul, place, and compact the mixture in compliance with the specification and as directed;
- control mixture production to yield a laboratory-molded density that is within ±1.0% of the target laboratory-molded density as tested by the Engineer;
- compact the mixture in accordance with Section 3077.4.8., "Compaction"; and
- when a thermal imaging system is not used, the Engineer may perform segregation (density profiles) and thermal profiles in accordance with the specification.

4.9.5. **Ride Quality**. Measure ride quality in accordance with Item 585, "Ride Quality for Pavement Surfaces," unless otherwise shown on the plans.

5. MEASUREMENT

5.1. **Superpave Mixtures.** Hot mix will be measured by the ton of composite hot-mix, which includes asphalt, aggregate, and additives. Measure the weight on scales in accordance with Item 520, "Weighing and Measuring Equipment."

5.2. **Tack Coat.** Tack coat will be measured at the applied temperature by strapping the tank before and after road application and determining the net volume in gallons from the calibrated distributor. The Engineer will witness all strapping operations for volume determination. All tack, including emulsions, will be measure by the gallon applied.

The Engineer may allow the use of a metering device to determine the asphalt volume used and application rate if the device is accurate within 1.5% of the strapped volume.

6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under Article 3077.5.1, "Measurement," will be paid for at the unit bid price for "Superpave Mixtures" of the mixture type, SAC, and binder specified. These prices are full compensation for surface preparation, materials, placement, equipment, labor, tools, and incidentals.

The work performed and materials furnished in accordance with this Item and measured as provided under Article 3077.5.2, "Measurement," will be paid for at the unit bid price for "Tack Coat" of the tack coat provided. These prices are full compensation for materials, placement, equipment, labor, tools, and incidentals. Payment adjustments will be applied as determined in this Item; however, a payment adjustment factor of 1.000 will be assigned for all placement sublots for "level ups" only when "level up" is listed as part of the item bid description code. A payment adjustment factor of 1.000 will be assigned to all production and placement sublots when "exempt" is listed as part of the item bid description code, and all testing requirements are met.

Payment for each sublot, including applicable payment adjustments greater than 1.000, will only be paid for sublots when the Contractor supplies the Engineer with the required documentation for production and placement QC/QA, thermal profiles, segregation density profiles, and longitudinal joint densities in accordance with Section 3077.4.2., "Reporting and Responsibilities." When a thermal imaging system is used, documentation is not required for thermal profiles or segregation density profiles on individual sublots; however, the thermal imaging system automated reports described in Tex-244-F are required.

Trial batches will not be paid for unless they are included in pavement work approved by the Department.

Payment adjustment for ride quality will be determined in accordance with Item 585, "Ride Quality for Pavement Surfaces."

6.1. **Production Payment Adjustment Factors**. The production payment adjustment factor is based on the laboratory-molded density using the Engineer's test results. The bulk specific gravities of the samples from each sublot will be divided by the Engineer's maximum theoretical specific gravity for the sublot. The individual sample densities for the sublot will be averaged to determine the production payment adjustment factor in accordance with Table 20 for each sublot using the deviation from the target laboratory-molded density defined in Table 10. The production payment adjustment factor for completed lots will be the average of the payment adjustment factors for the four sublots sampled within that lot.

Table 20
Production Payment Adjustment Factors for Laboratory-Molded Density[1]

Absolute Deviation from Target Laboratory-Molded Density	Production Payment Adjustment Factor (Target Laboratory-Molded Density)
0.0	1.075
0.1	1.075
0.2	1.075
0.3	1.066
0.4	1.057
0.5	1.047
0.6	1.038
0.7	1.029
0.8	1.019
0.9	1.010
1.0	1.000
1.1	0.900
1.2	0.800
1.3	0.700
> 1.3	Remove and replace

1. If the Engineer's laboratory-molded density on any sublot is less than 95.0% or greater than 97.0%, take immediate corrective action to bring the mixture within these tolerances. The Engineer may suspend operations if the Contractor's corrective actions do not produce acceptable results. The Engineer will allow production to resume when the proposed corrective action is likely to yield acceptable results.

6.1.1. **Payment for Incomplete Production Lots**. Production payment adjustments for incomplete lots, described under Section 3077.4.9.2.1.1., "Incomplete Production Lots," will be calculated using the average production pay factors from all sublots sampled.

A production payment factor of 1.000 will be assigned to any lot when the random sampling plan did not result in collection of any samples within the first sublot.

6.1.2. **Production Sublots Subject to Removal and Replacement**. If after referee testing, the laboratory-molded density for any sublot results in a "remove and replace" condition as listed in Table 20, the Engineer may require removal and replacement or may allow the sublot to be left in place without payment. The Engineer may also accept the sublot in accordance with Section 3077.5.3.1., "Acceptance of Defective or Unauthorized Work." Replacement material meeting the requirements of this Item will be paid for in accordance with this Section.

6.2. **Placement Payment Adjustment Factors**. The placement payment adjustment factor is based on in-place air voids using the Engineer's test results. The bulk specific gravities of the cores from each sublot will be divided by the Engineer's average maximum theoretical specific gravity for the lot. The individual core densities for the sublot will be averaged to determine the placement payment adjustment factor in accordance with Table 21 for each sublot that requires in-place air void measurement. A placement payment adjustment factor of 1.000 will be assigned to the entire sublot when the random sample location falls in an area designated on the plans as not subject to in-place air void determination. A placement payment adjustment factor of 1.000 will be assigned to quantities placed in areas described in Section 3077.4.9.3.1.4., "Miscellaneous Areas." The placement payment adjustment factor for completed lots will be the average of the placement payment adjustment factors for up to four sublots within that lot.

Table 21
Placement Payment Adjustment Factors for In-Place Air Voids

In-Place Air Voids	Placement Payment Adjustment Factor	In-Place Air Voids	Placement Payment Adjustment Factor
< 2.7	Remove and Replace	5.9	1.048
2.7	0.710	6.0	1.045
2.8	0.740	6.1	1.042
2.9	0.770	6.2	1.039
3.0	0.800	6.3	1.036
3.1	0.830	6.4	1.033
3.2	0.860	6.5	1.030
3.3	0.890	6.6	1.027
3.4	0.920	6.7	1.024
3.5	0.950	6.8	1.021
3.6	0.980	6.9	1.018
3.7	1.000	7.0	1.015
3.8	1.015	7.1	1.012
3.9	1.030	7.2	1.009
4.0	1.045	7.3	1.006
4.1	1.060	7.4	1.003
4.2	1.075	7.5	1.000
4.3	1.075	7.6	0.980
4.4	1.075	7.7	0.960
4.5	1.075	7.8	0.940
4.6	1.075	7.9	0.920
4.7	1.075	8.0	0.900
4.8	1.075	8.1	0.880
4.9	1.075	8.2	0.860
5.0	1.075	8.3	0.840
5.1	1.072	8.4	0.820
5.2	1.069	8.5	0.800
5.3	1.066	8.6	0.780
5.4	1.063	8.7	0.760
5.5	1.060	8.8	0.740
5.6	1.057	8.9	0.720
5.7	1.054	9.0	0.700
5.8	1.051	> 9.0	Remove and Replace

6.2.1. **Payment for Incomplete Placement Lots**. Payment adjustments for incomplete placement lots described under Section 3077.4.9.3.1.2., "Incomplete Placement Lots," will be calculated using the average of the placement pay factors from all sublots sampled and sublots where the random location falls in an area designated on the plans as not eligible for in-place air void determination.

If the random sampling plan results in production samples, but not in placement samples, the random core location and placement adjustment factor for the sublot will be determined by applying the placement random number to the length of the sublot placed.

If the random sampling plan results in placement samples, but not in production samples, no placement adjustment factor will apply for that sublot placed.

A placement payment adjustment factor of 1.000 will be assigned to any lot when the random sampling plan did not result in collection of any production samples.

6.2.2. **Placement Sublots Subject to Removal and Replacement**. If after referee testing, the placement payment adjustment factor for any sublot results in a "remove and replace" condition as listed in Table 21, the Engineer will choose the location of two cores to be taken within 3 ft. of the original failing core location. The Contractor will obtain the cores in the presence of the Engineer. The Engineer will take immediate possession of the untrimmed cores and submit the untrimmed cores to the Materials and Tests Division,

where they will be trimmed, if necessary, and tested for bulk specific gravity within 10 working days of receipt.

The bulk specific gravity of the cores from each sublot will be divided by the Engineer's average maximum theoretical specific gravity for the lot. The individual core densities for the sublot will be averaged to determine the new payment adjustment factor of the sublot in question. If the new payment adjustment factor is 0.700 or greater, the new payment adjustment factor will apply to that sublot. If the new payment adjustment factor is less than 0.700, no payment will be made for the sublot. Remove and replace the failing sublot, or the Engineer may allow the sublot to be left in place without payment. The Engineer may also accept the sublot in accordance with Section 3077.5.3.1., "Acceptance of Defective or Unauthorized Work." Replacement material meeting the requirements of this Item will be paid for in accordance with this Section.

6.3. **Total Adjusted Pay Calculation**. Total adjusted pay (TAP) will be based on the applicable payment adjustment factors for production and placement for each lot.

TAP = (A+B)/2

where:
A = Bid price × production lot quantity × average payment adjustment factor for the production lot
B = Bid price × placement lot quantity × average payment adjustment factor for the placement lot + (bid price × quantity placed in miscellaneous areas × 1.000)

Production lot quantity = Quantity actually placed - quantity left in place without payment

Placement lot quantity = Quantity actually placed - quantity left in place without payment - quantity placed in miscellaneous areas

Special Specification 3079
Permeable Friction Course

1. DESCRIPTION

Construct a hot-mix asphalt (HMA) surface course composed of a compacted permeable mixture of aggregate, asphalt binder, and additives mixed hot in a mixing plant.

2. MATERIALS

Furnish uncontaminated materials of uniform quality that meet the requirements of the plans and specifications.

Notify the Engineer of all material sources and before changing any material source or formulation. The Engineer will verify that the specification requirements are met when the Contractor makes a source or formulation change, and may require a new laboratory mixture design, trial batch, or both. The Engineer may sample and test project materials at any time during the project to verify specification compliance in accordance with Item 6, "Control of Materials."

2.1. **Aggregate.** Furnish aggregates from sources that conform to the requirements in accordance with Table 1 and as specified in this Section. Aggregate requirements in this Section, including those shown in Table 1, may be modified or eliminated when shown on the plans. Additional aggregate requirements may be specified when shown on the plans. Provide aggregate stockpiles that meet the definitions in this Section for coarse aggregate. Do not use intermediate or fine aggregate in permeable friction course (PFC) mixtures. Supply aggregates that meet the definitions in Tex-100-E for crushed gravel or crushed stone. The Engineer will designate the plant or the quarry as the sampling location. Provide samples from materials produced for the project. The Engineer will establish the Surface Aggregate Classification (SAC) and perform Los Angeles abrasion, magnesium sulfate soundness, and Micro-Deval tests. Perform all other aggregate quality tests in accordance with Table 1. Document all test results on the mixture design report. The Engineer may perform tests on independent or split samples to verify Contractor test results. Stockpile aggregates for each source and type separately. Determine aggregate gradations for mixture design and production testing based on the washed sieve analysis given in Tex-200-F, Part II.

2.1.1. **Coarse Aggregate.** Coarse aggregate stockpiles must have no more than 20% material passing the No. 8 sieve. Aggregates from sources listed in the Department's *Bituminous Rated Source Quality Catalog* (BRSQC) are preapproved for use. Use only the rated values for hot-mix listed in the BRSQC. Rated values for surface treatment (ST) do not apply to coarse aggregate sources used in hot-mix asphalt.

For sources not listed on the Department's BRSQC:

- build an individual stockpile for each material;
- request the Department test the stockpile for specification compliance;
- approved only when tested by the Engineer;
- once approved, do not add material to the stockpile unless otherwise approved; and
- allow 30 calendar days for the Engineer to sample, test, and report results.

Provide coarse aggregate with at least the minimum SAC shown on the plans. SAC requirements only apply to aggregates used on the surface of travel lanes, unless otherwise shown on the plans. SAC requirements apply to aggregates used on surfaces other than travel lanes when shown on the plans. The SAC for sources on the Department's *Aggregate Quality Monitoring Program* (AQMP) (Tex-499-A) is listed in the BRSQC.

2.1.1.1. **Blending Class A and Class B Aggregates.** To prevent crushing of the Class B aggregate when blending, Class B aggregate may be blended with a Class A aggregate to meet requirements for Class A materials if the Department's BRSQC rated source soundness magnesium (RSSM) rating for the Class B aggregate is less than the Class A aggregate or if the RSSM rating for the Class B aggregate is less than or equal to 10%. Use the rated values for hot mix asphaltic concrete (HMAC) published in the BRSQC. When blending Class A and B aggregates to meet a Class A requirement, ensure that at least 50% by weight, or volume if required, of all the aggregates used in the mixture design retained on the No. 4 sieve comes from the Class A aggregate source, unless otherwise shown on the plans. Blend by volume if the bulk specific gravities of the Class A and B aggregates differ by more than 0.300. Class B aggregate may be disallowed when shown on the plans.

The Engineer may perform tests at any time during production, when the Contractor blends Class A and B aggregates to meet a Class A requirement, to ensure that at least 50% by weight, or volume if required, of the material retained on the No. 4 sieve comes from the Class A aggregate source. The Engineer will use the Department's mix design template, when electing to verify conformance, to calculate the percent of Class A aggregate retained on the No. 4 sieve by inputting the bin percentages shown from readouts in the control room at the time of production and stockpile gradations measured at the time of production. The Engineer may determine the gradations based on either washed or dry sieve analysis from samples obtained from individual aggregate cold feed bins or aggregate stockpiles. The Engineer may perform spot checks using the gradations supplied by the Contractor on the mixture design report as an input for the template; however, a failing spot check will require confirmation with a stockpile gradation determined by the Engineer.

2.1.1.2. **Micro-Deval Abrasion.** The Engineer will perform a minimum of one Micro-Deval abrasion test in accordance with Tex-461-A for each coarse aggregate source used in the mixture design that has a Rated Source Soundness Magnesium (RSSM) loss value greater than 10 as listed in the BRSQC, unless otherwise directed. The Engineer will perform testing before the start of production and may perform additional testing at any time during production. The Engineer may obtain the coarse aggregate samples from each coarse aggregate source or may require the Contractor to obtain the samples. The Engineer may waive all Micro-Deval testing based on a satisfactory test history of the same aggregate source.

The Engineer will estimate the magnesium sulfate soundness loss for each coarse aggregate source, when tested, using the following formula:

$$Mg_{est.} = (RSSM)(MD_{act.}/RSMD)$$

where:
$Mg_{est.}$ = magnesium sulfate soundness loss
RSSM = Rated Source Soundness Magnesium
$MD_{act.}$ = actual Micro-Deval percent loss
RSMD = Rated Source Micro-Deval

When the estimated magnesium sulfate soundness loss is greater than the maximum magnesium sulfate soundness loss specified, the coarse aggregate source will not be allowed for use unless otherwise approved. The Engineer will consult the Soils and Aggregates Section of the Materials and Tests Division, and additional testing may be required before granting approval.

Table 1
Coarse Aggregate Quality Requirements

Property	Test Method	Requirement
SAC	Tex-499-A (AQMP)	As shown on the plans
Deleterious material, %, Max	Tex-217-F, Part I	1.0
Decantation, %, Max	Tex-217-F, Part II	1.5
Micro-Deval abrasion, %	Tex-461-A	Note [1]
Los Angeles abrasion, %, Max	Tex-410-A	30
Magnesium sulfate soundness, 5 cycles, %, Max	Tex-411-A	20
Crushed face count,[2] %, Min	Tex-460-A, Part I	95
Flat and elongated particles @ 5:1, %, Max	Tex-280-F	10

1. Used to estimate the magnesium sulfate soundness loss in accordance with Section 3079.2.1.1.2., "Micro-Deval Abrasion."
2. Only applies to crushed gravel.

2.2. **Baghouse Fines.** Fines collected by the baghouse or other dust-collecting equipment may be reintroduced into the mixing drum.

2.3. **Asphalt Binder.** Furnish the type and grade of binder specified on the plans that meets the requirements of Item 300, "Asphalts, Oils, and Emulsions."

2.3.1. **Performance-Graded (PG) Binder.** Provide an asphalt binder with a high-temperature grade of PG 76 and low-temperature grade as shown on the plans in accordance with Section 300.2.10., "Performance-Graded Binders," when PG binder is specified.

2.3.2. **Asphalt-Rubber (A-R) Binder.** Provide A-R binder that meets the Type I or Type II requirements of Section 300.2.9., "Asphalt-Rubber Binders," when A-R is specified unless otherwise shown on the plans. Use at least 15.0% by weight of Crumb Rubber Modifier (CRM) that meets the Grade B or Grade C requirements of Section 300.2.7., "Crumb Rubber Modifier," unless otherwise shown on the plans. Provide the Engineer the A-R binder blend design with the mix design (JMF1) submittal. Provide the Engineer with documentation such as the bill of lading showing the quantity of CRM used in the project unless otherwise directed.

2.4. **Tack Coat.** Furnish CSS-1H, SS-1H, EBL, or a PG binder with a minimum high-temperature grade of PG 58 for tack coat binder in accordance with Item 300, "Asphalts, Oils, and Emulsions." Specialized tack coat materials listed on the Department's Tracking Resistant Asphalt Interlayer (TRAIL) MPL may be allowed or required when shown on the plans. Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use.

2.5. **Additives.** Provide the Engineer with documentation such as the bill of lading showing the quantity of additives used in the project unless otherwise directed.

2.5.1. **Fibers.** Provide cellulose or mineral fibers when PG binder is specified. Do not use fibers when A-R binder is specified. Submit written certification to the Engineer that the fibers proposed for use meet the requirements of DMS-9204, "Fiber Additives for Bituminous Mixtures." Fibers may be pre-blended into the binder at the asphalt supply terminal unless otherwise shown on the plans.

2.5.2. **Lime Mineral Filler.** Add lime as mineral filler at a rate of 1.0% by weight of the total dry aggregate in accordance with Item 301, "Asphalt Antistripping Agents," unless otherwise shown on the plans or waived by the Engineer based on Hamburg Wheel test results. Do not add lime directly into the mixing drum of any plant where lime is removed through the exhaust stream unless the plant has a baghouse or dust collection system that reintroduces the lime into the drum.

2.5.3. **Lime and Liquid Antistripping Agent.** When lime or a liquid antistripping agent is used, add in accordance with Item 301, "Asphalt Antistripping Agents." Do not add lime directly into the mixing drum of any plant where lime is removed through the exhaust stream unless the plant has a baghouse or dust collection system that reintroduces the lime into the drum. When the plans require lime to be added as an antistripping agent, lime added as mineral filler will count towards the total quantity of lime specified.

2.5.4. **Compaction Aid.** Compaction aid is defined as a Department-approved chemical warm mix additive denoted as "chemical additive" on the Department's materials producer list (MPL) that is used to facilitate mixing and compaction of HMA.

Compaction aid is allowed for use on all projects. Compaction aid is required when shown on the plans or as required in Section 3079.4.7.1., "Weather Conditions."

Warm mix foaming processes, denoted as "foaming process" on the Department-approved MPL, may be used to facilitate mixing and compaction of HMA; however warm mix foaming processes are not defined as a Compaction aid.

2.6. **Recycled Materials.** Recycled materials are not allowed for use.

3. EQUIPMENT

Provide required or necessary equipment in accordance with Item 320, “Equipment for Asphalt Concrete Pavement.” When A-R binder is specified, equip the hot-mix plant with an in-line viscosity-measuring device located between the blending unit and the mixing drum. Provide a means to calibrate the asphalt mass flow meter on-site when a meter is used.

4. CONSTRUCTION

Produce, haul, place, and compact the specified paving mixture. In addition to tests required by the specification, Contractors may perform other QC tests as deemed necessary. At any time during the project, the Engineer may perform production and placement tests as deemed necessary in accordance with Item 5, “Control of the Work.” Schedule and participate in a mandatory pre-paving meeting with the Engineer on or before the first day of paving unless otherwise shown on the plans.

4.1. **Certification.** Personnel certified by the Department-approved hot-mix asphalt certification program must conduct all mixture designs, sampling, and testing in accordance with Table 2. Supply the Engineer with a list of certified personnel and copies of their current certificates before beginning production and when personnel changes are made. Provide a mixture design developed and signed by a Level 2 certified specialist. Provide Level 1A certified specialists at the plant during production operations. Provide Level 1B certified specialists to conduct placement tests. Provide Level AGG101 certified specialists for aggregate testing.

Table 2
Test Methods, Test Responsibility, and Minimum Certification Levels

Test Description	Test Method	Contractor	Engineer	Level[1]
1. Aggregate Testing				
Sampling	Tex-221-F	✓	✓	1A/AGG101
Dry sieve	Tex-200-F, Part I	✓	✓	1A/AGG101
Washed sieve	Tex-200-F, Part II	✓	✓	1A/AGG101
Deleterious material	Tex-217-F, Parts I & III	✓	✓	AGG101
Decantation	Tex-217-F, Part II	✓	✓	AGG101
Los Angeles abrasion	Tex-410-A		✓	Department
Magnesium sulfate soundness	Tex-411-A		✓	Department
Micro-Deval abrasion	Tex-461-A		✓	AGG101
Crushed face count	Tex-460-A	✓	✓	AGG101
Flat and elongated particles	Tex-280-F	✓	✓	AGG101
2. Asphalt Binder & Tack Coat Sampling				
Asphalt binder sampling	Tex-500-C, Part II	✓	✓	1A/1B
Tack coat sampling	Tex-500-C, Part III	✓	✓	1A/1B
3. Mix Design & Verification				
Design and JMF changes	Tex-204-F	✓	✓	2
Mixing	Tex-205-F	✓	✓	2
Molding (SGC)	Tex-241-F	✓	✓	1A
Laboratory-molded density	Tex-207-F, Parts I, VI, & VIII	✓	✓	1A
Rice gravity	Tex-227-F, Part II	✓	✓	1A
Ignition oven correction factors[2]	Tex-236-F, Part II	✓	✓	2
Drain-down	Tex-235-F	✓	✓	1A
Hamburg Wheel test	Tex-242-F	✓	✓	1A
Boil test[4]	Tex-530-C	✓	✓	1A
Cantabro loss	Tex-245-F	✓	✓	1A
4. Production Testing				
Control charts	Tex-233-F	✓	✓	1A
Mixture sampling	Tex-222-F	✓	✓	1A/1B
Gradation & asphalt binder content[2]	Tex-236-F, Part I	✓	✓	1A
Moisture content	Tex-212-F, Part II	✓	✓	1A/AGG101
Micro-Deval abrasion	Tex-461-A		✓	AGG101
Drain-down	Tex-235-F	✓	✓	1A
Boil test[4]	Tex-530-C	✓	✓	1A
Abson recovery	Tex-211-F		✓	Department
5. Placement Testing				
Control charts	Tex-233-F	✓	✓	1A
Ride quality measurement	Tex-1001-S	✓	✓	Note 3
Thermal profile	Tex-244-F	✓	✓	1B
Water flow test	Tex-246-F	✓	✓	1B
Shear bond strength test	Tex-249-F		✓	Department

1. Level 1A, 1B, AGG101, and 2 are certification levels provided by the Hot Mix Asphalt Center certification program.
2. Refer to Section 3079.4.9.2.3., "Production Testing," for exceptions to using an ignition oven.
3. Profiler and operator are required to be certified at the Texas A&M Transportation Institute facility when Surface Test Type B is specified.
4. When shown on the plans.

4.2. **Reporting and Responsibilities**. Use Department-provided templates to record and calculate all test data, including mixture design, production and placement tests, control charts, and thermal profiles. Obtain the current version of the templates at https://www.txdot.gov/inside-txdot/forms-publications/consultants-contractors/forms/site-manager.html or from the Engineer. The Engineer and the Contractor will provide any available test results to the other party when requested. The maximum allowable time for the Contractor and Engineer to exchange test data is given in Table 3. The Engineer and the Contractor will immediately report to the other party any test result that requires suspension of production or placement or that fails to meet the specification requirements. Record and electronically submit all test results and pertinent information on Department-provided templates.

Subsequent sublots placed after test results are available to the Contractor, which require suspension of operations, may be considered unauthorized work. Unauthorized work will be accepted or rejected at the discretion of the Engineer in accordance with Article 5.3., "Conformity with Plans, Specifications, and Special Provisions."

Table 3
Reporting Schedule

Description	Reported By	Reported To	To Be Reported Within
Production Quality Control			
Gradation[1]	Contractor	Engineer	1 working day of completion of the sublot
Asphalt binder content[1]			
Laboratory-molded density[1]			
Moisture content[2]			
Drain-down[1]			
Boil test[4]			
Production Quality Assurance			
Gradation[2]	Engineer	Contractor	1 working day of completion of the sublot
Asphalt binder content[2]			
Laboratory-molded density[2]			
Hamburg Wheel test[3]			
Boil test[4]			
Drain-down[2]			
Binder tests[3]			
Placement Quality Control			
Thermal profile[1]	Contractor	Engineer	1 working day of completion of the lot
Water flow[1]			
Placement Quality Assurance			
Thermal profile[2]	Engineer	Contractor	1 working day of completion of the lot
Aging ratio[3]			
Water flow[2]			

1. These tests are required on every sublot.
2. To be performed at the frequency in accordance with Table 9 or as shown on the plans.
3. To be reported as soon as the results become available.
4. When shown on the plans

Use the procedures described in Tex-233-F to plot the results of all production and placement testing, when directed. Update the control charts as soon as test results for each sublot become available. Make the control charts readily accessible at the field laboratory. The Engineer may suspend production for failure to update control charts.

4.3. **Quality Control Plan (QCP).** Develop and follow the QCP in detail. Obtain approval for changes to the QCP made during the project. The Engineer may suspend operations if the Contractor fails to comply with the QCP.

Submit a written QCP before the mandatory pre-paving meeting when directed. Receive approval of the QCP before pre-paving meeting. Include the following items in the QCP:

4.3.1. **Project Personnel.** For project personnel, include:

- a list of individuals responsible for QC with authority to take corrective action;
- current contact information for each individual listed; and

- current copies of certification documents for individuals performing specified QC functions.

4.3.2. **Material Delivery and Storage.** For material delivery and storage, include:

- the sequence of material processing, delivery, and minimum quantities to assure continuous plant operations;
- aggregate stockpiling procedures to avoid contamination and segregation;
- frequency, type, and timing of aggregate stockpile testing to assure conformance of material requirements before mixture production; and
- procedure for monitoring the quality and variability of asphalt binder.

4.3.3. **Production.** For production, include:

- loader operation procedures to avoid contamination in cold bins;
- procedures for calibrating and controlling cold feeds;
- procedures to eliminate debris or oversized material;
- procedures for adding and verifying rates of each applicable mixture component (e.g., aggregate, asphalt binder, lime, liquid antistrip, compaction aid, foaming process, fibers);
- procedures for reporting job control test results; and
- procedures to avoid segregation and drain-down in the silo.

4.3.4. **Loading and Transporting.** For loading and transporting, include:

- type and application method for release agents; and
- truck loading procedures to avoid segregation.

4.3.5. **Placement and Compaction.** For placement and compaction, include:

- proposed agenda for mandatory pre-paving meeting, including date and location;
- proposed paving plan (e.g., production rate, paving widths, joint offsets, and lift thicknesses);
- type and application method for release agents in the paver and on rollers, shovels, lutes, and other utensils;
- procedures for the transfer of mixture into the paver, while avoiding physical and thermal segregation and preventing material spillage;
- process to balance production, delivery, paving, and compaction to achieve continuous placement operations and good ride quality;
- paver operations (e.g., speed, operation of wings, height of mixture in auger chamber) to avoid physical and thermal segregation and other surface irregularities; and
- procedures to construct quality longitudinal and transverse joints.

4.4. **Mixture Design.**

4.4.1. **Design Requirements.** Use the PFC design procedure provided in Tex-204-F, unless otherwise shown on the plans. Design the mixture to meet the requirements in accordance with Tables 1, 4, 5, and 6. Use a Superpave Gyratory Compactor (SGC) at 50 gyrations as the design number of gyrations (Ndesign).

The Engineer will provide the mixture design when shown on the plans. The Contractor may submit a new mixture design at any time during the project. The Engineer will verify and approve all mixture designs (JMF1) before the Contractor can begin production.

Provide the Engineer with a mixture design report using the Department-provided template. Include the following items in the report:

- the combined aggregate gradation, source, specific gravity, and percent of each material used;
- results of all applicable tests;
- the mixing and molding temperatures;
- the signature of the Level 2 person or persons that performed the design;

- the date the mixture design was performed; and
- a unique identification number for the mixture design.

Table 4
Master Gradation Limits (% Passing by Weight or Volume)

Sieve Size	PG 76 Mixtures		A-R Mixtures		Test Procedure
	Fine (PFC-F)	Coarse (PFC-C)	Fine (PFCR-F)	Coarse (PFCR-C)	
3/4"	–	100.0[1]	100.0[1]	100.0[1]	Tex-200-F
1/2"	100.0[1]	80.0–100.0	95.0–100.0	80.0–100.0	
3/8"	95.0–100.0	35.0–60.0	50.0–80.0	35.0–60.0	
#4	20.0–55.0	1.0–20.0	0.0–8.0	0.0–20.0	
#8	1.0–10.0	1.0–10.0	0.0–4.0	0.0–10.0	
#200	1.0–4.0	1.0–4.0	0.0–4.0	0.0–4.0	

1. Defined as maximum sieve size. No tolerance allowed.

Table 5
Mixture Design Properties

Mix Property	PG 76 Mixtures		A-R Mixtures		Test Procedure
	Fine (PFC-F) Requirements	Coarse (PFC-C) Requirements	Fine (PFCR-F) Requirements	Coarse (PFCR-C) Requirements	
Design gyrations (Ndesign)	50	50	50	50	Tex-241-F
Lab-molded density, %	78.0 Max	82.0 Max	82.0 Max	82.0 Max	Tex-207-F
Asphalt Binder Content, %	6.0–7.0	6.0–7.0	8.0–10.0	7.0–9.0	--
Hamburg Wheel test,[1] passes at 12.5 mm rut depth	10,000 Min[2]	Note 3	Note 3	Note 3	Tex-242-F
Drain-down, %	0.10 Max	0.10 Max	0.10 Max	0.10 Max	Tex-235-F
Fiber content, % by wt. of total PG 76 mixture	0.20–0.50	0.20–0.50	–	–	Calculated
Lime content, % by wt. of total aggregate	1.0[4]	1.0[4]	–	–	Calculated
CRM content, % by wt. of A-R binder	–	–	15.0 Min	15.0 Min	Calculated
Boil test[5]	–	–	–	–	Tex-530-C
Cantabro loss, %	20.0 Max	20.0 Max	20.0 Max	20.0 Max	Tex-245-F

1. Mold test specimens to Ndesign at the optimum asphalt binder content.
2. May be decreased when shown on the plans.
3. No specification value is required unless otherwise shown on the plans.
4. Unless otherwise shown on the plans or waived by the Engineer based on Hamburg Wheel results.
5. When shown on the plans. Used to establish baseline for comparison to production results.

4.4.2. **Job-Mix Formula Approval.** The job-mix formula (JMF) is the combined aggregate gradation, Ndesign level, and target asphalt percentage used to establish target values for hot-mix production. JMF1 is the original laboratory mixture design used to produce the trial batch. When a compaction aid or foaming process is used, JMF1 may be designed and submitted to the Engineer without including the compaction aid or foaming process. When a compaction aid or foaming process is used, document the compaction aid or foaming process used and recommended rate on the JMF1 submittal. The Engineer and the Contractor will verify JMF1 based on plant-produced mixture from the trial batch unless otherwise approved. The Engineer may accept an existing mixture design previously used on a Department project and may waive the trial batch to verify JMF1. The Department may require the Contractor to reimburse the Department for verification tests if more than two trial batches per design are required.

4.4.2.1. **Contractor's Responsibilities.**

4.4.2.1.1. **Providing Gyratory Compactor.** Furnish an SGC calibrated in accordance with Tex-241-F for molding production samples. Locate the SGC at the Engineer's field laboratory or make the SGC available to the Engineer for use in molding production samples.

4.4.2.1.2. **Gyratory Compactor Correlation Factors.** Use Tex-206-F, Part II, to perform a gyratory compactor correlation when the Engineer uses a different SGC. Apply the correlation factor to all subsequent production test results.

4.4.2.1.3. **Submitting JMF1.** Furnish a mix design report (JMF1) with representative samples of all component materials and request approval to produce the trial batch. Provide an additional 25 lb. of the design mixture if opting to have the Department perform the Hamburg Wheel test on the laboratory mixture when required in accordance with Table 5, and request that the Department perform the test.

4.4.2.1.4. **Supplying Aggregates.** Provide approximately 40 lb. of each aggregate stockpile unless otherwise directed.

4.4.2.1.5. **Supplying Asphalt.** Provide at least 1 gal. of the asphalt material and enough quantities of any additives proposed for use.

4.4.2.1.6. **Ignition Oven Correction Factors.** Determine the aggregate and asphalt correction factors from the ignition oven in accordance with Tex-236-F, Part II. Provide correction factors that are not more than 12 mo. old. Note that the asphalt content correction factor takes into account the percent fibers in the mixture so that the fibers are excluded from the binder content determination. Provide the Engineer with split samples of the mixtures before the trial batch production, including all additives (except water), and blank samples used to determine the correction factors for the ignition oven used for quality assurance (QA) testing during production. Correction factors established from a previously approved mixture design may be used for the current mixture design if the mixture design and ignition oven are the same as previously used and the correction factors are not more than 12 mo. old, unless otherwise directed.

4.4.2.1.7. **Boil Test.** When shown on the plans, perform the test and retain the tested sample from Tex-530-C until completion of the project or as directed. Use this sample for comparison purposes during production. Add lime or liquid antistripping agent, as directed, if signs of stripping exist.

4.4.2.1.8. **Trial Batch Production.** Provide a plant-produced trial batch upon receiving conditional approval of JMF1 and authorization to produce a trial batch including the compaction aid or foaming process, if applicable, for verification testing of JMF1 and development of JMF2. Produce a trial batch mixture that meets the requirements in accordance with Table 6. The Engineer may accept test results from recent production of the same mixture instead of a new trial batch.

4.4.2.1.9. **Trial Batch Production Equipment.** Use only equipment and materials proposed for use on the project to produce the trial batch. Provide documentation to verify the calibration or accuracy of the asphalt mass flow meter to measure the binder content. Verify that asphalt mass flow meter meets the requirements of 0.4% accuracy, when required, in accordance with Item 520, "Weighing and Measuring Equipment." The Engineer may require that the accuracy of the mass flow meter be verified based on quantities used.

4.4.2.1.10. **Trial Batch Quantity.** Produce enough quantity of the trial batch to ensure that the mixture meets the specification requirements.

4.4.2.1.11. **Number of Trial Batches.** Produce trial batches as necessary to obtain a mixture that meets the specification requirements.

4.4.2.1.12. **Trial Batch Sampling.** Obtain a representative sample of the trial batch and split it into three equal portions in accordance with Tex-222-F. Label these portions as "Contractor," "Engineer," and "Referee." Deliver samples to the appropriate laboratory as directed.

4.4.2.1.13. **Trial Batch Testing.** Test the trial batch to ensure the mixture produced using the proposed JMF1 meets the mixture requirements in accordance with Table 6. Ensure the trial batch mixture is also in compliance with the requirements in accordance with Table 5. Use a Department-approved laboratory listed on the MPL to perform

the Hamburg Wheel test on the trial batch mixture or request that the Department perform the Hamburg Wheel test. Provide an additional 25 lb. of the trial batch mixture if opting to have the Department perform the Hamburg Wheel test, if applicable, and request that the Department perform the test. The Engineer will be allowed 10 working days to provide the Contractor with Hamburg Wheel test results on the trial batch. Provide the Engineer with a copy of the trial batch test results.

4.4.2.1.14. **Development of JMF2.** Evaluate the trial batch test results, determine the target mixture proportions, and submit as JMF2 after the Engineer grants full approval of JMF1 based on results from the trial batch. The mixture produced using JMF2 must meet the requirements in accordance with Tables 4 and 5. Verify that JMF2 meets the operational tolerances in accordance with Table 6.

4.4.2.1.15. **Mixture Production.** Use JMF2 to produce Lot 1 after receiving approval for JMF2.

4.4.2.1.16. **Development of JMF3.** Evaluate the test results from Lot 1, determine the optimum mixture proportions, and submit as JMF3 for use in Lot 2.

4.4.2.1.17. **JMF Adjustments.** If JMF adjustments are necessary to achieve the specified requirements, make the adjustments before beginning a new lot. The adjusted JMF must:

- be provided to the Engineer in writing before the start of a new lot;
- be numbered in sequence to the previous JMF;
- meet the master gradation limits in accordance with Table 4; and
- be within the operational tolerances of JMF2 in accordance with Table 6.

4.4.2.1.18. **Requesting Referee Testing.** Use referee testing, if needed, in accordance with Section 3079.4.9.1., "Referee Testing," to resolve testing differences with the Engineer.

Table 6
Operational Tolerances

Test Description	Test Method	Allowable Difference between JMF2 and JMF1 Target[1]	Allowable Difference from Current JMF and JMF2[2]	Allowable Difference between Contractor and Engineer[3]
Individual % retained for sieve sized larger than #200	Tex-200-F	Must be Within Master Grading Limits in accordance with Table 4	±3.0[4]	±5.0[4]
% passing the #200 sieve				±2.0[4]
Laboratory-molded density, %	Tex-207-F, Part VIII	±1.0	±1.0	±1.0
Asphalt binder content, %	Tex-236-F, Part I[5]	±0.3[6,7]	±0.3[4,6,7]	±0.3[6,7]
Drain-down, %	Tex-235-F	Note 8	Note 8	N/A
Boil test	Tex-530-C	Note 9	Note 9	N/A

1. JMF1 is the approved laboratory mixture design used for producing the trial batch. JMF2 is the approved mixture design developed from the trial batch used to produce Lot 1.
2. Current JMF is JMF3 or higher. JMF3 is the approved mixture design used to produce Lot 2.
3. Contractor may request referee testing only when values exceed these tolerances.
4. Only applies to mixture produced for Lot 1 and higher. Aggregate gradation is not allowed to be outside the limits shown in Table 4.
5. Ensure the binder content determination excludes fibers.
6. May be obtained from asphalt mass flow meter readouts as determined by the Engineer.
7. Binder content is not allowed to be outside the limits in accordance with Table 5.
8. Verify that Table 5 requirements are met.
9. When shown on the plans.

4.4.2.2. **Engineer's Responsibilities.**

4.4.2.2.1. **Superpave Gyratory Compactor.** The Engineer will use a Department SGC calibrated in accordance with Tex-241-F to mold samples for laboratory mixture design verification. For molding trial batch and production specimens, the Engineer will use the Contractor-provided SGC at the

field laboratory or provide and use a Department SGC at an alternate location.

4.4.2.2.2. **Conditional Approval of JMF1 and Authorizing Trial Batch.** The Engineer will review and verify conformance of the following information within two working days of receipt:

- the Contractor's mix design report (JMF1);
- the Contractor-provided Hamburg Wheel test results;
- all required materials including aggregates, asphalt, and additives; and
- the mixture specifications.

The Engineer will grant the Contractor conditional approval of JMF1 if the information provided on the paper copy of JMF1 indicates that the Contractor's mixture design meets the specifications. When the Contractor does not provide Hamburg Wheel test with laboratory mixture design, 10 working days are allowed for conditional approval of JMF1. The Engineer will base full approval of JMF1 on the test results on mixture from the trial batch.

Unless waived, the Engineer will determine the Micro-Deval abrasion loss in accordance with Section 3079.2.1.1.2., "Micro-Deval Abrasion." If the Engineer's test results are pending after two working days, conditional approval of JMF1 will still be granted within two working days of receiving JMF1. When the Engineer's test results become available, they will be used for specification compliance.

The Contractor is authorized to produce a trial batch after the Engineer grants conditional approval of JMF1.

4.4.2.2.3. **Hamburg Wheel Testing.** At the Contractor's request, the Department will perform the Hamburg Wheel test on the laboratory mixture in accordance with Tex-242-F to verify compliance with the Hamburg Wheel test requirement in accordance with Table 5. The Engineer will be allowed 10 working days to provide the Contractor with Hamburg Wheel test results on the laboratory mixture design.

4.4.2.2.4. **Ignition Oven Correction Factors.** The Engineer will use the split samples provided by the Contractor to determine the aggregate and asphalt correction factors for the ignition oven used for QA testing during production in accordance with Tex-236-F, Part II. Provide correction factors that are not more than 12 mo. old. The Engineer will verify that the asphalt content correction factor takes into account the percent fibers in the mixture so that the fibers are excluded from the binder content determination.

4.4.2.2.5. **Testing the Trial Batch.** Within one full working day, the Engineer will sample and test the trial batch to ensure that the mixture meets the requirements in accordance with Table 6. If the Contractor requests the option to have the Department perform the Hamburg Wheel test on the trial batch mixture, the Engineer will mold samples in accordance with Tex-242-F to verify compliance with the Hamburg Wheel test requirement in accordance with Table 5.

The Engineer will have the option to perform Tex-530-C on the trial batch when shown on the plans. These results may be retained and used for comparison purposes during production.

4.4.2.2.6. **Full Approval of JMF1.** The Engineer will grant full approval of JMF1 and authorize the Contractor to proceed with developing JMF2 if the Engineer's results for the trial batch meet the requirements in accordance with Table 5.

The Engineer will notify the Contractor that an additional trial batch is required if the trial batch does not meet these requirements.

4.4.2.2.7. **Approval of JMF2.** The Engineer will approve JMF2 within one working day if the mixture meets the requirements in accordance with Tables 4, 5, and 6.

4.4.2.2.8. **Approval of Lot 1 Production.** The Engineer will authorize the Contractor to proceed with Lot 1 production (using JMF2).

4.4.2.2.9. **Approval of JMF3 and Subsequent JMF Changes.** JMF3 and subsequent JMF changes are approved if they meet the master grading limits in accordance with Table 4, the asphalt binder content in accordance with Table 5, and are within the operational tolerances of JMF2 in accordance with Table 6.

4.4.2.2.10. **Binder Content Adjustments.** For JMF2 and above, the Engineer may require the Contractor to adjust the target binder content by no more than 0.3% from the current JMF.

4.5. **Production Operations.** Perform a new trial batch when the plant or plant location is changed. Take corrective action and receive approval to proceed after any production suspension for noncompliance to the specification.

4.5.1. **Storage and Heating of Materials.** Do not heat the asphalt binder above the temperatures specified in Item 300, "Asphalts, Oils, and Emulsions," or outside the manufacturer's recommended values. Provide the Engineer with daily records of asphalt binder and hot-mix asphalt discharge temperatures (in legible and discernible increments) in accordance with Item 320, "Equipment for Asphalt Concrete Pavement," unless otherwise directed. Do not store mixture for a period long enough to affect the quality of the mixture, nor in any case longer than 12 hr. unless otherwise approved.

4.5.2. **Mixing and Discharge of Materials.** Notify the Engineer of the target discharge temperature and produce the mixture within 25°F of the target. Monitor the temperature of the material in the truck before shipping to ensure that it does not exceed the maximum production temperatures in accordance with Table 7. The Department will not pay for or allow placement of any mixture produced above the maximum production temperatures in accordance with Table 7.

Table 7
Maximum Production Temperature

High-Temperature Binder Grade[1]	Maximum Production Temperature
PG 76	345˚F
A-R Binder	345˚F

1. The high-temperature binder grade refers to the high-temperature grade of the virgin asphalt binder used to produce the mixture.

Control the mixing time and temperature so that substantially all moisture is removed from the mixture before discharging from the plant. Determine the moisture content, if requested, by oven-drying in accordance with Tex-212-F, Part II, and verify that the mixture contains no more than 0.2% of moisture by weight. Obtain the sample immediately after discharging the mixture into the truck and perform the test promptly.

4.6. **Hauling Operations.** Clean all truck beds before use to ensure that mixture is not contaminated. Use a release agent, when necessary, shown on the Department's MPL to coat the inside bed of the truck. Do not use diesel or any release agent not shown on the Department's MPL.

Use equipment for hauling as defined in Section 3079.4.7.3.3., "Hauling Equipment." Use other hauling equipment only when allowed.

4.7. **Placement Operations.** Collect haul tickets from each load of mixture delivered to the project and provide the Department's copy to the Engineer approximately every hour or as directed. Use a hand-held thermal camera or infrared thermometer, when a thermal imaging system is not used, to measure and record the internal temperature of the mixture as discharged from the truck or Material Transfer Device (MTD) before or as the mix enters the paver and an approximate station number or GPS coordinates on each ticket. Calculate the daily yield and cumulative yield for the specified lift and provide to the Engineer at the end of paving operations for each day unless otherwise directed. The Engineer may suspend production if the Contractor fails to produce and provide haul tickets and yield calculations by the end of paving operations for each day.

Prepare the surface by removing raised pavement markers and objectionable material such as moisture, dirt, sand, leaves, and other loose impediments from the surface before placing mixture. Remove vegetation from

pavement edges. Place the mixture to meet the typical section requirements and produce a smooth, finished surface with a uniform appearance and texture. Offset longitudinal joints of successive courses of hot-mix by at least 6 in. Place mixture so that longitudinal joints on the surface course coincide within 6-in. of lane lines and are not placed in the wheel path, or as directed. Ensure that all finished surfaces will drain properly.

4.7.1. **Weather Conditions.**

4.7.1.1. **When Using a Thermal Imaging System.** The Contractor may pave any time the roadway is dry and the roadway surface temperature is at least 60°F unless otherwise approved or as shown on the plans; however, the Engineer may restrict the Contractor from paving if the ambient temperature is likely to drop below 32°F within 12 hr. of paving. Place mixtures when weather conditions and moisture conditions of the roadway surface are suitable as determined by the Engineer. Provide output data from the thermal imaging system to demonstrate to the Engineer that no recurring severe thermal segregation exists in accordance with Section 3079.4.7.3.1.2., "Thermal Imaging System."

Produce mixture with a target discharge temperature higher than 300°F and with a compaction aid to facilitate compaction when the air temperature is 70°F and falling.

4.7.1.1.1. **When Not Using a Thermal Imaging System.** When using a thermal camera instead of the thermal imaging system, place mixture when the roadway surface temperature is at or above 70°F unless otherwise approved or as shown on the plans. Measure the roadway surface temperature with a hand-held thermal camera or infrared thermometer. Place mixtures only when weather conditions and moisture conditions of the roadway surface are suitable as determined by the Engineer. The Engineer may restrict the Contractor from paving if the air temperature is 60°F and falling.

Produce mixture with a target discharge temperature higher than 300°F and with a compaction aid to facilitate compaction when the air temperature is 70°F and falling.

4.7.2. **Tack Coat.**

4.7.2.1. **Application.** Clean the surface before placing the tack coat. The Engineer will set the rate between 0.04 and 0.10 gal. of residual asphalt per square yard of surface area. Apply a uniform tack coat at the specified rate unless otherwise directed. Apply the tack coat in a uniform manner to avoid streaks and other irregular patterns. Apply adequate overlap of the tack coat in the longitudinal direction during the placement of the mat to ensure bond of adjacent PFC mats, unless otherwise directed. Unless otherwise directed, avoid tacking the vertical faces of adjacent PFC mats in the longitudinal direction to avoid restricting lateral drainage. Apply tack coat to all transverse joints. Allow adequate time for emulsion to break completely before placing any material. Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use.

4.7.2.2. **Sampling.** The Engineer will obtain at least one sample of the tack coat binder per project in accordance with Tex-500-C, Part III, and test it to verify compliance with Item 300, "Asphalts, Oils, and Emulsions." The Engineer will notify the Contractor when the sampling will occur and will witness the collection of the sample from the asphalt distributor immediately before use. Label the can with the corresponding lot and sublot numbers, producer, producer facility, grade, district, date sampled, and project information including highway and CSJ. For emulsions, the Engineer may test as often as necessary to ensure the residual of the emulsion is greater than or equal to the specification requirement in Item 300, "Asphalts, Oils, and Emulsions."

4.7.3. **Lay-Down Operations.** Use the placement temperature in accordance with Table 8 to establish the minimum placement temperature of the mixture delivered to the paving operation.

Table 8
Minimum Mixture Placement Temperature

High-Temperature Binder Grade[1]	Minimum Placement Temperature (Before Entering Paving Operation)[2,3]
PG 76	280˚F
A-R Binder	280˚F

1. The high-temperature binder grade refers to the high-temperature grade of the virgin asphalt binder used to produce the mixture.
2. The mixture temperature must be measured using a hand-held thermal camera or infrared thermometer nearest to the point of entry of the paving operation.
3. Minimum placement temperatures may be reduced 10°F if using a compaction aid.

4.7.3.1. **Thermal Profile.** Use a hand-held thermal camera or a thermal imaging system to obtain a continuous thermal profile in accordance with Tex-244-F. Thermal profiles are not applicable in areas described in Section 3079.4.9.3.2., "Miscellaneous Areas."

4.7.3.1.1. **Thermal Segregation.**

4.7.3.1.1.1. **Moderate.** Any areas that have a temperature differential greater than 25°F, but not exceeding 50°F.

4.7.3.1.1.2. **Severe.** Any areas that have a temperature differential greater than 50°F.

4.7.3.1.2. **Thermal Imaging System.** Review the output results when a thermal imaging system is used, and provide the report described in Tex-244-F to the Engineer daily. Modify the paving process as necessary to eliminate any recurring (moderate or severe) thermal segregation identified by the thermal imaging system.

The Engineer may suspend subsequent paving operations if the Contractor cannot successfully modify the paving process to eliminate recurring severe or moderate thermal segregation.

Provide the Engineer with electronic copies of all daily data files that can be used with the thermal imaging system software to generate temperature profile plots daily or as requested by the Engineer.

4.7.3.1.2.1. **Thermal Camera.** When using a thermal camera instead of the thermal imaging system, take immediate corrective action to eliminate recurring moderate thermal segregation when a hand-held thermal camera is used. Provide the Engineer with the thermal profile of every sublot within one working day of the completion of each lot. When requested by the Engineer, provide the electronic files generated using the thermal camera. Report the results of each thermal profile in accordance with Section 3079.4.2., "Reporting and Responsibilities." The Engineer will use a hand-held thermal camera to obtain a thermal profile at least once per project. Suspend operations and take immediate corrective action to eliminate severe thermal segregation unless otherwise directed. Resume operations when the Engineer determines that subsequent production will meet the requirements of this Section.

4.7.3.2. **Windrow Operations.** Operate windrow pickup equipment so that when hot-mix is placed in windrows, substantially all the mixture deposited on the roadbed is picked up and loaded into the paver.

4.7.3.3. **Hauling Equipment.** Use belly dumps, live bottom, or end dump trucks to haul and transfer mixture; however, with exception of paving miscellaneous areas, end dump trucks are only allowed when used in conjunction with an MTD with remixing capability or when a thermal imaging system is used unless otherwise allowed.

4.7.3.4. **Screed Heaters.** Turn off screed heaters to prevent overheating of the mat if the paver stops for more than 5 min. The Engineer may evaluate the suspect area in accordance with Section 3079.4.9.3.3., "Recovered Asphalt Dynamic Shear Rheometer (DSR)," if the screed heater remains on for more than 5 min. while the paver is stopped.

4.8. **Compaction.** Roll the freshly placed PFC with as many steel-wheeled rollers as necessary, operated in static mode, to seat the mixture without excessive breakage of the aggregate and to provide a smooth surface and uniform texture. Do not use pneumatic rollers. Moisten the roller drums thoroughly with a soap and water solution to prevent adhesion. Use only water or an approved release agent on rollers, tamps, and

other compaction equipment unless otherwise directed.

Use Tex-246-F to test and verify that the compacted mixture has adequate permeability. Measure the water flow once per sublot at locations directed by the Engineer. The water flow rate must be less than 20 sec. Investigate the cause of the water flow rate test failures and take corrective actions during production and placement to ensure the water flow rate is less than 20 sec. Suspend production if two consecutive water flow rate tests fail unless otherwise approved. Resume production after the Engineer approves changes to production or placement methods.

Complete all compaction operations before the pavement temperature drops below 180°F unless otherwise allowed. The Engineer may allow compaction with a light finish roller operated in static mode for pavement temperatures below 180°F.

Allow the compacted pavement to cool to 160°F or lower before opening to traffic unless otherwise directed. Sprinkle the finished mat with water or limewater, when directed, to expedite opening the roadway to traffic.

4.9. **Acceptance Plan.** Sample and test the hot-mix on a lot and sublot basis.

4.9.3. **Referee Testing.** The Materials and Tests Division is the referee laboratory. The Contractor may request referee testing if the differences between Contractor and Engineer test results exceed the operational tolerances in accordance with Table 6 and the differences cannot be resolved. The Contractor may also request referee testing if the Engineer's test results require suspension of production and the Contractor's test results are within specification limits. Make the request within five working days after receiving test results and cores from the Engineer. Referee tests will be performed only on the sublot in question and only for the particular tests in question. Allow 10 working days from the time the referee laboratory receives the samples for test results to be reported. The Department may require the Contractor to reimburse the Department for referee tests if more than three referee tests per project are required and the Engineer's test results are closer to the referee test results than the Contractor's test results.

4.9.4. **Production Acceptance**.

4.9.4.1. **Production Lot.** A production lot consists of four equal sublots. The default quantity for Lot 1 is 1,000 ton; however, when requested by the Contractor, the Engineer may increase the quantity for Lot 1 to no more than 2,000 ton. The Engineer will select subsequent lot sizes based on the anticipated daily production such that approximately three to four sublots are produced each day. The lot size will be between 1,000 ton and 4,000 ton. The Engineer may change the lot size before the Contractor begins any lot.

4.9.4.1.1. **Incomplete Production Lots.** If a lot is begun but cannot be completed, such as on the last day of production or in other circumstances deemed appropriate, the Engineer may close the lot. Close all lots within five working days unless otherwise allowed.

4.9.4.2. **Production Sampling**.

4.9.4.2.1. **Mixture Sampling.** Obtain hot-mix samples from trucks at the plant in accordance with Tex-222-F. The sampler will split each sample into three equal portions in accordance with Tex-200-F and label these portions as "Contractor," "Engineer," and "Referee." The Engineer will perform or witness the sample splitting and take immediate possession of the samples labeled "Engineer" and "Referee." The Engineer will maintain the custody of the samples labeled "Engineer" and "Referee" until the Department's testing is completed.

4.9.4.2.1.1. **Random Sample.** At the beginning of the project, the Engineer will select random numbers for all production sublots. Determine sample locations in accordance with Tex-225-F. Take one sample for each sublot at the randomly selected location. The Engineer will perform or witness the sampling of production sublots.

4.9.4.2.1.2. **Blind Sample.** For one sublot per lot, the Engineer will obtain and test a "blind" sample instead of the random sample collected by the Contractor. Test either the "blind" or the random sample; however, referee testing (if applicable) will be based on a comparison of results from the "blind" sample. The location of the Engineer's "blind" sample will not be disclosed to the Contractor. The Engineer's "blind" sample may be randomly selected in accordance with Tex-225-F for any sublot or selected at the discretion of the Engineer. The

Engineer will use the Contractor's split sample for sublots not sampled by the Engineer.

4.9.4.2.2. **Informational Shear Bond Strength Testing.** Select one random sublot from Lot 2 or higher for shear bond strength testing. Obtain full depth cores in accordance with Tex-249-F. Label the cores with the Control Section Job (CSJ), producer of the tack coat, mix type, shot rate, lot, and sublot number and provide to the Engineer. The Engineer will ship the cores to the Materials and Tests Division or district laboratory for shear bond strength testing. Results from these tests will not be used for specification compliance.

4.9.4.2.3. **Informational Hamburg and Overlay Testing.** Select one random sublot from Lot 2 or higher for Hamburg and Overlay testing during the first week of production. Obtain and provide the Engineer with approximately 90 lb. of mixture, sampled in accordance with Tex-222-F, in sealed containers, boxes, or bags labeled with the Control-Section-Job (CSJ), mixture type, lot, and sublot number. The Engineer will ship the mixture to the Materials and Tests Division for Hamburg and Overlay testing. Results from these tests will not be used for specification compliance.

4.9.4.2.4. **Asphalt Binder Sampling.** Obtain a 1 qt. (1 gal. for A-R binder) sample of the asphalt binder witness by the Engineer for each lot of mixture produced. The Contractor will notify the Engineer when the sampling will occur. Obtain the sample at approximately the same time the mixture random sample is obtained. Sample from a port located immediately upstream from the mixing drum or pug mill and upstream from the introduction of any additives in accordance with Tex-500-C, Part II. Label the can with the corresponding lot and sublot numbers, producer, producer facility, grade, district, date sampled, and project information including highway and CSJ. The Engineer will retain these samples for one year. The Engineer may also obtain independent samples. If obtaining an independent asphalt binder sample and upon request of the Contractor, the Engineer will split a sample of the asphalt binder with the Contractor

At least once per project, the Engineer will collect split samples of each binder grade and source used. The Engineer will submit one split sample to the Materials and Tests Division to verify compliance with Item 300, "Asphalts, Oils, and Emulsions" and will retain the other split sample for one year.

4.9.4.3. **Production Testing.** The Contractor and Engineer must perform production tests in accordance with Table 9. The Contractor has the option to verify the Engineer's test results on split samples provided by the Engineer. Determine compliance with operational tolerances in accordance with Table 6 for all sublots.

At any time during production, the Engineer may require the Contractor to verify the following based on quantities used:

- lime content (within ±0.1% of JMF), when PG binder is specified;
- fiber content (within ±0.03% of JMF), when PG binder is specified; and
- CRM content (within ±1.5% of JMF), when A-R binder is specified.

Maintain the in-line measuring device when A-R binder is specified to verify the A-R binder viscosity between 2,500 and 4,000 centipoise at 350°F unless otherwise approved. Record A-R binder viscosity at least once per hour and provide the Engineer with a daily summary unless otherwise directed.

If the aggregate mineralogy is such that Tex-236-F, Part I does not yield reliable results, the Engineer may allow alternate methods for determining the asphalt content and aggregate gradation. The Engineer will require the Contractor to provide evidence that results from Tex-236-F, Part I are not reliable before permitting an alternate method unless otherwise allowed. Use the applicable test procedure as directed if an alternate test method is allowed.

Table 9
Production and Placement Testing Frequency

Description	Test Method	Minimum Contractor Testing Frequency	Minimum Engineer Testing Frequency
Individual % retained for sieve sized larger than #200 % passing the #200 sieve	Tex-200-F	1 per sublot	1 per 12 sublots
Laboratory-molded density, %	Tex-207-F, Part VIII	1 per sublot	1 per lot
Asphalt binder content[1], %	Tex-236-F, Part I[2]	1 per sublot	1 per lot
Drain-down, %	Tex-235-F	1 per sublot	1 per 12 sublots
Boil test[3]	Tex-530-C	1 per project	1 per project
Moisture content	Tex-212-F, Part II	When directed	1 per project
Cantabro loss, %	Tex-245-F	1 per project (sample only)	1 per project
Overlay test	Tex-248-F	1 per project (sample only)	1 per project[4,9]
Hamburg Wheel test	Tex-242-F	1 per project (sample only)	1 per project[4,9]
Water flow test	Tex-246-F	1 per sublot	1 per project
Asphalt binder sampling	Tex-500-C, Part II	1 per lot (sample only)[5]	1 per project
Tack coat sampling and testing	Tex-500-C, Part III	N/A	1 per project
Thermal profile	Tex-244-F	1 per sublot,[6,7,8]	1 per project[7]

1. May be obtained from t mass flow meter readouts as determined by the Engineer.
2. Ensure the binder content determination excludes fibers.
3. When shown on the plans.
4. Testing performed by the Materials and Tests Division on sample obtained from Lot 2 or higher.
5. Obtain samples witness by the Engineer. The Engineer will retain these samples for one year.
6. To be performed in the presence of the Engineer when using the thermal camera, unless otherwise approved.
7. Not required when a thermal imaging system is used.
8. When using the thermal imaging system, the test report must include the temperature measurements taken in accordance with Tex-244-F.
9. Testing performed by the Materials and Tests Division for informational purposes only.

4.9.4.4. **Operational Tolerances.** Control the production process within the operational tolerances in accordance with Table 6. Suspend production and placement operations when production or placement test results exceed the tolerances in accordance with Table 6 unless otherwise allowed. When production is suspended, the Engineer will allow production to resume when test results or other information indicates the next mixture produced will be within the operational tolerances.

4.9.4.5. **Individual Loads of Hot-Mix.** The Engineer can reject individual truckloads of hot-mix. When a load of hot-mix is rejected for reasons other than temperature, contamination, or excessive uncoated particles, the Contractor may request that the rejected load be tested. Make this request within 4 hr. of rejection. The Engineer will sample and test the mixture. If test results are within the operational tolerances in accordance with Table 6, payment will be made for the load. If test results are not within operational tolerances, no payment will be made for the load.

4.9.5. **Placement Acceptance.**

4.9.5.1. **Placement Lot.** A placement lot consists of four placement sublots. A placement sublot consists of the area placed during a production sublot.

4.9.5.2. **Miscellaneous Areas.** Miscellaneous areas include areas that typically involve significant handwork or discontinuous paving operations such as driveways, mailbox turnouts, crossovers, gores, spot level-up

areas, and other similar areas. The specified layer thickness is based on the rate of 90 lb. per square yard for each inch of pavement unless another rate is shown on the plans. Miscellaneous areas are not subject to thermal profiles testing.

4.9.5.3. **Recovered Asphalt Dynamic Shear Rheometer (DSR).** The Engineer may take production samples or cores from suspect areas of the project to determine recovered asphalt properties. Asphalt binders with an aging ratio greater than 3.5 do not meet the requirements for recovered asphalt properties and may be deemed defective when tested and evaluated by the Materials and Tests Division. The aging ratio is the DSR value of the extracted binder divided by the DSR value of the original unaged binder. Obtain DSR values in accordance with AASHTO T 315 at the specified high temperature performance grade of the asphalt. The Engineer may require removal and replacement of the defective material at the Contractor's expense. The asphalt binder will be recovered for testing from production samples or cores in accordance with Tex-211-F.

4.9.5.4. **Irregularities.** Identify and correct irregularities, including segregation, rutting, raveling, flushing, fat spots, mat slippage, irregular color, irregular texture, roller marks, tears, gouges, streaks, uncoated aggregate particles, or broken aggregate particles. The Engineer may also identify irregularities, and in such cases, the Engineer will promptly notify the Contractor. If the Engineer determines that the irregularity will adversely affect pavement performance, the Engineer may require the Contractor to remove and replace (at the Contractor's expense) areas of the pavement that contain irregularities. The Engineer may also require the Contractor to remove and replace (at the Contractor's expense) areas where the mixture does not bond to the existing pavement.

If irregularities are detected, the Engineer may require the Contractor to immediately suspend operations or may allow the Contractor to continue operations for no more than one day while the Contractor is taking appropriate corrective action.

4.9.6. **Exempt Production.** When the anticipated daily production is less than 100 ton, all QC and QA sampling and testing are waived. The Engineer may deem the mixture as exempt production for the following conditions:

- anticipated daily production is more than 100 ton but less than 250 ton;
- total production for the project is less than 2,500 ton;
- when mutually agreed between the Engineer and the Contractor; or
- when shown on the plans.

For exempt production, the Contractor is relieved of all production and placement sampling and testing requirements. All other specification requirements apply, and the Engineer will perform acceptance tests for production and placement in accordance with Table 9.

For exempt production:

- produce, haul, place, and compact the mixture as directed by the Engineer; and
- control mixture production to yield a laboratory-molded density that is within ±1.0% of the target density as tested by the Engineer.

4.9.7. **Ride Quality.** Measure ride quality in accordance with Item 585, "Ride Quality for Pavement Surfaces," unless otherwise shown on the plans.

5. MEASUREMENT

5.1. **PFC Hot-Mix Asphalt.** Permeable friction course (PFC) hot-mix will be measured by the ton of composite mixture which includes asphalt, aggregate, and additives. Measure the weight on scales in accordance with Item 520, "Weighing and Measuring Equipment.

5.2. **Tack Coat.** Tack coat will be measured at the applied temperature by strapping the tank before and after road application and determining the net volume in gallons from the calibrated distributor. The Engineer will witness all strapping operations for volume determination. All tack, including emulsions, will be measured by the gallon applied.

The Engineer may allow the use of a metering device to determine asphalt volume used and application rate if the device is accurate to within 1.5% of the strapped volume.

6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under Section 3079.5.1., "PFC Hot-Mix Asphalt," will be paid for at the unit bid price for "Permeable friction course Hot Mix Asphalt" of the mixture type, SAC, and binder specified. These prices are full compensation for surface preparation, materials, placement, equipment, labor, tools, and incidentals.

The work performed and materials furnished in accordance with this Item and measured as provided under Section 3079.5.2., "Tack Coat," will be paid for at the unit bid price for "Tack Coat" of the tack coat provided. These prices are full compensation for materials, placement, equipment, labor, tools, and incidentals.

Trial batches will not be paid for unless they are included in pavement work approved by the Department.

Payment adjustment for ride quality will be determined in accordance with Item 585, "Ride Quality for Pavement Surfaces."

Special Specification 3081
Thin Overlay Mixtures

1. DESCRIPTION

Construct a thin surface course composed of a compacted mixture of aggregate and asphalt binder mixed hot in a mixing plant. Produce a thin overlay mixture (TOM) with a minimum lift thickness of 1/2 in. for a Type F mixture and 3/4 in. for a Type C mixture.

2. MATERIALS

Furnish uncontaminated materials of uniform quality that meet the requirements of the plans and specifications.

Notify the Engineer of all material sources and before changing any material source or formulation. The Engineer will verify that the specification requirements are met when the Contractor makes a source or formulation change, and may require a new laboratory mixture design, trial batch, or both. The Engineer may sample and test project materials at any time during the project to verify specification compliance in accordance with Item 6, "Control of Materials."

2.1. **Aggregate.** Furnish aggregates from sources that conform to the requirements in accordance with Table 1 and as specified in this Section. Aggregate requirements in this Section, including those shown in Table 1, may be modified or eliminated when shown on the plans. Additional aggregate requirements may be specified when shown on the plans. Provide aggregate stockpiles that meet the definitions in this Section for coarse, intermediate, or fine aggregate. Do not use reclaimed asphalt pavement (RAP) or recycled asphalt shingles (RAS). Supply aggregates that meet the definitions in accordance with Tex-100-E for crushed gravel or crushed stone. The Engineer will designate the plant or the quarry as the sampling location. Provide samples from materials produced for the project. The Engineer will establish the Surface Aggregate Classification (SAC) and perform Los Angeles abrasion, magnesium sulfate soundness, and Micro-Deval tests. Perform all other aggregate quality tests in accordance with Table 1. Document all test results on the mixture design report. The Engineer may perform tests on independent or split samples to verify Contractor test results. Stockpile aggregates for each source and type separately. Determine aggregate gradations for mixture design and production testing based on the washed sieve analysis in accordance with Tex-200-F, Part II.

2.1.1. **Coarse Aggregate.** Coarse aggregate stockpiles must have no more than 20% material passing the No. 8 sieve. Aggregates from sources listed in the Department's *Bituminous Rated Source Quality Catalog* (BRSQC) are preapproved for use. Use only the rated values for hot-mix listed in the BRSQC. Rated values for surface treatment (ST) do not apply to coarse aggregate sources used in hot-mix asphalt.

For sources not listed on the Department's BRSQC:

- build an individual stockpile for each material;
- request the Department test the stockpile for specification compliance;
- approved only when tested by the Engineer;
- once approved, do not add material to the stockpile unless otherwise approved; and
- allow 30 calendar days for the Engineer to sample, test, and report results.

2.1.1.1. **Blending Class A and Class B Aggregates.** Class B aggregate meeting all other requirements in blending Class A and B aggregates to meet a Class A requirement, ensure that at least 50% by weight, or volume if required, of all aggregates used in the mixture design retained on the No. 8 sieve comes from the Class A

aggregate source, unless otherwise shown on the plans. Blend by volume if the bulk specific gravities of the Class A and B aggregates differ by more than 0.300. Class B aggregate may be disallowed when shown on the plans.

The Engineer may perform tests at any time during production, when the Contractor blends Class A and B aggregates to meet a Class A requirement, to ensure that at least 50% by weight, or volume if required, of the material retained on the No. 8 sieve comes from the Class A aggregate source. The Engineer will use the Department's mix design template, when electing to verify conformance, to calculate the percent of Class A aggregate retained on the No. 8 sieve by inputting the bin percentages shown from readouts in the control room at the time of production and stockpile gradations measured at the time of production. The Engineer may determine the gradations based on either washed or dry sieve analysis from samples obtained from individual aggregate cold feed bins or aggregate stockpiles. The Engineer may perform spot checks using the gradations supplied by the Contractor on the mixture design report as an input for the template; however, a failing spot check will require confirmation with a stockpile gradation determined by the Engineer.

2.1.1.2. **Micro-Deval Abrasion.** The Engineer will perform a minimum of one Micro-Deval abrasion test in accordance with Tex-461-A for each coarse aggregate source used in the mixture design that has a Rated Source Soundness Magnesium (RSSM) loss value greater than 15 as listed in the BRSQC, unless otherwise directed. The Engineer will perform testing before the start of production and may perform additional testing at any time during production. The Engineer may obtain the coarse aggregate samples from each coarse aggregate source or may require the Contractor to obtain the samples. The Engineer may waive all Micro-Deval testing based on a satisfactory test history of the same aggregate source.

The Engineer will estimate the magnesium sulfate soundness loss for each coarse aggregate source, when tested, using the following formula:

$$Mg_{est.} = (RSSM)(MD_{act.}/RSMD)$$

where:
Mg_{est} = magnesium sulfate soundness loss
$RSSM$ = Rated Source Soundness Magnesium
MD_{act} = actual Micro-Deval percent loss
$RSMD$ = Rated Source Micro-Deval

When the estimated magnesium sulfate soundness loss is greater than the maximum magnesium sulfate soundness loss specified, the coarse aggregate source will not be allowed for use unless otherwise approved. The Engineer will consult the Soils and Aggregates Section of the Materials and Tests Division, and additional testing may be required before granting approval.

2.1.2. **Intermediate Aggregate.** Aggregates not meeting the definition of coarse or fine aggregate will be defined as intermediate aggregate. Supply intermediate aggregates, when used that are free from organic impurities. The Engineer may test the intermediate aggregate in accordance with Tex-408-A to verify the material is free from organic impurities. Supply intermediate aggregate from coarse aggregate sources, when used that meet the requirements in accordance with Table 1 unless otherwise approved.

If 10% or more of the stockpile is retained on the No. 4 sieve, verify that it meets the requirements in accordance with Table 1 for crushed face count (Tex-460-A) and flat and elongated particles (Tex-280-F).

2.1.3. **Fine Aggregate.** Fine aggregates consist of manufactured sands and screenings. Natural sands are not allowed in any mixture. Fine aggregate stockpiles must meet the fine aggregate properties in accordance with Table 1 and the gradation requirements in accordance with Table 2. Supply fine aggregates that are free from organic impurities. The Engineer may test the fine aggregate in accordance with Tex-408-A to verify the material is free from organic impurities. Use fine aggregate from coarse aggregate sources that meet the requirements in accordance with Table 1 unless otherwise approved.

If 10% or more of the stockpile is retained on the No. 4 sieve, verify that it meets the requirements in accordance with Table 1 for crushed face count (Tex-460-A) and flat and elongated particles (Tex-280-F).

Table 1
Aggregate Quality Requirements

Property	Test Method	Requirement
Coarse Aggregate		
SAC	Tex-499-A	A[1]
Deleterious material, %, Max	Tex-217-F, Part I	1.5
Decantation, %, Max	Tex-217-F, Part II	1.5
Micro-Deval abrasion, %	Tex-461-A	Note [2]
Los Angeles abrasion, %, Max	Tex-410-A	30
Magnesium sulfate soundness, 5 cycles, %, Max	Tex-411-A	20
Crushed face count,[3] %, Min	Tex-460-A, Part I	95
Flat and elongated particles @ 5:1, %, Max	Tex-280-F	10
Fine Aggregate		
Linear shrinkage, %, Max	Tex-107-E	3
Sand equivalent, %, Min	Tex-203-F	45

1. Surface Aggregate Classification of "A" is required unless otherwise shown on the plans.
2. Used to estimate the magnesium sulfate soundness loss in accordance with Section 3081.2.1.1.2., "Micro-Deval Abrasion."
3. Only applies to crushed gravel.

Table 2
Gradation Requirements for Fine Aggregate

Sieve Size	% Passing by Weight or Volume
3/8"	100
#8	70–100
#200	0–30

2.2. **Mineral Filler.** Mineral filler consists of finely divided mineral matter such as agricultural lime, crusher fines, or hydrated lime. Mineral filler is allowed unless otherwise shown on the plans. Fly ash is not permitted unless otherwise shown on the plans. Use no more than 2% hydrated lime unless otherwise shown on the plans. Test all mineral fillers except hydrated lime and fly ash in accordance with Tex-107-E to ensure specification compliance. The plans may require or disallow specific mineral fillers. Provide mineral filler, when used, that:

- is sufficiently dry, free-flowing, and free from clumps and foreign matter as determined by the Engineer;
- does not exceed 3% linear shrinkage when tested in accordance with Tex-107-E; and
- meets the gradation requirements in Table 3, unless otherwise shown on the plans.

Table 3
Gradation Requirements for Mineral Filler

Sieve Size	% Passing by Weight or Volume
#8	100
#200	55–100

2.3. **Baghouse Fines.** Fines collected by the baghouse or other dust-collecting equipment may be reintroduced into the mixing drum.

2.4. **Asphalt Binder.** Furnish performance-graded (PG) asphalt binder with a high temperature grade of PG 76 unless otherwise shown in the plans and a low temperature grade as shown on the plans, in accordance with Section 300.2.10., "Performance-Graded Binders."

2.5. **Tack Coat.** Furnish CSS-1H, SS-1H, EBL, or a PG binder with a minimum high-temperature grade of PG 58 for tack coat binder in accordance with Item 300, "Asphalts, Oils, and Emulsions." Specialized tack coat materials listed on the Department's Tracking Resistant Asphalt Interlayer (TRAIL) MPL may be allowed or required when shown on the plans. Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use.

2.6. **Additives.** Provide the Engineer with documentation such as the bill of lading showing the quantity of additives used in the project unless otherwise directed.

2.6.1. **Lime and Liquid Antistripping Agent.** When lime or a liquid antistripping agent is used, add in accordance with Item 301, "Asphalt Antistripping Agents." Use no more than 1% hydrated lime when using crushed gravel. Do not add lime directly into the mixing drum of any plant where lime is removed through the exhaust stream unless the plant has a baghouse or dust collection system that reintroduces the lime into the drum.

2.6.2. **Compaction Aid.** Compaction Aid is defined as a department-approved chemical warm mix additive denoted as "chemical additive" on the Department's materials producer list (MPL) that is used to facilitate mixing and compaction of HMA.

Compaction Aid is allowed for use on all projects. Compaction aid is required when shown on the plans or as required in Section 3081.4.7.1., "Weather Conditions."

Warm mix foaming processes, denoted as "foaming process" on the Department-approved MPL, may be used to facilitate mixing and compaction of HMA; however warm mix foaming processes are not defined as a Compaction Aid.

2.7. **Recycled Materials.** Recycled materials are not allowed for use.

3. EQUIPMENT

Provide required or necessary equipment in accordance with Item 320, "Equipment for Asphalt Concrete Pavement."

4. CONSTRUCTION

Produce, haul, place, and compact the specified paving mixture. In addition to tests required by the specification, Contractors may perform other QC tests as deemed necessary. At any time during the project, the Engineer may perform production and placement tests as deemed necessary in accordance with Item 5, "Control of the Work." Schedule and participate in a mandatory pre-paving meeting with the Engineer on or before the first day of paving unless otherwise shown on the plans.

4.1. **Certification.** Personnel certified by the Department-approved hot-mix asphalt certification program must conduct all mixture designs, sampling, and testing in accordance with Table 4. Supply the Engineer with a list of certified personnel and copies of their current certificates before beginning production and when personnel changes are made. Provide a mixture design developed and signed by a Level 2 certified specialist. Provide Level 1A certified specialists at the plant during production operations. Provide Level 1B certified specialists to conduct placement tests. Provide AGG101 certified specialists for aggregate testing.

Table 4
Test Methods, Test Responsibility, and Minimum Certification Levels

Test Description	Test Method	Contractor	Engineer	Level[1]
1. Aggregate Testing				
Sampling	Tex-221-F	✓	✓	1A/AGG101
Dry sieve	Tex-200-F, Part I	✓	✓	1A/AGG101
Washed sieve	Tex-200-F, Part II	✓	✓	1A/AGG101
Deleterious material	Tex-217-F, Part I	✓	✓	AGG101
Decantation	Tex-217-F, Part II	✓	✓	AGG101
Los Angeles abrasion	Tex-410-A		✓	Department
Magnesium sulfate soundness	Tex-411-A		✓	Department
Micro-Deval abrasion	Tex-461-A		✓	AGG101
Crushed face count	Tex-460-A	✓	✓	AGG101
Flat and elongated particles	Tex-280-F	✓	✓	AGG101
Sand equivalent	Tex-203-F	✓	✓	AGG101
Organic impurities	Tex-408-A	✓	✓	AGG101
Methylene blue test	Tex-252-F		✓	Department
2. Asphalt Binder & Tack Coat Sampling				
Asphalt binder sampling	Tex-500-C, Part II	✓	✓	1A/1B
Tack coat sampling	Tex-500-C, Part III	✓	✓	1A/1B
3. Mix Design & Verification				
Design and JMF changes	Tex-204-F	✓	✓	2
Mixing	Tex-205-F	✓	✓	2
Molding (TGC)	Tex-206-F	✓	✓	1A
Molding (SGC)	Tex-241-F	✓	✓	1A
Laboratory-molded density	Tex-207-F, Parts I & VI	✓	✓	1A
Rice gravity	Tex-227-F, Part II	✓	✓	1A
Drain-down	Tex-235-F	✓	✓	1A
Ignition oven correction factors[2]	Tex-236-F, Part II	✓	✓	2
Indirect tensile strength	Tex-226-F	✓	✓	1A
Overlay test	Tex-248-F		✓	Department
Hamburg Wheel test	Tex-242-F	✓	✓	1A
Boil test[4]	Tex-530-C	✓	✓	1A
4. Production Testing				
Selecting production random numbers	Tex-225-F, Part I		✓	1A
Mixture sampling	Tex-222-F	✓	✓	1A/1B
Molding (TGC)	Tex-206-F	✓	✓	1A
Molding (SGC)	Tex-241-F	✓	✓	1A
Laboratory-molded density	Tex-207-F, Parts I & VI	✓	✓	1A
Rice gravity	Tex-227-F, Part II	✓	✓	1A
Gradation & asphalt binder content[2]	Tex-236-F, Part I	✓	✓	1A
Drain-down	Tex-235-F	✓	✓	1A
Control charts	Tex-233-F	✓	✓	1A
Moisture content	Tex-212-F, Part II	✓	✓	1A/AGG101
Hamburg Wheel test	Tex-242-F	✓	✓	1A
Overlay test	Tex-248-F	✓	✓	Department
Micro-Deval abrasion	Tex-461-A		✓	AGG101
Boil test[4]	Tex-530-C	✓	✓	1A
Absorn recovery	Tex-211-F		✓	Department
5. Placement Testing				
Establish rolling pattern	Tex-207-F, Part IV	✓		1B
In-place density (nuclear method)	Tex-207-F, Part III	✓		1B
Control charts	Tex-233-F	✓	✓	1A
Ride quality measurement	Tex-1001-S	✓	✓	Note 3
Thermal profile	Tex-244-F	✓	✓	1B
Water flow test	Tex-246-F	✓	✓	1B

1. Level 1A, 1B, AGG101, and 2 are certification levels provided by the Hot Mix Asphalt Center certification program.
2. Refer to Section 3081.4.9.2.3., "Production Testing," for exceptions to using an ignition oven.
3. Profiler and operator are required to be certified at the Texas A&M Transportation Institute facility when Surface Test Type B is specified.
4. When shown on the plans.

4.2. **Reporting and Responsibilities.** Use Department-provided templates to record and calculate all test data, including mixture design, production and placement QC/QA, control charts, and thermal profiles. Obtain the current version of the templates at https://www.txdot.gov/inside-txdot/forms-publications/consultants-contractors/forms/site-manager.html or from the Engineer. The Engineer and the Contractor will provide any available test results to the other party when requested. The maximum allowable time for the Contractor and Engineer to exchange test data is as given in Table 5 unless otherwise approved. The Engineer and the Contractor will immediately report to the other party any test result that requires suspension of production or placement or that fails to meet the specification requirements. Record and electronically submit all test results and pertinent information on Department-provided templates.

Subsequent sublots placed after test results are available to the Contractor, which require suspension of operations, may be considered unauthorized work. Unauthorized work will be accepted or rejected at the discretion of the Engineer in accordance with Section 5.3., "Conformity with Plans, Specifications, and Special Provisions."

Table 5
Reporting Schedule

Description	Reported By	Reported To	To Be Reported Within
Production Quality Control			
Gradation[1]	Contractor	Engineer	1 working day of completion of the sublot
Asphalt binder content[1]			
Laboratory-molded density[2]			
Moisture content[3]			
Boil test[5]			
Production Quality Assurance			
Gradation[3]	Engineer	Contractor	1 working day of completion of the sublot
Asphalt binder content[3]			
Laboratory-molded density[1]			
Hamburg Wheel test[4]			
Overlay test[4]			
Boil test[5]			
Binder tests[4]			
Placement Quality Control			
Thermal profile[1]	Contractor	Engineer	1 working day of completion of the lot
Water flow[1]			
Placement Quality Assurance			
Thermal profile[3]	Engineer	Contractor	1 working day of completion of the lot
Aging ratio[4]			
Water flow			

1. These tests are required on every sublot.
2. Optional test. When performed on split samples, report the results as soon as they become available.
3. To be performed at the frequency specified and in accordance with Table 13 or as shown on the plans.
4. To be reported as soon as the results become available.
5. When shown on the plans.

Use the procedures described in Tex-233-F to plot the results of all quality control (QC) and quality assurance (QA) testing. Update the control charts as soon as test results for each sublot become available. Make the control charts readily accessible at the field laboratory. The Engineer may suspend production for failure to update control charts.

4.3. **Quality Control Plan (QCP).** Develop and follow the QCP in detail. Obtain approval for changes to the QCP made during the project. The Engineer may suspend operations if the Contractor fails to comply with the QCP.

Submit a written QCP before the mandatory pre-paving meeting. Receive approval of the QCP before pre-paving meeting. Include the following items in the QCP:

4.3.1. **Project Personnel**. For project personnel, include:

- a list of individuals responsible for QC with authority to take corrective action;
- current contact information for each individual listed; and
- current copies of certification documents for individuals performing specified QC functions.

4.3.2. **Material Delivery and Storage.** For material delivery and storage, include:

- the sequence of material processing, delivery, and minimum quantities to assure continuous plant operations;
- aggregate stockpiling procedures to avoid contamination and segregation;
- frequency, type, and timing of aggregate stockpile testing to assure conformance of material requirements before mixture production; and
- procedure for monitoring the quality and variability of asphalt binder.

4.3.3. **Production.** For production, include:

- loader operation procedures to avoid contamination in cold bins;
- procedures for calibrating and controlling cold feeds;
- procedures to eliminate debris or oversized material;
- procedures for adding and verifying rates of each applicable mixture component (e.g., aggregate, asphalt binder, lime, liquid antistrip, compaction aid, foaming process);
- procedures for reporting job control test results; and
- procedures to avoid segregation and drain-down in the silo.

4.3.4. **Loading and Transporting.** For loading and transporting, include:

- type and application method for release agents; and
- truck loading procedures to avoid segregation.

4.3.5. **Placement and Compaction.** For placement and compaction, include:

- proposed agenda for mandatory pre-paving meeting, including date and location;
- proposed paving plan (e.g., production rate, paving widths, joint offsets, and lift thicknesses);
- type and application method for release agents in the paver and on rollers, shovels, lutes, and other utensils;
- procedures for the transfer of mixture into the paver, while avoiding physical and thermal segregation and preventing material spillage;
- process to balance production, delivery, paving, and compaction to achieve continuous placement operations and good ride quality;
- paver operations (e.g., speed, operation of wings, height of mixture in auger chamber) to avoid physical and thermal segregation and other surface irregularities; and
- procedures to construct quality longitudinal and transverse joints.

4.4. **Mixture Design.**

4.4.1. **Design Requirements.** The Contractor may design the mixture using a Texas Gyratory Compactor (TGC) or a Superpave Gyratory Compactor (SGC) unless otherwise shown on the plans. Use the typical weight design example given in Tex-204-F, Part I, when using a TGC. Use the Superpave mixture design procedure provided in Tex-204-F, Part IV, when using a SGC. Design the mixture to meet the requirements in accordance with Tables 1, 2, 3, 6, and 7.

4.4.1.1. **Target Laboratory-Molded Density When the TGC Is Used.** Design the mixture at a 97.5% target laboratory-molded density or in accordance with Table 7.

4.4.1.2. **Design Number of Gyrations (Ndesign) When the SGC Is Used.** Design the mixture at 50 gyrations (Ndesign). Use a target laboratory-molded density of 96.0% to design the mixture; however, adjustments can be made to the Ndesign value as noted in Table 7. The Ndesign level may be reduced to no less than 35 gyrations at the Contractor's discretion.

Use an approved laboratory from the Department's MPL to perform the Hamburg Wheel test, and the Department will perform the Overlay test and provide results with the mixture design, or provide the laboratory mixture and request that the Department perform the Hamburg Wheel test and Overlay test. The Engineer will be allowed 10 working days to provide the Contractor with Hamburg Wheel test and Overlay test results on the laboratory mixture design.

The Engineer will provide the mixture design when shown on the plans. The Contractor may submit a new mixture design at any time during the project. The Engineer will verify and approve all mixture designs (JMF1) before the Contractor can begin production.

Provide the Engineer with a mixture design report using the Department-provided template. Include the following items in the report:

- the combined aggregate gradation, source, specific gravity, and percent of each material used;
- the target laboratory-molded density (or Ndesign level when using the SGC);
- results of all applicable tests;
- the mixing and molding temperatures;
- the signature of the Level 2 person or persons that performed the design;
- the date the mixture design was performed; and
- a unique identification number for the mixture design.

Table 6
Master Gradation Limits (% Passing by Weight or Volume) and Volumetric Requirements

Sieve Size	Coarse (TOM-C)	Fine (TOM-F)
1/2"	100.0[1]	100.0[1]
3/8"	95.0–100.0	98.0–100.0
#4	40.0–60.0	70.0–95.0
#8	17.0–27.0	40.0–65.0
#16	5.0–27.0	20.0–45.0
#30	5.0–27.0	10.0–35.0
#50	5.0–27.0	10.0–20.0
#200	5.0–9.0	2.0–12.0
Asphalt Binder Content,[2] % Min		
-	6.0	6.5
Design VMA,[3] % Min		
-	16.0	16.5
Production (Plant-Produced) VMA,[3] % Min		
-	15.5	16.0

1. Defined as maximum sieve size. No tolerance allowed.
2. Unless otherwise shown on the plans or approved by the Engineer.
3. Voids in Mineral Aggregates (VMA).

Table 7
Mixture Design Properties

Mixture Property	Test Method	Requirement
Target laboratory-molded density, % (TGC)	Tex-207-F	97.5[1]
Design gyrations (Ndesign for SGC)	Tex-241-F	50[2]
Hamburg Wheel test, passes at 12.5 mm rut depth for PG 76 mixtures	Tex-242-F	20,000 Min
Overlay test, Critical Fracture Energy, lb.-in/sq. in	Tex-248-F	1.5 Min
Overlay test, Crack Progression Rate	Tex-248-F	0.40 Max
Drain-down, %	Tex-235-F	0.20 Max

1. Unless otherwise shown on the plans or approved by the Engineer. Laboratory-molded density requirement using the TGC may be waived when approved by the Engineer.

2. May be adjusted within the range of 35–100 gyrations when shown on the plans or specification or when mutually agreed between the Engineer and Contractor. Laboratory-molded density requirement using the SGC may be waived when approved by the Engineer.

4.4.1 **Job-Mix Formula Approval.** The job-mix formula (JMF) is the combined aggregate gradation, target laboratory-molded density (or Ndesign level), and target asphalt percentage used to establish target values for hot-mix production. JMF1 is the original laboratory mixture design used to produce the trial batch. When a compaction aid or foaming process is used, JMF1 may be designed and submitted to the Engineer without including the compaction aid or foaming process. When a compaction aid or foaming process is used, document the compaction aid or foaming process used and recommended rate on the JMF1 submittal. The Engineer and the Contractor will verify JMF1 based on plant-produced mixture from the trial batch unless otherwise approved. The Engineer may accept an existing mixture design previously used on a Department project and may waive the trial batch to verify JMF1. The Department may require the Contractor to reimburse the Department for verification tests if more than two trial batches per design are required.

4.4.2.1. **Contractor's Responsibilities.**

4.4.2.1.1. **Providing Gyratory Compactor.** Use a TGC calibrated in accordance with Tex-914-K when electing or required to design the mixture in accordance with Tex-204-F, Part I, for molding production samples. Furnish an SGC calibrated in accordance with Tex-241-F when electing or required to design the mixture in accordance with Tex-204-F, Part IV, for molding production samples. Locate the SGC if used, at the Engineer's field laboratory or make the SGC available to the Engineer for use in molding production samples.

4.4.2.1.2. **Gyratory Compactor Correlation Factors.** Use Tex-206-F, Part II, to perform a gyratory compactor correlation when the Engineer uses a different gyratory compactor. Apply the correlation factor to all subsequent production test results.

4.4.2.1.3. **Submitting JMF1.** Furnish a mix design report (JMF1) with representative samples of all component materials and request approval to produce the trial batch. Provide approximately 25 lb. of the design mixture if opting to have the Department perform the Hamburg Wheel test on the laboratory mixture, and request that the Department perform the test. Provide approximately 60 lb. of the design mixture to perform the Overlay test.

4.4.2.1.4. **Supplying Aggregates.** Provide approximately 40 lb. of each aggregate stockpile unless otherwise directed.

4.4.2.1.5. **Supplying Asphalt.** Provide at least 1 gal. of the asphalt material and enough quantities of any additives proposed for use.

4.4.2.1.6. **Ignition Oven Correction Factors.** Determine the aggregate and asphalt correction factors from the ignition oven in accordance with Tex-236-F, Part II. Provide correction factors that are not more than 12 mo. old. Provide the Engineer with split samples of the mixtures before the trial batch production, including all additives (except water), and blank samples used to determine the correction factors for the ignition oven used for QA testing during production. Correction factors established from a previously approved mixture design may be used for the current mixture design if the mixture design and ignition oven are the same as previously used and the correction factors are not more than 12 mo. old, unless otherwise directed.

4.4.2.1.7. **Boil Test.** When shown on the plans, perform the test and retain the tested sample from Tex-530-C until completion of the project or as directed. Use this sample for comparison purposes during production.

4.4.2.1.8. **Trial Batch Production.** Provide a plant-produced trial batch upon receiving conditional approval of JMF1 and authorization to produce a trial batch, including the compaction aid or foaming process, if applicable, for verification testing of JMF1 and development of JMF2. Produce a trial batch mixture that meets the requirements in accordance with Table 8. The Engineer may accept test results from recent production of the same mixture instead of a new trial batch.

4.4.2.1.9. **Trial Batch Production Equipment.** Use only equipment and materials proposed for use on the project to produce the trial batch.

4.4.2.1.10. **Trial Batch Quantity.** Produce enough quantity of the trial batch to ensure that the mixture meets the specification requirements.

4.4.2.1.11. **Number of Trial Batches.** Produce trial batches as necessary to obtain a mixture that meets the specification requirements.

4.4.2.1.12. **Trial Batch Sampling.** Obtain a representative sample of the trial batch and split it into three equal portions in accordance with Tex-222-F. Label these portions as "Contractor," "Engineer," and "Referee." Deliver samples to the appropriate laboratory as directed.

4.4.2.1.13. **Trial Batch Testing.** Test the trial batch to ensure the mixture produced using the proposed JMF1 meets the mixture requirements in accordance with Table 8. Ensure the trial batch mixture is also in compliance with the requirements in accordance with Tables 6 and 7. Use a Department-approved laboratory listed on the MPL to perform the Hamburg Wheel test on the trial batch mixture or request that the Department perform the Hamburg Wheel test. Provide approximately 25 lb. of the trial batch mixture if opting to have the Department perform the Hamburg Wheel test, and request that the Department perform the test. Obtain and provide approximately 60 lb. of trial batch mixture in sealed containers, boxes, or bags labeled with the CSJ, mixture type, lot, and sublot number in accordance with Tex-222-F for the Overlay test. The Engineer will be allowed 10 working days to provide the Contractor with Hamburg Wheel test and Overlay test results on the trial batch. Provide the Engineer with a copy of the trial batch test results.

4.4.2.1.14. **Development of JMF2.** Evaluate the trial batch test results after the Engineer grants full approval of JMF1 based on results from the trial batch, determine the optimum mixture proportions, and submit as JMF2. Adjust the asphalt binder content or gradation to achieve the specified target laboratory-molded density. The mixture produced using JMF2 must meet the requirements in accordance with Tables 6 and 7. Verify that JMF2 meets the operation tolerances of JMF1 in accordance with Table 8.

4.4.2.1.15. **Mixture Production.** Use JMF2 to produce Lot 1 after receiving approval for JMF2 and a passing result from the Department's or a Department-approved laboratory's Hamburg Wheel test and the Department's Overlay test on the trial batch. If desired, proceed to Lot 1 production, once JMF2 is approved, at the Contractor's risk without receiving the results from either the Department's Hamburg Wheel test or Overlay test on the trial batch.

Notify the Engineer if electing to proceed without Hamburg Wheel test and Overlay test results from the trial batch. Note that the Engineer may require up to the entire sublot of any mixture failing the Hamburg Wheel test or Overlay test to be removed and replaced at the Contractor's expense.

4.4.2.1.16. **Development of JMF3.** Evaluate the test results from Lot 1, determine the optimum mixture proportions, and submit as JMF3 for use in Lot 2.

4.4.2.1.17. **JMF Adjustments.** If JMF adjustments are necessary to achieve the specified requirements, make the adjustments before beginning a new lot. The adjusted JMF must:

- be provided to the Engineer in writing before the start of a new lot;
- be numbered in sequence to the previous JMF;
- meet the master gradation limits in accordance with Table 6; and
- be within the operational tolerances of JMF2 in accordance with Table 8.

4.4.2.1.18. **Requesting Referee Testing.** Use referee testing, if needed, in accordance with Section 3081.4.9.1., "Referee Testing," to resolve testing differences with the Engineer.

Table 8
Operational Tolerances

Description	Test Method	Allowable Difference between JMF2 and JMF1 Target[1]	Allowable Difference from Current JMF and JMF2[2]	Allowable Difference between Contractor and Engineer[3]
Individual % retained for #8 sieve and larger	Tex-200-F or Tex-236-F	Must be Within Master Grading Limits in accordance with Table 6	±3.0[4,5]	±5.0
Individual % retained for sieves smaller than #8 and larger than #200			±3.0[4,5]	±3.0
% passing the #200 sieve			±2.0[4,5]	±1.6
Asphalt binder content, %[6]	Tex-236-F	±0.3	±0.3[5]	±0.3
Laboratory-molded density, %	Tex-207-F	±1.0	±1.0	±1.0
Laboratory-molded bulk specific gravity		N/A	N/A	±0.020
VMA, % Min	Tex-204-F	Note 7	Note 7	N/A
Theoretical Max specific (Rice) gravity	Tex-227-F	N/A	N/A	±0.020
Drain-down, %	Tex-235-F	Note 8	Note 8	N/A

1. JMF1 is the approved laboratory mixture design used for producing the trial batch. JMF2 is the approved mixture design developed from the trial batch used to produce Lot 1.
2. Current JMF is JMF3 or higher. JMF3 is the approved mix design used to produce Lot 2.
3. Contractor may request referee testing only when values exceed these tolerances.
4. When within these tolerances, mixture production gradations may fall outside the master grading limits; however, the % passing the #200 will be considered out of tolerance when outside the master grading limits.
5. Only applies to mixture produced for Lot 1 and higher.
6. Binder content is not allowed to be outside the limits in accordance with Table 6. May be obtained from asphalt meter readouts as determined by the Engineer.
7. Verify that Table 6 requirements are met.
8. Verify that Table 7 requirements are met.

4.4.2.2. **Engineer's Responsibilities.**

4.4.2.2.1. **Gyratory Compactor.** For mixtures designed in accordance with Tex-204-F, Part I, the Engineer will use a Department TGC, calibrated in accordance with Tex-914-K, to mold samples for trial batch and production testing.

For mixtures designed in accordance with Tex-204-F, Part IV, the Engineer will use a Department SGC, calibrated in accordance with Tex-241-F, to mold samples for laboratory mixture design verification. For molding trial batch and production specimens, the Engineer will use the Contractor-provided SGC at the field laboratory or provide and use a Department SGC at an alternate location.

4.4.2.2.2. **Conditional Approval of JMF1 and Authorizing Trial Batch.** The Engineer will review and verify conformance of the following information within two working days of receipt:

- the Contractor's mix design report (JMF1);
- the Department-provided Overlay test results;
- the Contractor-provided Hamburg Wheel test results;
- all required materials including aggregates, asphalt, and additives; and
- the mixture specifications.

The Engineer will grant the Contractor conditional approval of JMF1 if the information provided on the paper copy of JMF1 indicates that the Contractor's mixture design meets the specifications. When the Contractor does not provide Hamburg Wheel test and department provided Overlay test results with laboratory mixture design, 10 working days are allowed for conditional approval of JMF1. The Engineer will base full approval of JMF1 on test results on mixture from the trial batch.

Unless waived, the Engineer will determine the Micro-Deval abrasion loss in accordance with

Section 3081.2.1.1., "Micro-Deval Abrasion." If the Engineer's test results are pending after two working days, conditional approval of JMF1 will still be granted within two working days of receiving JMF1. When the Engineer's test results become available, they will be used for specification compliance.

The Contractor is authorized to produce a trial batch after the Engineer grants conditional approval of JMF1.

4.4.2.2.3. **Hamburg Wheel and Overlay Testing of JMF1.** If the Contractor requests the option to have the Department perform the Hamburg Wheel test on the laboratory mixture, the Engineer will mold samples in accordance with Tex-242-F to verify compliance with the Hamburg Wheel test requirement in Table 7. The Engineer will perform the Overlay test and mold samples in accordance with Tex-248-F to verify compliance with the Overlay test requirements in Table 7. The Engineer will be allowed 10 working days to provide the Contractor with Hamburg Wheel and Overlay test results on the laboratory mixture design.

4.4.2.2.4. **Ignition Oven Correction Factors.** The Engineer will use the split samples provided by the Contractor to determine the aggregate and asphalt correction factors for the ignition oven used for QA testing during production in accordance with Tex-236-F, Part II. Provide correction factors that are not more than 12 mo. old.

4.4.2.2.5. **Testing the Trial Batch.** Within one full working day, the Engineer will sample and test the trial batch to ensure that the mixture meets the requirements in accordance with Table 8. The Engineer will mold samples in accordance with Tex-242-F if the Contractor requests the option to have the Department perform the Hamburg Wheel test on the trial batch mixture to verify compliance with Hamburg Wheel test requirements in Table 7. The Engineer will mold samples for the Overlay test in accordance with Tex-248-F to verify compliance with the Overlay test requirement in Table 7.

The Engineer will have the option to perform Tex-530-C on the trial batch when shown on the plans. These results may be retained and used for comparison purposes during production.

4.4.2.2.6. **Full Approval of JMF1.** The Engineer will grant full approval of JMF1 and authorize the Contractor to proceed with developing JMF2 if the Engineer's results for the trial batch meet the requirements in accordance with Tables 6 and 7. The Engineer will notify the Contractor that an additional trial batch is required if the trial batch does not meet these requirements.

4.4.2.2.7. **Approval of JMF2.** The Engineer will approve JMF2 within one working day if the mixture meets the requirements in accordance with Table 6, 7, and 8.

4.4.2.2.8. **Approval of Lot 1 Production.** The Engineer will authorize the Contractor to proceed with Lot 1 production (using JMF2) as soon as a passing result is achieved from the Department's or a Department-approved laboratory's Hamburg Wheel test and the Department's Overlay test on the trial batch. The Contractor may proceed at its own risk with Lot 1 production without the results from the Hamburg Wheel test or Overlay test on the trial batch.

If the Department's or Department-approved laboratory's sample from the trial batch fails the Hamburg Wheel test or Overlay test, the Engineer will suspend production until further Hamburg Wheel tests or Overlay tests meet the specified values. The Engineer may require up to the entire sublot of any mixture failing the Hamburg Wheel test or Overlay test to be removed and replaced at the Contractor's expense.

4.4.2.2.9. **Approval of JMF3 and Subsequent JMF Changes.** JMF3 and subsequent JMF changes are approved if they meet the master grading limits and asphalt binder content shown in Table 6 and are within the operational tolerances of JMF2 shown in accordance with Table 8.

4.5. **Production Operations.** Perform a new trial batch when the plant or plant location is changed. Take corrective action and receive approval to proceed after any production suspension for noncompliance to the specification.

4.5.1. **Storage and Heating of Materials.** Do not heat the asphalt binder above the temperatures specified in Item 300, "Asphalts, Oils, and Emulsions," or outside the manufacturer's recommended values. Provide the Engineer with daily records of asphalt binder and hot-mix asphalt discharge temperatures (in legible and discernible increments) in accordance with Item 320, "Equipment for Asphalt Concrete Pavement," unless otherwise directed. Do not store mixture for a period long enough to affect the quality of the mixture, nor in any case longer than 12 hr. unless otherwise approved.

4.5.2. **Mixing and Discharge of Materials.** Notify the Engineer of the target discharge temperature and produce the mixture within 25°F of the target. Monitor the temperature of the material in the truck before shipping to ensure that it does not exceed the maximum production temperatures in accordance with Table 9. The Department will not pay for or allow placement of any mixture produced above the maximum production temperatures listed in Table 9.

Table 9
Maximum Production Temperature

High-Temperature Binder Grade[1]	Max Production Temperature
PG 76	345˚F

1. The high-temperature binder grade refers to the high-temperature grade of the virgin asphalt binder used to produce the mixture.

Control the mixing time and temperature so that substantially all moisture is removed from the mixture before discharging from the plant. Determine the moisture content, if requested, by oven-drying in accordance with Tex-212-F, Part II, and verify that the mixture contains no more than 0.2% of moisture by weight. Obtain the sample immediately after discharging the mixture into the truck and perform the test promptly.

4.6. **Hauling Operations.** Clean all truck beds before use to ensure that mixture is not contaminated. Use a release agent shown on the Department's MPL to coat the inside bed of the truck when necessary. Do not use diesel or any release agent not shown on the Department's MPL.

Use equipment for hauling as defined in Section 3081.4.7.3.3., "Hauling Equipment." Use other hauling equipment only when allowed.

4.7. **Placement Operations.** Collect haul tickets from each load of mixture delivered to the project and provide the Department's copy to the Engineer approximately every hour, or as directed. Use a hand-held thermal camera or infrared thermometer, when a thermal imaging system is not used, to measure and record the internal temperature of the mixture as discharged from the truck or Material Transfer Device (MTD) before or as the mix enters the paver and an approximate station number or GPS coordinates on each ticket. Calculate the daily yield and cumulative yield for the specified lift and provide to the Engineer at the end of paving operations for each day unless otherwise directed. The Engineer may suspend production if the Contractor fails to produce and provide haul tickets and yield calculations by the end of paving operations for each day.

Prepare the surface by removing raised pavement markers and objectionable material such as moisture, dirt, sand, leaves, and other loose impediments from the surface before placing mixture. Remove vegetation from pavement edges. Place the mixture to meet the typical section requirements and produce a smooth, finished surface with a uniform appearance and texture. Place mixture so that longitudinal joints on the surface course coincide within 6-in. of lane lines and are not placed in the wheel path, or as directed, and offset longitudinal joints of successive courses of hot-mix by at least 6-in. Ensure that all finished surfaces will drain properly. Place the mixture at the rate or thickness shown on the plans. The Engineer will use the guidelines in Table 10 to determine the compacted lift thickness. The thickness determined is based on the rate of 110–115 lb. per square inch. for each inch of pavement unless otherwise shown on the plans.

Table 10
Compacted Lift Thickness

Mixture Type	Compacted Lift Thickness[1]	
	Min (in.)	Max (in.)
TOM-C	0.75	1.25
TOM-F	0.5	1.00

1. Compacted target lift thickness will be specified on the plans.

4.7.1. **Weather Conditions.**

4.7.1.1. **When Using a Thermal Imaging System.** The Contractor may pave any time the roadway is dry and the roadway surface temperature is at least 60°F unless otherwise approved or as shown on the plans; however, the Engineer may restrict the Contractor from paving surface mixtures if the ambient temperature is likely to drop below 32°F within 12 hr. of paving. Place mixtures only when weather conditions and moisture conditions of the roadway surface are suitable as determined by the Engineer. Provide output data from the thermal imaging system to demonstrate to the Engineer that no recurring severe thermal segregation exists in accordance with Section 3081.4.7.3.1.2., "Thermal Imaging System."

Produce mixture with a target discharge temperature higher than 300°F and with a compaction aid to facilitate compaction when the air temperature is 70°F and falling

4.7.1.2. **When Not Using a Thermal Imaging System.** When using a thermal camera instead the thermal imaging system, place mixture when the roadway surface temperature is at or above 70°F unless otherwise approved or as shown on the plans. Measure the roadway surface temperature with a hand-held thermal camera or infrared thermometer. Place mixtures only when weather conditions and moisture conditions of the roadway surface are suitable as determined by the Engineer. The Engineer may restrict the Contractor from paving if the air temperature is 70°F and falling.

Produce mixture with a target discharge temperature higher than 300°F and with a compaction aid to facilitate compaction when the air temperature is 70°F and falling.

4.7.2. **Tack Coat.**

4.7.2.1. **Application.** Clean the surface before placing the tack coat. The Engineer will set the rate between 0.04 and 0.10 gal. of residual asphalt per square yard of surface area, unless otherwise specified on the plans. Apply a uniform tack coat at the specified rate unless otherwise directed. Apply the tack coat in a uniform manner to avoid streaks and other irregular patterns. Apply the tack coat to all surfaces that will come in contact with the subsequent HMA placement unless otherwise directed. Apply adequate overlap of the tack coat in the longitudinal direction during placement of the mat to ensure bond of adjacent mats, unless otherwise directed. Allow adequate time for emulsion to break completely before placing any material. Prevent splattering of tack coat when placed adjacent to curb, gutter, and structures. The Engineer may suspend paving operations until there is adequate coverage. Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use.

4.7.2.2. **Sampling.** The Engineer will obtain at least one sample of the tack coat binder per project in accordance with Tex-500-C, Part III, and test it to verify compliance with Item 300, "Asphalts, Oils, and Emulsions." The Engineer will notify the Contractor when the sampling will occur and will witness the collection of the sample from the asphalt distributor immediately before use. Label the can with the corresponding lot and sublot numbers, producer, producer facility, grade, district, date sampled, and project information including highway and CSJ. For emulsions, the Engineer may test as often as necessary to ensure the residual of the emulsion is greater than or equal to the specification requirement in Item 300, "Asphalts, Oils, and Emulsions."

4.7.3. **Lay-Down Operations.** Use the placement temperatures in accordance with Table 11 to establish the minimum placement temperature of mixture delivered to the paving operation.

Table 11
Minimum Mixture Placement Temperature

High-Temperature Binder Grade[1]	Min Placement Temperature (Before Entering Paving Operation)2,3
PG 76	280°F

1. The high-temperature binder grade refers to the high-temperature grade of the virgin asphalt binder used to produce the mixture.
2. The mixture temperature must be measured using a hand-held thermal camera or infrared thermometer nearest to the point of entry of the paving operation.
3. Minimum placement temperatures may be reduced 10°F if using a compaction aid.

4.7.3.1. **Thermal Profile.** Use a hand-held thermal camera or a thermal imaging system to obtain a continuous thermal profile in accordance with Tex-244-F.

4.7.3.1.1. **Thermal Segregation.**

4.7.3.1.1.1. **Moderate.** Any areas that have a temperature differential greater than 25°F, but not exceeding 50°F.

4.7.3.1.1.2. **Severe.** Any areas that have a temperature differential greater than 50°F.

4.7.3.1.2. **Thermal Imaging System.** Review the output results when a thermal imaging system is used, and provide the report described in accordance with Tex-244-F to the Engineer daily. Modify the paving process as necessary to eliminate any recurring (moderate or severe) thermal segregation identified by the thermal imaging system.

The Engineer may suspend subsequent paving operations if the Contractor cannot successfully modify the paving process to eliminate recurring severe or moderate thermal segregation.

Provide the Engineer with electronic copies of all daily data files that can be used with the thermal imaging system software to generate temperature profile plots daily or as requested by the Engineer.

4.7.3.1.3. **Thermal Camera.** When using a thermal camera instead of the thermal imaging system, take immediate corrective action to eliminate recurring moderate thermal segregation when a hand-held thermal camera is used. Evaluate areas with moderate thermal segregation by performing water flow testing in accordance with Tex-246-F and verify the water flow is greater than 120 sec. Provide the Engineer with the thermal profile of every sublot within one working day of the completion of each lot. When requested by the Engineer, provide the electronic files generated using the thermal camera. Report the results of each thermal profile in accordance with Section 3081.4.2., "Reporting and Responsibilities." The Engineer will use a hand-held thermal camera to obtain a thermal profile at least once per project, unless the thermal imaging system is used. Suspend operations and take immediate corrective action to eliminate severe thermal segregation unless otherwise directed. Resume operations when the Engineer determines that subsequent production will meet the requirements of this Section. Evaluate areas with severe thermal segregation by performing water flow testing in accordance with Tex-246-F and verify the water flow is greater than 120 sec. Remove and replace the material in any areas that have both severe thermal segregation and a failing result for water flow test unless otherwise directed.

4.7.3.2. **Windrow Operations.** Operate windrow pickup equipment so that when hot-mix is placed in windrows, substantially all the mixture deposited on the roadbed is picked up and loaded into the paver.

4.7.3.3. **Hauling Equipment.** Use belly dumps, live bottom, or end dump trucks to haul and transfer mixture. End dump trucks are only allowed when used in conjunction with an MTD with remixing capability unless otherwise allowed.

4.7.3.4. **Screed Heaters.** Turn off screed heaters to prevent overheating of the mat if the paver stops for more than 5 min. The Engineer may evaluate the suspect area in accordance with Section 3081.4.9.3.1.1., "Recovered Asphalt Dynamic Shear Rheometer (DSR)," if the screed heater remains on for more than 5 min. while the paver is stopped.

4.8. **Compaction.** Roll the freshly placed mixture with as many steel-wheeled rollers as necessary to ensure adequate compaction without excessive breakage of the aggregate and to provide a smooth surface and uniform texture. Operate each roller in static mode for TOM-F mixtures only. Do not use pneumatic-tire rollers. Use the control strip method given in accordance with Tex-207-F, Part IV, to establish the rolling pattern. Thoroughly moisten the roller drums with a soap and water solution to prevent adhesion. Use only water or an approved release agent on rollers, tamps, and other compaction equipment unless otherwise directed.

Use tamps to thoroughly compact the edges of the pavement along curbs, headers, and similar structures and in locations that will not allow thorough compaction with rollers. The Engineer may require rolling with a trench roller on widened areas, in trenches, and in other limited areas.

Use Tex-246-F to measure water flow to verify the mixture is adequately compacted. Measure the water flow once per sublot at locations directed by the Engineer. Take additional water flow measurements when the minimum temperature of the uncompacted mat is below the temperature requirements in accordance with Table 12.

Table 12
Minimum Uncompacted Mat Temperature Requiring Additional Water Flow Measurements

High-Temperature Binder Grade[1]	Min Temperature of the Uncompacted Mat Allowed Before Initial Break Down Rolling[2,3]
PG 76	<270˚F

1. The high-temperature binder grade refers to the high-temperature grade of the virgin asphalt binder used to produce the mixture.
2. The surface of the uncompacted mat must be measured using a hand-held thermometer or infrared thermometer.
3. Minimum uncompacted mat temperature requiring a water flow measurement may be reduced 10°F if using a compaction aid.

Use Tex-246-F to measure water flow to verify the mixture is adequately compacted at confined longitudinal joints as directed by the Engineer.

The water flow rate should be greater than 120 sec. Investigate the cause of the water flow rate test failures and take corrective actions during production and placement to ensure the water flow rate is greater than 120 sec. Suspend production if two consecutive water flow rate tests fail unless otherwise approved. Resume production after the Engineer approves changes to production or placement methods.

Complete all compaction operations before the pavement temperature drops below 180°F unless otherwise allowed. The Engineer may allow compaction with a light finish roller operated in static mode for pavement temperatures below 180°F when approved.

Allow the compacted pavement to cool to 160°F or lower before opening to traffic unless otherwise directed. Sprinkle the finished mat with water or limewater, when directed, to expedite opening the roadway to traffic.

4.9. **Acceptance Plan.** Sample and test the hot-mix asphalt on a lot and sublot basis.

4.9.1. **Referee Testing.** The Materials and Tests Division is the referee laboratory. The Contractor may request referee testing if the differences between Contractor and Engineer test results exceed the maximum allowable difference in accordance with Table 8 and the differences cannot be resolved. The Contractor may also request referee testing if the Engineer's test results require suspension of production and the Contractor's test results are within specification limits. Make the request within five working days after receiving test results from the Engineer. Referee tests will be performed only on the sublot in question and only for the particular tests in question. Allow 10 working days from the time the referee laboratory receives the samples for test results to be reported. The Department may require the Contractor to reimburse the Department for referee tests if more than three referee tests per project are required and the Engineer's test results are closer to the referee test results than the Contractor's test results.

The Materials and Tests Division will determine the laboratory-molded density based on the molded specific gravity and the maximum theoretical specific gravity of the referee sample.

4.9.2. **Production Acceptance.**

4.9.2.1. **Production Lot.** A production lot consists of four equal sublots. The default quantity for Lot 1 is 500 ton; however, when requested by the Contractor, the Engineer may increase the quantity for Lot 1 to no more than 2,000 ton. The Engineer will select subsequent lot sizes based on the anticipated daily production such that approximately three to four sublots are produced each day. The lot size will be between 500 ton and 2,000 ton. The Engineer may change the lot size before the Contractor begins any lot.

4.9.2.1.1. **Incomplete Production Lots.** If a lot is begun but cannot be completed, such as on the last day of production or in other circumstances deemed appropriate, the Engineer may close the lot. Close all lots within five working days unless otherwise allowed.

4.9.2.2. **Production Sampling.**

4.9.2.2.1. **Mixture Sampling.** Obtain hot-mix samples from trucks at the plant in accordance with Tex-222-F. The sampler will split each sample into three equal portions in accordance with Tex-200-F and label these portions as "Contractor," "Engineer," and "Referee." The Engineer will perform or witness the sample splitting and take immediate possession of the samples labeled "Engineer" and "Referee." The Engineer will maintain the custody of the samples labeled "Engineer" and "Referee" until the Department's testing is completed.

4.9.2.2.1.1. **Random Sample.** At the beginning of the project, the Engineer will select random numbers for all production sublots. Determine sample locations in accordance with Tex-225-F. Take one sample for each sublot at the randomly selected location. The Engineer will perform or witness the sampling of production sublots.

4.9.2.2.1.2. **Blind Sample.** For one sublot per lot, the Engineer will obtain and test a "blind" sample instead of the random sample collected by the Contractor. Test either the "blind" or the random sample; however, referee testing (if applicable) will be based on a comparison of results from the "blind" sample. The location of the Engineer's "blind" sample will not be disclosed to the Contractor. The Engineer's "blind" sample may be randomly selected in accordance with Tex-225-F for any sublot or selected at the discretion of the Engineer. The Engineer will use the Contractor's split sample for sublots not sampled by the Engineer.

4.9.2.2.2. **Informational Methylene Blue Testing.** During the project and at random, obtain and provide the Engineer with approximately 50 lb. of each fine aggregate and approximately 20 lb. of all mineral fillers used to produce the mixture. Label the samples with the Control Section Job (CSJ), mixture type, and approximate lot and sublot number corresponding to when the sample was taken. The Engineer will ship the samples to the Materials and Tests Division for Methylene Blue testing in accordance with Tex-252-F. Results from these tests will not be used for specification compliance.

4.9.2.2.3. **Asphalt Binder Sampling.** Obtain a 1-qt. sample of the asphalt binder witnessed by the Engineer for each lot of mixture produced. The Contractor will notify the Engineer when the sampling will occur. Obtain the sample at approximately the same time the mixture random sample is obtained. Sample from a port located immediately upstream from the mixing drum or pug mill and upstream from the introduction of any additives in accordance with Tex-500-C, Part II. Label the can with the corresponding lot and sublot numbers, producer, producer facility location, grade, district, date sampled, and project information including highway and CSJ. The Engineer will retain these samples for one year. The Engineer may also obtain independent samples. If obtaining an independent asphalt binder sample and upon request of the Contractor, the Engineer will split a sample of the asphalt binder with the Contractor.

At least once per project, the Engineer will collect split samples of each binder grade and source used. The Engineer will submit one split sample to the Materials and Tests Division to verify compliance with Item 300, "Asphalts, Oils, and Emulsions," and will retain the other split sample for 1 yr.

4.9.2.3. **Production Testing.** The Contractor and Engineer must perform production tests in accordance with Table 13. The Contractor has the option to verify the Engineer's test results on split samples provided by the Engineer. Determine compliance with operational tolerances listed in accordance with Table 8 for all sublots. Take immediate corrective action if the Engineer's laboratory-molded density on any sublot is less than 95.0% or greater than 98.0% when using the SGC or less than 96.5% or greater than 98.5% when using the TGC, to bring

the mixture within these tolerances. The Engineer may suspend operations if the Contractor's corrective actions do not produce acceptable results. The Engineer will allow production to resume when the proposed corrective action is likely to yield acceptable results.

The Engineer may allow alternate methods for determining the asphalt binder content and aggregate gradation if the aggregate mineralogy is such that Tex-236-F, Part I does not yield reliable results. Provide evidence that results from Tex-236-F, Part I are not reliable before requesting permission to use an alternate method unless otherwise directed. Use the applicable test procedure as directed if an alternate test method is allowed.

Table 13
Production and Placement Testing Frequency

Description	Test Method	Min Contractor Testing	Min Engineer Testing
Individual % retained for #8 sieve and larger	Tex-200-F or Tex-236-F	1 per sublot	1 per 12 sublots[1]
Individual % retained for sieves smaller than #8 and larger than #200			
% passing the #200 sieve			
Laboratory-molded density	Tex-207-F	N/A	1 per sublot[1]
Laboratory-molded bulk specific gravity			
VMA	Tex-204-F		
Moisture content	Tex-212-F, Part II	When directed	
Theoretical maximum specific (Rice) gravity	Tex-227-F, Part II	N/A	1 per sublot[1]
Asphalt binder content[2]	Tex-236-F, Part I	1 per sublot	1 per lot[1]
Overlay test[3]	Tex-248-F	N/A	1 per project
Hamburg Wheel test	Tex-242-F	N/A	1 per project
Thermal profile	Tex-244-F	1 per sublot[4,5,6]	1 per project[5]
Asphalt binder sampling and testing	Tex-500-C, Part II	1 per lot (sample only)[7]	1 per project
Tack coat sampling and testing	Tex-500-C, Part III	N/A	1 per project
Boil test[8]	Tex-530-C	1 per sublot[9]	1 per project
Water flow	Tex-246-F		
Methylene blue test[10]	Tex-252-F	1 per project (sample only)	

1. For production defined in Section 3081.4.9.4., "Exempt Production," the Engineer will test one per day if 100 ton or more are produced. For Exempt Production, no testing is required with less than 100 ton are produced.
2. May be obtained from asphalt flow meter readout as determined by the Engineer.
3. Testing performed by the Materials and Tests Division on sample obtained from Lot 2 or higher.
4. To be performed in the presence of the Engineer when a thermal camera is used, unless otherwise approved.
5. Not required when a thermal imaging system is used.
6. When using the thermal imaging system, the test report must include the temperature measurements taken in accordance with Tex-244-F.
7. Obtain samples witnessed by the Engineer. The Engineer will retain these samples for 1 yr.
8. When shown on the plans.
9. To be performed in the presence of the Engineer, unless otherwise directed.
10. Testing performed by the Materials and Tests Division for informational purposes only.

4.9.2.4. **Operational Tolerances.** Control the production process within the operational tolerances in accordance with Table 8. When production is suspended, the Engineer will allow production to resume when test results or other information indicates the next mixture produced will be within the operational tolerances.

4.9.2.4.1. **Gradation.** Suspend operation and take corrective action if any aggregate is retained on the maximum sieve size in accordance with Table 6. A sublot is defined as out of tolerance if either the Engineer's or the Contractor's test results are out of operational tolerance. Suspend production when test results for gradation exceed the operational tolerances in accordance with Table 8 for three consecutive sublots on the same sieve or four consecutive sublots on any sieve unless otherwise directed. The consecutive sublots may be from more than one lot.

4.9.2.4.2. **Asphalt Binder Content.** A sublot is defined as out of operational tolerance if either the Engineer's or the Contractor's test results exceed the values in accordance with Table 8. Suspend production when two or

more sublots within a lot are out of operational tolerance or below the minimum asphalt binder content specified in accordance with Table 6 unless otherwise directed. Suspend production and shipment of mixture if the Engineer's or Contractor's asphalt binder content deviates from the current JMF by more than 0.5% for any sublot or is less than the minimum asphalt content allowed in accordance with Table 6.

4.9.2.4.3. **Voids in Mineral Aggregates (VMA).** The Engineer will determine the VMA for every sublot. For sublots when the Engineer does not determine asphalt binder content, the Engineer will use the asphalt binder content results from QC testing performed by the Contractor to determine VMA.

Take immediate corrective action if the VMA value for any sublot is less than the minimum VMA requirement for production in accordance with Table 6. Suspend production and shipment of the mixture if the Engineer's VMA results on two consecutive sublots are below the minimum VMA requirement for production in accordance with Table 6.

Suspend production and shipment of the mixture if the Engineer's VMA result is more than 0.5% below the minimum VMA requirement for production in accordance with Table 6. In addition to suspending production, the Engineer may require removal and replacement or may allow the sublot to be left in place without payment.

4.9.2.4.4. **Hamburg Wheel.** The Engineer may perform a Hamburg Wheel on plant produced mixture at any time during production. In addition to testing production samples, the Engineer may obtain cores and perform the Hamburg Wheel test on any area of the roadway where rutting is observed. Suspend production until further Hamburg Wheel meet the specified values when the production or core samples fail to meet the Hamburg Wheel criteria in accordance with Table 7. Core samples, if taken, will be obtained from the center of the finished mat or other areas excluding the vehicle wheel paths. The Engineer may require up to the entire sublot of any mixture failing the Hamburg Wheel to be removed and replaced at the Contractor's expense.

If the Department's or Department-approved laboratory's Hamburg Wheel test results in a "remove and replace" condition, the Contractor may request that the Department confirm the results by re-testing the failing material. The Materials and Tests Division will perform the Hamburg Wheel and determine the final disposition of the material in question based on the Department's test results.

4.9.2.5. **Individual Loads of Hot-Mix.** The Engineer can reject individual truckloads of hot-mix. When a load of hot-mix is rejected for reasons other than temperature, contamination, or excessive uncoated particles, the Contractor may request that the rejected load be tested. Make this request within 4 hr. of rejection. The Engineer will sample and test the mixture. If test results are within the operational tolerances in accordance with Table 8, payment will be made for the load. If test results are not within operational tolerances, no payment will be made for the load.

4.9.3. **Placement Acceptance.**

4.9.3.1. **Placement Lot.** A placement lot consists of four placement sublots. A placement sublot consists of the area placed during a production sublot.

4.9.3.1.1. **Recovered Asphalt Dynamic Shear Rheometer (DSR).** The Engineer may take production samples or cores from suspect areas of the project to determine recovered asphalt properties. Asphalt binders with an aging ratio greater than 3.5 do not meet the requirements for recovered asphalt properties and may be deemed defective when tested and evaluated by the Materials and Tests Division. The aging ratio is the DSR value of the extracted binder divided by the DSR value of the original unaged binder. Obtain DSR values in accordance with AASHTO T 315 at the specified high temperature performance grade of the asphalt. The Engineer may require removal and replacement of the defective material at the Contractor's expense. The asphalt binder will be recovered for testing from production samples or cores in accordance with Tex-211-F.

4.9.3.1.2. **Irregularities.** Identify and correct irregularities including segregation, rutting, raveling, flushing, fat spots, mat slippage, irregular color, irregular texture, roller marks, tears, gouges, streaks, uncoated aggregate particles, or broken aggregate particles. The Engineer may also identify irregularities, and in such cases, the Engineer will promptly notify the Contractor. The Engineer may require the Contractor to remove and replace (at the

Contractor's expense) areas of the pavement that contain irregularities if the Engineer determines that the irregularity will adversely affect pavement performance. The Engineer may also require the Contractor to remove and replace (at the Contractor's expense) areas where the mixture does not bond to the existing pavement.

The Engineer may require the Contractor to immediately suspend operations if irregularities are detected or may allow the Contractor to continue operations for no more than one day while the Contractor is taking appropriate corrective action.

4.9.4. **Exempt Production.** When the anticipated daily production is less than 100 ton, all QC and QA sampling and testing are waived. The Engineer may deem the mixture as exempt production for the following conditions:

- anticipated daily production is more than 100 ton but less than 250 ton;
- total production for the project is less than 2,500 ton;
- when mutually agreed between the Engineer and the Contractor; or
- when shown on the plans.

For exempt production, the Contractor is relieved of all production and placement sampling and testing requirements. All other specification requirements apply, and the Engineer will perform acceptance tests for production and placement in accordance with Table 13.

For exempt production:

- produce, haul, place, and compact the mixture as directed by the Engineer; and
- control mixture production to yield a laboratory-molded density that is within ±1.0% of the target density as tested by the Engineer.

4.9.5. **Ride Quality.** Measure ride quality in accordance with Item 585, "Ride Quality for Pavement Surfaces," unless otherwise shown on the plans.

5. MEASUREMENT

5.1. **TOM Hot-Mix Asphalt.** TOM hot-mix will be measured by the ton of composite mixture, which includes asphalt, aggregate, and additives. Measure the weight on scales in accordance with Item 520, "Weighing and Measuring Equipment."

5.2. **Tack Coat.** Tack coat will be measured at the applied temperature by strapping the tank before and after road application and determining the net volume in gallons from the calibrated distributor. The Engineer will witness all strapping operations for volume determination. All tack, including emulsions, will be measured by the gallon applied.

The Engineer may allow the use of a metering device to determine asphalt volume used and application rate if the device is accurate within 1.5% of the strapped volume.

6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under Section 3081.5.1., "TOM Hot-Mix Asphalt," will be paid for at the unit bid price for "Thin Overlay Mixture" of the mixture type, SAC, and binder specified. These prices are full compensation for surface preparation, removing pavement marking and markers, materials, placement, equipment, labor, tools, and incidentals.

The work performed and materials furnished in accordance with this Item and measured as provided under Section 3081.5.2., "Tack Coat," will be paid for at the unit bid price for "Tack Coat" of the tack coat provided. These prices are full compensation for materials, placement, equipment, labor, tools, and incidentals.

Trial batches will not be paid for unless they are included in pavement work approved by the Department.

Payment adjustment for ride quality will be determined in accordance with Item 585, "Ride Quality for Pavement Surfaces."

Special Specification 3082
Thin Bonded Friction Courses

1. DESCRIPTION

Construct a hot-mix asphalt (HMA) surface course composed of a warm spray-applied polymer modified emulsion membrane followed immediately with a compacted permeable mixture of aggregate, asphalt binder, and additives mixed hot in a mixing plant.

2. MATERIALS

Furnish uncontaminated materials of uniform quality that meet the requirements of the plans and specifications.

Notify the Engineer of all material sources and before changing any material source or formulation. The Engineer will verify that the specification requirements are met when the Contractor makes a source or formulation change, and may require a new laboratory mixture design, trial batch, or both. The Engineer may sample and test project materials at any time during the project to verify specification compliance in accordance with Item 6, "Control of Materials."

2.1. **Aggregate.** Furnish aggregates from sources that conform to the requirements shown in Table 1 and as specified in this Section. Aggregate requirements in this Section, including those shown in Table 1, may be modified or eliminated when shown on the plans. Additional aggregate requirements may be specified when shown on the plans. Provide aggregate stockpiles that meet the definitions in this Section for coarse or fine aggregate. Do not use intermediate or fine aggregate in PFC mixtures. Supply aggregates that meet the definitions in Tex-100-E for crushed gravel or crushed stone. The Engineer will designate the plant or the quarry as the sampling location. Provide samples from materials produced for the project. The Engineer will establish the Surface Aggregate Classification (SAC) and perform Los Angeles abrasion, magnesium sulfate soundness, and Micro-Deval tests. Perform all other aggregate quality tests listed in accordance with Table 1. Document all test results on the mixture design report. The Engineer may perform tests on independent or split samples to verify Contractor test results. Stockpile aggregates for each source and type separately. Determine aggregate gradations for mixture design and production testing based on the washed sieve analysis given in Tex-200-F, Part II.

2.1.1. **Coarse Aggregate.** Coarse aggregate stockpiles must have no more than 20% material passing the No. 8 sieve. Aggregates from sources listed in the Department's *Bituminous Rated Source Quality Catalog* (BRSQC) are preapproved for use. Use only the rated values for hot-mix listed in the BRSQC. Rated values for surface treatment (ST) do not apply to coarse aggregate sources used in hot-mix asphalt.

For sources not listed on the Department's BRSQC:

- build an individual stockpile for each material;
- request the Department test the stockpile for specification compliance;
- approved only when tested by the Engineer;
- once approved, do not add material to the stockpile unless otherwise approved; and
- allow 30 calendar days for the Engineer to sample, test, and report results.

Provide coarse aggregate with at least the minimum SAC shown on the plans. SAC requirements only apply to aggregates used on the surface of travel lanes, unless otherwise shown on the plans. SAC requirements apply to aggregates used on surfaces other than travel lanes when shown on the plans. The SAC for sources on the Department's *Aggregate Quality Monitoring Program* (AQMP) (Tex-499-A) is listed in the BRSQC.

2.1.1.1. **Blending Class A and Class B Aggregates.** To prevent crushing of the Class B aggregate when blending, Class B aggregate may be blended with a Class A aggregate to meet requirements for Class A materials if the Department's BRSQC rated source soundness magnesium (RSSM) rating for the Class B aggregate is less than the Class A aggregate or if the RSSM rating for the Class B aggregate is less than or equal to 10%. Use the rated values for hot mix asphaltic concrete (HMAC) published in the BRSQC. When blending Class A and B aggregates to meet a Class A requirement, ensure that at least 50% by weight, or volume if required, of all the aggregates used in the mixture design retained on the No. 4 sieve comes from the Class A aggregate source, unless otherwise shown on the plans. Blend by volume if the bulk specific gravities of the Class A and B aggregates differ by more than 0.300. Class B aggregate may be disallowed when shown on the plans.

The Engineer may perform tests at any time during production, when the Contractor blends Class A and B aggregates to meet a Class A requirement, to ensure that at least 50% by weight, or volume if required, of the material retained on the No. 4 sieve comes from the Class A aggregate source. The Engineer will use the Department's mix design template, when electing to verify conformance, to calculate the percent of Class A aggregate retained on the No. 4 sieve by inputting the bin percentages shown from readouts in the control room at the time of production and stockpile gradations measured at the time of production. The Engineer may determine the gradations based on either washed or dry sieve analysis from samples obtained from individual aggregate cold feed bins or aggregate stockpiles. The Engineer may perform spot checks using the gradations supplied by the Contractor on the mixture design report as an input for the template; however, a failing spot check will require confirmation with a stockpile gradation determined by the Engineer.

2.1.1.2. **Micro-Deval Abrasion.** The Engineer will perform a minimum of one Micro-Deval abrasion test in accordance with Tex-461-A for each coarse aggregate source used in the mixture design that has a Rated Source Soundness Magnesium (RSSM) loss value greater than 15 as listed in the BRSQC, unless otherwise directed. The Engineer will perform testing before the start of production and may perform additional testing at any time during production. The Engineer may obtain the coarse aggregate samples from each coarse aggregate source or may require the Contractor to obtain the samples. The Engineer may waive all Micro-Deval testing based on a satisfactory test history of the same aggregate source.

The Engineer will estimate the magnesium sulfate soundness loss for each coarse aggregate source, when tested, using the following formula:

$Mg_{est.} = (RSSM)(MD_{act.}/RSMD)$

where:
$Mg_{est.}$ = magnesium sulfate soundness loss
$RSSM$ = Rated Source Soundness Magnesium
$MD_{act.}$ = actual Micro-Deval percent loss
$RSMD$ = Rated Source Micro-Deval

When the estimated magnesium sulfate soundness loss is greater than the maximum magnesium sulfate soundness loss specified, the coarse aggregate source will not be allowed for use unless otherwise approved. The Engineer will consult the Soils and Aggregates Section of the Materials and Tests Division, and additional testing may be required before granting approval.

2.1.2. **Fine Aggregate.** Fine aggregates consist of manufactured sands and screenings. Fine aggregate stockpiles must meet the fine aggregate properties in accordance with Table 1 and the gradation requirements in accordance with Table 2. Supply fine aggregates that are free from organic impurities. The Engineer may test the fine aggregate in accordance with Tex-408-A to verify the material is free from organic impurities. Do not use field sand or other uncrushed fine aggregate. Use fine aggregate from coarse aggregate sources that meet the requirements shown in accordance with Table 1 unless otherwise approved.

Table 1
Coarse Aggregate Quality Requirements

Property	Test Method	Requirement
SAC	Tex-499-A (AQMP)	As shown on the plans
Deleterious material, %, Max	Tex-217-F, Part I	1.0
Decantation, %, Max	Tex-217-F, Part II	1.5
Micro-Deval abrasion, %	Tex-461-A	Note [1]
Los Angeles abrasion, %, Max	Tex-410-A	30
Magnesium sulfate soundness, 5 cycles, %, Max	Tex-411-A	20
Crushed face count[2], %, Min	Tex-460-A, Part I	95
Flat and elongated particles @ 5:1, %, Max	Tex-280-F	10
Fine Aggregate Properties		
Sand Equivalent, %, Min	Tex-203-F	45
Methylene Blue, mg/g, Max	Tex-252-F	10.0

1. Used to estimate the magnesium sulfate soundness loss in accordance with section 3082.2.1.1.2., "Micro-Deval Abrasion."
2. Only applies to crushed gravel.

Table 2
Gradation Requirements for Fine Aggregate

Sieve Size	% Passing by Weight or Volume
3/8"	100
#8	70–100
#200	0–30

2.2. **Mineral Filler.** Mineral filler consists of finely divided mineral matter such as agricultural lime, crusher fines, or hydrated lime. Fly ash is not allowed unless otherwise shown on the plans. Mineral filler is allowed unless otherwise shown on the plans. Use no more than 2% hydrated lime, unless otherwise shown on the plans. Test all mineral fillers except hydrated lime and fly ash in accordance with Tex-252-F to ensure specification compliance. The plans may require or disallow specific mineral fillers. Provide mineral filler, when used, that:

- is sufficiently dry, free-flowing, and free from clumps and foreign matter as determined by the Engineer;
- does not exceed 3% linear shrinkage when tested in accordance with Tex-107-E; and
- meets the gradation requirements in accordance with Table 3, unless otherwise shown on the plans.

Table 3
Gradation Requirements for Mineral Filler

Sieve Size	% Passing by Weight or Volume
#8	100
#200	55–100

2.3. **Baghouse Fines.** Fines collected by the baghouse or other dust-collecting equipment may be reintroduced into the mixing drum.

2.4. **Asphalt Binder.** Furnish the type and grade of binder specified on the plans that meets the requirements of Item 300, "Asphalts, Oils, and Emulsions."

2.4.1. **Performance-Graded (PG) Binder.** Provide an asphalt binder with a high-temperature grade of PG 76 and low-temperature grade as shown on the plans in accordance with Section 300.2.10., "Performance-Graded Binders," when PG binder is specified.

2.4.2. **Asphalt-Rubber (A-R) Binder.** Provide A-R binder that meets the Type I or Type II requirements of Section 300.2.9., "Asphalt-Rubber Binders," when A-R is specified unless otherwise shown on the plans. Use at least 15.0% by weight of Crumb Rubber Modifier (CRM) that meets the Grade B or Grade C requirements of Section 300.2.7., "Crumb Rubber Modifier," unless otherwise shown on the plans. Provide the Engineer the A-R binder blend design with the mix design (JMF1) submittal. Provide the Engineer with documentation such as the bill of lading showing the quantity of CRM used in the project unless otherwise directed.

2.5. **Membrane.** Provide a smooth and homogeneous polymer modified emulsion meeting the requirements in accordance with Table 4.

Table 4
Polymer Modified Emulsion Requirements

Test on Emulsion	Test Method	Min	Max
Viscosity @ 77°F, SSF	T 72	20	100
Storage Stability,[1] %	T 59		1
Demulsibility (for anionic emulsions), 35 mL of 0.02 N CaCl2, %	T 59	55	
Demulsibility (for cationic emulsions), 35 mL 0.8% Sodium dioctyl sulfosuccinate, %	T 59	55	
Sieve Test,[2] %	T 59		0.05
Distillation Test:[3] Residue by distillation, % by wt. Oil portion of distillate, % by vol.	T 59	63	0.5
Test on Residue from Distillation	**Test Method**	**Min**	**Max**
Elastic Recovery @ 50°F, 50 mm/min., %	Tex-539-C	60	
Penetration @ 77°F, 100 g, 5 sec, 0.1 mm	T 49	100	150

1. After standing undisturbed for 24 hr., the surface must be smooth, must not exhibit a white or milky colored substance, and must be a homogeneous color throughout.
2. May be required by the Engineer only when the emulsion cannot be easily applied in the field.
3. The temperature on the lower thermometer should be brought slowly to 350°F ±10°F and maintained at this temperature for 20 min. The total distillation should be complete in 60 ±5 min. from the first application of heat.

2.6. **Additives.** Provide the Engineer with documentation such as the bill of lading showing the quantity of additives used in the project unless otherwise directed.

2.6.1. **Fibers.** Provide cellulose or mineral fibers when PG binder is specified. Do not use fibers when A-R binder is specified. Submit written certification to the Engineer that the fibers proposed for use meet the requirements of DMS-9204, "Fiber Additives for Bituminous Mixtures." Fibers may be pre-blended into the binder at the asphalt supply terminal unless otherwise shown on the plans.

2.6.2. **Lime Mineral Filler.** Add lime as mineral filler at a rate of 1.0% by weight of the total dry aggregate in accordance with Item 301, "Asphalt Antistripping Agents," unless otherwise shown on the plans or waived by the Engineer based on Hamburg Wheel test results. Do not add lime directly into the mixing drum of any plant where lime is removed through the exhaust stream unless the plant has a baghouse or dust collection system that reintroduces the lime into the drum.

2.6.3. **Lime and Liquid Antistripping Agent.** When lime or a liquid antistripping agent is used, add in accordance with Item 301, "Asphalt Antistripping Agents." Do not add lime directly into the mixing drum of any plant where lime is removed through the exhaust stream unless the plant has a baghouse or dust collection system that reintroduces the lime into the drum. Lime added as mineral filler will count towards the total quantity of lime specified when the plans require lime to be added as an antistripping agent.

2.6.4. **Compaction Aid.** Compaction Aid is defined as a Department-approved chemical warm mix additive denoted as "chemical additive" on the Department's material producer list (MPL) that is used to facilitate mixing and compaction of HMA.

Compaction aid is allowed for use on all projects. Compaction aid is required when shown on the plans or as required in Section 3082.4.7.1., "Weather Conditions."

Warm mix foaming processes, denoted as "foaming process" on the Department-approved MPL, may be used to facilitate mixing and compaction of HMA; however warm mix processes are not defined as a Compaction Aid.

2.7. **Recycled Materials.** Recycled materials are not allowed for use.

3. EQUIPMENT

Provide required or necessary equipment in accordance with Item 320, "Equipment for Asphalt Concrete Pavement." When A-R binder is specified, equip the hot-mix plant with an in-line viscosity-measuring device located between the blending unit and the mixing drum. Provide a means to calibrate the asphalt mass flow meter on-site when a meter is used.

3.1. **Placement Equipment.** Provide a paver that meets all the requirements listed below.

3.1.1. **Paver.** Furnish a paver that will spray the membrane, apply the PFC mixture, and level the surface of the mat in a single pass. Configure the paver so that the mixture is placed no more than 5 sec. after the membrane is applied. Ensure the paver does not support the weight of any portion of hauling equipment other than the connection. Provide loading equipment that does not transmit vibrations or other motions to the paver that adversely affects the finished pavement quality. Equip the paver with an automatic dual longitudinal-grade control system and an automatic transverse-grade control system.

3.1.1.1. **Tractor Unit.** Supply a tractor unit that can push or propel vehicles, dumping directly into the finishing machine to obtain the desired lines and grades to eliminate any hand finishing. Equip the unit with a hitch to maintain contact between the hauling equipment's rear wheels and the finishing machine's pusher rollers while mixture is unloaded.

3.1.1.2. **Membrane Storage Tank and Distribution System.** Equip the paver with an insulated storage tank with a minimum capacity of 900 gal. Provide a metered mechanical pressure sprayer on the paver to apply a uniform membrane at the specified rate. Locate the spray bar on the paver so that the membrane is applied immediately in front of the screed unit. Provide a read-out device on the paver to monitor the membrane application rate.

Furnish a volumetric calibration and strap stick for the tank in accordance with Tex-922-K, Part I, unless otherwise directed. Calibrate the tank within the previous 5 yr. of the date first used on the project. The Engineer may verify calibration accuracy in accordance with Tex-922-K, Part II.

3.1.1.3. **Screed.** Provide a variable width vibratory screed that meets Item 320, "Equipment for Asphalt Concrete Pavement."

3.1.2. **Material Transfer Device (MTD).** Provide the specified type of MTD when shown on the plans. Ensure MTDs provide a continuous, uniform mixture flow to the asphalt paver.

3.1.3. **Rollers.** Provide steel-wheel rollers meeting the requirements of Item 210, "Rolling," except provide rollers weighing a minimum of 10 ton for each roller required. Operate rollers in static (non-vibrating) mode unless otherwise allowed.

4. CONSTRUCTION

Produce, haul, place, and compact the specified paving mixture. In addition to tests required by the specification, Contractors may perform other QC tests as deemed necessary. At any time during the project, the Engineer may perform production and placement tests as deemed necessary in accordance with Item 5, "Control of the Work." Schedule and participate in a mandatory pre-paving meeting with the Engineer on or before the first day of paving unless otherwise shown on the plans.

4.1. **Certification.** Personnel certified by the Department-approved hot-mix asphalt certification program must conduct all mixture designs, sampling, and testing in accordance with Table 5. Supply the Engineer with a list of certified personnel and copies of their current certificates before beginning production and when personnel changes are made. Provide a mixture design developed and signed by a Level 2 certified specialist. Provide Level 1A certified specialists at the plant during production operations. Provide Level 1B certified specialists to conduct placement tests. Provide AGG101 certified specialists for aggregate testing.

Table 5

Test Methods, Test Responsibility, and Minimum Certification Levels

Test Description	Test Method	Contractor	Engineer	Level[1]
1. Aggregate Testing				
Sampling	Tex-221-F	✓	✓	1A/AGG101
Dry sieve	Tex-200-F, Part I	✓	✓	1A/AGG101
Washed sieve	Tex-200-F, Part II	✓	✓	1A/AGG101
Deleterious material	Tex-217-F, Parts I & III	✓	✓	AGG101
Decantation	Tex-217-F, Part II	✓	✓	AGG101
Los Angeles abrasion	Tex-410-A		✓	Department
Magnesium sulfate soundness	Tex-411-A		✓	Department
Micro-Deval abrasion	Tex-461-A		✓	AGG101
Crushed face count	Tex-460-A	✓	✓	AGG101
Flat and elongated particles	Tex-280-F	✓	✓	AGG101
Methylene blue test	Tex-252-F		✓	Department
2. Asphalt Binder & Tack Coat Sampling				
Asphalt binder sampling	Tex-500-C, Part II	✓	✓	1A/1B
Membrane sampling	Tex-500-C, Part III	✓	✓	1A/1B
3. Mix Design & Verification				
Design and JMF changes	Tex-204-F	✓	✓	2
Mixing	Tex-205-F	✓	✓	2
Molding (SGC)	Tex-241-F	✓	✓	1A
Laboratory-molded density	Tex-207-F, Parts I, VI, & VIII	✓	✓	1A
Rice gravity	Tex-227-F, Part II	✓	✓	1A
Ignition oven correction factors[2]	Tex-236-F, Part II	✓	✓	2
Drain-down	Tex-235-F	✓	✓	1A
Hamburg Wheel test	Tex-242-F	✓	✓	1A
Boil test[4]	Tex-530-C	✓	✓	1A
Cantabro loss	Tex-245-F	✓	✓	1A
4. Production Testing				
Control charts	Tex-233-F	✓	✓	1A
Mixture sampling	Tex-222-F	✓	✓	1A/1B
Gradation & asphalt binder content[2]	Tex-236-F, Part I	✓	✓	1A
Moisture content	Tex-212-F, Part II	✓	✓	1A/AGG101
Micro-Deval abrasion	Tex-461-A		✓	AGG101
Drain-down	Tex-235-F	✓	✓	1A
Boil test[4]	Tex-530-C	✓	✓	1A
Abson recovery	Tex-211-F		✓	Department
5. Placement Testing				
Control charts	Tex-233-F	✓	✓	1A
Ride quality measurement	Tex-1001-S	✓	✓	Note 3
Thermal profile	Tex-244-F	✓	✓	1B
Water flow test	Tex-246-F	✓	✓	1B

1. Level 1A, 1B, AGG101, and 2 are certification levels provided by the Hot Mix Asphalt Center certification program.
2. Refer to Section 3082.4.5., "Production Operations," for exceptions to using an ignition oven.
3. Profiler and operator are required to be certified at the Texas A&M Transportation Institute facility when Surface Test Type B is specified.
4. When shown on the plans.

4.2. **Reporting and Responsibilities.** Use Department-provided templates to record and calculate all test data, including mixture design, production and placement tests, control charts, and thermal profiles. Obtain the current version of the templates at https://www.txdot.gov/inside-txdot/forms-publications/consultants-contractors/forms/site-manager.html or from the Engineer. The Engineer and the Contractor will provide any available test results to the other party when requested. The Contractor and Engineer must exchange test data within the maximum allowable time in accordance with Table 6 unless otherwise approved. The Engineer and the

Contractor will immediately report to the other party any test result that requires suspension of production or placement or that fails to meet the specification requirements. Record and electronically submit all test results and pertinent information on Department-provided templates.

Subsequent sublots placed after test results are available to the Contractor, which require suspension of operations, may be considered unauthorized work. Unauthorized work will be accepted or rejected at the discretion of the Engineer in accordance with Section 5.3., "Conformity with Plans, Specifications, and Special Provisions."

Table 6
Reporting Schedule

Description	Reported By	Reported To	To Be Reported Within
Production Quality Control			
Gradation[1]	Contractor	Engineer	1 working day of completion of the sublot
Asphalt binder content[1]			
Laboratory-molded density[1]			
Moisture content[2]			
Drain-down[1]			
Boil test[4]			
Production Quality Assurance			
Gradation[2]	Engineer	Contractor	1 working day of completion of the sublot
Asphalt binder content[2]			
Laboratory-molded density[2]			
Hamburg Wheel test[3]			
Boil test[4]			
Drain-down[2]			
Binder tests[3]			
Placement Quality Control			
Thermal profile[1]	Contractor	Engineer	1 working day of completion of the lot
Water flow[1]			
Membrane application rate[2]			
Placement Quality Assurance			
Thermal profile[2]	Engineer	Contractor	1 working day of completion of the lot
Aging ratio[3]			
Water flow[2]			
Membrane application rate[2]			

1. These tests are required on every sublot.
2. To be performed at the frequency in accordance with Table 14 or as shown on the plans.
3. To be reported as soon as the results become available.
4. When shown on the plans

Use the procedures described in Tex-233-F, when directed, to plot the results of all production and placement testing. Update the control charts as soon as test results for each sublot become available. Make the control charts readily accessible at the field laboratory. The Engineer may suspend production for failure to update control charts.

4.3. **Quality Control Plan (QCP).** Develop and follow the QCP in detail. Obtain approval for changes to the QCP made during the project. The Engineer may suspend operations if the Contractor fails to comply with the QCP.

Submit a written QCP before the mandatory pre-paving meeting, when directed. Receive approval of the QCP before pre-paving meeting. Include the following items in the QCP:

4.3.1. **Project Personnel.** For project personnel, include:

- a list of individuals responsible for QC with authority to take corrective action;
- current contact information for each individual listed; and
- current copies of certification documents for individuals performing specified QC functions.

4.3.2. **Material Delivery and Storage.** For material delivery and storage, include:

- the sequence of material processing, delivery, and minimum quantities to assure continuous plant

operations;

- aggregate stockpiling procedures to avoid contamination and segregation;
- frequency, type, and timing of aggregate stockpile testing to assure conformance of material requirements before mixture production; and
- procedure for monitoring the quality and variability of asphalt binder.

4.3.3. **Production.** For production, include:

- loader operation procedures to avoid contamination in cold bins;
- procedures for calibrating and controlling cold feeds;
- procedures to eliminate debris or oversized material;
- procedures for adding and verifying rates of each applicable mixture component (e.g., aggregate, asphalt binder, lime, liquid antistrip, compaction aid, foaming process, fibers);
- procedures for reporting job control test results; and
- procedures to avoid segregation and drain-down in the silo.

4.3.4. **Loading and Transporting.** For loading and transporting, include:

- type and application method for release agents; and
- truck loading procedures to avoid segregation.

4.3.5. **Placement and Compaction.** For placement and compaction, include:

- proposed agenda for mandatory pre-paving meeting, including date and location;
- proposed paving plan (e.g., production rate, paving widths, joint offsets, and lift thicknesses);
- type and application method for release agents in the paver and on rollers, shovels, lutes, and other utensils;
- procedures for the transfer of mixture into the paver while avoiding physical and thermal segregation and preventing material spillage;
- process to balance production, delivery, paving, and compaction to achieve continuous placement operations and good ride quality;
- paver operations (e.g., speed, operation of wings, height of mixture in auger chamber) to avoid physical and thermal segregation and other surface irregularities; and
- procedures to construct quality longitudinal and transverse joints.

4.4. **Mixture Design.**

4.4.1. **Design Requirements.** Use the design procedure provided in Tex-204-F, unless otherwise shown on the plans. Design the mixture to meet the requirements in accordance with Tables 1, 2, 3, 7, 8, and 9. Use a Superpave Gyratory Compactor (SGC) at 50 gyrations as the design number of gyrations (Ndesign).

The Engineer will provide the mixture design when shown on the plans. The Contractor may submit a new mixture design at any time during the project. The Engineer will verify and approve all mixture designs (JMF1) before the Contractor can begin production.

Provide the Engineer with a mixture design report using the Department-provided template. Include the following items in the report:

- the combined aggregate gradation, source, specific gravity, and percent of each material used;
- the membrane application rate based on design volumetrics;
- results of all applicable tests;
- the mixing and molding temperatures;
- the signature of the Level 2 person or persons that performed the design;
- the date the mixture design was performed; and
- a unique identification number for the mixture design.

Table 7
Master Gradation Limits (% Passing by Weight or Volume)
and Laboratory Mixture Design Properties

Sieve Size	Permeable Friction Course		Thin Bonded Friction Course		
	Fine (PFC-F)	Coarse (PFC-C and PFCR-C)	Type A	Type B	Type C
3/4"	–	100.0[1]	–	–	100[1]
1/2"	100.0[1]	80.0–100.0	–	100[1]	75–100
3/8"	95.0–100.0	35.0–60.0	100[1]	75–100	55–80
#4	20.0–55.0	1.0–20.0	35–55	22–36	22–36
#8	1.0–10.0	1.0–10.0	19–30	19–30	19–30
#16	–	–	14–25	14–24	14–24
#50	–	–	7–14	7–14	7–14
#200	1.0–4.0	1.0–4.0	4–6	4–6	4–6

1. Defined as maximum sieve size. No tolerance allowed.

Table 8
Mixture Design Properties

Mixture Property	Test Method	PG 76 Mixtures		A-R Mixtures	Thin Bonded Friction Course		
		Fine (PFC-F)	Coarse (PFC-C)	Coarse (PFCR-C)	Type A	Type B	Type C
Asphalt binder content, %	–	6.0–7.0	6.0–7.0	7.0–9.0	5.0–5.8	4.8–5.6	4.8–5.6
Film thickness, microns	–	–	–	–	9.0 Min	9.0 Min	9.0 Min
Design gyrations (Ndesign)	Tex-241-F	50	50	50	50	50	50
Laboratory-molded density, %	Tex-207-F	78.0 Max	82.0 Max	82.0 Max	92.0 Max	92.0 Max	92.0 Max
Hamburg Wheel test,[1] passes at 12.5 mm rut depth	Tex-242-F	10,000 Min	Note 2	Note 2	Note 2	Note 2	Note 2
Drain-down, %	Tex-235-F	0.10 Max	0.10 Max	0.10 Max	0.10 Max	0.10 Max	0.10 Max
Fiber content, % by wt. of total PG 76 mixture	Calculated	0.20–0.50	0.20-0.50	–	–	–	–
Lime content, % by wt. of total aggregate	Calculated	1.0[3]	1.0[3]	–	Note 4	Note 4	Note 4
CRM content, % by wt. of A-R binder	Calculated	–	–	15.0 Min	–	–	–
Boil test[5]	Tex-530-C	–	–	–	–	–	–
Cantabro loss, %	Tex-245-F	20.0 Max	20.0 Max	20.0 Max	20.0 Max	20.0 Max	20.0 Max

1. Mold test specimens to Ndesign at the optimum asphalt binder content.
2. No specification value is required unless otherwise shown on the plans.
3. Unless otherwise shown on the plans or waived by the Engineer based on Hamburg Wheel results.
4. Lime may be required when shown on the plans.
5. When shown on the plans. Used to establish baseline for comparison to production results.

4.4.2. **Job-Mix Formula Approval.** The job-mix formula (JMF) is the combined aggregate gradation, Ndesign level, and target asphalt percentage used to establish target values for hot-mix production. JMF1 is the original laboratory mixture design used to produce the trial batch. When a compaction aid or foaming process is used, JMF1 may be designed and submitted to the Engineer without including the compaction aid or foaming process. When a compaction aid or foaming process is used, document the compaction aid or foaming process used and recommended rate on the JMF1 submittal. The Engineer and the Contractor will verify JMF1 based on plant-produced mixture from the trial batch unless otherwise approved. The Engineer may accept an existing mixture design previously used on a Department project and may waive the trial batch to verify JMF1. The Department may require the Contractor to reimburse the Department for verification tests if more than two trial batches per design are required.

4.4.2.1. **Contractor's Responsibilities.**

4.4.2.1.1. **Providing Superpave Gyratory Compactor.** Furnish an SGC calibrated in accordance with Tex-241-F for molding production samples. Locate the SGC at the Engineer's field laboratory or make the SGC available to the Engineer for use in molding production samples.

4.4.2.1.2. **Gyratory Compactor Correlation Factors.** Use Tex-206-F, Part II, to perform a gyratory compactor

correlation when the Engineer uses a different SGC. Apply the correlation factor to all subsequent production test results.

4.4.2.1.3. **Submitting JMF1.** Furnish a mix design report (JMF1) with representative samples of all component materials and request approval to produce the trial batch. Provide an additional 25 lb. of the design mixture if opting to have the Department perform the Hamburg Wheel test on the laboratory mixture when required in accordance with Table 8, and request that the Department perform the test.

4.4.2.1.4. **Supplying Aggregates.** Provide approximately 40 lb. of each aggregate stockpile unless otherwise directed.

4.4.2.1.5. **Supplying Asphalt.** Provide at least 1 gal. of the asphalt material and enough quantities of any additives proposed for use.

4.4.2.1.6. **Ignition Oven Correction Factors.** Determine the aggregate and asphalt correction factors from the ignition oven in accordance with Tex-236-F, Part II. Provide correction factors that are not more than 12 mo. old. Note that the asphalt content correction factor takes into account the percent fibers in the mixture so that the fibers are excluded from the binder content determination. Provide the Engineer with split samples of the mixtures before the trial batch production, including all additives (except water), and blank samples used to determine the correction factors for the ignition oven used for quality assurance testing during production. Correction factors established from a previously approved mixture design may be used for the current mixture design if the mixture design and ignition oven are the same as previously used and the correction factors are not more than 12 mo. old, unless otherwise directed.

4.4.2.1.7. **Boil Test.** When shown on the plans, perform the test and retain the tested sample from Tex-530-C until completion of the project or as directed. Use this sample for comparison purposes during production. Add lime or liquid antistripping agent as directed if signs of stripping exist.

4.4.2.1.8. **Trial Batch Production.** Provide a plant-produced trial batch upon receiving conditional approval of JMF1 and authorization to produce a trial batch, including the compaction aid or foaming process, if applicable, for verification testing of JMF1 and development of JMF2. Produce a trial batch mixture that meets the requirements in accordance with Table 9. The Engineer may accept test results from recent production of the same mixture instead of a new trial batch.

4.4.2.1.9. **Trial Batch Production Equipment.** Use only equipment and materials proposed for use on the project to produce the trial batch. Provide documentation to verify the calibration or accuracy of the asphalt mass flow meter to measure the binder content. Verify that asphalt mass flow meter meets the requirements of 0.4 % accuracy, when required, in accordance with Item 520, "Weighing and Measuring Equipment." The Engineer may require that the accuracy of the mass flow meter be verified based on quantities used.

4.4.2.1.10. **Trial Batch Quantity.** Produce enough quantity of the trial batch to ensure that the mixture meets the specification requirements.

4.4.2.1.11. **Number of Trial Batches.** Produce trial batches as necessary to obtain a mixture that meets the specification requirements.

4.4.2.1.12. **Trial Batch Sampling.** Obtain a representative sample of the trial batch and split it into three equal portions in accordance with Tex-222-F. Label these portions as "Contractor," "Engineer," and "Referee." Deliver samples to the appropriate laboratory as directed.

4.4.2.1.13. **Trial Batch Testing.** Test the trial batch to ensure the mixture produced using the proposed JMF1 meets the mixture requirements in accordance with Table 9. Ensure the trial batch mixture is also in compliance with the requirements in accordance with Tables 7 and 8. Use a Department-approved laboratory listed on the MPL to perform the Hamburg Wheel test on the trial batch mixture or request that the Department perform the Hamburg Wheel test. The Engineer will be allowed 10 working days to provide the Contractor with Hamburg Wheel test results on the trial batch. Provide the Engineer with a copy of the trial batch test results.

4.4.2.1.14. **Development of JMF2.** Evaluate the trial batch test results, determine the target mixture proportions, and

submit as JMF2 after the Engineer grants full approval of JMF1 based on results from the trial batch. Verify that JMF2 meets the mixture requirements in accordance with Table 9.

4.4.2.1.15. **Mixture Production.** After receiving approval for JMF2, use JMF2 to produce Lot 1.

4.4.2.1.16. **Development of JMF3.** Evaluate the test results from Lot 1, determine the optimum mixture proportions, and submit as JMF3 for use in Lot 2.

4.4.2.1.17. **JMF Adjustments.** If JMF adjustments are necessary to achieve the specified requirements, make the adjustments before beginning a new lot. The adjusted JMF must:

- be provided to the Engineer in writing before the start of a new lot;
- be numbered in sequence to the previous JMF;
- meet the master gradation limits in accordance with Table 7
- meet the binder content limits in accordance with Table 8; and
- be within the operational tolerances of JMF2 in accordance with Table 9.

4.4.2.1.18. **Requesting Referee Testing.** Use referee testing, if needed, in accordance with Section 3082.4.9.1., "Referee Testing," to resolve testing differences with the Engineer.

Table 9
Operational Tolerances

Test Description	Test Method	Allowable Difference between JMF2 and JMF1 Target[1]	Allowable Difference from Current JMF and JMF2[2]	Allowable Difference between Contractor and Engineer[3]
Individual % retained for sieve sized larger than #200	Tex-200-F	Must be Within Master Grading Limits in accordance with Table 7	±3.0[4]	±5.0[4]
% passing the #200 sieve			±2.0[4]	±3.0[4]
Laboratory-molded density, %	Tex-207-F, Part VIII	±1.0	±1.0	±1.0
Asphalt binder content, %	Tex-236-F, Part I[5]	±0.3[6,7]	±0.3[4,6,7]	±0.3[6,7]
Drain-down, %	Tex-235-F	Note 8	Note 8	N/A
Boil test	Tex-530-C	Note 9	Note 9	N/A
Membrane application rate	Tex-247-F	±0.02	±0.02	N/A

1. JMF1 is the approved laboratory mixture design used for producing the trial batch. JMF2 is the approved mixture design developed from the trial batch used to produce Lot 1.
2. Current JMF is JMF3 or higher. JMF3 is the approved mixture design used to produce Lot 2.
3. Contractor may request referee testing only when values exceed these tolerances.
4. Only applies to mixture produced for Lot 1 and higher. Aggregate gradation is not allowed to be outside the limits in accordance with Table 7.
5. Ensure the binder content determination excludes fibers.
6. May be obtained from asphalt mass flow meter readouts as determined by the Engineer.
7. Binder content is not allowed to be outside the limits shown in Table 8.
8. Verify that Table 8 requirements are met.
9. When shown on the plans.

4.4.2.2. **Engineer's Responsibilities.**

4.4.2.2.1. **Superpave Gyratory Compactor.** The Engineer will use a Department SGC calibrated in accordance with Tex-241-F to mold samples for laboratory mixture design verification. For molding trial batch and production specimens, the Engineer will use the Contractor-provided SGC at the field laboratory or provide and use a Department SGC at an alternate location.

4.4.2.2.2. **Conditional Approval of JMF1 and Authorizing Trial Batch.** The Engineer will review and verify conformance of the following information within two working days of receipt:

- the Contractor's mix design report (JMF1);
- the Contractor-provided Hamburg Wheel test results, if applicable;
- all required materials including aggregates, asphalt, and additives; and
- the mixture specifications.

The Engineer will grant the Contractor conditional approval of JMF1 if the information provided on the paper copy of JMF1 indicates that the Contractor's mixture design meets the specifications. When the Contractor does not provide Hamburg Wheel test with laboratory mixture design, 10 working days are allowed for conditional approval of JMF1. The Engineer will base full approval of JMF1 on the test results on mixture from the trial batch.

Unless waived, the Engineer will determine the Micro-Deval abrasion loss in accordance with

Section 3082.2.1.1.2., "Micro-Deval Abrasion." If the Engineer's test results are pending after two working days, conditional approval of JMF1 will still be granted within two working days of receiving JMF1. When the Engineer's test results become available, they will be used for specification compliance.

The Contractor is authorized to produce a trial batch after the Engineer grants conditional approval of JMF1.

4.4.2.2.3. **Hamburg Wheel Testing.** At the Contractor's request, the Department will perform the Hamburg Wheel test on the laboratory mixture in accordance with Tex-242-F to verify compliance with the Hamburg Wheel test requirement in accordance with Table 8. The Engineer will be allowed 10 working days to provide the Contractor with Hamburg Wheel results on the laboratory mixture design.

4.4.2.2.4. **Ignition Oven Correction Factors.** The Engineer will use the split samples provided by the Contractor to determine the aggregate and asphalt correction factors for the ignition oven used for quality assurance testing during production in accordance with Tex-236-F, Part II. Provide correction factors that are not more than 12 mo. old. The Engineer will verify that the asphalt content correction factor takes into account the percent fibers in the mixture so that the fibers are excluded from the binder content determination.

4.4.2.2.5. **Testing the Trial Batch.** The Engineer will sample and test the trial batch within one full working day to ensure that the mixture meets the requirements in accordance with Table 9. If the Contractor requests the option to have the Department perform the Hamburg Wheel test on the trial batch mixture, the Engineer will mold samples in accordance with Tex-242-F to verify compliance with the Hamburg Wheel test requirement in accordance with Table 8.

The Engineer will have the option to perform Tex-530-C on the trial batch when shown on the plans. These results may be retained and used for comparison purposes during production.

4.4.2.2.6. **Full Approval of JMF1.** The Engineer will grant full approval of JMF1 and authorize the Contractor to proceed with developing JMF2 if the Engineer's results for the trial batch meet the requirements in accordance with Tables 7 and 8.

The Engineer will notify the Contractor that an additional trial batch is required if the trial batch does not meet these requirements.

4.4.2.2.7. **Approval of JMF2.** The Engineer will approve JMF2 within one working day if the mixture meets the requirements in accordance with Tables 7, 8, and 9.

4.4.2.2.8. **Approval of Lot 1 Production.** The Engineer will authorize the Contractor to proceed with Lot 1 production (using JMF2).

4.4.2.2.9. **Approval of JMF3 and Subsequent JMF Changes.** JMF3 and subsequent JMF changes are approved if they meet the master grading and asphalt binder content shown in accordance with Tables 7 and 8 and are within the operational tolerances of JMF2 in accordance with Table 9.

4.4.2.2.10. **Binder Content Adjustments.** For JMF2 and above, the Engineer may require the Contractor to adjust the target binder content by no more than 0.3% from the current JMF.

4.5. **Production Operations.** Perform a new trial batch when the plant or plant location is changed. Take corrective action and receive approval to proceed after any production suspension for noncompliance to the specification.

4.5.1. **Storage and Heating of Materials.** Do not heat the asphalt binder above the temperatures specified in Item 300, "Asphalts, Oils, and Emulsions," or outside the manufacturer's recommended values. Provide the Engineer with daily records of asphalt binder and hot-mix asphalt discharge temperatures (in legible and discernible increments) in accordance with Item 320, "Equipment for Asphalt Concrete Pavement," unless otherwise directed. Do not store mixture for a period long enough to affect the quality of the mixture, nor in any case longer than 12 hr. unless otherwise approved.

4.5.2. **Mixing and Discharge of Materials.** Notify the Engineer of the target discharge temperature and produce the mixture within 25°F of the target. Monitor the temperature of the material in the truck before shipping to ensure that it does not exceed the maximum production temperatures in accordance with Table 10. The Department will not pay for or allow placement of any mixture produced above the maximum production temperatures in accordance with Table 10.

Table 10
Maximum Production Temperature

High-Temperature Binder Grade[1]	Max Production Temperature
PG 76	345˚F
A-R Binder	345˚F

1. The high-temperature binder grade refers to the high-temperature grade of the virgin asphalt binder used to produce the mixture.

Control the mixing time and temperature so that substantially all moisture is removed from the mixture before discharging from the plant. Determine the moisture content, if requested, by oven-drying in accordance with Tex-212-F, Part II, and verify that the mixture contains no more than 0.2% of moisture by weight. Obtain the sample immediately after discharging the mixture into the truck and perform the test promptly.

4.6. **Hauling Operations.** Clean all truck beds before use to ensure that mixture is not contaminated. Use a release agent shown on the Department's MPL to coat the inside bed of the truck when necessary. Do not use diesel or any release agent not shown on the Department's MPL.

Use equipment for hauling as defined in Section 3082.4.7.3.2., "Hauling Equipment." Use other hauling equipment only when allowed.

4.7. **Placement Operations.** Collect haul tickets from each load of mixture delivered to the project and provide the Department's copy to the Engineer approximately every hour, or as directed. Use a hand-held thermal camera or infrared thermometer, when a thermal imaging system is not used, to measure and record the internal temperature of the mixture as discharged from the truck or Material Transfer Device (MTD) before or as the mix enters the paver and an approximate station number or GPS coordinates on each ticket. Calculate the daily yield and cumulative yield for the specified lift and provide to the Engineer at the end of paving operations for each day unless otherwise directed. The Engineer may suspend production if the Contractor fails to produce and provide haul tickets and yield calculations by the end of paving operations for each day.

Prepare the surface by removing raised pavement markers and objectionable material such as moisture, dirt, sand, leaves, and other loose impediments from the surface before placing mixture. Remove vegetation from pavement edges. Do not allow any loose mixture onto the prepared surface before application of the membrane. Place the mixture to meet the typical section requirements and produce a smooth, finished surface with a uniform appearance and texture. Offset longitudinal joints of successive courses of hot-mix by at least 6 in. Place mixture so that longitudinal joints on the surface course coincide within 6-in. of lane lines and are not placed in the wheel path, or as directed, and offset longitudinal joints of successive courses of hot-mix by at least 6-in. Ensure that all finished surfaces will drain properly.

4.7.1. **Weather Conditions.**

4.7.1.1. **When Using a Thermal Imaging System.** The Contractor may pave any time the roadway is dry and the roadway surface temperature is at least 60°F unless otherwise approved or as shown on the plans; however, the Engineer may restrict the Contractor from paving if the ambient temperature is likely to drop below 32°F within 12 hr. of paving. Place mixtures when weather conditions and moisture conditions of the roadway surface are suitable as determined by the Engineer. Provide output data from the thermal imaging system to demonstrate to the Engineer that no recurring severe thermal segregation exists in accordance with Section 3082.4.7.3.1.2., "Thermal Imaging System."

Produce mixture with a target discharge temperature higher than 300°F and with a compaction aid to facilitate compaction when the air temperature is 70°F and falling.

4.7.1.2. **When Not Using a Thermal Imaging System.** When using a thermal camera instead of the thermal imaging system, place mixture when the roadway surface temperature is at or above 70°F unless otherwise approved or as shown on the plans. Measure the roadway surface temperature with a hand-held thermal camera or infrared thermometer. Place mixtures only when weather conditions and moisture conditions of the roadway surface are suitable as determined by the Engineer. The Engineer may restrict the Contractor from paving if the air temperature is 60°F and falling.

Produce mixture with a target discharge temperature higher than 300°F and with a compaction aid to facilitate compaction when the air temperature is 70°F and falling.

4.7.2. **Application of Membrane.** Apply the membrane at the rates in accordance with Table 11 unless otherwise directed. Spray the membrane using a metered mechanical pressure spray bar at a temperature of 140°F to 180°F. Monitor the membrane application rate and make adjustments to the rate when directed. Verify that the spray bar is capable of applying the membrane at a uniform rate across the entire paving width. Apply adequate overlap of the tack coat in the longitudinal direction during placement of the mat to ensure bond of adjacent mats, unless otherwise directed. Unless otherwise directed, avoid tacking the vertical faces of adjacent PFC mats in the longitudinal direction to avoid restricting lateral drainage. Apply tack coat to all transverse joints. Do not let the wheels or other parts of the paving machine contact the freshly applied membrane. Do not dilute the membrane at the terminal, in the field, or at any other location before use. Do not allow any loose mixture onto the prepared surface before application of the membrane.

Table 11
Membrane Application Rate Limits, (Gal. per square yard)

Mix Type	Lift Thickness	Membrane Rate
Permeable Friction Course	1-1/2 in.	0.30–0.33
	1-1/4 in.	0.27–0.30
	1 in.	0.25–0.28
	3/4 in.	0.22–0.25
Thin Bonded Friction Course	3/4 in.	0.17–0.27
	5/8 in.	0.16–0.24
	1/2 in.	0.14–0.20

4.7.2.1. **Non-uniform Application of Membrane**. Stop application if it is not uniform due to streaking, ridging, pooling, or flowing off the roadway surface. Verify equipment condition including plugged nozzles on the spray bar, operating procedures, application temperature, and material properties. Determine and correct the cause of non-uniform application.

4.7.2.2. **Test Strips.** The Engineer may perform independent tests to confirm Contractor compliance and may require testing differences or failing results to be resolved before resuming production.

The Engineer may cease operations and require construction of test strips at the Contractor's expense if any of the following occurs:

- non-uniformity of application continues after corrective action;
- in three consecutive shots, application rate differs by more than 0.03 gal. per square yard from the rate

directed; or

- any shot differs by more than 0.05 gal. per square yard from the rate directed.

The Engineer will approve the test strip location. The Engineer may require additional test strips until the membrane application meets specification requirements.

4.7.3. **Lay-Down Operations.** Use the placement temperature in accordance with Table 12 to establish the minimum placement temperature of the mixture delivered to the paving operation.

Table 12
Min Mixture Placement Temperature

High-Temperature Binder Grade[1]	Min Placement Temperature (Before Entering Paving Operation)[2,3]
PG 76	280˚F
A-R Binder	280˚F

1. The high-temperature binder grade refers to the high-temperature grade of the virgin asphalt binder used to produce the mixture.
2. The mixture temperature must be measured using a hand-held thermal camera or infrared thermometer nearest to the point of entry of the paving operation.
3. Minimum placement temperatures may be reduced 10°F if using a compaction aid.

4.7.3.1. **Thermal Profile.** Use a hand-held thermal camera or a thermal imaging system to obtain a continuous thermal profile in accordance with Tex-244-F. Thermal profiles are not applicable in areas described in Section 3082.4.9.8., "Miscellaneous Areas."

4.7.3.1.1. **Thermal Segregation.**

4.7.3.1.1.1. **Moderate.** Any areas that have a temperature differential greater than 25°F, but not exceeding 50°F.

4.7.3.1.1.2. **Severe.** Any areas that have a temperature differential greater than 50°F.

4.7.3.1.2. **Thermal Imaging System.** Review the output results when a thermal imaging system is used, and provide the report described in Tex-244-F to the Engineer daily unless otherwise directed. Modify the paving process as necessary to eliminate any recurring (moderate or severe) thermal segregation identified by the thermal imaging system.

The Engineer may suspend subsequent paving operations if the Contractor cannot successfully modify the paving process to eliminate recurring severe or moderate thermal segregation.

Provide the Engineer with electronic copies of all daily data files that can be used with the thermal imaging system software to generate temperature profile plots daily or as requested by the Engineer.

4.7.3.1.3. **Thermal Camera.** When using the thermal camera instead of the thermal imaging system, take immediate corrective action to eliminate recurring moderate thermal segregation when a hand-held thermal camera is used. Provide the Engineer with the thermal profile of every sublot within one working day of the completion of each lot. When requested by the Engineer, provide the electronic files generated using the thermal camera. Report the results of each thermal profile in accordance with Section 3082.4.2., "Reporting and Responsibilities." The Engineer will use a hand-held thermal camera to obtain a thermal profile at least once per project unless the thermal imaging system is used. Suspend operations and take immediate corrective action to eliminate severe thermal segregation unless otherwise directed. Resume operations when the Engineer determines that subsequent production will meet the requirements of this Section.

4.7.3.2. **Hauling Equipment.** Use live bottom or end dump trucks to haul and transfer mixture; however, with exception of paving miscellaneous areas, end dump trucks are only allowed when used in conjunction with an MTD with remixing capability or when a thermal imaging system is used unless otherwise allowed.

4.7.3.3. **Screed Heaters.** Turn off screed heaters to prevent overheating of the mat if the paver stops for more than 5 min. The Engineer may evaluate the suspect area in accordance with Section 3082.4.9.9., "Recovered

Asphalt Dynamic Shear Rheometer (DSR)," if the screed heater remains on for more than 5 min. while the paver is stopped.

4.8. **Compaction.** Roll the freshly placed mixture with as many steel-wheeled rollers as necessary, operated in static mode, to seat the mixture without excessive breakage of the aggregate and to provide a smooth surface and uniform texture. Do not use pneumatic rollers. Use the control strip method given in Tex-207-F, Part IV, to establish the rolling pattern. Moisten the roller drums thoroughly with a soap and water solution to prevent adhesion. Use only water or an approved release agent on rollers, tamps, and other compaction equipment unless otherwise directed.

For PFC mixtures, use Tex-246-F to test and verify that the compacted mixture has adequate permeability. Measure the water flow once per sublot at locations directed by the Engineer. The water flow rate should be less than 20 sec. Investigate the cause of the water flow rate test failures and take corrective actions during production and placement to ensure the water flow rate is less than 20 sec. Suspend production if two consecutive water flow rate tests fail unless otherwise approved. Resume production after the Engineer approves changes to production or placement methods.

Complete all compaction operations before the pavement temperature drops below 180°F unless otherwise allowed. The Engineer may allow compaction with a light finish roller operated in static mode for pavement temperatures below 180°F.

Allow the compacted pavement to cool to 160°F or lower before opening to traffic unless otherwise directed. Sprinkle the finished mat with water or limewater, when directed, to expedite opening the roadway to traffic.

4.9. **Acceptance Plan.** Sample and test the hot-mix on a lot and sublot basis.

4.9.1. **Referee Testing.** The Materials and Tests Division is the referee laboratory. The Contractor may request referee testing if the differences between Contractor and Engineer test results exceed the operational tolerances in accordance with Table 9 and the differences cannot be resolved. The Contractor may also request referee testing if the Engineer's test results require suspension of production and the Contractor's test results are within specification limits. Make the request within five working days after receiving test results and cores from the Engineer. Referee tests will be performed only on the sublot in question and only for the particular tests in question. Allow 10 working days from the time the referee laboratory receives the samples for test results to be reported. The Department may require the Contractor to reimburse the Department for referee tests if more than three referee tests per project are required and the Engineer's test results are closer to the referee test results than the Contractor's test results.

4.9.2. **Production Acceptance.**

4.9.2.1. **Production Lot.** A production lot consists of four equal sublots. The default quantity for Lot 1 is 1,000 ton; however, when requested by the Contractor, the Engineer may increase the quantity for Lot 1 to no more than 2,000 ton. The Engineer will select subsequent lot sizes based on the anticipated daily production such that approximately three to four sublots are produced each day. The lot size will be between 1,000 ton and 4,000 ton. The Engineer may change the lot size before the Contractor begins any lot.

4.9.2.1.1. **Incomplete Production Lots.** If a lot is begun but cannot be completed, such as on the last day of production or in other circumstances deemed appropriate, the Engineer may close the lot. Close all lots within five working days unless otherwise allowed.

4.9.2.2. **Production Sampling.**

4.9.2.2.1. **Mixture Sampling.** Obtain hot-mix samples from trucks at the plant in accordance with Tex-222-F. The sampler will split each sample into three equal portions in accordance with Tex-200-F and label these portions as "Contractor," "Engineer," and "Referee." The Engineer will perform or witness the sample splitting and take immediate possession of the samples labeled "Engineer" and "Referee." The Engineer will maintain the custody of the samples labeled "Engineer" and "Referee" until the Department's testing is completed.

4.9.2.2.1.1. **Random Sample.** At the beginning of the project, the Engineer will select random numbers for all production sublots. Determine sample locations in accordance with Tex-225-F. Take one sample for each sublot at the randomly selected location. The Engineer will perform or witness the sampling of production sublots.

4.9.2.2.1.2. **Blind Sample.** For one sublot per lot, the Engineer will obtain and test a "blind" sample instead of the random sample collected by the Contractor. Test either the "blind" or the random sample; however, referee testing (if applicable) will be based on a comparison of results from the "blind" sample. The location of the Engineer's "blind" sample will not be disclosed to the Contractor. The Engineer's "blind" sample may be randomly selected in accordance with Tex-225-F for any sublot or selected at the discretion of the Engineer. The Engineer will use the Contractor's split sample for sublots not sampled by the Engineer.

4.9.2.2.2. **Informational Hamburg and Overlay Testing.** Select one random sublot from Lot 2 or higher for Hamburg and Overlay testing during the first week of production. Obtain and provide the Engineer with approximately 90 lb. of mixture, sampled in accordance with Tex-222-F, in sealed containers, boxes, or bags labeled with the Control-Section-Job (CSJ), mixture type, lot, and sublot number. The Engineer will ship the mixture to the Materials and Tests Division for Hamburg and Overlay testing. Results from these tests will not be used for specification compliance.

4.9.2.2.3. **Asphalt Binder Sampling**. Obtain a 1-qt. (1 gal. for A-R binder) sample of the asphalt binder witness by the Engineer for each lot of mixture produced. The Contractor will notify the Engineer when the sampling will occur. Obtain the sample at approximately the same time the mixture random sample is obtained. Sample from a port located immediately upstream from the mixing drum or pug mill and upstream from the introduction of any additives in accordance with Tex-500-C, Part II. Label the can with the corresponding lot and sublot numbers, producer, producer facility, grade, district, date sampled, and project information including highway and CSJ. The Engineer will retain these samples for one year. The Engineer may also obtain independent samples. If obtaining an independent asphalt binder sample and upon request of the Contractor, the Engineer will split a sample of the asphalt binder with the Contractor.

At least once per project, the Engineer will collect split samples of each binder grade and source used. The Engineer will submit one split sample to the Materials and Tests Division to verify compliance with Item 300, "Asphalts, Oils, and Emulsions" and will retain the other split sample for 1 yr.

4.9.2.3. **Membrane Sampling.** The Engineer will obtain a 1-qt. sample of the polymer modified emulsion for each lot of mixture produced in accordance with Tex-500-C, Part III. The Engineer will notify the Contractor when the sampling will occur and will witness the collection of the sample. Obtain the sample at approximately the same time the mixture random sample is obtained. Label the can with the corresponding lot and sublot numbers, producer, producer facility, grade, district, date sampled, and project information including highway and CSJ. The Engineer will retain theses samples for two months.

At least once per project, the Engineer will collect split samples of the polymer modified emulsion. The Engineer will submit one split sample to the Materials and Tests Division to verify compliance with Item 300, "Asphalts, Oils, and Emulsions" and will retain the other split sample for two months. The Engineer may test as often as necessary to ensure the residual of the emulsion is greater than or equal to the specification requirement in Item 300, "Asphalts, Oils, and Emulsions."

4.9.2. **Production Testing.** The Contractor and Engineer must perform production tests in accordance with Table 13. The Contractor has the option to verify the Engineer's test results on split samples provided by the Engineer. Determine compliance with operational tolerances in accordance with Table 9 for all sublots.

At any time during production, the Engineer may require the Contractor to verify the following based on quantities used:

- lime content (within ±0.1% of JMF), when PG binder is specified;
- fiber content (within ±0.03% of JMF), when PG binder is specified; and
- CRM content (within ±1.5% of JMF), when A-R binder is specified.

Maintain the in-line measuring device when A-R binder is specified to verify the A-R binder viscosity between

2,500 and 4,000 centipoise at 350°F unless otherwise approved. Record A-R binder viscosity at least once per hour and provide the Engineer with a daily summary unless otherwise directed.

If the aggregate mineralogy is such that Tex-236-F Part I does not yield reliable results, the Engineer may allow alternate methods for determining the asphalt content and aggregate gradation. The Engineer will require the Contractor to provide evidence that results from Tex-236-F, Part I are not reliable before permitting an alternate method unless otherwise allowed. Use the applicable test procedure as directed if an alternate test method is allowed.

Table 13
Production and Placement Testing Frequency

Description	Test Method	Min Contractor Testing Frequency	Min Engineer Testing Frequency
Individual % retained for sieve sized larger than #200	Tex-200-F	1 per sublot	1 per 12 sublots
% passing the #200 sieve			
Laboratory-molded density, %	Tex-207-F, Part VIII	1 per sublot	1 per lot
Asphalt binder content[1], %	Tex-236-F, Part I[2]	1 per sublot	1 per lot
Drain-down, %	Tex-235-F	1 per sublot	1 per 12 sublots
Boil test[3]	Tex-530-C	1 per project	1 per project
Membrane application rate	Tex-247-F	1 per lot	1 per 12 sublots
Moisture content	Tex-212-F, Part II	When directed	1 per project
Cantabro loss, %	Tex-245-F	1 per project (sample only)	1 per project
Overlay test	Tex-248-F	1 per project (sample only) [10]	1 per project[4]
Hamburg Wheel test	Tex-242-F	1 per project (sample only)[10]	1 per project[4]
Water flow test[5]	Tex-246-F	1 per sublot	1 per project
Asphalt binder sampling	Tex-500-C, Part II	1 per lot (sample only)[6]	1 per project
Membrane sampling and testing	Tex-500-C, Part III	N/A	1 per project
Thermal profile	Tex-244-F	1 per sublot[7,8,9]	1 per project[8]

1. May be obtained from asphalt mass flow meter readouts as determined by the Engineer.
2. Ensure the binder content determination excludes fibers.
3. When shown on the plans.
4. When required according to mixture type and requirements in accordance with Table 8.
5. Only required for PFC mixtures.
6. Obtain samples witness by the Engineer. The Engineer will retain these samples for 1 yr.
7. To be performed in the presence of the Engineer when using the thermal camera, unless otherwise approved.
8. Not required when a thermal imaging system is used.
9. When using the thermal imaging system, the test report must include the temperature measurements taken in accordance with Tex-244-F.
10. Testing performed by the Materials and Tests Division for informational purposes only.

4.9.3. **Operational Tolerances.** Control the production process within the operational tolerances in accordance with Table 9. Suspend production and placement operations when production or placement test results exceed the tolerances in accordance with Table 9 unless otherwise allowed. The Engineer will allow suspended production to resume when test results or other information indicates the next mixture produced will be within the operational tolerances.

4.9.4. **Individual Loads of Hot-Mix**. The Engineer can reject individual truckloads of hot-mix. When a load of hot-mix is rejected for reasons other than temperature, contamination, or excessive uncoated particles, the Contractor may request that the rejected load be tested. Make this request within 4 hr. of rejection. The Engineer will sample and test the mixture. If test results are within the operational tolerances in accordance with Table 9 , payment will be made for the load. If test results are not within operational tolerances, no payment will be made for the load.

4.9.5. **Placement Acceptance.**

4.9.6. **Placement Lot.** A placement lot consists of four placement sublots. A placement sublot consists of the area placed during a production sublot.

4.9.7. **Miscellaneous Areas.** Miscellaneous areas include areas that typically involve significant handwork or discontinuous paving operations such as driveways, mailbox turnouts, crossovers, gores, spot level-up areas, and other similar areas. The specified layer thickness is based on the rate of 90 lb. per square yard for each inch of pavement unless another rate is shown on the plans. Miscellaneous areas are not subject to thermal profiles testing.

4.9.8. **Recovered Asphalt Dynamic Shear Rheometer (DSR).** The Engineer may take production samples or cores from suspect areas of the project to determine recovered asphalt properties. Asphalt binders with an aging ratio greater than 3.5 do not meet the requirements for recovered asphalt properties and may be deemed defective when tested and evaluated by the Materials and Tests Division. The aging ratio is the DSR value of the extracted binder divided by the DSR value of the original unaged binder. Obtain DSR values in accordance with AASHTO T 315 at the specified high temperature performance grade of the asphalt. The Engineer may require removal and replacement of the defective material at the Contractor's expense. The asphalt binder will be recovered for testing from production samples or cores in accordance with Tex-211-F.

4.9.9. **Irregularities.** Identify and correct irregularities including segregation, rutting, raveling, flushing, fat spots, mat slippage, irregular color, irregular texture, roller marks, tears, gouges, streaks, uncoated aggregate particles, or broken aggregate particles. The Engineer may also identify irregularities, and in such cases, the Engineer will promptly notify the Contractor. If the Engineer determines that the irregularity will adversely affect pavement performance, the Engineer may require the Contractor to remove and replace (at the Contractor's expense) areas of the pavement that contain irregularities. The Engineer may also require the Contractor to remove and replace (at the Contractor's expense) areas where the mixture does not bond to the existing pavement.

If irregularities are detected, the Engineer may require the Contractor to immediately suspend operations or may allow the Contractor to continue operations for no more than one day while the Contractor is taking appropriate corrective action.

4.9.10. **Exempt Production.** When the anticipated daily production is less than 100 ton, all QC and QA sampling and testing are waived. The Engineer may deem the mixture as exempt production for the following conditions:

- anticipated daily production is more than 100 ton but less than 250 ton;
- total production for the project is less than 2,500 ton;
- when mutually agreed between the Engineer and the Contractor; or
- when shown on the plans.

For exempt production, the Contractor is relieved of all production and placement sampling and testing requirements. All other specification requirements apply, and the Engineer will perform acceptance tests for production and placement in accordance with Table 13.
For exempt production:

- produce, haul, place, and compact the mixture as directed by the Engineer; and
- control mixture production to yield a laboratory-molded density that is within ±1.0% of the target density as tested by the Engineer.

4.9.11. **Ride Quality**. Measure ride quality in accordance with Item 585, "Ride Quality for Pavement Surfaces," unless otherwise shown on the plans.

5. MEASUREMENT

5.1. **PFC Hot-Mix Asphalt.** Permeable friction course (PFC) hot-mix will be measured by the ton of composite mixture, which includes asphalt, aggregate, and additives. Measure the weight on scales in accordance with Item 520, "Weighing and Measuring Equipment."

5.2. **TBFC Hot-Mix Asphalt.** Thin bonded friction course (TBFC) hot-mix will be measured by the ton of composite mixture, which includes asphalt, aggregate, and additives. Measure the weight on scales in accordance with Item 520, "Weighing and Measuring Equipment."

5.3. **Membrane.** Membrane material will be measured by volume. Membrane material will be measured at the applied temperature by strapping the tank before and after road application and determining the net volume in gallons from the distributor's calibrated strap stick. The Engineer will witness all operations for volume determination. All membrane will be measured by the gallon applied, in the accepted membrane.

6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under Section 3082.5.1., "PFC Hot-Mix Asphalt," will be paid for at the unit bid price for "Permeable friction course" of the mixture type, SAC, and binder specified. These prices are full compensation for surface preparation, removing pavement marking and markers, materials, placement, equipment, labor, tools, and incidentals.

The work performed and materials furnished in accordance with this Item and measured as provided under Section 3082.5.2., "TBFC Hot-Mix Asphalt," will be paid for at the unit bid price for "Thin bonded friction course" of the mixture type, SAC, and binder specified. These prices are full compensation for surface preparation, removing pavement marking and markers, materials, placement, equipment, labor, tools, and incidentals.

The work performed and materials furnished in accordance with this Item and measured as provided under Section 3082.5.3., "Membrane," will be paid for at the unit bid price for "Membrane" of the membrane material provided. These prices are full compensation for materials, placement, equipment, labor, tools, and incidentals.

Trial batches will not be paid for unless they are included in pavement work approved by the Department.

Payment adjustment for ride quality will be determined in accordance with Item 585, "Ride Quality for Pavement Surfaces."

Special Specification 3084
Bonding Course

1. DESCRIPTION

Construct a bonding course where improved bonding is needed using a Tracking-Resistant Asphalt Interlayer (TRAIL) or a Spray Applied Underseal Membrane, applied before the placement of a new hot-mix asphalt concrete pavement.

2. MATERIALS

2.1. Furnish the materials for one of the following two options:

2.1.1. **TRAIL.** Furnish asphalt material described as "tack" for typical use in the TRAIL Material Producer List. Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use.

2.1.2. **Spray Applied Underseal Membrane.** Furnish asphalt material meeting the requirements of Special Specification 3002, "Spray Applied Underseal Membrane." Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use.

2.2. Furnish the material for applying tack coat to all miscellaneous contact surfaces when approved by the Engineer:

2.2.1. **Miscellaneous Tack.** FurnishTRAIL asphalt, CSS-1H, SS-1H, or a PG binder with a minimum high-temperature of PG 58 for tack coat binder in accordance with Item 300, "Asphalts, Oils, and Emulsions." Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use.

2.3. **Sampling**. The Engineer will witness the collection of at least one sample of each asphalt binder per project in accordance with Tex-500-C, Part III, and test it to verify compliance with Item 300, "Asphalts, Oils, and Emulsions" or Special Specification 3002, "Spray Applied Underseal Membrane."

3. EQUIPMENT

3.1. **TRAIL.** Provide the equipment recommended by the producer.

3.2. **Spray Applied Underseal Membrane.** Provide in accordance with Special Specification 3002, "Spray Applied Underseal Membrane."

4. CONSTRUCTION

4.1. **Preparation.** Remove existing raised pavement markers. Repair any damage incurred by removal as directed. Remove dirt, dust, or other harmful material before sealing. When shown on the plans, remove vegetation and blade pavement edges. When approved by the Engineer, apply a thin, uniform coating of Miscellaneous Tack to all miscellaneous contact surfaces such as curbs, structures, and manholes. Prevent splattering of the tack coat when placed adjacent to curb, gutter, and structures.

4.2. **Test Strips.** When required by the Engineer, perform a test strip of TRAIL at a location on or near the project as directed. Allow the strip to cure for a maximum of 30 min. Drive over the test strip with equipment used during laid-down construction to simulate the effect of paving equipment. There should be no evidence of tracking or picking up of the TRAIL material on the wheels of the equipment.

4.3. **TRAIL.** Perform the following construction methods when applying a TRAIL for a bonding course:

4.3.1. **Placement.** Uniformly apply the TRAIL material to all areas where mix will be placed, including joints, at the rate shown on the plans or as directed, within 15°F of the approved temperature, and not above the maximum allowable temperature. Unless otherwise directed, uniformly apply the TRAIL material at a minimum rate specified on the plans. The Engineer may adjust the application rate, taking into consideration the existing pavement surface conditions.

4.4. **Spray Applied Underseal Membrane.** Place in accordance with Special Specification 3002, "Spray Applied Underseal Membrane."

4.4.1. **Placement.** Do not allow any loose mixture onto the prepared surface before application of the membrane. Unless otherwise directed, uniformly apply the membrane to all areas where mix will be placed, including joints, at the rate shown on the plans. Unless otherwise directed, uniformly apply the membrane at the minimum rate specified on the plans. The Engineer may adjust the application rate, taking into consideration the existing pavement surface conditions.

4.5. **Informational Shear Test.** Obtain one set of full depth core specimens per project in accordance with Tex-249-F within one working day of the time the lot placement is completed. The Engineer will select the core locations. Provide the cores to the Engineer in a container labeled with the Control-Section-Job (CSJ) and lot number. The district will determine the shear bond strength between the two bonded pavement layers in accordance with Tex-249-F. Results from these tests will not be used for specification compliance.

4.6. **Quality Control.** Stop application if it is not uniform due to streaking, ridging, pooling, or flowing off the roadway surface. Verify equipment condition, operating procedures, application temperature, and material properties. Determine and correct the cause of non-uniform application.

The Engineer may perform independent tests to confirm contractor compliance and may require testing differences or failing results to be resolved before resuming production.

The Engineer may stop the application and require construction of test strips at the Contractor's expense if any of the following occurs:

- Non-uniformity of application continues after corrective action;
- Evidence of tracking or picking up of the TRAIL;
- In 3 consecutive shots, application rate differs by more than 0.02 gal. per square yard from the rate directed; or
- Any shot differs by more than 0.04 gal. per square yard from the rate directed.

The Engineer will approve the test strip location. The Engineer may require additional test strips until surface treatment application meets specification requirements.

5. MEASUREMENT

5.1. **Volume**. The asphalt material, including all components, will be measured at the applied temperature by strapping the tank before and after road application and determining the net volume from the calibrated distributor. The Engineer will witness all strapping operations for volume determination. All asphalt material, including emulsions, will be measured by the gallon applied.

The Engineer may allow the use of a metering device to determine the asphalt volume used and application rate if the device is accurate to within 1.5% of the strapped volume.

6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit bid price for "Bonding Course." These prices are full compensation

for all materials, Miscellaneous Tack used for miscellaneous contact surfaces, equipment, labor, tools, and incidentals necessary to complete the work.

Special Specification 3085
Underseal Course

1. DESCRIPTION

Construct an underseal course where sealing of the underlying surface is needed using a Tracking-Resistant Asphalt Interlayer (TRAIL), a Spray Applied Underseal Membrane, or a single layer of Seal Coat, applied before the placement of a new hot-mix asphalt concrete pavement.

2. MATERIALS

2.1. Furnish the materials for one of the following three options:

2.1.1. **TRAIL.** Furnish asphalt material described as "seal" for typical use in the TRAIL Material Producer List.

2.1.2. **Spray Applied Underseal Membrane.** Furnish asphalt material meeting the requirements of Special Specification 3002, "Spray Applied Underseal Membrane." Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use.

2.1.3. **Seal Coat.** Furnish asphalt and aggregate materials meeting the requirements of Item 316, "Seal Coat." Use a polymer modified asphalt or emulsion and aggregate as shown on the plans. Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use.

2.2. Furnish the material for applying tack coat to all miscellaneous contact surfaces when approved by the Engineer:

2.2.1. **Miscellaneous Tack.** Furnish TRAIL asphalt, CSS-1H, SS-1H, or a PG binder with a minimum high-temperature of PG 58 for tack coat binder in accordance with Item 300, "Asphalts, Oils, and Emulsions." Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use.

2.3. **Sampling.** The Engineer will witness the collection of at least one sample of each asphalt binder per project in accordance with Tex-500-C, Part III, and test it to verify compliance with Item 300, "Asphalts, Oils, and Emulsions" or Special Specification 3002, "Spray Applied Underseal Membrane."

The Engineer will sample and test the type and grade of the aggregate as shown on the plans at the frequency listed in the Department's *Guide Schedule of Sampling and Testing* in accordance with Item 302, "Aggregates for Surface Treatments."

3. EQUIPMENT

3.1. **TRAIL.** Provide the equipment recommend by the producer.

3.2. **Spray Applied Underseal Membrane.** Provide in accordance with Special Specification 3002, "Spray Applied Underseal Membrane."

3.3. **Seal Coat.** Provide in accordance with Item 316, "Seal Coat."

4. CONSTRUCTION

4.1. **Preparation.** Remove existing raised pavement markers. Repair any damage incurred by removal as directed. Remove dirt, dust, or other harmful material before sealing. When shown on the plans, remove

vegetation and blade pavement edges. When approved by the Engineer, apply a thin, uniform coating of Miscellaneous Tack to all miscellaneous contact surfaces such as curbs, structures, and manholes. Prevent splattering of the tack coat when placed adjacent to curb, gutter, and structures.

4.2. **TRAIL.** Perform the following construction methods when applying a TRAIL for an underseal course:

4.2.1. **Placement.** Uniformly apply the TRAIL material to all areas where mix will be placed, including joints, at the rate shown on the plans or as directed, within 15°F of the approved temperature, and not above the maximum allowable temperature. Unless otherwise directed, uniformly apply the TRAIL material at the minimum rate specified on the plans. The Engineer may adjust the application rate taking into consideration the existing pavement surface conditions.

4.3. **Spray Applied Underseal Membrane.** Place in accordance with Special Specification 3002, "Spray Applied Underseal Membrane."

4.3.1. **Placement.** Do not allow any loose mixture onto the prepared surface before application of the membrane. Unless otherwise directed, uniformly apply the membrane to all areas where mix will be placed, including joints, at the rate shown on the plans. Unless otherwise directed, uniformly apply the membrane at the minimum rate specified on the plans. The Engineer may adjust the application rate, taking into consideration the existing pavement surface conditions.

4.4. **Seal Coat.** Place in accordance with Item 316, "Seal Coat."

4.4.1. **Placement.** Unless otherwise directed, apply the asphalt material and aggregate at the minimum rate shown on the plans. The Engineer may adjust the application rate, taking into consideration the existing pavement surface conditions.

4.5. **Informational Shear Test.** Obtain one set of full depth core specimens per project in accordance with Tex-249-F within one working day of the time the lot placement is completed. The Engineer will select the core locations. Provide the cores to the Engineer in a container labeled with the Control-Section-Job (CSJ) and lot number. The district will determine the shear bond strength between the two bonded pavement layers in accordance with Tex-249-F. Results from these tests will not be used for specification compliance.

4.6. **Nonuniform Application.** Stop application if it is not uniform due to streaking, ridging, pooling, or flowing off the roadway surface. Verify equipment condition, operating procedures, application temperature, and material properties. Determine and correct the cause of non-uniform application.

4.7. **Test Strips.** The Engineer may perform independent tests to confirm contractor compliance and may require testing differences or failing results to be resolved before resuming production.

The Engineer may stop the application and require construction of test strips at the Contractor's expense if any of the following occurs:

- Non-uniformity of application continues after corrective action;
- Evidence of tracking or picking up of the TRAIL;
- In 3 consecutive shots, application rate differs by more than 0.03 gal. per square yard from the rate directed; or
- Any shot differs by more than 0.05 gal. per square yard from the rate directed.

The Engineer will approve the test strip location. The Engineer may require additional test strips until surface treatment application meets specification requirements.

5. MEASUREMENT

5.1. **Asphalt Material.**

5.1.1. **Volume**. The asphalt material, including all components, will be measured at the applied temperature by strapping the tank before and after road application and determining the net volume from the calibrated distributor. The Engineer will witness all strapping operations for volume determination. All asphalt material, including emulsions, will be measured by the gallon applied.

The Engineer may allow the use of a metering device to determine the asphalt volume used and application rate if the device is accurate to within 1.5% of the strapped volume.

5.2. **Aggregate.** The work performed, materials furnished, equipment, labor, tools, and incidentals will not be paid for directly but will be subsidiary.

5.3. **Quantity Adjustments.** Quantity based price adjustment factors are not applicable to compensate for over and under runs resulting from the method chosen.

6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Underseal Course." These prices are full compensation for surface preparation; furnishing, preparing, hauling, Miscellaneous Tack used for all miscellaneous contact surfaces, and placing materials; removing existing pavement markers and excess aggregate; rolling; cleaning up stockpiles; and equipment, labor, tools, and incidentals.

Special Specification 3096
Asphalts, Oils, and Emulsions

1. DESCRIPTION

Provide asphalt cements, cutback and emulsified asphalts, performance-graded asphalt binders, and other miscellaneous asphalt materials as specified on the plans.

2. MATERIALS

Provide asphalt materials that meet the stated requirements when tested in conformance with the referenced Department, AASHTO, and ASTM test methods. Use asphalt containing recycled materials only if the recycled components meet the requirements of Article 6.9., "Recycled Materials." Provide asphalt materials that the Department has preapproved for use in accordance with Tex-545-C, "Asphalt Binder Quality Program."

Inform the Department of all additives or modifiers included in the asphalt binder as part of the facility quality plan, as required by Tex-545-C, "Asphalt Binder Quality Program," and provide that information to Department personnel. The Department reserves the right to prohibit the use of any asphalt additive or modifier.

Limit the use of polyphosphoric acid to no more than 0.5% by weight of the asphalt binder.

The use of re-refined engine oil bottoms is prohibited.

Acronyms used in this Item are defined in Table 1.

Table1
Acronyms

Acronym	Definition
Test Procedure Designations	
Tex	Department
T or R	AASHTO
D	ASTM
Polymer Modifier Designations	
P	polymer-modified
SBR or L	styrene-butadiene rubber (latex)
SBS	styrene-butadiene-styrene block co-polymer
TR	tire rubber (from ambient temperature grinding of truck and passenger tires)
AC	asphalt cement
AE	asphalt emulsion
AE-P	asphalt emulsion prime
A-R	asphalt-rubber
C	cationic
EAP&T	emulsified asphalt prime and tack
EBL	emulsified bonding layer
FDR	full depth reclamation
H-suffix	harder residue (lower penetration)
HF	high float
HY	high yield
MC	medium-curing
MS	medium-setting
PCE	prime, cure, and erosion control
PG	performance grade
RC	rapid-curing
RS	rapid-setting
S-suffix	stockpile usage
SCM	special cutback material
SS	slow-setting
SY	standard yield
TRAIL	tracking resistant asphalt interlayer

2.1. **Asphalt Cement**. Provide asphalt cement that is homogeneous, water-free, and nonfoaming when heated to 347°F, and meets the requirements in Table 2.

Table 2
Asphalt Cement

Property	Test Procedure	Viscosity Grade									
		AC-0.6		AC-1.5		AC-3		AC-5		AC-10	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity	T 202										
140°F, poise		40	80	100	200	250	350	400	600	800	1,200
275°F, poise		0.4	–	0.7	–	1.1	–	1.4	–	1.9	–
Penetration, 77°F, 100g, 5 sec.	T 49	350	–	250	–	210	–	135	–	85	–
Flash point, C.O.C., °F	T 48	425	–	425	–	425	–	425	–	450	–
Solubility in trichloroethylene, %	T 44	99.0	–	99.0	–	99.0	–	99.0	–	99.0	–
Spot test	Tex-509-C	Neg.		Neg.		Neg.		Neg.		Neg.	
Tests on residue from RTFOT:	T 240										
Viscosity, 140°F, poise	T 202	–	180	–	450	–	900	–	1,500	–	3,000
Ductility,[1] 77°F 5 cm/min., cm	T 51	100	–	100	–	100	–	100	–	100	–

1. If AC-0.6 or AC-1.5 ductility at 77°F is less than 100 cm, material is acceptable if ductility at 60°F is more than 100 cm.

2.2. **Polymer-Modified Asphalt Cement**. Provide polymer-modified asphalt cement that is smooth, homogeneous, and meets the requirements Table 3. Supply samples of the base asphalt cement and polymer additives if requested.

Table 3
Polymer-Modified Asphalt Cement

Property	Test Procedure	Polymer-Modified Viscosity Grade											
		AC-12-5TR		NT-HA[1]		AC-15P		AC-20XP		AC-10-2TR		AC-20-5TR	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Polymer		TR		–		SBS		SBS		TR		TR	
Polymer content, % (solids basis)	Tex-533-C or Tex-553-C	5.0	–	–	–	3.0	–	–	–	2.0	–	5.0	–
Dynamic shear, G*/sinδ, 82°C, 10 rad/s, kPa	T 315			1.0	–								
Dynamic shear, G*/sinδ, 64°C, 10 rad/s, kPa	T 315	–	–	–	–	–	–	1.0	–	–	–	1.0	–
Dynamic shear, G*/sinδ, 58°C, 10 rad/s, kPa	T 315	1.0	–	–	–	–	–	–	–	1.0	–	–	–
Viscosity 140°F, poise 275°F, poise	 T 202 T 202	 1,200	 –	 –	 4,000	 1,500 –	 – 8.0	 2,000 –	 – –	 1,000 –	 – 8.0	 2,000 –	 – 10.0
Penetration, 77°F, 100 g, 5 sec.	T 49	110	150	–	25	100	150	75	115	95	130	75	115
Ductility, 5cm/min., 39.2°F, cm	T 51					–	–	–	–	–	–	–	–
Elastic recovery, 50°F, %	Tex-539-C	55	–			55	–	55	–	30	–	55	–
Softening point, °F	T 53	113	–	170	–	–	–	120	–	110	–	120	–
Polymer separation, 5 hr.	Tex-540-C	None				None		None		None		None	
Flash point, C.O.C., °F	T 48	425	–	425	–	425	–	425	–	425	–	425	–
Tests on residue from RTFOT aging and pressure aging:	T 240 and R 28												
Creep stiffness S, -18°C, MPa m-value, -18°C	T 313	 – 0.300	 300 –	 – –	 – –	 – 0.300	 300 –	 – 0.300	 300 –	 – 0.300	 300 –	 – 0.300	 300 –

1. Non-Tracking Hot Applied Tack Coat - TRAIL product

2.3. **Cutback Asphalt**. Provide cutback asphalt that meets the requirements of Tables 4, 5, and 6, for the specified type and grade. Supply samples of the base asphalt cement and polymer additives if requested.

Table 4
Rapid-Curing Cutback Asphalt

Property	Test Procedure	Type–Grade					
		RC-250		RC-800		RC-3000	
		Min	Max	Min	Max	Min	Max
Kinematic viscosity, 140°F, cSt	T 201	250	400	800	1,600	3,000	6,000
Water, %	D95	–	0.2	–	0.2	–	0.2
Flash point, T.O.C., °F	T 79	80	–	80	–	80	–
Distillation test:	T 78						
Distillate, percentage by volume of total distillate to 680°F							
to 437°F		40	75	35	70	20	55
to 500°F		65	90	55	85	45	75
to 600°F		85	–	80	–	70	–
Residue from distillation, volume %		70	–	75	–	82	–
Tests on distillation residue:							
Viscosity, 140°F, poise	T 202	600	2,400	600	2,400	600	2,400
Ductility, 5 cm/min., 77°F, cm	T 51	100	–	100	–	100	–
Solubility in trichloroethylene, %	T 44	99.0	–	99.0	–	99.0	–
Spot test	Tex-509-C	Neg.		Neg.		Neg.	

Table 5
Medium-Curing Cutback Asphalt

Property	Test Procedure	Type–Grade							
		MC-30		MC-250		MC-800		MC-3000	
		Min	Max	Min	Max	Min	Max	Min	Max
Kinematic viscosity, 140°F, cSt	T 201	30	60	250	500	800	1,600	3,000	6,000
Water, %	D95	–	0.2	–	0.2	–	0.2	–	0.2
Flash point, T.O.C., °F	T 79	95	–	122	–	140	–	149	–
Distillation test:	T 78								
Distillate, percentage by volume of total distillate to 680°F									
to 437°F		–	35	–	20	–	–	–	–
to 500°F		30	75	5	55	–	40	–	15
to 600°F		75	95	60	90	45	85	15	75
Residue from distillation, volume %		50	–	67	–	75	–	80	–
Tests on distillation residue:									
Viscosity, 140°F, poise	T 202	300	1,200	300	1,200	300	1,200	300	1,200
Ductility, 5 cm/min., 77°F, cm	T 51	100	–	100	–	100	–	100	–
Solubility in trichloroethylene, %	T 44	99.0	–	99.0	–	99.0	–	99.0	–
Spot test	Tex-509-C	Neg.		Neg.		Neg.		Neg.	

Table 6
Special-Use Cutback Asphalt

Property	Test Procedure	Type–Grade					
		MC-2400L		SCM I		SCM II	
		Min	Max	Min	Max	Min	Max
Kinematic viscosity, 140°F, cSt	T 201	2,400	4,800	500	1,000	1,000	2,000
Water, %	D95	–	0.2	–	0.2	–	0.2
Flash point, T.O.C., °F	T 79	150	–	175	–	175	–
Distillation test:	T 78						
Distillate, percentage by volume of total distillate to 680°F							
to 437°F		–	–	–	–	–	–
to 500°F		–	35	–	0.5	–	0.5
to 600°F		35	80	20	60	15	50
Residue from distillation, volume %		78	–	76	–	82	–
Tests on distillation residue:							
Polymer		SBR		–		–	
Polymer content, % (solids basis)	Tex-533-C	2.0	–	–	–	–	–
Penetration, 100 g, 5 sec., 77°F	T 49	150	300	180	–	180	–
Ductility, 5 cm/min., 39.2°F, cm	T 51	50	–	–	–	–	–
Solubility in trichloroethylene, %	T 44	99.0	–	99.0	–	99.0	–

2.4. **Emulsified Asphalt**. Provide emulsified asphalt that is homogeneous, does not separate after thorough mixing, and meets the requirements for the specified type and grade in Tables 7, 8, 9, 10, and 10A-C.

Table 7
Emulsified Asphalt

Property	Test Procedure	Type–Grade									
		Rapid-Setting		Medium-Setting				Slow-Setting			
		HFRS-2		MS-2		AES-300		SS-1		SS-1H	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol	T 72										
77°F, sec.		–	–	–	–	75	400	20	100	20	100
122°F, sec.		150	400	100	300	–	–	–	–	–	–
Sieve test, %	T 59	–	0.1	–	0.1	–	0.1	–	0.1	–	0.1
Miscibility	T 59	–		–		–		Pass		Pass	
Cement mixing, %	T 59	–	–	–	–	–	–	–	2.0	–	2.0
Coating ability and water resistance:	T 59										
Dry aggregate/after spray		–		–		Good/Fair		–		–	
Wet aggregate/after spray		–		–		Fair/Fair		–		–	
Demulsibility, 35 mL of 0.02 N $CaCl_2$, %	T 59	50	–	–	30	–	–	–	–	–	–
Storage stability, 1 day, %	T 59	–	1	–	1	–	1	–	1	–	1
Freezing test, 3 cycles[1]	T 59	–		Pass		–		Pass		Pass	
Distillation test:	T 59										
Residue by distillation, % by wt.		65	–	65	–	65	–	60	–	60	–
Oil distillate, % by volume of emulsion		–	0.5	–	0.5	–	5	–	0.5	–	0.5
Tests on residue from distillation:											
Penetration, 77°F, 100 g, 5 sec.	T 49	100	140	120	160	300	–	120	160	70	100
Solubility in trichloroethylene, %	T 44	97.5	–	97.5	–	97.5	–	97.5	–	97.5	–
Ductility, 77°F, 5 cm/min., cm	T 51	100	–	100	–	–	–	100	–	80	–
Float test, 140°F, sec.	T 50	1,200	–	–	–	1,200	–	–	–	–	–

1. Applies only when the Engineer designates material for winter use.

Table 8
Cationic Emulsified Asphalt

Property	Test Procedure	Type–Grade											
		Rapid-Setting				Medium-Setting				Slow-Setting			
		CRS-2		CRS-2H		CMS-2		CMS-2S		CSS-1		CSS-1H	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol	T 72												
77°F, sec.		–	–	–	–	–	–	–	–	20	100	20	100
122°F, sec.		150	400	150	400	100	300	100	300	–	–	–	–
Sieve test, %	T 59	–	0.1	–	0.1	–	0.1	–	0.1	–	0.1	–	0.1
Cement mixing, %	T 59	–	–	–	–	–	–	–	–	–	2.0	–	2.0
Coating ability and water resistance:	T 59												
Dry aggregate/after spray		–		–		Good/Fair		Good/Fair		–		–	
Wet aggregate/after spray		–		–		Fair/Fair		Fair/Fair		–		–	
Demulsibility, 35 mL of 0.8% Sodium dioctyl sulfosuccinate, %	T 59	70	–	70	–	–	–	–	–	–	–	–	–
Storage stability, 1 day, %	T 59	–	1	–	1	–	1	–	1	–	1	–	1
Particle charge	T 59	Positive		Positive		Positive		Positive		Positive		Positive	
Distillation test:													
Residue by distillation, % by wt.	T 59	65	–	65	–	65	–	65	–	60	–	60	–
Oil distillate, % by volume of emulsion		–	0.5	–	0.5	–	7	–	5	–	0.5	–	0.5
Tests on residue from distillation:													
Penetration, 77°F, 100 g, 5 sec.	T 49	120	160	70	110	120	200	300	–	120	160	70	110
Solubility in trichloroethylene, %	T 44	97.5	–	97.5	–	97.5	–	97.5	–	97.5	–	97.5	–
Ductility, 77°F, 5 cm/min., cm	T 51	100	–	80	–	100	–		–	100	–	80	–

Table 9
Polymer-Modified Emulsified Asphalt

Property	Test Procedure	Type–Grade									
		Rapid-Setting		Medium-Setting				Slow-Setting			
		HFRS-2P		AES-150P		AES-300P		AES-300S		SS-1P	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol	T 72										
77°F, sec.		–	–	75	400	75	400	75	400	30	100
122°F, sec.		150	400					–	–	–	–
Sieve test, %	T 59	–	0.1	–	0.1	–	0.1	–	0.1	–	0.1
Miscibility	T 59	–		–		–		–		Pass	
Coating ability and water resistance:											
Dry aggregate/after spray	T 59	–		Good/Fair		Good/Fair		Good/Fair		–	
Wet aggregate/after spray		–		Fair/Fair		Fair/Fair		Fair/Fair		–	
Demulsibility, 35 mL of 0.02 N $CaCl_2$, %	T 59	50	–	–	–	–	–	–	–	–	–
Storage stability, 1 day, %	T 59	–	1	–	1	–	1	–	1	–	1
Breaking index, g	Tex-542-C	–	–								
Distillation test:[1]	T 59										
Residue by distillation, % by wt.		65	–	65	–	65	–	65	–	60	–
Oil distillate, % by volume of emulsion		–	0.5	–	3	–	5	–	7	–	0.5
Tests on residue from distillation:											
Polymer content, wt. % (solids basis)	Tex-533-C	3.0	–	–	–	–	–	–	–	3.0	–
Penetration, 77°F, 100 g, 5 sec.	T 49	90	140	150	300	300	–	300	–	100	140
Solubility in trichloroethylene, %	T 44	97.0	–	97.0	–	97.0	–	97.0	–	97.0	–
Viscosity, 140°F, poise	T 202	1,500	–	–	–	–	–	–	–	1,300	–
Float test, 140°F, sec	T 50	1,200	–	1,200	–	1,200	–	1,200	–	–	–
Ductility,[2] 39.2°F, 5 cm/min., cm	T 51	50	–	–	–	–	–	–	–	50	–
Elastic recovery,2 50°F, %	Tex-539-C	55	–	–	–	–	–	–	–	–	–
Tests on RTFO curing of distillation residue	T 240										
Elastic recovery, 50°F, %	Tex-536-C	–	–	50	–	50	–	30	–	–	–

1. Exception to T 59: Bring the temperature on the lower thermometer slowly to 350°F ±10°F. Maintain at this temperature for 20 min. Complete total distillation in 60 min. (±5 min.) from the first application of heat.
2. HFRS-2P must meet one of either the ductility or elastic recovery requirements.

Table 10
Polymer-Modified Cationic Emulsified Asphalt

Property	Test Procedure	Type–Grade											
		Rapid-Setting						Medium-Setting				Slow-Setting	
		CRS-2P		CHFRS-2P		CRS-2TR		CMS-1P[3]		CMS-2P[3]		CSS 1P	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol	T 72												
77°F, sec.		–	–	–	–	–	–	10	100	–	–	20	100
122°F, sec.		150	400	100	400	150	500	–	–	50	400	–	–
Sieve test, %	T 59	–	0.1	–	0.1	–	0.1	–	0.1	–	0.1	–	0.1
Demulsibility, 35 ml of 0.8% sodium dioctyl sulfosuccinate, %	T 59	70	–	60	–	40	–	–	–	–	–	–	–
Storage stability, 1 day, %	T 59	–	1	–	1	–	1	–	1	–	1	–	1
Breaking index, g	Tex-542-C	–	–	–	–	–	–	–	–	–	–	–	–
Particle charge	T 59	Positive		Positive		Positive		Positive		Positive		Positive	
Distillation test[1]:	T 59												
Residue by distillation, % by weight		65	–	65	–	65	–	30	–	60	–	62	–
Oil distillate, % by volume of emulsion		–	0.5	–	0.5	–	3	–	0.5	–	0.5	–	0.5
Tests on residue from distillation:													
Polymer content, wt. % (solids basis)	Tex-533-C	3.0	–	3.0	–	5.0[7]	–	–	–	–	–	3.0	–
Penetration, 77°F, 100 g, 5 sec.	T 49	90	150	80	130	90	150	30	–	30	–	55	90
Viscosity, 140°F, poise	T 202	1,300	–	1,300	–	1,000	–	–	–	–	–	–	–
Solubility in trichloroethylene, %	T44	97.0	–	95.0	–	98	–	–	–	–	–	97.0	–
Softening point, °F	T 53	–	–	–	–	–	–	–	–	–	–	135	–
Ductility, 77°F, 5 cm/min., cm	T 51	–	–	–	–	40	–	–	–	–	–	70	–
Float test, 140°F, sec.	T 50	–	–	1,800	–	–	–	–	–	–	–	–	–
Ductility,[2] 39.2°F, 5 cm/min., cm	T 51	50	–	–	–	–	–	–	–	–	–	–	–
Elastic recovery,[2] 50°F, %	Tex-539-C	55	–	55	–	–	–	–	–	–	–	–	–
Tests on residue from evaporative recovery:	R 78, Procedure B												
Nonrecoverable creep compliance of residue, 3.2 kPa, 52°C, kPa-[1]	T 350	–	–	–	–	–	–	–	2.0	–	4.0	–	–
Tests on rejuvenating agent:													
Viscosity, 140°F, cSt	T 201	–	–	–	–	–	–	50	175	50	175	–	–
Flash point, C.O.C., °F	T 48	–	–	–	–	–	–	380	–	380	–	–	–
Saturates, % by weight	D 2007	–	–	–	–	–	–	–	30	–	30	–	–
Solubility in n-pentane, % by weight	D 2007	–	–	–	–	–	–	99	–	99	–	–	–
Tests on rejuvenating agent after RTFO	T 240												
Weight Change, %		–	–	–	–	–	–	–	6.5	–	6.5	–	–
Viscosity Ratio		–	–	–	–	–	–	–	3.0	–	3.0	–	–
Tests on latex[4]:													
Tensile strength, die C dumbbell, psi	D 412[5]	–	–	–	–	–	–	800	–	800	–	–	–
Change in mass after immersion in rejuvenating agent, %	D 471	–	–	–	–	–	–	–	40[6]	–	40[6]	–	–

1. Exception to T 59: Bring the temperature on the lower thermometer slowly to 350°F (±0°F). Maintain at this temperature for 20 min. Complete total distillation in 60 min. (±5 min.) from the first application of heat.
2. CRS-2P must meet one of either the ductility or elastic recovery requirements.
3. With all precertification samples of CMS-1P or CMS-2P, submit certified test reports showing that the rejuvenating agent and latex meet the stated requirements. Submit samples of these raw materials if requested by the Engineer.
4. Preparation of latex specimens: use any substrate and recovery method which produces specimens of uniform dimensions and which delivers enough material to achieve desired residual thickness.
5. Cut samples for tensile strength determination using a crosshead speed of 20 in. per minute.
6. Specimen must remain intact after exposure and removal of excess rejuvenating agent.
7. Modifier type is tire rubber.

Table 10A
Non-Tracking Tack Coat Emulsion[1]

Property	Test Procedure	NT-HRE		NT-RRE		NT-SRE	
		Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol 77º F, sec.	T 72	15	–	15	–	10	100
Storage stability, 1 Day, %	T 59	–	1	–	1	–	1
Settlement, 5-day, %	T 59	–	5	–	5	–	5
Sieve test, %	T 59	–	0.30	–	0.30	–	0.1
Distillation test:[2]	T 59						
Residue by distillation, % by wt.		50	–	58	–	50	–
Oil distillate, by volume of emulsion		–	1.0	–	1.0	–	1.0
Test on residue from distillation:							
Penetration, 77ºF, 100 g, 5 sec.	T 49	–	20	15	45	40	90
Solubility in trichloroethylene, %	T 44	97.5	–	97.5	–	97.5	–
Softening point, ºF	T 53	150	–	–	–	–	–
Dynamic shear, G*/sin(δ), 82°C, 10 rad/s, kPa	T 315	1.0	–	–	–	–	–

1. Due to the hardness of the residue, these emulsions should be heated to 120-140°F before thoroughly mixing as the emulsion is being prepared for testing.
2. Exception to T 59: Bring the temperature on the lower thermometer slowly to 350ºF ± 10ºF. Maintain at this temperature for 20 min. Complete total distillation in 60 ± 5 min. from first application of heat.

Table10B
Spray Applied Underseal Membrane Polymer-Modified Emulsions (EBL)

Property	Test Procedure	Min	Max
Viscosity @ 77°F, SSF	T 72	20	100
Storage Stability[1], %	T 59	–	1
Demulsibility[2] Anionic emulsions – 35 mL of 0.02 N CaCl2, % Cationic emulsions – 35 mL of 0.8% sodium dioctyl sulfosuccinate, %	T 59	55	–
Sieve Test[3], %	T 59	–	0.05
Distillation Test[4]	T 59		
Residue by distillation, % by wt.		63	
Oil portion of distillate, % by vol.			0.5
Test on Residue from Distillation			
Elastic Recovery @ 50°F, 50 mm/min., %	Tex-539-C	60	–
Penetration @ 77°F, 100 g, 5 sec., 0.1 mm	T 49	80	130

1. After standing undisturbed for 24 hr., the surface must be smooth, must not exhibit a white or milky colored substance, and must be a homogeneous color throughout.
2. Material must meet demulsibility test for emulsions.
3. May be required by the Engineer only when the emulsion cannot be easily applied in the field.
4. The temperature on the lower thermometer should be brought slowly to 350°F ± 10°F and maintained at this temperature for 20 min. The total distillation should be completed in 60 ± 5 min. from the first application of heat.

Table 10C
Full-Depth Reclamation Emulsion (FDR EM)

Property	Test Procedure	Standard Yield (SY)		High Yield (HY)	
		Min	Max	Min	Max
Sieve test, %	T 59	–	0.1	–	0.1
Viscosity Saybolt Furol @ 77°F, sec.	T 59	20	100	20	100
Distillation test[1]:	T 59				
Residue by distillation, % by wt.		60	–	63	–
Oil portion of distillate, % by vol.		–	0.5	–	0.5
Test on residue from distillation:	T 49				
Penetration @ 77°F, dmm		55	95	120	–
Test on rejuvenating agent:					
BWOA, %[2]	***	–	–	2	–
Viscosity @ 140°F, cSt	T 201	–	–	50	175
Flash Point, COC, °F	T 48	–	–	380	–
Solubility in n-pentane, % by wt.	D2007	–	–	99	–

1. The temperature on the lower thermometer should be brought slowly to 350°F ±10°F and maintained at this temperature for 20 min. The total distillation should be completed in 60 ± 5 min. from the first application of heat.
2. BWOA = By weight of asphalt. Provide a manufacturer's certificate of analysis (COA) with the percent of rejuvenator added.

2.5. **Specialty Emulsions.** Provide specialty emulsion that is either asphalt-based or resin-based and meets the requirements of Table 11 or Table 11A.

Table 11
Specialty Emulsions

Property	Test Procedure	Type–Grade					
		Medium-Setting				Slow-Setting	
		AE-P		EAP&T		PCE[1]	
		Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol	T 72						
77°F, sec.		–	–	–	–	10	100
122°F, sec.		15	150	–	–	–	–
Sieve test, %	T 59	–	0.1	–	0.1	–	0.1
Miscibility[2]	T 59	–		Pass		Pass	
Demulsibility, 35 mL of 0.10 N $CaCl^2$, %	T 59	–	70	–	–	–	–
Storage stability, 1 day, %	T 59	–	1	–	1	–	–
Particle size,[5] % by volume < 2.5 μm	Tex-238-F[3]	–	–	90	–	90	–
Asphalt emulsion distillation to 500°F followed by Cutback asphalt distillation of residue to 680°F:	T 59 & T 78						
Residue after both distillations, % by wt.		40	–	–	–	–	–
Total oil distillate from both distillations, % by volume of emulsion		25	40	–	–	–	–
Residue by distillation, % by wt.	T 59	–	–	60	–	–	–
Residue by evaporation,[4] % by wt.	T 59	–	–	–	–	60	–
Tests on residue after all distillations:							
Viscosity, 140°F, poise	T 202	–	–	800	–	–	–
Kinematic viscosity,[5] 140°F, cSt	T 201	–	–	–	–	100	350
Flash point C.O.C., °F	T 48	–	–	–	–	400	–
Solubility in trichloroethylene, %	T 44	97.5	–	–	–	–	–
Float test, 122°F, sec.	T 50	50	200	–	–	–	–

1. Supply with each shipment of PCE:
   - a copy of a lab report from an approved analytical lab, signed by a lab official, indicating the PCE formulation does not meet any characteristics of a Resource Conservation Recovery Act (RCRA) hazardous waste;
   - a certification from the producer that the formulation supplied does not differ from the one tested and that no listed RCRA hazardous wastes or Polychlorinated Biphenyls (PCBs) have been mixed with the product; and
   - a Safety Data Sheet.
2. Exception to T 59: In dilution, use 350 mL of distilled or deionized water and a 1,000-mL beaker.
3. Use Tex-238-F, beginning at "Particle Size Analysis by Laser Diffraction," with distilled or deionized water as a medium and no dispersant, or use another approved method.
4. Exception to T 59: Leave sample in the oven until foaming ceases, then cool and weigh.
5. PCE must meet either the kinematic viscosity requirement or the particle size requirement.

Table 11A
Hard Residue Surface Sealant

Property	Test Procedure	Min	Max
Viscosity, Krebs unit, 77ºF, Krebs units	D 562	45	75
Softening point, ºF	Tex-505-C[1]	250	–
Uniformity	D 2939	Pass[2]	
Resistance to heat	D 2939	Pass[3]	
Resistance to water	D 2939	Pass[4]	
Wet flow, mm	D 2939	–	0
Resistance to Kerosene (optional)[5]	D 2939	Pass[6]	
Ultraviolet exposure, UVA-340, 0.77 W/m^2, 50°C chamber, 8 hr. UV lamp, 5 min. spray, 3 hr. 55 min. condensation, 1,000 hr. total exposure[7]	G 154	Pass[8]	
Abrasion loss, 1.6 mm thickness, liquid only, %	ISSA TB-100	–	1.0
Residue by evaporation, % by weight	D 2939	33	–
Tests on residue from evaporation: Penetration, 77ºF, 100 g, 5 sec. Flash point, Cleveland open cup, °F	 T 49 T 48	 15 500	 30
Tests on base asphalt before emulsification Solubility in trichloroethylene, %	 T 44	 98	 –

1. Cure the emulsion in the softening point ring in a 200°F ± 5°F oven for 2 hr.
2. Product must be homogenous and show no separation or coagulation that cannot be overcome by moderate stirring.
3. No sagging or slippage of film beyond the initial reference line.
4. No blistering or re-emulsification.
5. Recommended for airport applications or where fuel resistance is desired.
6. No absorption of Kerosene into the clay tile past the sealer film. Note sealer surface condition and loss of adhesion.
7. Other exposure cycles with similar levels of irradiation and conditions may be used with Department approval.
8. No cracking, chipping, surface distortion, or loss of adhesion. No color fading or lightening.

2.6. **Recycling Agent**. Recycling agent and emulsified recycling agent must meet the requirements in Table 12. Additionally, recycling agent and residue from emulsified recycling agent, when added in the specified proportions to the recycled asphalt, must meet the properties specified on the plans.

Table 12
Recycling Agent and Emulsified Recycling Agent

Property	Test Procedure	Recycling Agent		Emulsified Recycling Agent (ARA-1)		Polymer Modified Emulsified Recycling Agent (ARA-1P)	
		Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol, 77°F, sec.	T 72	–	–	15	100	15	110
Sieve test, %	T 59	–	–	–	0.1	–	0.1
Miscibility[1]	T 59	–		No coagulation			
Residue by evaporation,[2] % by wt.	T 59	–	–	60	–	–	–
Distillation test: Residue by distillation, % by wt. Oil distillate, % by volume of emulsion	T 59					 60 –	 65 2
Penetration of Distillation Residue at 39.2°F, 100 g, 5 sec.	T 49					110	190
Tests on recycling agent or residue from evaporation: Flash point, C.O.C., °F Kinematic viscosity, 140°F, cSt 275°F, cSt	 T 48 T 201	 400 75 –	 – 200 10.0	 400 75 –	 – 200 10.0	 400	 –

1. Exception to T 59: Use 0.02 N CaCl2 solution in place of water.
2. Exception to T 59: Maintain sample at 300°F until foaming ceases, then cool and weigh.

2.7. **Crumb Rubber Modifier**. Crumb rubber modifier (CRM) consists of automobile and truck tires processed by ambient temperature grinding.

CRM must be:

- free from contaminants including fabric, metal, and mineral and other nonrubber substances;
- free-flowing; and
- nonfoaming when added to hot asphalt binder.

Ensure rubber gradation meets the requirements of the grades in Table 13 when tested in accordance with Tex-200-F, Part I, using a 50-g sample.

Table 13
CRM Gradations

Sieve Size (% Passing)	Grade A		Grade B		Grade C		Grade D	Grade E
	Min	Max	Min	Max	Min	Max		
#8	100	–	–	–	–	–	As shown on the plans	As approved
#10	95	100	100	–	–	–		
#16	–	–	70	100	100	–		
#30	–	–	25	60	90	100		
#40	–	–	–	–	45	100		
#50	0	10	–	–	–	–		
#200	–	–	0	5	–	–		

2.8. **Crack Sealer**. Provide polymer-modified asphalt-emulsion crack sealer meeting the requirements of Table 14. Provide rubber-asphalt crack sealer meeting the requirements of Table 15.

Table 14
Polymer-Modified Asphalt-Emulsion Crack Sealer

Property	Test Procedure	Min	Max
Rotational viscosity, 77°F, cP	D 2196, Method A	10,000	25,000
Sieve test, %	T 59	–	0.1
Storage stability, 1 day, %	T 59	–	1
Evaporation Residue by evaporation, % by wt.	Tex-543-C	65	–
Tests on residue from evaporation: Penetration, 77°F, 100 g, 5 sec. Softening point, °F Ductility, 39.2°F, 5 cm/min., cm	 T 49 T 53 T 51	 35 140 100	 75 – –

Table 15
Rubber-Asphalt Crack Sealer

Property	Test Procedure	Class A		Class B	
		Min	Max	Min	Max
CRM content, Grade A or B, % by wt.	Tex-544-C	22	26	–	–
CRM content, Grade B, % by wt.	Tex-544-C	–	–	13	17
Virgin rubber content,[1] % by wt.		–	–	2	–
Flash point,[2] C.O.C., °F	T 48	400	–	400	–
Penetration,[3] 77°F, 150 g, 5 sec.	T 49	30	50	30	50
Penetration,[3] 32°F, 200 g, 60 sec.	T 49	12	–	12	–
Softening point, °F	T 53	–	–	170	–
Bond Test, non-immersed, 0.5 in specimen, 50% extension, 20°F[4]	D5329	–		Pass	

1. Provide certification that the Min % virgin rubber was added.
2. Agitate the sealing compound with a 3/8- to 1/2 in. (9.5- to 12.7 mm) wide, square-end metal spatula to bring the material on the bottom of the cup to the surface (i.e., turn the material over) before passing the test flame over the cup. Start at one side of the thermometer, move around to the other, and then return to the starting point using 8 to 10 rapid circular strokes. Accomplish agitation in 3 to 4 sec. Pass the test flame over the cup immediately after stirring is completed.
3. Exception to T 49: Substitute the cone specified in D 217 for the penetration needle.
4. Allow no crack in the crack sealing materials or break in the bond between the sealer and the mortar blocks over 1/4 in. deep for any specimen after completion of the test.

2.9. **Asphalt-Rubber Binders**. Provide asphalt-rubber (A-R) binders that are mixtures of asphalt binder and CRM, which have been reacted at elevated temperatures. Provide A-R binders meeting D6114 and containing a minimum of 15% CRM by weight. Provide Types I or II, containing CRM Grade C, for use in hot-mixed aggregate mixtures. Provide Types II or III, containing CRM Grade B, for use in surface treatment binder. Ensure binder properties meet the requirements of Table 16.

Table 16
A-R Binders

Property	Test Procedure	Binder Type					
		Type I		Type II		Type III	
		Min	Max	Min	Max	Min	Max
Apparent viscosity, 347°F, cP	D2196, Method A	1,500	5,000	1,500	5,000	1,500	5,000
Penetration, 77°F, 100 g, 5 sec.	T 49	25	75	25	75	50	100
Penetration, 39.2°F, 200 g, 60 sec.	T 49	10	–	15	–	25	–
Softening point, °F	T 53	135	–	130	–	125	–
Resilience, 77°F, %	D5329	25	–	20	–	10	–
Flash point, C.O.C., °F	T 48	450	–	450	–	450	–
Tests on residue from Thin-Film Oven Test: Retained penetration ratio, 39.2°F, 200 g, 60 sec., % of original	T 179 T 49	75	–	75	–	75	–

2.10. **Performance-Graded Binders**. Provide PG binders that are smooth and homogeneous, show no separation when tested in accordance with Tex-540-C, and meet the requirements of Table 17.

Separation testing is not required if:

- a modifier is introduced separately at the mix plant either by injection in the asphalt line or mixer,
- the binder is blended on site in continuously agitated tanks, or
- binder acceptance is based on field samples taken from an in-line sampling port at the hot-mix plant after the addition of modifiers.

Table 17
Performance-Graded Binders

Property and Test Method	Performance Grade																		
	PG 58			PG 64				PG 70				PG 76				PG 82			
	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28	
Average 7-day max pavement design temperature, °C[1]	58			64				70				76				82			
Min pavement design temperature, °C[1]	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28	
Original Binder																			
Flash point, T 48, Min, °C	230																		
Viscosity, T 316[2, 3]: Max, 3.0 Pa·s, test temperature, °C	135																		
Dynamic shear, T 315[4]: G*/sin(δ), Min, 1.00 kPa, Max, 2.00 kPa[7], Test temperature @ 10 rad/sec., °C	58			64				70				76				82			
Elastic recovery, D6084, 50°F, % Min[8]	–	–	30	–	–	30	50	–	30	50	60	30	50	60	70	50	60	70	
Rolling Thin-Film Oven (Tex-506-C)																			
Mass change, T 240, Max, %	1.0																		
Dynamic shear, T 315: G*/sin(δ), Min, 2.20 kPa, Max, 5.00 kPa[7], Test temperature @ 10 rad/sec., °C	58			64				70				76				82			
MSCR, T350, Recovery, 0.1 kPa, High Temperature, % Min[8]	–	–	20	–	–	20	30	–	20	30	40	20	30	40	50	30	40	50	
Pressure Aging Vessel (PAV) Residue (R 28)																			
PAV aging temperature, °C	100																		
Dynamic shear, T 315: G*sin(δ), Max, 5,000 kPa Test temperature @ 10 rad/sec., °C	25	22	19	28	25	22	19	28	25	22	19	28	25	22	19	28	25	22	
Creep stiffness, T 313[5, 6]: *S*, max, 300 MPa, *m*-value, Min, 0.300 Test temperature @ 60 sec., °C	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	
Direct tension, T 314[6]: Failure strain, min, 1.0% Test temperature @ 1.0 mm/min., °C	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	

1. Pavement temperatures are estimated from air temperatures and using an algorithm contained in a Department-supplied computer program, may be provided by the Department, or by following the procedures outlined in AASHTO MP 2 and PP 28.
2. This requirement may be waived at the Department's discretion if the supplier warrants that the asphalt binder can be adequately pumped, mixed, and compacted at temperatures that meet all applicable safety, environmental, and constructability requirements. At test temperatures where the binder is a Newtonian fluid, any suitable standard means of viscosity measurement may be used, including capillary (T 201 or T 202) or rotational viscometry (T 316).
3. Viscosity at 135°C is an indicator of mixing and compaction temperatures that can be expected in the lab and field. High values may indicate high mixing and compaction temperatures. Additionally, significant variation can occur from batch to batch. Contractors should be aware that variation could significantly impact their mixing and compaction operations. Contractors are therefore responsible for addressing any constructability issues that may arise.
4. For quality control of unmodified asphalt binder production, measurement of the viscosity of the original asphalt binder may be substituted for dynamic shear measurements of G*/sin(δ) at test temperatures where the asphalt is a Newtonian fluid. Any suitable standard means of viscosity measurement may be used, including capillary (T 201 or T 202) or rotational viscometry (T 316).
5. Silicone beam molds, as described in AASHTO TP 1-93, are acceptable for use.
6. If creep stiffness is below 300 MPa, direct tension test is not required. If creep stiffness is between 300 and 600 MPa, the direct tension failure strain requirement can be used instead of the creep stiffness requirement. The m value requirement must be satisfied in both cases.
7. Maximum values for unaged and RTFO aged dynamic shear apply only to materials used as substitute binders, as described in Item 340, "Dense-Graded Hot-Mix Asphalt (Small Quantity)", Item 341, "Dense-Graded Hot-Mix Asphalt, and Item 344, "Superpave Mixtures."
8. Elastic Recovery (ASTM D6084) is not required unless MSCR (AASHTO T 350) is less than the minimum % recovery. Elastic Recovery must be used for the acceptance criteria in this instance.

3. EQUIPMENT

Provide all equipment necessary to transport, store, sample, heat, apply, and incorporate asphalts, oils, and emulsions.

4. CONSTRUCTION

Typical Material Use. Use materials shown in Table 18, unless otherwise determined by the Engineer.

Table18
Typical Material Use

Material Application	Typically Used Materials
Hot-mixed, hot-laid asphalt mixtures	PG binders, A-R binders Types I and II
Surface treatment	AC-5, AC-10, AC-15P, AC-20XP, AC-10-2TR, AC-20-5TR, HFRS-2, MS-2, CRS-2, CRS-2H, CRS-2TR, CMS-2P HFRS-2P, CRS-2P, CHFRS-2P, A-R binders Types II and III
Surface treatment (cool weather)	AC12-5TR, RC-250, RC-800, RC-3000, MC-250, MC-800, MC-3000, MC-2400L, CMS-2P
Precoating	AC-5, AC-10, PG 64-22, SS-1, SS-1H, CSS-1, CSS-1H
Tack coat	PG Binders, SS-1H, CSS-1H, EAP&T, TRAIL, EBL
Fog seal	SS-1, SS-1H, CSS-1, CSS-1H, CMS-1P
Hot-mixed, cold-laid asphalt mixtures	AC-0.6, AC-1.5, AC-3, AES-300, AES-300P, CMS-2, CMS-2S
Patching mix	MC-800, SCM I, SCM II, AES-300S
Recycling	AC-0.6, AC-1.5, AC-3, AES-150P, AES-300P, recycling agent, emulsified recycling agent
Crack sealing	SS-1P, polymer mod AE crack sealant, rubber asphalt crack sealers (Class A, Class B)
Microsurfacing	CSS-1P
Prime	MC-30, AE-P, EAP&T, PCE
Curing membrane	SS-1, SS-1H, CSS-1, CSS-1H, PCE
Erosion control	SS-1, SS-1H, CSS-1, CSS-1H, PCE
FDR -Foaming	PG 64-22, FDR EM-SY, FDR EM-HY

4.1. **Storage and Application Temperatures**. Use storage and application temperatures in accordance with Table 19. Store and apply materials at the lowest temperature yielding satisfactory results. Follow the manufacturer's instructions for any agitation requirements in storage. Manufacturer's instructions regarding recommended application and storage temperatures supersede those of Table 19.

Table19
Storage and Application Temperatures

Type-Grade	Application		Storage Max (°F)
	Recommended Range (°F)	Max Allowable (°F)	
AC-0.6, AC-1.5, AC-3	200–300	350	350
AC-5, AC-10	275–350	350	350
AC-15P, AC-20-5TR, AC12-5TR and AC10-2TR	300–375	375	360
RC-250	125–180	200	200
RC-800	170–230	260	260
RC-3000	215–275	285	285
MC-30, AE-P	70–150	175	175
MC-250	125–210	240	240
MC-800, SCM I, SCM II	175–260	275	275
MC-3000, MC-2400L	225–275	290	290
HFRS-2, MS-2, CRS-2, CRS-2H, HFRS-2P, CRS-2P, CMS-2, CMS-2S, AES-300, AES-300S, AES-150P, AES-300P, CRS-2TR	120–160	180	180
SS-1, SS-1H, CSS-1, CSS-1H, PCE, EAP&T, SS-1P, RS-1P, CRS-1P, CSS-1P, recycling agent, emulsified recycling agent, polymer mod AE crack sealant	50–130	140	140
PG binders	275–350	350	350
Rubber asphalt crack sealers (Class A, Class B)	350–375	400	–
A-R binders Types I, II, and III	325–425	425	425

5. MEASUREMENT AND PAYMENT

The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly but is subsidiary or is included in payment for other pertinent Items.

Special Specification 4021
Thermal Integrity Profiler (TIP) Testing of Drilled Shafts

1. DESCRIPTION

Perform the nondestructive testing (NDT) method termed Thermal Integrity Profiler (TIP) testing by obtaining records of the heat generated by curing cement (hydration energy) to assess the quality of drilled shafts. TIP measurements that are colder than normal indicate necks, inclusions, or poor-quality concrete, while warmer than normal measurements are indicative of bulges. Variations of temperatures between tubes reveal cage eccentricity. Furnish all materials, equipment, and labor necessary to conduct TIP testing on production drilled shafts. The TIP testing must meet the requirements of ASTM D 7949, except as noted below.

2. EQUIPMENT

Supply all materials and equipment required to perform TIP tests. Equipment to perform the test must have the following minimum requirements:

2.1. **Probe or Wire Option**. A computer based TIP data acquisition system for (a) display of signals during data acquisition (probe option only), or (b) to monitor temperature versus time after casting (wire option only).

2.2. **Probe Only Option.** Thermal probe with four infrared sensors equally spaced at 90° around the perimeter that read temperatures of the tube wall to within 1°F accuracy. The probes must be less than 1-1/4 in. in diameter and must freely descend through the full depth of properly installed access tubes in the drilled shafts; one depth encoder sensor to determine probe depths; and ability to collect data at user specified depth increment.

2.3. **Wire only option.** Ability to collect data at user defined time intervals (typically 15 to 60 min.).

3. TESTING PROCEDURE

Conform to testing procedures in ASTM D 7949 specification.

4. TEST RESULT REPORTING

Submit a written report within five working days of completion of testing. The report must present results of TIP tests by including:

4.1. **Graphical Displays**. Provide graphical displays of all temperature measurements (probes or wires) versus depth.

4.2. **Significant Temperature Deviations**. Report indication of unusual temperatures, particularly significantly cooler local deviations of the average at any depth from the overall average over the entire length, in either probe or thermal wire measurements.

4.3. **Overall Average Temperature.** This temperature is proportional to the average radius computed from the actual total concrete volume installed (assuming a consistent concrete mix throughout). Radius at any point can then be determined from the temperature at that point compared to the overall average temperature.

4.4. **Temperature Variation.** Report variations in temperature between tubes (at each depth) which in turn correspond to variations in cage alignment. Where concrete volume is known, report the cage alignment or offset from center.

4.5. **Shaft Specific Information**. Report shaft specific construction information (e.g. elevations of the top of shaft, bottom of casing, bottom of shaft, etc.) when available. These values should be noted on all pertinent graphical displays.

5. MEASUREMENT

This Item measured by each successful test that is approved by the Engineer. Quantities of TIP testing must be shown on the plans.

6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for each "Thermal Integrity Profiler (TIP) Testing of Drilled Shaft" of size and type specified. This price is full compensation for material, equipment, labor, work, tools, and incidentals.

Special Specification 4171
Install Bridge Identification Numbers

1. DESCRIPTION

This item will govern for the installation of bridge identification numbers on bridge structures in accordance with this specification, project plans, or as directed.

2. MATERIALS

Furnish materials that conform to the pertinent requirement of the following items:

- stencil ink, black 11 oz., spray can (lead, CFC, and CFHC free). Black spray will be waterproof, weather resistance and dry instantly on all surfaces, without smearing, smudging or rippling and
- brass stencil, 3 in., numbers and letters, adjustable interlocking stencil, set content 92 piece numbers and letters, legend height 3 in., symbol height 3 in. Stencils must be industrial grade and interlocking.

3. WORK METHODS

Install bridge identification numbers according to the requirements shown on the plans, and the following:

Clean the surface thoroughly before applying the painted structure number including removal of existing structure number by chemical cleaning, or by water blasting according to Item 427, if required.

4. MEASUREMENT

This Item will be measured by each bridge identification number installed.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Installing Bridge Identification Numbers." This price must be full compensation for removing existing bridge identification numbers, cleaning and preparing surfaces, and furnishing all materials, equipment, labor and incidentals necessary to complete the work.

Special Specification 6004

Networking Intelligent Transportation System (ITS) Communications Cable

1. DESCRIPTION

Furnish, install, and test twisted-pair cable for networking and telecommunication uses in the field environment.

2. MATERIALS

2.1. **General Requirements.** Provide new cable and connectors that are in conformance with the details shown on the plans and in the specifications. The cable must be free of deformations, holes, splits and splices.

ITS networking copper cables must be constructed for installation in an outdoor underground conduit environment. All cable provided for underground installation must contain the Outside Plant designation for outdoor usage and must be rated Non-Plenum.

Provide cable in compliance with the most current version of the following industry standards:

- NFPA National Electric Code (NEC),
- Rural Electrification Administration (REA) -PE-22 (7 CFR 1755.403), PE-39 (7 CFR 1755.390),
- ANSI /TIA-568-C, EIA/TIA-568-B.2-2001 (Category 5E Cable),
- EIA-232, EIA-422, EIA-485,
- TSB-36, and
- Underwriters Laboratory (UL).

Included in this Item are the ITS cable types listed in Table 1.

Table 1
Common Networking ITS Communication Cable Types

Cable Type	Nominal AWG Gauge	Application
Category 5e Ethernet Cable	#24 AWG	Standard 100Base-Tx, Gigabit Ethernet, up to 100 MHz bandwidth performance
Category 6 Ethernet Cable	#24 AWG	Gigabit Ethernet; up to 250MHz bandwidth performance
Category 7 Ethernet Cable	#24 AWG	10-Gigabit Ethernet, up to 600 MHz bandwidth performance. Category 7 cable is not typically utilized for ITS device applications. Category 7 cable applications include high bandwidth performance at network layer switches with 10 Gigabit connections.
Serial Communications Cable (RS-232, RS-422, RS-485)	#22, #24 AWG	Serial port applications, low bandwidth and small data rate transmission (<100 kb/s)
Shielded Twisted Pair Cable	#18-24 AWG	Telephone communications, below 16 MHz bandwidth performance
Unshielded Twisted Pair (UTP) Cable	#18-24 AWG	

Included in this Item are all terminating connectors and associated equipment required for installation and testing in a field environment.

Provide cable conforming to the gauge, type, and length shown on the plans. Ensure the cable gauge supplied meets the bandwidth requirements specific to the cable application and run length.

Provide signal amplification or repeater locations for communications cable runs as shown on the plans and in the specifications.

When selecting serial communications cable for longer cable runs, verify the conductor gauge to be provided will meet signal loss requirements for cable application. Refer to Table 2 for typical cable distance limitations for ITS serial communications cable.

Table 2
Typical Network Communications Cable
Distance Limitations

Cable Type	Recommended Maximum Cable Run[1]
RS-232	50 ft.
RS-422 (4 wire system)	500 ft.
RS-485 (2 wire system)	500 ft.
Category 5e	300 ft.
Category 6	300 ft.

1. Cable distance limitation to be verified according to manufacturer for the cable application.

All cable provided must be manufactured with permanent markings at approximate 2 ft. intervals on the outer jacket according to manufacturer name, serial number, type, UL list and classification for identification purposes. All pairs must be color coded using standard North American communication industry colors to uniquely identify each pair in the cable.

2.2. **Physical Requirements.** Provide networking communications cable meeting the following physical requirements.

2.2.1. **Conductor.** All networking cable must be constructed of solid bare copper conductor.

2.2.2. **Insulation.** All networking cable must be of foamed, cellular dielectric construction. Dielectric material must adhere to and support the center cable conductor.

2.2.2.1. **Insulation Material.** Serial communications cable insulation must be high-density polyethylene (HDPE) or equivalent. Ethernet networking cable insulation must be polyolefin or HDPE. UTP cable insulation must be polyethylene, polyolefin, polypropylene , or fluorinated ethylene propylene.

2.2.3. **Shielding.** Serial communications cable shielding must contain combination foil-polyester and copper braid shield to reduce EMI interference. Ethernet networking cable must contain a combination foil-polyester shield.

2.2.3.1. **Coverage.** Serial communications cable must be constructed of 100% effective foil coverage, minimum 65% braided coverage. Ethernet networking cable (Category 5e, 6, 7) must contain 100% effective foil cover.

2.2.4. **Outer Jacket.** Outer jacket must be rated for heavy duty ultraviolet (UV) exposure, sunlight, oil, and weather resistance necessary for outdoor installation.

2.2.4.1. **Jacket Material.** All networking cable outer jackets must be of PVC or polyethylene construction.

2.2.5. **Connectors.** Connectors must be matching, weather resistant, water and moisture proof, and outdoor-rated hardware that meet cable operating voltage, temperature, and impedance characteristics. Connectors must prevent the entry and collection of moisture to the cable and electrical connection point. Provide cable sealant during installation to seal connections from moisture and corrosion.

2.3. **Electrical and Mechanical Requirements.** Ethernet networking cable as shown on the plans must conform to the TIA/EIA-568-C standard, and according to performance characteristics defined in TIA/EIA-568-C.4-1. All Ethernet networking cable provided must meet IEEE 802.3af and IEEE 802.3at for Power over Ethernet (PoE) applications.

Serial communications cable and UTP must conform to the following requirements:

2.3.1. **Capacitance.** Serial communications cable capacitance must not exceed 35 picofarads (pF) per foot of cable. UTP cable capacitance must not exceed 15 pF per foot of cable.

2.3.2. **Inductance.** Serial communications cable inductance must not exceed 0.30 microhenry's (μH) per foot of cable.

2.3.3. **Impedance.** Provide 100 ohm nominal impedance for UTP cables and according to the manufacturer recommendation for cable application.

2.3.4. **Attenuation.** Attenuation of the cable must be compliant with requirements of the proposed application.

2.3.5. **Resistance**. The DC resistance of the serial communications cable inner conductor must not exceed 20 ohms per 1000 ft.

2.4. **Environmental Design Requirements.**

2.4.1. **Installation Temperature Rating.** Cable must be rated for an outside ambient temperature range of -20°F to 165°F.

2.4.2. **Storage Temperature Rating.** Cable must be rated for a storage temperature range of -40°F to 165°F.

3. CONSTRUCTION METHODS

3.1. **General.** Cable must be installed in accordance with the following industry procedures:

- ANSI/TIA -568-C,
- BICSI Telecommunications Distribution Methods Manual (TDMM) and Information Transport Systems Installation (ITSIM),
- NFPA National Electric Code (NEC),
- USDA Construction of Direct Buried Plant, and
- ICEA Standard for Aerial Service Wire - ANSI/ICEA 5-89-648.

3.1.1. **Cable Storage.** All uninstalled cable must be stored according to manufacturer recommended bend radius and cable reel requirements.

3.1.2. **Cable Labeling.** All cable must be labeled using pre-laminated labels with UV protection according to usage at all terminations. Provide weatherproof labels rated for outdoor use.

3.1.3. **Installation Procedure.** All cable must be inspected and tested for continuity when received, with results compared with factory pre-shipping tests. Inspect the cable nomenclature to make certain that the correct product has been received. Notify the supplier (or manufacturer) of all discrepancies for immediate correction.

Install the network cable routed as shown on the plans and follow the manufacturer recommendations for installation.

Ensure that all exposed cable ends are covered and protected against moisture and dust penetration at all times during installation. Protect cable ends during storage, cable pulls, and post-installation.

3.1.4. **Conduit Fill Requirements.** Install cable as shown on the plans and ensure that NEC and TIA/EIA fill requirements must be met for all cable runs.

3.1.5. **Cable Slack Requirements**. Provide 25 ft. cable slack maximum in pull boxes and per manufacturer requirements.

3.1.6. **Spacing Requirements.** Provide minimum 12 in. spacing between electrical power cable and communications cable types as described for underground installations within NEC Sections 840.44 and 840.47.

3.2. **Testing.** Procedures for the tests noted below are to be in accordance with industry standard practice and recorded in accordance with ANSI/TIA/EIA rules for documentation for the cable type. Perform tests in accordance with testing requirements in this Item. For all tests, provide test forms to be used that compare measured results with threshold values. The following tests must be performed, recorded, and submitted to verify the cable performance and installation:

3.2.1. **Cable Continuity.** Perform cable continuity test for center conductor and shield continuity and record results. The test must be performed on received cable reels to identify any discrepancies and upon final installed cable interconnections. Test continuity of each pair to show a resistance of not more than 8 ohms per 1000 ft. of conductor. Use meter with a minimum input resistance measurement to comply with RUS 7 CFR 1755.403 Copper Cable Telecommunications Plant Measurements. .

3.2.2. **Time Domain Reflectometry (TDR)**. Perform TDR test for impedance continuity per manufacturer recommendations in coaxial cable interconnections and record results.

3.2.3. **Ground Resistance.** Use a Megohmmeter to perform ground resistance testing of all conductors including the shield, and conductor-to-conductor, including all individual conductors to the shield. Ensure that all conductor tests, including the shield, read infinity to ground, and from conductor to conductor and all individual conductors to the shield, read infinity. Replace cable not meeting the infinity test result at no expense to the department, whether one or multiple readings per cable are defective.

3.2.4. **Visual Inspection.** Where cable installation is visible, perform visual inspection (with a Department representative) to verify any evidence of the following:

- cable damage (cracks, shield damage, kinks, knots, jacket damage, crushed cable),
- bend radius violations (at conduit fittings, cabinet locations), and
- cable crimping method—use of manufacturers specified cable crimp tool only (use of pliers not permitted).

3.3. **Documentation.** Submit 3 copies of the following materials for each cable type provided for approval prior item supply:

- manufacturer cutsheets and complete specifications (physical, electrical, mechanical, and environmental),
- manufacturer warranty information,
- independent test lab certification, and
- blank test forms.

Submit 3 copies of the following materials for each cable run provided for approval post installation:

- test results,
  - completed test forms,

- cable continuity test,
- TDR test,

- "as-built" documentation for cable path as shown on the plans,
- complete maintenance and trouble-shooting procedures, and
- furnish additional information as shown on the plans.

3.4. **Warranty.** Warrant all cable against defects or failure in design, materials, and workmanship in accordance with the manufacturer's standard warranty.

Supply cable with no less than 95% of the manufacturer's warranty remaining on the date that equipment invoices are submitted for final payment. Any material with less than 95% warranty remaining will be rejected.

Warrant all cable furnished and installed to perform according to the manufacturer published specifications for a period of 1 year after final acceptance of the project by the Department. Provide for "on-site" repair or replacement within 2 working days and at no cost to the Department. Repair or replace any defective cable, at the manufacturer's option, at no cost to the Department.

4. MEASUREMENT

This Item will be measured by the linear foot of cable.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "ITS Communications Cable (Ethernet)" and "ITS Communication Cable (Serial)." For twisted pair communications cable runs, work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "ITS Communications Cable" of the type, size, and number of pairs specified. The price is full compensation for furnishing, installing, splicing and testing cable and connectors, as well as for installation equipment, materials, tools, and incidentals.

Special Specification 6005

Testing, Training, Documentation, Final Acceptance, and Warranty

1. DESCRIPTION

Perform or furnish testing, training, documentation, final acceptance, and warranty on the applicable equipment or systems.

2. TESTING

Unless otherwise shown on the plans, perform the following tests on the applicable equipment or systems.

2.1. **Test Procedures Documentation**. Provide 5 copies of the test procedures and blank data forms 60 days prior to testing for each test required on this project. Include the sequence of the tests in the procedures. The Engineer will approve test procedures prior to submission of equipment for tests. Conduct all tests in accordance with the approved test procedures.

Record test data on the data forms, as well as quantitative results. Ensure the data forms are signed by an authorized representative (company official) of the equipment manufacturer. Submit 1 copy of the completed and signed data forms for acceptance or rejection of the test or equipment.

2.2. **Design Approval Test**. Conduct a Design Approval Test on randomly selected units from the prototype design manufacturing run. If only 1 design prototype is manufactured, perform this test on that unit. If supplying multiple types of the equipment, provide and test a sample of each type.

Certification from an independent testing laboratory of a successfully completed Design Approval Test is acceptable. Ensure that the testing by this laboratory is performed in accordance with the requirements of this specification. Failure of independent tests to comply with the requirements of this specification will be grounds for rejection of any certification.

Notify the Engineer 10 working days before conducting this testing. The Department may witness all the tests. Perform the following tests:

2.2.1. **Power Service Transients**. The equipment must meet the performance requirements, specified in the parent specification, when subjected to the power service transients as specified in Section 2.2.7.2, “Transient Tests (Power Service)” of the NEMA TS 2 standard, latest edition.

2.2.2. **Temperature and Condensation**. The equipment must meet the performance requirements, specified in the parent specification, when subjected to the following conditions in the order specified below:

- Stabilize the equipment at -30°F and test as specified in Sections 2.2.7.3., “Low-Temperature Low-Voltage Tests” and 2.2.7.4., “Low-Temperature High-Voltage Tests” of the NEMA TS 2 standard, latest edition.
- Allow the equipment to warm up to room temperature in an atmosphere having relative humidity of at least 40%. Operate the equipment for 2 hr., while wet, without degradation or failure.
- Stabilize the equipment at 165°F and test as specified in Sections 2.2.7.5., “High-Temperature High Voltage Tests” and 2.2.7.6, “High-Temperature Low-Voltage Tests” of the NEMA TS 2 standard, latest edition.

2.2.3. **Relative Humidity**. The equipment must meet the performance requirements, specified in the parent specification, within 30 min. of being subjected to a temperature of 165°F and a relative humidity of 18% for 48 hr.

2.2.4. **Vibration**. The equipment must show no degradation of mechanical structure, soldered components, or plug-in components and must operate in accordance with the manufacturer's equipment specifications after being subjected to the vibration tests as described in Section 2.2.8, “Vibration Test,” of the NEMA TS 2 standard, latest edition.

2.2.5. **Power Interruption**. The equipment must meet the performance requirements, specified in the parent specification, when subjected to nominal input voltage variations as specified in Section 2.2.10, “Power Interruption Test,” of the NEMA TS 2 standard, latest edition.

2.3. **Demonstration Test**. Conduct a Demonstration Test on applicable equipment at an approved Contractor facility. Notify the Engineer 10 working days before conducting this testing. The Department may witness all the tests. Perform the following tests:

2.3.1. **Examination of Product**. Examine each unit carefully to verify that the materials, design, construction, markings and workmanship comply with the requirements of the parent specification.

2.3.2. **Continuity Tests**. Check the wiring to determine conformance with the requirements of the appropriate paragraphs in the parent specification.

2.3.3. **Operational Test**. Operate each unit for at least 15 min. to permit equipment temperature stabilization and an adequate number of performance characteristics to ensure compliance with the requirements of the parent specification.

2.4. **Stand-Alone Tests**. Conduct a Stand-Alone Test for each unit after installation. The test must exercise all stand-alone (non-network) functional operations. Notify the Engineer 5 working days before conducting this test. The Department may witness all the tests.

2.5. **System Integration Test**. Conduct a System Integration Test on the complete functional system. Demonstrate all control and monitor functions for each system component for 72 hr. Supply 2 copies of the System Operations manual before the System Integration Test. Notify the Engineer 10 working days before conducting this testing. The Department may witness all the tests.

2.6. **Final Acceptance Test**. Conduct a Final Acceptance Test on the complete functional system. Demonstrate all control, monitor, and communication requirements for 90 days. The Engineer will furnish a Letter of Approval stating the first day of the Final Acceptance Test. The completion of the Final Acceptance Test occurs when system downtime due to mechanical, electrical, or other malfunctions to equipment furnished or installed does not exceed 72 hr. and any individual points of failure identified during the test period have operated free of defects as required in Section 2.7.5., “Consequences of Final Acceptance Test Failure.”

2.7. **Consequences of Test Failure**. If a unit fails a test, submit a report describing the nature of the failure and the actions taken to remedy the situation prior to modification or replacement of the unit. If a unit requires modification, correct the fault and then repeat the test until successfully completed. Correct minor discrepancies within 30 days of written notice to the Engineer. If a unit requires replacement, provide a new unit and then repeat the test until successfully completed. Major discrepancies that will substantially delay receipt and acceptance of the unit will be sufficient cause for rejection of the unit.

If a failure pattern develops in similar units within the system, implement corrective measures, including modification or replacement of units, to all similar units within the system as directed. Perform the corrective measures without additional cost or extension of the contract period.

2.7.1. **Consequences of Design Approval Test Failure**. If the equipment fails the Design Approval Test, correct the fault and then repeat the Design Approval Test until successfully completed.

2.7.2. **Consequences of Demonstration Test Failure**. If the equipment fails the Demonstration Test, correct the fault and then repeat the Demonstration Test until successfully completed.

2.7.3. **Consequences of Stand-Alone Test Failure**. If the equipment fails the Stand-Alone Test, correct the fault and then repeat the Demonstration Test until successfully completed.

2.7.4. **Consequence of System Integration Test Failure**. If the equipment fails the System Integration Test, correct the fault and then repeat the Systems Integration Test until successfully completed.

2.7.5. **Consequences of Final Acceptance Test Failure**. If a defect within the system is detected during the Final Acceptance Test, document and correct the source of failure. Once corrective measures are taken, monitor the point of failure until a consecutive 30 day period free of defects is achieved.

If after completion of the initial test period, the system downtime exceeds 72 hr. or individual points of failure have not operated for 30 consecutive days free of defects, extend the test period by an amount of time equal to the greater of the downtime in excess of 72 hr. or the number of days required to complete the performance requirement of the individual point of failure.

3. TRAINING

When required on the plans, provide a minimum of 24 hr. of instruction to 10 designated personnel in the operation and maintenance procedures of equipment or systems installed. Provide the training during installation, testing, and integration. Provide the training through practical demonstrations, seminars, and other related technical procedures.

Furnish a training session agenda, a complete set of training material (manuals and schematics), and the names and qualifications of proposed instructors for approval 60 days before the training. Provide a training location. Provide 1 copy of the course material for each person. Provide training in the following areas of interest and as shown on the plans:

- The “Hands-on” operation for each type of equipment.
- Explanation of all system commands, their function and usage.
- Required preventative maintenance procedures.
- All equipment servicing procedures.
- System “troubleshooting”/problem identification procedures.

4. DOCUMENTATION

Provide “as-built” documentation for the entire system and all of its individual components. Supply one (1) 11 in. x 17 in. reproducible copy of the wiring diagrams. Supply three (3) copies of the following in a manual for each equipment component:

- Complete and accurate schematic diagrams.
- Complete and accurate cabinet, enclosure, and building wiring diagrams.
- Complete installation procedures.
- Complete performance specifications (functional, electrical, mechanical and environmental) on the unit.
- Complete parts list including names of vendors for parts not identified by universal part numbers such as JEDEC, RETMA, or EIA.
- Pictorial of component layout on circuit board.
- Complete maintenance and trouble-shooting procedures.
- Complete stage-by-stage explanation of circuit theory and operation.
- Complete and detailed system operations manuals.

Furnish additional information as shown on the plans.

5. FINAL ACCEPTANCE

Final acceptance is made when all work is complete, the system has successfully completed all test requirements, and the Engineer, in writing, accepts all work for the work locations in the Contract in accordance with Article 5.12., “Final Acceptance.” Final acceptance relieves the Contractor from further Contract responsibilities.

6. WARRANTY

Guarantee equipment furnished and installed to perform according to the manufacturer’s published specifications. Warrant equipment against defects or failure in design, materials, and workmanship in accordance with the manufacturer’s standard warranty. Supply equipment with no less than 95% of the manufacturer’s warranty remaining on the date that equipment invoices are submitted for final payment. Any equipment with less than 95% warranty remaining will be rejected.

The Contractor will warrant or guarantee all such electronic, electrical, and mechanical equipment, materials, technical data, and products furnished and installed for a period of 1 yr. after final acceptance of the project by the Department. The Contractor’s warranty or guarantee must provide for the “on-site” repair or replacement, at the Contractor’s option, within 2 working days and at no cost to the Department.

Once the Contractor’s warranty or guarantee expires, assign to the Department any manufacturer’s standard warranty or guarantee coverage still remaining on all such electronic, electrical, and mechanical equipment, materials, technical data, and products furnished for and installed on the project. Repair or replace defective equipment, at the manufacturer’s option, at no cost to the Department.

7. MEASUREMENT AND PAYMENT

The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly but will be considered subsidiary to bid items of the Contract.

Special Specification 6006
Electronic Components

1. DESCRIPTION

Use electronic components to manufacture electronic equipment.

2. MATERIALS AND CONSTRUCTION METHODS

Use electronic components that comply with Electronic Industries Association (EIA) and Joint Electronic Device Engineering Council (JEDEC) Specifications. Provide industry standard electronic components available from several manufacturers. When special monolithic integrated circuits are necessary for cost-effective designs, waiving the multi-source requirements will be as directed.

Design the electronic circuitry to ensure an adjustment range from normal adjustment settings of variable components. Provide a range of adjustment to compensate for composite variations in the associated circuitry due to changes in part values during the normal or specified life of the device. Ensure the range of adjustment can compensate for variations in replacement parts within the specified tolerances. Unless otherwise shown on the plans, design the components to be under operating conditions 24 hr. a day for 10 yr. Derate electronic components by 20% with regard to ambient temperature, applied voltage, and power dissipation.

On electronic components weighing more than 2 oz., use supports other than the component's pins or electrical connectors. Solder electronic components of 2 or more leads in place. Mark the circuit reference symbol next to the component.

Meet the above requirements and satisfy the following specific requirements for the different components:

2.1. **Capacitors**. Provide industrial grade capacitors. Insulate the capacitors. Mark capacitors with their capacitance value, working voltage, and polarity.

Provide capacitor encasements resistant to cracking, peeling, and discoloration due to humidity and changes in temperature. Provide electrolytic capacitors capable of operating at least 185°F. Do not use electrolytic capacitors of less than 1.0 microfarad.

Use a clamp or fastener to support a capacitor to avoid damage by shock or vibration. Use a capacitor with a specific ripple or AC voltage rating, if possibly subjected to a ripple voltage in excess of 10% of the actual DC voltage across the capacitor. Use an aluminum electrolytic capacitor only when continually energized.

2.2. **Diodes**. If low forward drop is required in logic circuit applications, furnish justification for use of Germanium diodes prior to incorporation in the design. Mark diodes with the JEDEC part number, using an industry approved color code or clearly legible printing. Indicate the diode polarity on the diode case by the use of the diode symbol, by the 360° band on the cathode end, or by the shape of case.

2.3. **Indicators**. Use solid-state (LED) indicators with a useful life at least 25,000 hr.

2.4. **Integrated Circuits**. Print the manufacturer's part number and any information required to install the integrated circuit assembly upon the package. Test integrated circuits with at least 1 test from each group below:

2.4.1. **Group 1:**

- Stabilization Bake
- Temperature Cycling
- Power Burn-in

2.4.2. **Group 2:**

- Functional test with the device at the manufacturer's maximum specified temperature
- Static and dynamic test per manufacturer's data sheet

2.5. **Potentiometers and Rheostats**. Use industrial grade potentiometers. Use potentiometers with a power rating at least 100% greater than the maximum power requirements of the circuit.

2.6. **Printed Circuit Boards**.

2.6.1. **Design, Fabrication and Mounting**. Use NEMA Grade G-10 glass epoxy or equivalent for printed circuit boards (refer to NEMA Publications No. L1 1-1982, Industrial Laminated Thermosetting Products). Provide a nominal thickness of 1/32 in. for circuit boards not exceeding 2 in. in any dimension. Provide a nominal thickness of 1/16 in. for circuit boards exceeding 2 in. in any dimension.

Coat the printed circuit board assembly with a protective coating to combat mildew, moisture, and fungus. Plate the through holes that carry electrical connections from one side of the board to the other. Use 1 oz. per square foot of copper to plate through holes. Use non-corrosive material for electrical mating surfaces.

Design and fabricate printed circuit boards and the mounting of parts and assemblies in accordance with MIL-STD-275 (latest revision) except as follows:

- Mount semiconductor devices on spacers or transipads if the device dissipates more than 250 mW or if the case temperature will rise 20°F above ambient.
- Remove residual flux from the printed circuit board.
- Provide a resistance between any 2 isolated, independent conductor paths of at least 100 megohms when a 500 VDC potential is applied.

Mark operating circuit components mounted on the circuit boards. Reference the identifying characters to their respective components in the schematic diagram and in the parts list.

2.6.2. **Soldering**. Hand solder in accordance with MIL-STD-55110. Use of automatic flow soldering is acceptable.

2.7. **Relays**. Install diodes across the coils for transient suppression in DC relays. Provide replaceable relays that do not require special tools for replacement.

2.8. **Resistors**. Use fixed composition insulated resistors in accordance with the performance requirements of MIL-R-11. Provide industrial grade resistors with a 15-yr. design life. Mark with their resistance value, using EIA color codes or industry approved marking technique.

Use resistors with a 10% tolerance or better and a resistance variation of no more than 5% over the temperature range 0°F to 165°F. Do not use resistors with a power rating greater than 2 W unless special ventilation or heat sinking is provided. Insulate these resistors from the printed circuit board.

2.9. **Transistors**. Use JEDEC registered transistors. Mark the JEDEC part number on the case. Designate the emitter or collector by use of an industry approved marking technique.

2.10. **Transformers**. Mark transformers with the manufacturer's part number on the case or frame, using a Radio-Electronics-Television Manufacturers Association (RETMA) color code or numbered in a manner to facilitate proper installation.

2.11. **Switches**. Derate switch contacts 50% from their maximum current ratings.

3. MEASUREMENT AND PAYMENT

The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly, but will be subsidiary to the bid items of the Contract.

Special Specification 6007

Intelligent Transportation System (ITS) Fiber Optic Cable

1. DESCRIPTION

Furnish, install, relocate and remove Intelligent Transportation System (ITS) fiber optic cable, fiber patch panels and splice enclosures as shown on the plans.

2. MATERIALS

2.1. **General Requirements.** Provide, assemble, fabricate and install materials that are new, corrosion resistant, and in accordance with the details shown on the plans and in these Specifications.

Furnish, install, splice, and test all new fiber optic cable. Provide all splicing kits, fiber optic cable caps, connectors, moisture or water sealants, terminators, splice trays, fiber optic jumpers, pig tails, fiber patch panels, fiber interconnect housing, and accessories necessary to complete the fiber optic network. Provide all equipment necessary for installation, splicing, and testing.

2.2. **Cable Requirements.** Furnish all-dielectric, dry-filled, gel-free, loose tube fiber optic cable, with low water peak, suitable for underground conduit environments or aerial applications.

Furnish self-supporting, all-dielectric, dry-filled, gel-free, loose tube fiber optic cable, with low water peak suitable for aerial applications when not lashing to strand cable.

All fiber optic cable furnished must have a design life of 20 yr. when installed to the manufacturer's specifications.

Splice fiber optic cables in ground boxes, field cabinets, or buildings. Terminate fiber optic cables in field cabinets and buildings that comply with the details shown on the plans and in this Specification.

Provide all fiber optic cable from the same manufacturer and the manufacturer is International Organization for Standardization (ISO) 9001 certified. Ensure the cables meet or exceed United States Department of Agriculture Rural Utilities Service (RUS) CFR 1755.900, American National Standards Institute/Insulated Cable Engineers Association (ANSI/ICEA) S-87-640, and Telecommunications Industry Association/Electronic Industries Alliance (TIA/EIA)-492-CAAB standard.

2.3. **Optical Requirements**.

2.3.1. **Optical Fiber.** Provide ITU G.652 single mode fiber optic cable with a core diameter of 8.3 ± 0.7 microns and a cladding diameter of 125 ± 0.7 microns. Provide optical fiber made of glass consisting of a silica core surrounded by concentric silica cladding, free of imperfections and inclusions.

2.3.2. **Core/Clad Concentricity.** Provide an offset between the center of the core and cladding less than 0.5 microns.

2.3.3. **Mode Field Diameter.** Provide single mode fiber optic cable with the effective area or Mode Field Diameter of the fiber must be 9.2 ± 0.4 µm at 1310 nm and 10.5 ± 1.0 µm at 1550 nm.

2.3.4. **Primary Coating.** Provide fiber with a coating diameter of 250 ± 15 microns.

2.3.5. **Attenuation.** Provide single mode fiber optic cable with nominal attenuation of 0.35 dB/km maximum at a wavelength of 1310 nm and nominal attenuation of 0.25 dB/km maximum at a wavelength of 1550 nm.

Attenuation at water peak must be less than 0.35 dB/km at 1383 nm.

2.3.6. **Bandwidth and Dispersion.** Provide single mode fiber optic cable with a maximum dispersion of:

- 3.2 ps/nm-km at a wavelength of 1310 nm, and
- 18 ps/nm-km at a wavelength of 1550 nm.

Zero dispersion wavelength must be between 1300 nm and 1324 nm and the zero dispersion slope at the zero dispersion wavelength must be less than 0.092 ps/($nm^2 \cdot km$).

The cutoff wavelength must be less than 1260 nm for single mode fibers specified to operate at 1310 nm. The cutoff wavelength must be less than 1480 for single mode fibers specified to operate only at 1550 nm or higher.

The macrobend attenuation per 100 turns must not exceed 0.05 dB at 1310 nm and 1550 nm.

2.3.7. **Mechanical Requirements(Tensile Strength).** Provide a cable withstanding a pulling tension of 600 lbf without increasing attenuation by more than 0.8 dB/mi when installing in underground conduit systems in accordance with EIA-455-33A. Conduct an impact test in accordance with TIA/EIA-455-25C (FOTP-25) and a compression load test in accordance with TIA/EIA-455-41A (FOTP-41).

For all-dielectric self-supporting cable (ADSS) and other self-supporting cables, meet tensile strength requirements in accordance with Section 25, Loading of Grades B and C, of National Electric Safety Code (NESC), for the maximum span and sag information as shown in the plans for aerial construction.

2.3.8. **Bend Radius.** Provide a cable withstanding a minimum bending radius of 10 times its outer diameter during operation, and 20 times its outer diameter during installation, removal and reinstallation without changing optical fiber characteristics. Test the cable in accordance with EIA-455-33A.

2.3.9. **Buffering.** Use a buffering tube or jacket with an outer diameter of 1.0 to 3.0 mm containing 12 individual fiber strands. The fibers must not adhere to the inside of the buffer tube.

2.3.10. **Color Coding.** Provide fiber and buffer tubes with a color coating applied to it by the manufacturer. Coating must not affect the optical characteristics of the fiber. Provide color configuration in accordance with TIA/EIA-598 as follows:

- 1. Blue
- 2. Orange
- 3. Green
- 4. Brown
- 5. Slate
- 6. White
- 7. Red
- 8. Black
- 9. Yellow
- 10. Violet
- 11. Rose
- 12. Aqua

3. EQUIPMENT

3.1. **Cable Type.** Provide cables with a reverse oscillation or planetary stranding structure.

Jacket construction and group configuration should separate at splice points to cut and splice 1 set of fibers while the others remain continuous. All cable jackets must have a ripcord to aid in the removal of the outer jacket. Submit cable designs for approval.

Strand loose buffer tubes around a dielectric central anti-buckling strength member. Provide dielectric aramid or fiber glass strength members with specified strength for the cable. Provide cable with a water-blocking material, which is non-hygroscopic, non-nutritive to fungus, non-conductive, non-toxic, and homogeneous. The water blocking material must comply with TIA/EIA-455-81B and 455-82B as well as TIA/EIA-455-98.

Ensure a polyethylene inner jacket is applied over the cable core, and that the entire cable is enclosed with a polyethylene outer jacket. Ensure the outer jacket contains black carbon to provide UV protection for the cable. Ensure each cable is marked with the manufacturer's name, the date of manufacture (month/year), the fiber count (example 48F SM), and sequential length markings at maximum 2 ft. increments, measured in U.S. units.

For aerial installation, provide standard fiber optic cable lashed to steel messenger cable or ADSS in accordance with the Institute of Electrical and Electronics Engineers (IEEE) 1222 Standard for Testing and Performance for All-Dielectric Self-Supporting (ADSS) Fiber Optic Cable for Use on Electric Utility Power Lines, or most current version. Provide ADSS cable in accordance with the maximum span distance, weather load rating, and allowable sag as shown on the plans. "Figure 8" self-supporting cable with integrated messenger cable within the outer jacket for aerial installation is acceptable.

3.1.1. **Cable Size.** Furnish cables with a maximum diameter not exceeding 19 mm.

3.1.2. **Environmental Requirements.** Provide cable that functions in a temperature range from -40°F to 158°F.

3.2. **Fiber Optic Accessories.**

3.2.1. **Splice Enclosures.** Furnish and install 1 of 3 types of underground splice enclosures at locations shown on the plans to accommodate the cables being spliced at that point. The types are as follows:

- Type 1: 4 cable entry ports total – 2 ports to accommodate backbone fiber of up to 144 fibers and 2 ports for drop cables of up to 48 fibers,
- Type 2: 6 cable entry ports total – 4 to accommodate backbone or arterial cables of up to 144 fibers and 2 ports for drop cables of up to 48 fibers, and
- Type 3: 8 cable entry ports total – 4 to accommodate backbone or arterial cables of up to 144 fibers and 4 ports for drop cables of up to 48 fibers.

Provide the end cap of the canister splice closure with re-enterable quick-seal cable entry ports to accommodate additional branch cables or backbone cables. Provide fiber optic splice enclosures with strain relief, splice organizers, and splice trays from the same manufacturer as the splice enclosure. Select the appropriate splice enclosure type based on the number of splices called for in the plans. Suspend all splice closures off floor of the ground box and secure to cable rack assembly on side wall of ground box.

For end of reel splicing, use a fiber optic splice enclosure sized to accommodate full cable splice in one enclosure. Fiber optic splice enclosure must be of the same manufacturer as other supplied on a project. Splice enclosure and fusion splicing required for end of reel will be incidental to the fiber optic cable.

Comply with the Telcordia Technologies' GR-711-CORE standard and all applicable NEC requirements.

Contain all optical fiber splices within a splice enclosure, providing storage for fiber splices, nonspliced fiber, and buffer tubes. Provide sufficient space inside the enclosure to prevent microbending of buffer tubes when coiled.

Ensure that the splice enclosure maintains the mechanical and environmental integrity of the fiber optic cable, encases the sheath opening in the cable, and organizes and stores optical fiber. Ensure all hinges and latching devices are stainless steel or of a non-corrosive material designed for harsh environments. Ensure that the enclosure is airtight and prevents water intrusion. Ensure that splice enclosures allow re-entry and are hermetically sealed to protect internal components from environmental hazards and foreign material such as moisture, dust, insects, and UV light.

3.2.2. **Field Rack Mount Splice Enclosures.** Provide a 19 in. EIA rack mounted splice enclosure module to hold spliced fibers as shown in the plans inside field equipment cabinets or buildings.

Splice or terminate fibers inside rack mounted fiber optic splice enclosures. Provide an enclosed unit designed to house a minimum of 4 cables, sized to accommodate at a minimum the cables shown on the plans plus future expansion.

Provide splice enclosures containing mounting brackets with a minimum of 4 cable clamps. Install cable according to manufacturer recommendations for the cable distribution panel.

3.2.3. **Fiber Patch Panels.** Provide fiber patch panels that are compatible with the fiber optic cable being terminated and color coded to match the optical fiber color scheme. Coil and protect a maintenance loop of at least 5 ft. of buffer tube inside the rack mount enclosure, patch panel, or splice tray. Allow for future splices in the event of a damaged splice or pigtail.

3.2.3.1. **Cabinet.** Terminate or splice fibers inside the compact and modular fiber patch panel in the cabinet. Provide fiber patch panel for installation inside a 19 in. EIA rack and sized appropriately to accommodate the fiber terminations shown on the plans or as directed by the Engineer. Provide each patch panel housing with pre-assembled compact modular snap-in simplex connector panel modules, each module having a minimum of 6 fiber termination/connection capabilities. Provide modules with a removable cover having 6 pre-connectorized fiber pigtails, interconnection sleeves, and dust caps installed by the manufacturer. Provide a 12 fiber or greater fusion splice tray capability housing, each tray holding 12 fusion splices as shown in the plans. Stack splice trays on a rack to permit access to individual trays without disturbing other trays. Locate splice trays in a rack within a pull-out shelf. Protect the housing with doors capable of pivoting up or down. Document the function of each terminated/spliced fiber, along with the designation of each connector on labels or charts located either on the inside or outside of the housing door. Provide labels or charts that are UV resistant design for harsh environments and used inside field equipment cabinets. Use permanent marker or method of identification that will withstand harsh environments. Provide each housing with strain relief. Terminate single mode fiber optic cable with SC connectors to the patch panels, unless otherwise shown on the plans.

Install the fiber patch panel as an integral unit as shown on the plans.

3.2.3.2. **Building.** Provide a fiber patch panel with a modular design allowing interchangeability of connector panel module housing and splice housing within the rack, as shown on the plans.

Provide the number of single mode fibers, connector panel module housings, and splice housings for the patch panel unit in the building as shown on the plans.

Provide a fiber patch panel unit, installed at a height less than 7 ft., capable of housing 8 connector panel module housings or 8 splice housings. Protect the housing with doors capable of pivoting up or down and sliding into the unit.

Provide 12 snap-in simplex connector panel modules with each connector panel module housing, each module having 6 fiber termination/connector capabilities. Use a pre-assembled compact modular unit with a removable cover for the snap-in simplex connector panel module having 6 pre-connectorized fiber pigtails, interconnection sleeves, and dust caps installed by the manufacturer. Provide each connector panel module housing with a jumper routing shelf, storing up to 5 ft. (minimum) of cable slack for each termination within the housing. Provide the fiber distribution unit with strain relief.

Provide splice enclosure with 24 fusion splice tray capabilities, each splice tray holding 12 or more fusion splices. Stack splice trays on a rack to permit access to individual trays without disturbing other trays. Locate the rack on a pull-out shelf.

Document the function of each terminated/spliced fiber, along with the designation of each connector on labels or charts located either on the inside or outside of the housing door. Provide labels or charts that are UV resistant design for harsh environments and used inside field equipment cabinets. Use permanent marker or method of identification that will withstand harsh environments. Also provide documentation of the function of each terminated or spliced fiber along with the designation of each connector on charts or

diagrams matching the fiber patch panel configuration and locate inside cabinet document drawer. Provide documentation at the conclusion of fiber terminations and splicing.

Allow terminations only in the fiber interconnect housings placed in the cabinets as shown on the plans or as directed.

3.2.4. **Splice Trays**. Use splice tray and fan-out tubing kit for handling each fiber. Provide a splice tray and 12 fiber fan-out tubing with each housing for use with the 250 microns coated fiber. The fan-out will occur within the splice tray (no splicing of the fiber required). Allow each tube to fan out each fiber for ease of connectorization. Label all fibers in splice tray on a log sheet securing it to the inside or outside of the splice tray. Provide UV resistant log sheet suitable for harsh environments, located inside field cabinets or splice enclosures. Provide fan-out tubing with 3 layers of protection consisting of fluoropolymer inner tube, a dielectric strength member, and a 2.9 mm minimum outer protective PVC orange jacketing.

3.2.5. **Jumpers.** Provide fiber optic jumper cables to cross connect the fiber patch panel to the fiber optic transmission equipment as shown on the plans or as directed. Match the core size, type, and attenuation from the cable to the simplex jumper. Use yellow jumpers and provide strain relief on the connectors. Provide fiber with a 900 micron polymer buffer, Kevlar strength member, and a PVC jacket with a maximum outer jacket of 2.4 mm in diameter.

Provide 5 ft. long jumpers, unless otherwise shown on the plans. On the patch panel end of each jumper, provide an SC connector. On the opposite end of the jumper, provide a connector that is suitable to be connected to the fiber optic transmission equipment selected. When providing jumpers for existing equipment, provide connectors suitable to be connected to patch panels and fiber optic transmission equipment in use. All jumpers must have factory terminated connectors. Field terminations of connectors is prohibited.

3.2.6. **Fiber Optic Cable Storage Device.** Furnish fiber optic cable storage device designed to store slack fiber optic cable by means of looping back from device to device on an aerial run. Furnish storage devices that are non-conductive and resistant to fading when exposed to UV sources and changes in weather. Ensure storage devices have a captive design such that fiber-optic cable will be supported when installed in the aerial rack apparatus and the minimum bending radius will not be violated. Provide stainless steel attachment hardware for securing storage devices to messenger cable and black UV resistant tie-wraps for securing fiber-optic cable to storage device. Provide tie-wraps that do not damage fiber when securing to storage device. Ensure storage devices are stackable so multiple cable configurations are possible. Ensure cable storage devices furnished are compatible with the type of aerial cable furnished and installed. Aerial cable storage devices will be considered incidental to the installation of the fiber optic cable.

4. CONSTRUCTION

Install fiber optic cable in accordance with United States Department of Agriculture Rural Utilities Service CFR 1755.900 specifications for underground and aerial plant construction without changing the optical and mechanical characteristics of the cables.

Utilize available machinery, jacking equipment, cable pulling machinery with appropriate tension monitors, splicing and testing equipment, and other miscellaneous tools to install cable, splice fibers, attach connectors and mount hardware in cabinets employed with the above “Mechanical Requirements.” Do not jerk the cable during installation. Adhere to the maximum pulling tensions of 600 lbf and bending radius of 20 times the cable diameter or as specified by the manufacturer, whichever is greater.

Use installation techniques and fixtures that provide for ease of maintenance and easy access to all components for testing and measurements. Take all precautions necessary to ensure the cable is not damaged during transport, storage, or installation. Protect as necessary the cables to prevent damage if being pulled over or around obstructions along the ground.

Where plans call for removal of existing cable to salvage or reuse elsewhere, take care to prevent damaging the existing cable during removal adhering to all of the requirements for installation that pertain to removal.

4.1. **Packaging, Shipping, and Receiving.** Ensure the completed cable is packaged for shipment on reels. Ensure the cable is wrapped in weather and temperature resistant covering. Ensure both ends of the cable are sealed to prevent the ingress of moisture.

Securely fasten each end of the cable to the reel to prevent the cable from coming loose during transit. Provide 6 ft. of accessible cable length on each end of the cable for testing. Ensure that the complete outer jacket marking is visible on these 6 ft. of cable length. Provide each cable reel with a durable weatherproof label or tag showing the Manufacturer's name, the cable type, the actual length of cable on the reel, the Contractor's name, the contract number, and the reel number. Include a shipping record in a weatherproof envelope showing the above information and also include the date of manufacture, cable characteristics (size, attenuation, bandwidth, etc.), factory test results, cable identification number and any other pertinent information. Ensure that all cable delivered has been manufactured within 6 mo. of the delivery date. Ensure that the minimum hub diameter of the reel is at least 30 times the diameter of the cable. Provide the cable in one continuous length per reel with no factory splices in the fiber. Provide a copy of the transmission loss test results as required by the TIA/EIA-455-61 standard, as well as results from factory tests performed prior to shipping.

4.2. **Installation in Conduit.** Install fiber optic cable in conduits in a method that does not alter the optical properties of the cable. If required, relocate existing cable to allow new fiber optic cable routing in conduits.

When pulling the cable, do not exceed the installation bending radius. Use rollers, wheels, or guides that have radii greater than the bending radius. Use a lubricating compound to minimize friction. Use fuse links and breaks to ensure that the cable tensile strength is not exceeded. Measure the pulling tension with a mechanical device and mechanism to ensure the maximum allowable pulling tension of 600 lbf is not exceeded at any time during installation.

Provide a single 1/C #14 XHHW insulated tracer wire in conduit runs where fiber optic cable is installed. Provide cable that is UL listed solid copper wire with orange color low density polyethylene insulation suitable for conduit installation and with a voltage rating of 600V. When more than one fiber optic cable is installed through a conduit run, only one tracer wire is required. Fuse or join tracer wires used in backbone, arterial, and drop runs, so that you have one continuous tracer wire. Terminate tracer wire at fiber optic test markers or equipment cabinets as identified in the plans for access to conduct a continuity test. Tracer wire will be paid for under Item 620, "Electrical Conductors."

Provide flat pull cord with a minimum tensile strength of 1,250 lb. in each conduit containing fiber optic cable. A traceable pull cord, with a metallic conducting material integral to the pull cord, may be substituted for a 1/C #14 tracer wire only with approval from the Department.

Seal conduit ends with a 2 part urethane after installation of fiber optic cable.

4.3. **Cable Installation between Pull Boxes and Cabinets or Buildings.** Do not break or splice a second fiber optic cable to complete a run when pulling the cable from the nearest ground box to a cabinet or building. Pull sufficient length of cable in the ground box to reach the designated cabinet or building. Pull the cable through the cabinet to coil, splice, or terminate the cable in the cabinet or building. Do not bend the cable beyond its minimum bend radius of 20 times the diameter.

Coil and tie cable inside cabinet, building, or boxes for future splicing or termination as shown in the plans. Cut off and remove the first 10 ft. of pulled or blown fiber stored. This work is incidental to this Item. Coat the open end of the coiled cable with protective coating and provide a dust cap.

4.4. **Aerial Installation.** Use pole attachment hardware and roller guides with safety clips to install aerial run cable. Maintain maximum allowable pulling tension of 600 lb. ft. during the pulling process for aerial run cable by using a mechanical device. Do not allow cable to contact the ground or other obstructions between poles during installation. Do not use a motorized vehicle to generate cable pulling forces. Use a cable suspension

clamp when attaching cable tangent to a pole. Select and place cable blocks and corner blocks so as not to exceed the cable's minimum bending radius. Do not pull cable across cable hangers. Store 100 ft. of fiber-optic cable slack, for future use, on all cable runs that are continuous without splices or where specified on the plans. Store spare fiber optic cable on fiber-optic cable storage racks of the type compatible with the aerial cable furnished. Locate spare cable storage in the middle of spans between termination points. Do not store spare fiber-optic cable over roadways, driveways or railroads.

Install standard cable on timber poles by lashing to steel messenger cable. Provide steel messenger cable in accordance with Item 625, "Zinc Coated Steel Wire Strand." Install all-dielectric self-supporting cable (ADSS) cable on timber poles using clinching clamp with cable hanger. Install aerial run cable in accordance with these specifications and as shown on the plans.

Locate aerial fiber in accordance with the NESC, Section 23, with respect to vertical clearances over the ground, between conductors carried on different supporting structures, and required separation distance of the cable from bridges, buildings, and other structures.

4.5. **Blowing Fiber Installation.** Use either the high-air speed blowing (HASB) method or the piston method. When using the HASB method, ensure that the volume of air passing through the conduit does not exceed 600 cu. ft. per min.or the conduit manufacturer's recommended air volume, whichever is more restrictive. When using the piston method, ensure that the volume of air passing through the conduit does not exceed 300 cu. ft. per min.or the conduit manufacturer's recommended air volume, whichever is more restrictive.

4.6. **Slack Cable**. Pull and store excess cable slack inside ITS ground boxes as shown on the plans. The following are minimum required lengths of slack cable, unless otherwise directed:

- ground boxes (No Splice) - 25 ft.,
- ground boxes (With Splice) - 100 ft.,
- future splice point - 100 ft., and
- cabinets - 25 ft.

Note that the slack is to be equally distributed on either side of the splice enclosure and secured to cable storage racks within the ground boxes.

Provide proper storage of slack cable, both long term and short term. Neatly bind cables to be spliced together from conduit to splice enclosure with tape. Do not over bind by pinching cable or fiber. Ground and bond the armor when installing armored fiber optic cable. Meet NEC and NESC requirements for grounding and bonding when using armored cable.

4.7. **Removal, Relocation and Reinstallation of Fiber Optic Cable.** Remove fiber optic cable from conduit as shown on plans. Use care in removing existing fiber optic cables so as not to damage them. Provide cable removal and reinstallation procedures that meet the minimum bending radius and tensile loading requirements during removal and reinstallation so that optical and mechanical characteristics of the existing cables are not degraded. Use entry guide chutes to guide the cable out of and in to existing or proposed conduit, utilizing lubricating compound where possible to minimize cable-to-conduit friction. Use corner rollers (wheels) with a radius not less than the minimum installation bending radius of cable. Dispose of removed fiber optic cable unless plans show for it to be re-used (relocated/re-installed) or salvaged and delivered to the Department. See plans for details. Test each optical fiber in the cable for performance and for loss at existing terminations or splices prior to cutting and removal. Retest following removal and following re-installation to ensure the removal and reinstallation has not affected the optical properties of the cable. Any fiber optic cable damaged by the contractor that is to be re-used shall be replaced by the contractor at no cost to the Department with new fiber optic cable meeting the approval of the Engineer. The Engineer reserves the right to reject the fiber based on the test results.

Maintain the integrity of existing cables, conduit, junction boxes and ground boxes contiguous to the section of cables to be removed. Replace or repair any cables, conduit, junction boxes or ground boxes damaged during work at the Contractor's expense. The replacement or repair method must be approved by the Engineer, prior to implementation.

4.8. **Splicing Requirements.** Fusion splice fibers as shown on the plans, in accordance with TIA/EIA-568 and TIA/EIA-758.

Use fusion splicing equipment recommended by the cable manufacturer. Clean, calibrate, and adjust the fusion splicing equipment at the start of each shift. Use splice enclosures, organizers, cable end preparation tools, and procedures compatible with the cable furnished. Employ local injection and detection techniques and auto fusion time control power monitoring to ensure proper alignment during fusion splicing.

When approaching end of shift or end of day, complete all splicing at the location. Package each spliced fiber in a protective sleeve or housing. Re-coat bare fiber with a protective 8 RTV, gel or similar substance, prior to application of the sleeve or housing.

Perform splices with losses no greater than 0.10 dB. Use an Optical Time Domain Reflectometer (OTDR) to test splices in accordance with Section 4.13.1.1. Record splice losses on a tabular form and submit for approval.

4.9. **Termination Requirements.** Provide matching connectors with 900 micron buffer fiber pigtails of sufficient length and splice the corresponding optical fibers in cabinets where the optical fibers are to be connected to terminal equipment. Buffer, strengthen, and protect pre-terminated fiber assemblies (pigtails) with dielectric aramid yarn and outer PVC jacket to reduce mishandling that can damage the fiber or connection. Pigtails must be duplex stranding with a yellow PVC outer jacket. Fiber optic pigtails must be factory terminated with SC connectors, unless otherwise shown on the plans. When providing pigtails for existing equipment, provide connectors suitable to be connected to patch panels and fiber optic transmission equipment in use.

Connectors must meet the TIA/EIA-568 and TIA/EIA-758 standards and be tested in accordance to the Telcordia/Bellcore GR-326-CORE standard. When tested according to TIA/EIA-455-171 (FOTP-171), ensure that the connectors test to an average insertion loss of less than or equal to 0.4 dB and a maximum loss of less than or equal to 0.75 dB for any mated connector. Maintain this loss characteristic for a minimum of 500 disconnections and reconnections with periodic cleanings per EIA-455-21A (FOTP-21). Qualify and accept connectors by the connector-to-connector mating using similar fibers. Ensure that the connector operating range is -40ºF to 167ºF. Provide connectors with a yellow color body or boot.

Test connections at the patch panel and splices made between cables to pigtails with the OTDR to verify acceptable losses.

Remove 5 ft. of unused optical fibers at the ends of the system from the buffer tube(s) and place coiled fibers into a splice tray. Clean the water blocking compound from all optical fibers destined for splice tray usage.

Install cable tags at all splice points identifying key features of each cable such as cable name or origin and destination and fiber count. Ensure tags are self-laminating or water resistant. Print the information onto the tags electronically or write neatly using a permanent marker. Locate tags just prior to entrance into splice enclosure.

4.10. **Mechanical Components.** Provide stainless steel external screws, nuts and locking washers. Do not use self-tapping screws unless approved. Provide corrosion resistant material parts and materials resistant to fungus growth and moisture deterioration.

4.11. **Experience Requirements**.

4.11.1. **Installing Fiber Optic Cable.** The Contractor or designated subcontractor involved in the installation of the fiber optic cable must meet the experience requirements in accordance with the following:

- minimum of 3 yr. of continuous existence offering services in the installation of fiber optic cable through an outdoor conduit system or aerial and terminating in ground boxes, field cabinets or enclosures or buildings, and

- completed a minimum of 3 projects where the personnel pulled a minimum of 5 mi. in length of fiber optic cable through an outdoor conduit system of aerial for each project. The completed fiber optic cable systems must have been in continuous satisfactory operation for a minimum of 1 yr.

4.11.2. **Splicing and Testing of Fiber Optic Cable.** The Contractor or designated subcontractor involved in the splicing and testing of fiber optic cable must meet the experience requirements in accordance with the following:

4.11.2.1. **Minimum Experience**. 3 yr. continuous existence offering services in the fields of fusion splicing and testing of fiber optic cable installed through a conduit system and terminating in ground boxes, field cabinets or enclosures or buildings. Experience must include all of the following:

- termination of a minimum of 48 fibers within a fiber distribution frame,
- OTDR testing and measurement of end to end attenuation of single mode and multimode fibers,
- system troubleshooting and maintenance,
- training of personnel in system maintenance,
- use of water-tight splice enclosures, and
- fusion splicing of fiber optic cable which meet the tolerable decibel (dB) losses within the range of 0.05 dB – 0.10 dB for single mode.

4.11.2.2. **Completed Projects**. A minimum of 3 completed projects where the personnel performed fiber optic cable splicing and terminations, system testing, system troubleshooting and maintenance during the course of the project and provided training on system maintenance. Each project must have consisted of a minimum 5 mi. of fiber optic cable installed, measured by project length not linear feet of fiber installed. The completed fiber optic cable systems must have been in continuous satisfactory operation for a minimum of 1 yr.

4.12. **Documentation Requirements.** Provide a minimum of 2 complete sets of fiber optic equipment submittal literature documenting compliance with the requirements of this Item including operation and maintenance manuals in hard copy format, bound, as well as an electronic version in Adobe PDF format on a CD/DVD or removable flash drive that includes the following:

- fiber optic cable literature consisting of manufacturer specification and cut sheets,
- fiber optic equipment literature consisting of manufacturer specification and cut sheets for splice enclosures, patch panels, splice trays, jumpers, cable storage devices, and fiber optic labeling devices,
- complete factory performance data documenting conformance with the performance and testing standards referenced in this Item, including pre-installation test results of the cable system,
- installation, splicing, terminating and testing plan and procedures,
- documentation of final terminated or spliced fibers, function, and equipment designation,
- OTDR calibration certificate,
- post-installation, post termination, subsystem, and final end-to-end test results,
- loss budget calculation and documentation,
- complete parts list including names of vendors,
- complete maintenance and trouble-shooting procedures, and
- proof of minimum experience and completed projects.

4.12.1. **Installation Practice**. Submit for approval electronic copy of the Contractors Installation Practices 30 working days prior to installation. Submit installation practices and procedures and a list of installation, splicing and test equipment used. Provide detailed field quality control procedures and corrective action procedures.

4.12.2. **Manufacturer's Certification.** Accompany each reel of fiber optic cable with the manufacturer's test data showing the conformance to the requirements in this Item.

4.12.3. **Test Procedures.** Submit test procedures and data forms for the pre-installation, post-installation, subsystem, final end to end test, and loss budget calculations for approval. Test procedures will require

approval before performing tests. Submit 1 copy data forms containing data and quantitative results, as well as an authorized signature. Submit a copy of the OTDR results as a hard copy or electronic copy in PDF format including all OTDR traces and clearly identifying each event (fusion splice, jumper, connector, etc.) with the measured loss identified.

4.13. **Testing.** Perform tests in accordance with testing requirements in this Item, USDA RUS CFR 1755.900, and TIA/EIA-455-61 test specifications. For all tests, provide test forms to be used that compare measured results with threshold values.

4.13.1. **Test Methods**.

4.13.1.1. **Optical Time Domain Reflectometer (OTDR) Tests.** Use the OTDR to measure fiber optic cable for overall attenuation (signal loss dB/km), fiber cable length, and identify fiber optic cable anomalies such as breaks. Perform the following 4 OTDR tests:

- pre-Installation test (Acceptance test),
- post installation test,
- post termination test, and
- final end to end test.

OTDR Settings:

- generate a file name for each OTDR scan. The file name must indicate the location or direction the test was run from, as well as the fiber number being tested,
- set the “A” cursor at the beginning of the fiber trace and set the “B” cursor at the end of the fiber trace. The distance to cursor “B” indicates the length of the fiber cable segment being measured,
- match the index of refraction to the index of the factory report,
- set the loss indicator to dB/km for the acceptance test,
- the reflectance is automatically set internally by the OTDR,
- set the pulse width at a medium range. Change the pulse width to a slow pulse width when an anomaly occurs on the fiber trace so that it can be examined closely,
- set the average at medium speed. Change the average to slow when an anomaly appears on the fiber trace to allow for closer examination of the anomaly, and
- set wavelength at 2 windows for single mode cable: 1310 nm and 1550 nm.

Provide the current OTDR calibration certificate for the device used, showing the unit has been calibrated within the last year. Show all settings on test result fiber scans.

4.13.1.2. **Pre-installation Tests.** Test and record the fiber optic cable at the site storage area prior to installation.

Conduct bi-directional OTDR tests for each fiber strand. Test each optical fiber in the cable from one end with an OTDR compatible with wavelength and fiber type. Check testing for length, point discontinuity, and approximate attenuation. Record each measurement by color, location, and type of fiber measured. Perform a measurement from the opposite end of that fiber in case a measurement cannot be made from one end. Wait for notification if loss per kilometer exceeds manufacturer’s test data by more than 0.5 dB/km or point discontinuity greater than 0.05 dB.

Perform this test within 5 days from receipt of the fiber optic cable. Test overall attenuation (dB/km), total cable length, anomalies, and cable problems. Test cable at both wavelengths (1310 nm and 1550 nm for single mode cable). Verify that the cable markings on the outer jacket are within 1% of the total cable length.

Compare factory test results with test results and return to manufacturer if test results are not identical to factory test results. If identical, document the test results. Deliver documentation for future reference.

4.13.1.3. **Post-installation Tests.** Re-test and re-record each optical fiber in the cable after installation, before termination, for loss characteristics. Test both directions of operations of the fiber.

Immediately perform the post installation test after the fiber optic cable has been installed. Test cable for overall attenuation, cable segment length, and evidence of damage or microbend with the OTDR. Replace any cable segment that is damaged during the test and document test results. Submit test results for approval.

Use the same OTDR settings for Post-Installation Tests as the Pre-Installation Tests.

4.13.1.4. **Post Termination Tests.** Perform the post termination test after the cable is terminated or spliced, including termination of fiber cable to fiber cable or fiber cable to fiber pigtail and fiber cable to patch panels. Check attenuation, fusion or termination point problems, and overall fiber cable segment. Determine if the attenuation and quality of the termination complies with these Specifications; if not, re-terminate the fiber and re-test until the Specification requirements are met. Test the fiber segment for attenuation and anomalies after termination acceptance. Document and submit test results after fiber segment acceptance.

4.13.1.5. **Subsystem Tests.** Perform network subsystem tests after integration to the fiber optic network. Test the capability of the fiber optic cable to transmit video and digital information from node to node. A node is defined as a communication cabinet, hub cabinet, surveillance cabinet, or hub building where network hub switches are located. Complete and submit approved data forms for approval.

Correct and substitute components in the subsystem if the subsystem tests fail and repeat the tests. Components may include: cable, jumper, patch panel module, or connector.

Prepare and submit a report if a component was modified as result of the subsystem test failure. Describe in the report the failure and action taken to remedy the situation.

4.13.1.6. **Final End-to-End Test.** Perform final end to end Test after fiber cable segments of the system are terminated using the OTDR and an optical Power Meter and Light Source (PMLS).

Perform the Part 1 of the final end to end test using OTDR:

- measure the overall fiber cable system length,
- measure the overall system attenuation, and
- check for anomalies.

Perform the Part 2 of the final end to end test using a PMLS:

- measure the absolute power of the fiber optic signal across all links, and
- check for anomalies.

Document and submit results after test acceptance.

4.13.2. **Loss Budget Calculation and Documentation.** Calculate the total loss budget of the system according to the following calculations and compare the actual loss in each segment of the system to the calculated budget. Submit the results for each section of fiber optic cable in tabular format reporting if the total loss is within the limits of these Specifications by noting “pass” or “fail” for each segment of fiber. A segment of fiber is defined as one that terminates at each end. Use the following calculations to determine the loss budget for each segment:

- splice loss budget = number of splices x 0.1 dB/splice,
- connector loss budget = number of connectors x 0.75 dB/connector,
- length loss budget = length of fiber optic cable (measured by OTDR) x 0.35 dB/km for 1310 nm wavelength or 0.25 dB/km for 1550 nm wavelength, and
- total Loss Budget = splice loss budget + connector loss budget + length loss budget.

Provide loss budget calculation equations on test form to be submitted as part of the documentation requirements. Provide threshold calculations described above along with measured results.

4.14. **Training.** Conduct a BISCI or IMSA certified training class (minimum of 16 hr.) for up to 10 representatives designated by the Department on procedures of installation, operations, testing, maintenance and repair of all equipment specified within this specification. Submit to the Engineer for approval, 10 copies of the training material at least 30 days before the training begins. Conduct training within the local area unless otherwise authorized by the Engineer Include the following training material:

- NESC, NEC, and ANSI/TIA 590 code compliance,
- fiber optic cable pulling and installation techniques,
- use of installation tools,
- splicing and terminating equipment and test instruments,
- trouble shooting procedures, and
- methods of recording installation and test data.

4.15. **Warranty.** Provide a warranty for all materials furnished in this Item. Ensure that the fiber optic cable, the splice enclosures, splice centers, and cable markers have a minimum of a 2 yr. manufacturer's warranty and that 95% of that warranty remains at the date of final acceptance by the Engineer. If the manufacturer's warranties for the components are for a longer period, those longer period warranties will apply. Guarantee that the materials and equipment furnished and installed for this project performs according to the manufacturer's specifications.

Ensure that the manufacturer's warranties for off-the-shelf equipment consisting of splice enclosures, splice trays, connectors, fiber jumper cables, and fiber patch panels are fully transferable from the Contractor to the Department. Ensure that these warranties require the manufacturer to furnish replacements for any off-the-shelf part or equipment found to be defective during the warranty period at no cost to the Department within 10 calendar days of notification by the Department.

Ensure that the manufacturer's warranty for fiber optic cable is fully transferable from the Contractor to the Department. Ensure that the warranty requires the manufacturer to furnish replacement fiber optic cable found to be defective during the warranty period at no cost to the Department within 45 calendar days of notification by the Department.

5. MEASUREMENT

Fiber optic cable installed, relocated and removed will be measured by the linear foot. Fiber optic splice enclosures, rack mounted splice enclosures and fiber optic patch panels will be measured by each unit installed. Splicing of Fiber Optic Cables will be measured by each fusion splice performed.

6. PAYMENT

6.1. **Furnish and Install.**

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Fiber Optic Cable" of the various types, and number of fibers specified. This price is full compensation for furnishing and installing all cable; for pulling through conduit or duct; aerial installation; terminating; testing; and for materials, equipment, labor, tools, documentation, warranty, training and incidentals.

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Fiber Optic Splice Enclosure" of the various types and "Rack Mounted Splice Enclosure." This price is full compensation for furnishing and installing all enclosures whether aerial, underground, in cabinet or in building; and for materials, equipment, labor, tools, documentation, warranty, training and incidentals.

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Fiber Optic Fusion Splice" for each fusion splice

shown on the plans and performed. This price is full compensation for splicing; testing; and for materials, equipment, labor, tools, documentation, warranty, training and incidentals.

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Fiber Patch Panel" of the various types and sizes specified. This price is full compensation for furnishing and installing all patch panels and terminating fibers on the panel as shown on the plans; and for materials, equipment, labor, tools, documentation, warranty, training and incidentals.

Conduit will be paid for under Item 618, "Conduit" and Special Specification 6016, "ITS Multi-Duct Conduit."

Electrical conductors will be paid for under Item 620, "Electrical Conductors."

6.2. **Install Only.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit bid price for "Fiber Optic Cable (Install Only)" of the various types, and number of fibers specified. This price is full compensation for installing fiber optic cable furnished by the Department; for pulling through conduit or duct; aerial installation; terminating; testing; and for materials, equipment, labor, tools, documentation, warranty, training and incidentals.

Conduit will be paid for under Item 618, "Conduit" and Special Specification 6016, "ITS Multi-Duct Conduit."

Electrical conductors will be paid for under Item 620, "Electrical Conductors."

6.3. **Relocate.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Relocate Fiber Optic Cable." This price is full compensation for relocating all cable, regardless of cable size; for pulling through conduit or duct; aerial installation; terminating; testing; and for materials, equipment, labor, tools, documentation, and incidentals.

6.4. **Remove.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Remove Fiber Optic Cable". This price is full compensation for removing all cable for salvage, regardless of cable size; testing; returning to the Department; and for materials, equipment, labor, tools, documentation, and incidentals.

Special Specification 6008

Intelligent Transportation System (ITS) Ground Mounted Cabinet

1. DESCRIPTION

Furnish, fabricate, deliver, install, and test Intelligent Transportation System (ITS) ground mounted cabinets of the various types and sizes at locations shown on the plans, or as directed.

1.1. **ITS Ground Mounted Cabinet Application.** Provide ITS ground mounted cabinet to house ITS field equipment as shown on the plans, or as directed. ITS equipment applications inside the cabinet may include, but are not limited to:

- radar vehicle sensing device (RVSD),
- wireless Ethernet radio,
- closed circuit television (CCTV) field equipment,
- bluetooth reader,
- automatic vehicle identification (AVI),
- loop detection equipment,
- dynamic message sign (DMS) equipment,
- DMS controller,
- lane control signal (LCS) controller units,
- drop/insert multiplexor/demultiplexor,
- data fiber optic transceivers,
- modular fiber distribution housing,
- subrate data multiplexor distribution panel,
- ramp meter control panel,
- fiber optic video transmitter,
- fiber optic splice trays,
- CCTV color video compression system (CVCS),
- solar power assembly,
- Environmental Sensor Station (ESS),
- highway advisory radio (HAR),
- terminal servers,
- surge arrestors,
- hardened ethernet switches, and
- codecs.

Provide each cabinet complete with all internal components, back and side panels, terminal strips, harnesses, and connectors. Provide all mounting hardware necessary to provide for installation of equipment as described in this Specification. Typically, an ITS ground mounted cabinet may contain, but is not limited to the following:

- 19-in. EIA racks,
- adjustable shelves,
- fan and thermostat assemblies,
- cabinet lights,
- power distribution panel, (as required on the plans or as directed),
- right or left side panel (as required on the plans or as directed),

- surge protection,
- terminal strips,
- interconnect harnesses with connectors,
- laptop shelf and slide out drawer with telescoping drawer guides “door open” connection to back panel,
- ITS equipment hardware (as listed in Article 2.1), and
- all necessary installation and mounting hardware.

Ensure all cabinets are identical in size, shape and quality for each type as provisioned in the plans or as directed. Equip and configure the cabinet set-up as defined in this Specification and as detailed in the ITS ground mounted cabinet standards.

Submit details of the cabinet design and equipment layout for each cabinet to the Engineer for review and approval prior to fabrication.

Ensure the equipment, design, and construction use industry standard techniques with a minimum number of different parts, subassemblies, circuits, cards, and modules to maximize standardization and commonality.

Design equipment for ease of maintenance. Component parts must be readily accessible for inspection and maintenance. Tools and test instruments required for maintenance by maintenance personnel must be simple hand held tools, basic meters and oscilloscopes.

2. MATERIALS

Provide new materials that comply with the details shown on the plans, the requirements of this Item, and the pertinent requirements of the following Items:

- Item 421, “Hydraulic Cement Concrete”
- Item 440, “Reinforcing Steel”
- Item 449, “Anchor Bolts”
- Item 618, “Conduits”
- Item 620, “Electrical Conductors”
- Item 656, “Foundations for Traffic Control Devices,” and
- Item 740, “Graffiti Removal and Anti-Graffiti Coating”.

2.1. **Electrical Requirements.**

2.1.1. **Primary Input Power Interruption.** Use material that meets all the requirements in Section 2.1.4., “Power Interruption” of the National Electrical Manufacturers Association (NEMA) Standard TS2 for Traffic Control System, or most current version.

2.1.2. **Power Service Transients.** Use material that meets all the requirements in Section 2.1.6., “Transients” of the National Electrical Manufacturers Association (NEMA) Standard TS 2 for Traffic Control System, or most current version.

2.1.3. **Power Service Protection.** Ensure that equipment contains readily accessible, manually resettable or replaceable circuit protection devices (such as circuit breakers or fuses) for equipment and power source protection. Provide circuit breakers or fuses sized such that no wire, component, connector, PC board or assembly is subjected to sustained current in excess of their respective design limits upon failure of any single circuit element or wiring.

2.1.4. **Power Distribution Panel.** Provide cabinets with a 120 VAC +/- 5 VAC power distribution panel. Provide the following components on the panel:

2.1.4.1. **Duplex Receptacles.** Provide two 120 VAC NEMA Type 5-15R duplex receptacles, or as shown on the plans, protected by a circuit breaker. Permanently label duplex receptacles “For Internal ITS Equipment

Only." Install duplex receptacles in an isolated location and provide a clear 1/8 in. thick removable cover made from transparent thermoplastic material to cover the duplex receptacles. Ensure this cover is installed as not to interfere with the functional operation within the cabinet and allows enough space to plug in AC adapters and any necessary equipment. Submit alternative cover material for approval as part of the documentation submittal requirement.

2.1.4.2. **Ground Fault Circuit Interrupter (GFCI) Duplex Receptacles.** Provide at least one 120 VAC NEMA Type 5-15R GFCI duplex receptacle, or as shown on the plans, protected by a circuit breaker. This GFCI duplex receptacle is intended for maintenance personnel and is not to be used to serve equipment inside the cabinet. Permanently label GFCI duplex receptacles "For Personnel Use." Install GFCI duplex receptacles in a readily accessible location.

Provide a 120 VAC, rack mountable outlet strip with 6 NEMA Type 5-15R receptacles with surge suppression. Plug outlet strip into GFCI duplex receptacle and label for personnel use.

Circuit Breakers. Determine the ampere rating, quantity, and configuration for main, accessory, spare, and equipment circuit breakers to support ITS equipment loads as shown on the plans. Provide Underwriters Laboratories (UL) 489 listed circuit breakers capable of operating in accordance with Section 2, "Environmental Standards and Test Procedures" of NEMA TS2-2003, or most current version. Provide circuit breakers with an interrupt capacity of 5,000 A. and insulation resistance of 100 megohms at 500 VDC. Provide minimum ampere rating for the following circuit types:

2.1.4.2.1. **Main Breaker.** Size the main circuit breaker such that the load of all branch circuits is less than the main circuit breaker ampere rating in accordance with the most current version of the National Electrical Code (NEC).

2.1.4.2.2. **Accessory Breaker.** Minimum 15 A. Size accessory circuit breaker to protect lighting, door switches, fans, and GFCI duplex receptacle in accordance with the most current version of the NEC.

2.1.4.2.3. **Equipment Breakers.** Minimum 15 A. Size equipment breaker to protect ITS equipment and duplex receptacles in accordance with the most current version of the NEC.

2.1.4.2.4. **Spare Equipment Breaker.** Minimum 20 A. Provide one spare equipment breaker for future use.

Furnish breakers, which are in addition to any auxiliary fuses, with the electronic equipment to protect component parts. Provide 3-terminal lightning arrestor to protect the load side of all circuit breakers. Connect the arrestor into the circuit with size 8 AWG or larger stranded copper conductors. Connect arrestor to the line filter as recommended by the manufacturer.

2.1.4.3. **Power Line Surge Protection.** Provide and install power line surge protection devices that meet the requirements of Article 2.4.1.

2.1.4.4. **Power Cable Input Junction Terminals.** Provide power distribution blocks suitable for use as a power feed and junction points for 2 and 3 wire circuits. Accommodate up to No. 4 AWG conductors on the line side of each circuit. Provide appropriate sized lugs at the junction terminals for conductors larger than a No. 4 AWG when shown on the plans.

Electrically isolate the AC neutral and equipment ground wiring from the line wiring by an insulation resistance of at least 10 megohms when measured at the AC neutral. Color code the AC neutral and equipment grounding wiring white and green respectively in accordance with the most current version of the NEC.

Utilize the back panel to distribute and properly interconnect all cabinet wiring related to the specific complement of equipment called out on the plans. Each item of equipment including any furnished by the Department must have the cable harness properly terminated at terminal boards on the back panel. Ensure all functions available at the equipment connector are carried in the connector cable harness to the terminal blocks from the power distribution panel mounted on the left side panel of the cabinet.

2.1.5. **Right Side Panel.** When shown on the plans, for a required ITS application, provide fully wired loop input distribution panel to be mounted on the lower right inside wall when facing the front inside of the door opening of the cabinet. Provide a detailed layout for approval by the Engineer. Provide a panel with the following:

2.1.5.1. **Power Distribution.** If any 115 VAC power is needed on the right side panel, it will be obtained from the power distribution terminal board located on the left side panel, which is fed from the equipment circuit breaker located on the left side panel.

2.1.5.2. **Loop Surge Protection.** Mount surge protection for incoming loop pairs on the right side panel.

2.1.6. **Back Panel.** When shown on the plans, for a required ITS application, provide cabinet with a fully wired equipment panel to be mounted on the lower rear inside wall of the cabinet. Provide a detailed layout for approval by the Engineer. Panel to include detector terminal boards to accommodate equipment shown on the plans or as directed.

2.1.7. **Alternative Power Option.** When shown on the plans, accommodate renewable electrical power source for the design load specified in accordance with "ITS Solar Power System" Specification. Renewable electrical power source may, or may not, be integrated with public utility electrical services, as shown on the plans or as directed. Accommodate solar system components including batteries and solar charge controller.

2.1.8. **Wiring.** Ensure all cabinet wiring identified by the use of insulated pre-printed sleeving slipped over the wire before attachment of the lug or making the connection. Supply enough text on wire markers in plain words or abbreviations with sufficient level of detail so that a translating sheet will not be required to identify the type and size of wire.

Cut all wires to the proper length before assembly. Ensure no wires are doubled back to take up slack. Ensure harnesses to connectors are covered with braided cable sleeves. Secure cables with nylon cable clamps.

Provide service loops to facilitate removal and replacement of assemblies, panels, and modules. Use insulated parts and wire rated for at least 600 V. Color-code harnesses and wiring.

Route and bundle all wiring containing line voltage AC separately or shield from all low voltage, i.e., control circuits. Cover all conductors and live terminals or parts, which could be hazardous to maintenance personnel, with suitable insulating material.

Provide AC internal cabinet wiring identified in accordance with the most current version of the NEC. Provide white insulated conductors for AC common. Provide green insulated conductors for equipment ground. Provide any color different from the foregoing on other conductors in accordance with the most current version of the NEC. For equipment that requires grounding, provide ground conductors and do not use conduit for grounding. Provide No. 22 AWG or larger stranded conductors for internal cabinet wiring. Provide conductors that are UL-listed THHN in accordance with the most current version of the NEC. Ensure the insulation has at least a thickness of 10 mm. Ensure all wiring containing line voltage is at least size No. 14 AWG. No strands of any conductor may be trimmed to "fit" the wiring into the breaker or terminal block.

2.1.9. **Terminal Strips.** Provide terminal strips located on the back panel that are accessible to the extent that it is not necessary to remove the electronic equipment from the cabinet to make an inspection or connection.

Ensure terminal blocks are 2 position, multiple pole barrier type.

Provide shorting bars in each of the positions provided, along with an integral marking strip.

Arrange terminal blocks such that they will not upset the entrance, training and connection of incoming field conductors.

Identify all terminals with legends permanently affixed and attached to the terminal blocks.

Ensure not more than 3 conductors are brought to any 1 terminal screw.

Ensure no electrically energized components or connectors extend beyond the protection afforded by the barriers.

Locate all terminal blocks below the shelves.

Ensure terminals used for field connections are secure conductors by means of a No. 10-32 nickel or cadmium plated brass binder head screw.

Ensure terminals used for interwiring connections, but not for field connections, are secure conductors by means of a No. 5-32 nickel plated brass binder head screw.

Terminate all connections to and from the electronic equipment to an interwiring- type block. These blocks will act as intermediate connection points for all electronic equipment input and output.

Provide termination panels that are used to distribute and properly interconnect all cabinet wiring related to the specific complement of equipment as shown on the plans. Provide properly terminated cable harnesses for each item, including any furnished by the Department. Provide all functions available at the equipment terminals that are carried in the connector cable harness.

2.1.10. **Cabinet Internal Grounding.** The cabinet internal ground consists of at least 1 ground bus-bar permanently affixed to the cabinet and connected to the grounding electrode.

Use bare stranded No. 4 AWG copper wire between bus-bars and between the bus-bar and grounding electrode.

Ensure each copper ground bus-bar has at least 14 connection points, each capable of securing bare conductor ranging in size from No 4 AWG to No 14 AWG.

Return AC neutral and equipment ground wiring to these bus-bars.

2.1.11. **Door Switch.** Provide a door switch meeting the following requirements:

- momentary, pin-type door switch,
- installed in the cabinet or on the door,
- connected to a terminal so that the equipment installed in the cabinet can confirm input is connected to logic ground when the cabinet door is open, and
- engage cabinet light when the door is opened.

Provide 2 momentary, pin-type door switches for each door provided with the cabinet. Wire 1 switch to turn on the cabinet lights when the door is open, and off when the door is closed. Wire the other in parallel to a terminal block to detect a cabinet intrusion condition.

2.2. **Mechanical Requirements.**

2.2.1. **Size and Construction.** Provide ITS ground mounted cabinets meeting the configuration types detailed in the ITS Ground Mounted Cabinet standards.

Table 1
Minimum Cabinet Dimensions

	Depth (in.)	Width (in.)	Height (in.)
Type 4	**30**	**24**	**66**
Type 5	**26**	**44**	**54**
Type 6	**26**	**44**	**66**

Determine the suitability of the listed cabinet configuration types for the equipment at each field location identified on the plans or as directed.

2.2.2. **Ventilation.** Provide the cabinet with vent openings to allow cooling of electronic components.

Locate louvered air intake vent openings on the lower portion of the cabinet doors and cover fully inside with a commercially available disposable 3 layer graded pleated type filter with a minimum size of 16 in. (high) x 16 in. (wide) and a thickness of 1 in. For Type 5 cabinet, provide 2 filters for each door. Securely mount so that any air entering the cabinet must pass through the filter. Ensure the cabinet opening for intake of air is large enough to accommodate filter size. Screen the exhaust to prevent entry of insects. Provide the screen openings no larger than 0.0125-sq. in.

Vent and cool the cabinet by thermostatically controlled electric fans. Provide adjustable thermostat with an adjustment range of 70 to 110°F. Provide a press-to-test switch to test the operation of the fan.

Provide at least 4 commercially available fans with a capacity of at least 110 cfm each. Provide the total free air opening of the vent large enough to prevent excessive back-pressure on the fan.

2.2.3. **Lighting.** Provide minimum 15 W fluorescent light fixtures above each door inside the cabinet, each with clear shatter proof lens. NEMA TS2 rated light-emitting diode (LED) fixtures are acceptable instead of fluorescent light fixtures. Determine the appropriate number of fixtures to achieve at least 1000 lumens to illuminate the equipment. Position the fixtures to provide illumination to the face of the equipment in the cabinet and not into a technician's eyes.

2.2.4. **Exterior Finish.** Provide cabinets with a smooth aluminum finish and the exterior in its unpainted natural color.

When shown on the plans or as directed, provide cabinets with an anti-graffiti coating in accordance with Item 740 “Graffiti Removal and Anti-Graffiti Coating.”

2.2.5. **Serial Number.** Provide the cabinets with a serial number unique to the manufacturer, preceded by an assigned 2 letter manufacturer's code. Provide at least a 0.2 in. letter height. Stamp the entire identification code and number on a metal plate riveted to the cabinet, stamp directly on the interior cabinet wall, or engrave on a metalized mylar plate that is epoxied to the cabinet on the upper right hand cabinet side wall.

2.2.6. **Modular Design.** Provide cabinets that have a modular design and allow ITS equipment to be installed in a variety of mounting configurations as detailed on the plans or as directed.

Provide Type 4 cabinets with 1 Electronic Industries Alliance (EIA) 19 in. rack cage, sized appropriately based on cabinet type inside height dimension. Provide a rack with at least 1 1RU (RU = rack unit) horizontal power strip. Provide 2 unistrut or DIN rail channels on each side wall of the cabinet for mounting power panel and auxiliary ITS equipment.

Provide Type 5 and Type 6 cabinets with 2 side by side EIA 19 in. racks, sized appropriately based on cabinet type inside height dimension. Provide a rack with at least of 1 1RU horizontal power strip. Provide 2 unistrut or DIN rail channels on each side wall of the cabinet for mounting power panel and auxiliary ITS equipment.

2.2.7. **Shelves.** Provide adjustable shelves in each cabinet as required to support the equipment as specified on the plans. Ensure shelf adjustment is at 1 RU intervals in the vertical position. Provide shelves that can be mounted to an EIA 19 in. rack cage or unistrut channel as detailed in the standards.

Provide shelves that are removable and capable of supporting the electronic equipment. Provide a minimum of 2 in. between the back and front edge of the shelf to back inside wall and door of the cabinet respectively to allow room for the equipment cables and connectors.

Provide each cabinet type with at least 1 slide out drawer with telescoping drawer guides to allow full extension from the rack frame. Provide at least 1.75 in. (high) x 16 in. (wide) x 14 in. (deep) drawer with a hinged lid to allow access to storage space.

2.3. **Surge Protective Devices (SPD).** Provide SPDs to protect electronics from lightning, transient voltage surges, and induced current. Install SPDs on all power, data, video, and any other conductive circuit.

2.3.1. **120 V or 120/240 V SPD at Service and ITS Cabinet Power Distribution Panel.** Install an SPD at the closest termination or disconnection point where the supply circuit enters the cabinet. Locate the SPD on the load side of the cabinet power distribution panel breakers and ahead of any and all electronic devices. Keep leads as short as possible with all conductor bends formed to the maximum possible radius. Connect the SPD ground lead directly to the ground bus. Use of wire nuts is prohibited. Install in accordance with manufacturers recommendations.

Provide UL Listed Type 1 or Type 2 SPD and labeled to UL1449 Third Edition, posted at UL.com, under Certifications UL Category Code VZCA, and have a 20kA I-nominal rating. Provide SPD rated as NEMA 4. SPD with integral EMI/RFI line filtering may be required if shown on the plans.

Do not exceed 700 V on the Voltage Protection Rating (VPR) on any mode (L-N, L-G, and N-G).

Do not exceed 150 V on the Maximum Continuous Operating Voltage (MCOV).

Equal or exceed 40kA the SPD surge current rating per mode (L-N), (L-G), (N-G).

Equal or exceed 50 kA or the available short circuit current, whichever is higher for the SPD Short Circuit Current Rating (SCCR).

Provide SPD with directly connected Metal Oxide Varistors (MOV) exceeding 32 mm in diameter with thermal safety disconnectors. Gas tube and spark gap SPD are not be permitted. Ensure each MOV's operational status can be monitored via visual indicator, including N-G mode.

Provide SPD with one set of Normally Open (NO), Normally Closed (NC) Form C contacts for remote monitoring.

Ensure the SPD utilized for AC power does not dissipate any energy and does not provide any series impedance during standby operation. Return the unit to its non-shunting mode after the passage of any surge and do not allow the shunting of AC power.

2.3.2. **Parallel SPD for 120 V Equipment.** Install an SPD inside of the cabinet on the power distribution to the equipment. Keep leads as short as possible with all conductor bends formed to the maximum possible radius. Connect the SPD ground lead directly to the ground bus. Use of wire nuts is prohibited. Install in accordance with manufacturers recommendations.

Provide UL Listed Type 1 or Type 2 SPD labeled to UL1449 Third Edition, posted at UL.com, under Certifications UL Category Code VZCA, and have a 20kA I-nominal rating. Provide SPD rated as NEMA 4.

Do not exceed 700 V on the Voltage Protection Rating (VPR) on any mode (L-N and N-G).

Do not exceed 150 V on the Maximum Continuous Operating Voltage (MCOV).

Equal or exceed 40 kA the SPD surge current rating per mode (L-N) and (N-G).

Equal or exceed 50 kA or the available short circuit current, whichever is higher for the SPD Short Circuit Current Rating (SCCR).

Provide SPD with directly connected Metal Oxide Varistors (MOV) exceeding 32 mm in diameter with thermal safety disconnectors. Gas tube and spark gap SPD are not be permitted. Ensure each MOV's operational status can be monitored via visual indicator, including N-G mode.

Provide SPD with one set of Normally Open (NO), Normally Closed (NC) Form C contacts for remote monitoring.

2.3.3. **Low-Voltage Power, Control, Data and Signal Systems SPD.** Install a specialized SPD on all conductive circuits including, but not limited to, data communication cables, coaxial video cables, and low-voltage power cables. Ensure that these devices comply with the functional requirements shown in Table 2 for all available modes (i.e., power L-N, N-G; data and signal center pin-to-shield, L-L, L-G, and shield-G where appropriate).

These specialized SPD must have an operating voltage matching the characteristics of the circuit. Ensure that these specialized SPD are UL 497B or UL 497C Listed, as applicable.

Provide the SPD with 3 stages of surge suppression in a Pi (π) configuration. The first stage (primary side) consists of parallel-connected Gas Discharge Tubes (GDTs). The second stage consists of a series connected resistor or inductor. The third stage (secondary side) consists of parallel-connected transorbs or silicone avalanche diodes (SADs).

Ground the SPD to the DIN rail and a wire terminal connection point. (Grounding solely through the DIN rail connection is not adequate and does not meet the performance or intent of this specification.)

Install coaxial SPDs in a manner that prevents ground loops and resulting signal deterioration. This is usually caused where the cable has different references to ground at either end and connecting SPDs at both ends that have only Pin to Shield protection completes a ground loop circuit through the Shield. SPDs having Pin to Shield protection, and separate Shield to Ground protection are acceptable to eliminate ground loops.

Table 2
SPD Minimum Requirements

Circuit Description	Maximum Continuous Operating Voltage (MCOV)	Frequency/ Bandwidth/ Data Rate	Surge Capacity	Maximum Let-Through Voltage
12 VDC	15-20 V	N/A	5 kA per mode (8x20 µs)	<150 Vpk
24 VAC	30-55 V	N/A	5 kA per mode (8x20 µs)	<175 Vpk
48 VDC	60-85 V	N/A	5 kA per mode (8x20 µs)	<200 Vpk
Coaxial Composite Video	4-8 V	Up to 1.5 GHz	10 kA per mode (8x20 µs)	<100 Vpk
RS422/RS485	8-15 V	Up to 10 Mbps	10 kA per mode (8x20 µs)	<30 Vpk
T1	13-30V	Up to 10 Mbps	10 kA per mode (8x20 µs)	<30 Vpk
Ethernet Data	7-12V	Up to 100 Mbps	3 kA per mode (10x1000 µs)	<30 Vpk

2.4. **Environmental Design Requirements.** Provide cabinets that meet the functional requirements of this Item during and after subjection to any combination of the following requirements:

- ambient temperature range of -30 to 165°F,
- temperature shock at most 30°F per hour, during which the relative humidity does not exceed 95%,
- relative humidity range at most 95% over the temperature range of 40 to 110°F, and
- operates with moisture condensation on all surfaces caused by temperature changes.

2.5. **Vibration.** Material used must show no degradation of mechanical structure, soldered components, plug in components or satisfactory operation in accordance with the manufacturer's equipment specifications after being subjected to the vibration test as described in the NEMA standard TS2, Section 2.2.8, “Vibration Test”, or the most current version.

3. FABRICATION

3.1. **Ground Mounted Cabinet.** Continuously weld all exterior seams for cabinet and doors. Fill edges to a radius of 0.03125 in. minimum. Smooth exterior welds.

Welding on aluminum cabinets are done by the gas metal arc (MIG) or gas tungsten arc (TIG) process using bare aluminum welding electrodes. Ensure electrodes conform to the requirements of the American Welding Society (AWS) A5.10 for ER5356 aluminum alloy bare welding electrodes.

Procedures, welding machines and welding machine operators for welding on aluminum must be qualified and conform with the requirements of AWS B3.0, “Welding Procedures and Performance Qualification”, and to the practices recommended in AWS C5.6.

Construct all cabinets of welded sheet aluminum with a thickness of at least 0.125 in. meeting NEMA 3R standards. Do not allow wood, wood fiber product, or flammable products in the cabinet. Seal cabinet structure to prevent the entry of rain, dust, and dirt.

Provide a sunshield on the exterior top of the cabinet to reflect solar rays and mitigate temperature build-up inside the cabinet. Construct sunshield out of 0.125 in. thick aluminum and provide a minimum of 1.25 in. clearance above the top of cabinet secured in four locations.

Attach aluminum lifting eyes or ears to the top of the cabinet to permit lifting the cabinet with a sling. Lifting eyes may be permanently fabricated to the cabinet frame as long as they do not interfere with the construction and operation of the sunshield. Manufacturer may provide removable lifting eyes that can be removed after installation. Seal any penetrations to the cabinet exterior or sunshield after removal of lifting eyes.

Ensure cabinets conform to the requirements of ASTM designation: B209 for 5052-H32 aluminum sheet.

3.1.1. **Door.** Provide sturdy and torsionally rigid cabinet doors that overlap and substantially cover the full area of the front of the cabinet. Attach cabinet doors by a minimum of 3 heavy duty hinges or full length hinge. Provide stainless steel hinge pins.

Fabricate the doors and hinges to withstand a 100 lb. per vertical foot force applied to the outer edge of the door when open without permanent deformation or impairment of the door or cabinet body when the load is removed.

Fit the cabinet doors with Number 2 Corbin lock and aluminum or chrome plated handle with at least a 3/8 in. drive pin and a 3 point latch. Design the lock and latch so that the handle cannot be released until the lock is released. Provide a padlock of the type directed by the Engineer. Provide a locking ring for a padlock. Provide 2 keys for the door and 2 keys for the padlock with each cabinet. Locate the lock clear of the arc of the handle. Keys must be removable in the locked position only. Mount locks with 2 stainless steel machine screws. Provide cabinet doors with a catch mechanism to hold the door open at 3 positions: 90°, 120°, and 160°.

Fabricate the door and door stop mechanism to withstand a simulated wind load of 5 lb. per sq. ft. applied to both inside and outside surfaces without failure, permanent deformation, or compromising of door position.

Provide cabinets without auxiliary police doors.

Provide a gasket to act as a permanent and weather resistant seal at the cabinet door facing. The gasket material must be of a non-absorbent material and maintain its resiliency after long term exposure to the outdoor environment.

Provide a gasket with a minimum thickness of 0.25 in. Locate the gasket in a channel provided for this purpose either on the cabinet or on the door. An “L” bracket is acceptable instead of this channel if the gasket is fitted snugly against the bracket to insure a uniformly dust and weather resistant seal around the entire door facing.

3.1.2. **Mechanical Components.** Ensure all external screws, nuts, and locking washers are stainless steel. Do not use self-tapping screws unless specifically approved by the Engineer.

Ensure all parts are made of corrosion resistant material, such as plastic, stainless steel, aluminum or brass.

Ensure all materials used in construction are resistant to fungus growth and moisture deterioration.

Separate dissimilar metals by an inert dielectric material.

4. CONSTRUCTION

4.1. **General**. For ITS cabinets installed on a slope, ensure the cabinet primary door faces and opens to the high side of the slope and provide safety railing in accordance with the ITS ground mounted cabinet standards. Safety railing is subsidiary to this Item. Stake cabinet foundation forms and underground conduit entering the foundation before installation and secure Department approval before pouring foundation. It is understood that cabinet location may vary from the plans to accommodate field conditions.

Construct the cabinet foundation in accordance with Item 656, “Foundations for Traffic Control Devices”, unless otherwise specified by the Engineer.

Concrete maintenance pads have been integrated into the foundation design found on the ITS ground mounted cabinet standards to accommodate door configuration options.

4.2. **Mounting Hardware.** Furnish anchor bolts to mount the cabinet to the foundation. Manufacturer to determine the appropriate size anchor bolts by cabinet type and foundation size. Provide appropriate mounting plates and any other necessary hardware to mount the cabinet on a foundation.

4.3. **Installation.** Ground the cabinet as depicted in the ITS grounding standards. For retrofit scenarios, measure resistance to ground before installing cabinet in accordance with IEEE 81. Provide additional grounding rods and install additional grounding conductors as detailed in the ITS Grounding Standards to achieve less than 5 ohms resistance. Additional ground rods and grounding conductors are subsidiary to this Item.

Immediately before mounting the cabinet on the foundation, apply a bead of silicone caulk to seal the cabinet base to the foundation.

Seal any space between conduit entering the cabinet and the foundation with silicone caulk or approved sealant compound.

Install conduits as shown on the plans or as directed and in accordance with Item 618, “Conduit.” Place wiring in a neat and orderly manner grouped together with nylon tie-downs.

After wiring is installed, seal the conduits terminated in the cabinet foundation with a duct seal or other similar approved sealant inside of the ends of the conduit in the cabinet to prevent moisture, insects and critters from entering the conduits.

4.3.1. **Connection of Lead-In Cable.** Connect the detector lead-in cables, when shown on the plans or as directed, to the detector terminal blocks in the following manner:

Dress each cable into position in conformance with the approved lead-in cable position on the panel (bundle cables together and broken out by their position on the terminal boards),

Place cable as close to the terminal points as possible and left floating, and

Ground the cable shield after testing and in accordance with the detector manufacturers' specifications.

4.3.2. **Connection of Miscellaneous Cables.** Terminate connection of signal wires, sign control wires and any other wires required to complete connections for an operational system on terminal blocks.

Design the equipment for ease of maintenance. All component parts must be readily accessible for inspection and maintenance. The only tools and test instruments required for maintenance by maintenance personnel must be simple hand held tools, basic meters and oscilloscopes.

Mount cabinet plumb in all directions.

4.4. **Removal and Replacement of Curbs and Walks.** The Contractor to secure approval of the Engineer before cutting into or removing sidewalks or curbs not shown on the plans to be removed or replaced.

Restore any curbs or sidewalks after work is completed, which have been removed, to equivalent original condition and to the satisfaction of the Engineer.

All completed surfaces that are adjacent to the cabinet foundation must be level and free of trip hazards. Any difference in level of adjacent structures are to be addressed in the field and approved by the department.

4.5. **Relocation.** Before removal of the existing cabinet, disconnect and isolate the power cables from the electric power supply and disconnect all cables (power and communication) from the equipment.

Inspect the existing cabinet, with a representative from the Department, and document any evidence of structural damage before removal. Remove and deliver to the Department existing cabinets that fail structural inspection to an address to be supplied by the Department.

Remove the existing cabinet in a manner acceptable to the Engineer. Use a method that does not cause undue overstress or damage to the structure or appurtenances attached.

Remove the existing concrete foundation to a depth of at least 2 ft. below finish grade with all steel cut off. Backfill the excavation with material equal in composition and density to the surrounding area. Replace any surfacing, such as asphalt pavement, concrete riprap or brick pavers, with like material to equivalent condition as approved by the Engineer.

Supply all new anchor bolts required for the installation of the cabinet. Match bolt dimensions and lengths previously used or as shown on the plans or as directed.

4.6. **Removal.** Present the work in a neat, professional finished appearance. Maintain safe construction and operation practices. Use established industry and utility safety practices when removing cabinets near overhead or underground facilities. Consult with the appropriate utility company before beginning work.

Inspect the cabinet, with a representative from the Department, and remove any ITS equipment, associated mounting hardware, and cabling inside the cabinet before commencing work.

Before removal of the existing cabinet, disconnect and isolate the power cables from the electric power supply and disconnect all cables (power and communication) from the equipment. Remove and coil existing cabling to the nearest ITS ground box or as identified on the plans.

Carefully remove the cabinet and avoid damage or injury to surrounding objects or individuals. Deliver the cabinet to an address to be supplied by the Department.

Remove the existing foundation to a depth of 2 ft. below grade with all steel cut off. Backfill the excavation with material equal in composition and density to the surrounding area. Replace any surfacing, such as asphalt pavement, concrete riprap, or brick pavers, with like material to equivalent condition as approved by the Engineer.

4.7. **Testing.**

4.7.1. **Installation**. Unless otherwise shown on the plans, perform the following tests on cabinets supplied through this Item.

4.7.1.1. **Test Procedures Documentation**. Provide 5 copies of the test procedures to include tests identified in Article 4.9.2 through Article 4.9.4 inclusive and blank data forms to the Engineer for review and comment at least 45 days before testing for each test required on this project. Include the sequence of the tests in the procedures. The Engineer will comment, approve, or reject test procedures within 30 days after Contractor submittal of equipment for tests. Contractor to resubmit if necessary rejected test procedures for final

approval within 10 days before testing. Review time is calendar days. Conduct all tests in accordance with the approved test procedures. The Department may witness all tests.

Record test data and quantitative results on data forms. No bid item measurement or payment will be made until the Engineer has verified the test results meet the requirements of the specification. The data forms for all tests, except design approval tests, must be signed by an authorized representative of the Contractor.

Provide written notice to the Engineer within 48 hr. of discovery of any testing discrepancy performed in testing by the contractor. Furnish data forms containing the acceptable range of expected results and measured values.

4.7.1.2. **Design Approval Test**. Conduct a design approval test on 10 percent of the total number of cabinets supplied as part of the project, with at least 1 of each type of cabinet used on the project.

Certification from an independent testing laboratory of a successfully completed design approval test is acceptable. Ensure that the testing by this laboratory is performed in accordance with the requirements of this specification. Failure of independent tests to comply with the requirements of this specification will be grounds for rejection of any certification.

Provide a copy of the certification to the Engineer. The data forms for the design approval tests must be signed by an authorized representative (company official) of the equipment manufacturer or by an authorized representative of an independent testing facility.

Notify the Engineer 10 working days before conducting this testing. The Department may witness all the tests. Perform the following tests:

4.7.1.2.1. **Power Service Transients.** Provide equipment that meets the performance requirements, specified in this Item, when subjected to the power service transients as specified in NEMA TS 2, Section 2.2.7.2, “Transient Tests (Power Service)”, or most current version.

4.7.1.2.2. **Temperature and Condensation.** Provide equipment that meets the performance requirements, specified in this Item, when subjected to the following conditions in the order specified below:

- Stabilize the equipment at -30°F and test as specified in NEMA TS2, Sections 2.2.7.3, “Low-Temperature Low-Voltage Tests” and 2.2.7.4, “Low-Temperature High-Voltage Tests”, or most current version.
- Allow the equipment to warm up to room temperature in an atmosphere with relative humidity of at least 40%. Operate the equipment for 2 hr., while wet, without degradation or failure.
- Stabilize the equipment at 165°F and test as specified in NEMA TS2, Sections 2.2.7.5, “High-Temperature High Voltage Tests” and 2.2.7.6, “High-Temperature Low-Voltage Tests”, or most current version.

4.7.1.2.3. **Relative Humidity.** Provide equipment that meets the performance requirements, specified in this Item, within 30 min. of being subjected to a temperature of 165°F and a relative humidity of 18% for 48 hr.

4.7.1.2.4. **Vibration.** Provide equipment that shows no degradation of mechanical structure, soldered components, or plug-in components and will operate in accordance with the manufacturer's equipment specifications after being subjected to the vibration tests as described in NEMA TS2, Section 2.2.8, “Vibration Test”, or most current version.

4.7.1.2.5. **Power Interruption.** Provide equipment that meets the performance requirements, specified in this Item, when subjected to nominal input voltage variations as specified in NEMA TS2, Section 2.2.10, “Power Interruption Test”, or most current version.

4.7.1.3. **Stand-Alone Tests**. Conduct a stand-alone test for each cabinet after installation. Exercise all stand-alone (non-network) functional operations consisting of the following, at a minimum:

- 19-in. EIA rack,
- adjustable shelves,
- locking mechanism,
- fan and thermostat,
- cabinet light,
- back panel,
- circuit breakers,
- surge protection,
- grounding system,
- terminal strips,
- interconnect harnesses with connectors,
- weatherproofing, and
- "Door Open" connection to back panel.

Notify the Engineer 5 working days before conducting this test. The Engineer may witness all the tests.

4.7.1.4. **Consequences of Test Failure**. If a unit fails a test, submit a report describing the nature of the failure and the actions taken to remedy the situation before modification or replacement of the unit. If a unit requires modification, correct the fault and then repeat the test until successfully completed. Correct minor discrepancies within 30 days of written notice to the Engineer. If a unit requires replacement, provide a new unit and then repeat the test until successfully completed. Major discrepancies that will substantially delay receipt and acceptance of the unit will be cause for rejection of the unit.

Failure to satisfy the requirements of any test is considered a defect and the equipment is subject to rejection by the Engineer. The rejected equipment may be offered again for retest provided all noncompliance has been corrected.

If a failure pattern develops in similar units within the system, implement corrective measures, including modification or replacement of units, to all similar units within the system as directed. Perform the corrective measures within 30 calendar days without additional cost or extension of the contract period.

4.7.1.4.1. **Consequences of Design Approval Test Failure.** If the equipment fails the design approval test, correct the fault within 30 days and then repeat the design approval test until successfully completed.

4.7.1.4.2. **Consequences of Demonstration Test Failure.** If the equipment fails the demonstration test, correct the fault within 30 days and then repeat the demonstration test until successfully completed.

4.7.1.4.3. **Consequences of Stand-Alone Test Failure.** If the equipment fails the stand-alone test, correct the fault and then repeat the stand-alone test until successfully completed.

4.7.2. **Relocation.**

4.7.2.1. **Pre-Test.** Conduct performance testing before removal of ITS ground mounted cabinets. Test all functional operations of the equipment, at a minimum, and document functional operations in the presence of representatives of the Contractor and the Department.

- locking mechanism,
- fan and thermostat,
- cabinet light,
- back panel,
- circuit breakers,
- surge protection system,
- grounding system, and

- "Door Open" connection to back panel.

Ensure that both representatives sign the test report indicating that the equipment has passed or failed each function. Once removed, the equipment becomes the responsibility of the Contractor until accepted by the Department. Compare test data before removal and test data after installation.

4.7.2.2. **Post Test**. Testing of the ITS ground mounted cabinet is for the purpose of relieving the Contractor of maintenance of the system. The Contractor will be relieved of the responsibility for maintenance of the system in accordance with Item 7, "Legal Relations and Responsibilities", after a successful test period. The Contractor will not be required to pay for electrical energy consumed by the system.

After all existing ITS equipment has been installed, perform the same functional operation test described under Article 4.9.2.1. Furnish test data forms containing the sequence of tests including all of the data taken and quantitative results for all tests. Submit the test data forms to the Engineer at least 30 days before the day the tests are to begin. Obtain Engineer's approval of test procedures before submission of equipment for tests. Send at least 2 copies of the data forms to the Engineer.

The performance test results after relocation must be equal to or better than the test results before removal. Contractor is responsible to repair or replace those components within the system which failed after relocation but which passed before removal.

The Department will conduct approved ITS equipment system tests on the field equipment hardware with the central equipment. The tests will exercise all remote control functions and display the return status codes from the controller.

If any unit fails to pass a test, prepare a report and deliver it to the Engineer. Describe in the report the nature of the failure and the corrective action needed. If the failure is the result of improper installation or damage during reinstallation, reinstall or replace the unit and repeat the test until the unit passes successfully, at no additional cost to the Department or extension of the Contract period.

4.8. **Documentation.** Submit documentation for this Item consisting of the following:

4.8.1. **Ground Mounted Cabinet.** Shop drawings should clearly detail the following for ITS ground mounted cabinets when required as shown on the plans:

- dimensions,
- shelves,
- door,
- gasket,
- door look,
- materials list,
- exterior finish,
- ventilation,
- terminal strips,
- harnesses,
- filter,
- power distribution panel,
- surge suppression,
- back panel,
- outlets,
- circuit breakers,
- power cable terminals,
- wiring diagrams,
- cabinet grounding,
- environmental parameters, and
- connectors.

Submit shop drawings, signed, sealed, and dated by a registered professional Engineer in Texas showing the fabrication, interior configuration, electrical distribution, and cabinet mounting details for each cabinet in accordance with Item 5, "Control of the Work."

Provide at least 2 complete sets of operation and maintenance manuals in hard copy format in addition to a CD/DVD or removable flash drive that includes the following:

- complete and accurate schematic diagrams,
- complete installation procedures,
- complete performance specifications (functional, electrical, mechanical and environmental) on the unit,
- complete parts list including names of vendors for parts not identified by universal part number such as JEDEC, RETMA, or EIA,
- pictorial of component layout on circuit board,
- complete maintenance and trouble-shooting procedures,
- complete stage-by-stage explanation of circuit theory and operation,
- recovery procedures for malfunction, and
- instructions for gathering maintenance assistance from manufacturer.

Identify material which is copyrighted or proprietary in nature as part of the documentation submittal. The Department will take proper provisions to secure such material and not distribute without written approval.

Provide the Department with certification documentation verifying conformance with environmental and testing requirements contained in the special specification. Certifications may be provided by the manufacturer or through independent labs.

4.9. **Warranty.** The start date of the manufacturer's standard warranty will begin when the stand-alone test plan has been approved. Any equipment with less than 95% of its warranty remaining at the beginning of the stand-alone test will not be accepted by the Department. Guarantee that equipment furnished and installed for this project performs according to the manufacturer's published specifications. Warrant the equipment against defects or failure in design, materials, and workmanship for a minimum of 5 years or in accordance with the manufacturer's standard warranty if warranty period is greater. Assign, to the Department, all manufacturer's normal warranties or guarantees on all electronic, electrical, and mechanical equipment, materials, technical data, and products furnished for and installed on the project. Repair or replace, at the manufacturer's option, defective equipment during the warranty period at no cost to the Department.

Repair or replace equipment at the Contractor's expense before beginning testing in the event of a malfunction or failure. Furnish replacement parts for all equipment within 30 days of notification of failure by the Department.

5. MEASUREMENT

This Item is measured as each unit furnished, installed, relocated, or removed as shown on the plans or as directed, excluding new conduit.

6. PAYMENT

6.1. **Furnish and Install.** The work performed and materials furnished in accordance with this Item and measured as provided for under "Measurement" will be paid for at the unit price bid for "ITS Ground Mount Cabinet" of the type and configuration specified. This price is full compensation for furnishing, fabricating, and installing ITS ground mounted cabinets as shown on the plans; for forming and setting the cabinet foundation; for furnishing and placing anchor bolts, nuts, and washers; for furnishing and placing electrical conduit in the foundation; for appropriately grounding the cabinet; and equipment, materials, labor, tools, and incidentals necessary to provide an ITS ground mounted cabinet, complete in place, and ready for the installation of ITS equipment.

New conduit will be paid for under Item 618, "Conduit" or Special Specification ITS Conduit.

6.2. **Install Only.** The work performed and materials furnished in accordance with this Item and measured as provided for under "Measurement" will be paid for at the unit price bid for "ITS Ground Mount Cabinet (Install Only) of the type and configuration specified. This price is full compensation for installing ITS ground mounted cabinets furnished by the Department as shown on the plans; for forming and setting the cabinet

foundation; for furnishing and placing anchor bolts, nuts, and washers; for furnishing and placing electrical conduit in the foundation; for appropriately grounding the cabinet; and equipment, materials, labor, tools, and incidentals necessary to install an ITS ground mounted cabinet, complete in place, and ready for the installation of ITS equipment.

New conduit will be paid for under Item 618, “Conduit” or Special Specification ITS Conduit.

6.3. **Relocate.** The work performed and materials furnished in accordance with this Item and measured as provided for under “Measurement” will be paid for at the unit price bid for “ITS Ground Mount Cabinet (Relocate)” of the type and configuration specified. This price is full compensation for removing existing ground mounted cabinets as shown on the plans; removing existing foundations; backfilling and surface placement; hauling and installing ITS ground mounted cabinets; for furnishing and placing anchor bolts, nuts, and washers; for appropriately grounding the cabinet; and equipment, materials, labor, tools, and incidentals necessary to relocate an existing ITS ground mounted cabinet, complete in place, and ready for the installation of ITS equipment.

New conduit will be paid for under Item 618, “Conduit” or Special Specification ITS Conduit.

6.4. **Remove.** The work performed and materials furnished in accordance with this Item and measured as provided for under “Measurement” will be paid for at the unit price bid for “ITS Ground Mount Cabinet (Remove)” of the type and configuration specified. This price is full compensation for removing existing ITS ground mounted cabinets as shown on the plans; removing existing foundations; backfilling and surface placement; loading and hauling; and equipment, materials, labor, tools, and incidentals necessary to complete the removal of existing ITS ground mounted cabinets.

Special Specification 6010
Closed Circuit Television (CCTV) Field Equipment

1. DESCRIPTION

Furnish, install, relocate, or remove closed circuit television (CCTV) field equipment at locations shown on the plans, or as directed.

2. MATERIALS

2.1. **General Requirements.** Fabricate, provide, assemble, and install materials that are new, corrosion resistant and in strict accordance with the details shown on the plans and in the specifications.

Provide CCTV field equipment that is compatible with software currently in operation in order to interface with the existing equipment and software located in the Department's Traffic Management Control (TMC) Centers across the state.

CCTV field equipment to include the following:

- color video camera units,
- camera lenses, filters, control circuits and accessories,
- camera housing,
- medium duty pan and tilt units with click and drag position control,
- camera control receivers,
- local field control unit (if required for operation),
- video and camera control and power cable connectors and assemblies,
- video, data, and power surge suppression, and
- built-in ID generator.

2.2. **Functional Requirements for Analog CCTV.** Provide color video cameras that are solid state design and that meet the following functional requirements:

2.2.1. **General.**

2.2.1.1. **Digital Signal Processing (DSP):**

- digital zoom with manual override functionality,
- auto and manual iris control,
- auto and manual exposure control with built in frame buffer,
- auto and manual focus control, and
- built-in ID generator, with white letters on black outline minimum or approved equivalent.

2.2.1.2. **Image Pickup Device.** Single chip interline transfer solid state color matrix charge-coupled device (CCD) or complementary metal-oxide semiconductor (CMOS) sensor. Provide a sensor having a minimum of 752 (H) X 480 (V) effective pixels.

2.2.1.3. **Resolution.** Greater than 350 lines vertical and greater than 460 lines horizontal, interlaced 2:1, measured per EIA-170A Standard. No discernible interlace jitter or line pairing on the viewing monitor. System limiting resolution that conforms to FCC regulations for broadcast signals.

2.2.1.4. **Frame Rate.** Adjustable frame rate frequency up to 30 frames per second.

2.2.1.5. **Encoded NTSC Video Signal Format.** Conformance to the National Television Standards Committee (NTSC) specification and produce NTSC compatible video in accordance with EIA-170A Standard, governed by the Electronic Components Association (ECA), for video output 1 V p-p composite also known as 140 IRE units per Institute of Radio Engineers (IRE). Provide up to 16 dB automatic gain control (AGC).

2.2.1.6. **Output Impedance.** 75 ohms ± 5%.

2.2.1.7. **Aspect Ratio.** Width to height aspect ratio of 4:3.

2.2.1.8. **Image Quality.** Ability to produce clear, free from distortion, usable video images of the areas, vehicles, objects, and other subjects visible from a roadside CCTV site. Ensure that video produced by the camera is true, accurate, distortion free, and free from transfer smear, oversaturation, and any other image defect that negatively impacts image quality under all lighting and weather conditions in both color and monochromatic modes.

2.2.1.9. **Over Exposure Protection.** Minimize glare and incur no permanent damage to the camera when pointed directly at strong light sources, including the sun, for brief periods of time.

2.2.1.10. **Geometric Distortion.** Zero.

2.2.1.11. **Signal to Noise Ratio (AGC Off).** 50 dB Minimum (weighted at 4.5 MHz).

2.2.1.12. **Electronic Shutter Speed.** Automatic shutter that is user selectable down to at least 1/10,000 sec.

2.2.1.13. **Electronic Image Stabilization.** User selectable on or off electronic image stabilization at 5 Hz and 10 Hz minimum.

2.2.1.14. **Day (Color) and Night (Mono).** Auto and manual switchover and iris control with user selectable modes for auto and manual control capabilities.

2.2.1.15. **Auto White Balance.** Color quality that is maintained by a continuous through the lens automatic white balance for color temperatures from 2850 K to greater than 5100 K with less than 10 IRE units unbalance.

2.2.1.16. **Inverted Operation.** Automatic or manual activation image inversion or “flip” operation when rotating through 0° or 180° vertical tilt positions.

2.2.1.17. **Mean Time Before Failure.** A minimum of 43,800 hr. or 5 yr. without mechanical malfunction or failure. Act of God failures are exempt.

2.2.2. **Lens.** Provide an integral lens assembly for each camera with the following features:

- an f/1.6 or better glass multi-coated zoom lens with variable focal lengths with a minimum 30X zoom range,
- 10X auto and manual digital zoom minimum, and
- automatic and manual focus and iris control.

Provide lenses with capabilities for remote control of the zoom, focus, and iris operations. Mechanical or electrical means provided to protect the motors from overrunning in extreme positions. Lens and controller system capable of both auto iris and remote manual iris operation. Capabilities of lens for auto and manual zoom and focus control. Motorized iris as opposed to auto iris type, for system control capability.

2.2.3. **Network Interface Requirements.** Provide equipment that is compatible with the Department’s Lonestar™ software and can be integrated into the Department’s TMC CCTV control sub-systems through NTCIP 1205 Version 1.08 or latest Department approved version, Open Network Video Interface Forum (ONVIF), or approved equal. Support Cohu, Pelco D, Pelco P protocols, or approved equal for control.

Provide equipment that is compatible with other devices using Telecommunications Industry Association/Electronic Industries Alliance (TIA/EIA)-232 or EIA-422/485 at a rate of 9600 bps.

Provide camera equipment that supports local and remote configuration and management. Configuration and management functions must include access to all user-programmed features, including but not limited to, network configuration, video settings, device monitoring, control setting, and security functions. Configuration and management is achieved through serial login, telnet login, web-based interface, or manufacturer software. Provide manufacturer software with camera for local configuration, system maintenance and management control.

2.3. **Functional Requirements for Digital CCTV.** Provide color video cameras that produce digital video in standard definition or high definition that meet the following functional requirements:

2.3.1. **General.**

2.3.1.1. **Digital Signal Processing (DSP):**

- digital zoom,
- auto and manual iris control,
- auto and manual exposure control with built in frame buffer,
- auto and manual focus control, and
- built-in ID generator, with white letters on black outline minimum or approved equivalent.

2.3.1.2. **Image Pickup Device.** 1.2 megapixel (1,200,000 pixels), or better, progressive scan digital CCD or CMOS sensor.

2.3.1.3. **Resolution.** Support the following resolutions:

- 720p (1280 x 720 pixel array),
- D1 (720 x 480 pixel array),
- CIF (352 x 240 pixel array), and
- VGA (640 x 480 pixel array) at a minimum dependent on video stream configuration.

2.3.1.4. **Frame Rate.** Allow user selectable frame rates at 30, 15, 7, 4, 2, and 1 frames per second.

2.3.1.5. **Data Rate.** Scalable from 64 kbps to 8 Mbps

2.3.1.6. **Video Stream Format.** Allow simultaneous encoding and transmission, of a minimum, two configurable digital video streams in conformance with the Moving Picture Experts Group's MPEG-4 part 10 (H.264) and Motion JPEG (MJPEG) video compression technology in accordance with the ISO and IEC requirements detailed in the ISO/IEC 14496-10 standard or most current version. Support configuration of the following at a minimum:

- H.264,
- MJPEG,
- H.264 + H.264, and
- H.264 + MJPEG.

2.3.1.7. **Video Stream.** Support both uni-cast (one-to-one) and multi-cast (one-to-many).

2.3.1.8. **Aspect Ratio.** Support width to height aspect ratio of 4:3 or 16:9 dependent on TMC monitor video format functionality.

2.3.1.9. **Image Quality.** Ensure that video produced by the camera is true, accurate, distortion free, and free from transfer smear, oversaturation, and any other image defect that negatively impacts image quality under all lighting and weather conditions in both color and monochromatic modes.

2.3.1.10. **Wide Dynamic Range (WDR).** Operation with manual override option.

2.3.1.11. **Over Exposure Protection.** Minimize glare and incur no permanent damage to the camera when pointed directly at strong light sources, including the sun, for brief periods of time.

2.3.1.12. **Geometric Distortion.** Zero.

2.3.1.13. **Signal to Noise Ratio (AGC Off).** 50 dB minimum (weighted at 4.5 MHz).

2.3.1.14. **Electronic Shutter Speed.** Automatic shutter that is user selectable down to at least 1/10,000 sec.

2.3.1.15. **Electronic Image Stabilization.** User selectable on or off electronic image stabilization at 5 Hz and 10 Hz minimum.

2.3.1.16. **Day (Color) and Night (Mono).** Auto and manual switchover and iris control with user selectable modes for auto and manual control capabilities.

2.3.1.17. **Auto White Balance.** Color quality that is maintained by a continuous through the lens automatic white balance for color temperatures from 2850 K to greater than 5100 K with less than 10 IRE units unbalance.

2.3.1.18. **Inverted Operation.** Automatic image inversion or "flip" when rotating through 0° or 180° vertical tilt positions when not an integrated unit.

2.3.1.19. **Mean Time Before Failure.** A minimum of 43,800 hr. or 5 yr. without mechanical malfunction or failure. Act of God failures are exempt.

2.3.2. **Lens.** Provide an integral lens assembly for each camera with the following features:

- an f/1.6 or better glass multi-coated zoom lens with variable focal lengths with a minimum 18X zoom range,
- 10X auto and manual digital zoom minimum, and
- automatic and manual focus and iris control.

Provide lenses with capabilities for remote control of the zoom, focus, and iris operations. Mechanical or electrical means provided to protect the motors from overrunning in extreme positions. Lens and controller system capable of both auto iris and remote manual iris operation. Capabilities of lens for auto and manual zoom and focus control. Motorized iris as opposed to auto iris type, for system control capability.

2.3.3. **Network Interface Requirements.**

Provide CCTV field equipment that can integrate with the Department's Lonestar™ software and can be integrated into the Department's TMC CCTV control sub-systems through NTCIP 1205 Version 1.08 or higher, Open Network Video Interface Forum (ONVIF), or approved equal. Support Cohu, Pelco D or Pelco P protocols, or approved equal for control.

Provide camera equipment with a Local Area Network (LAN) connection that supports the requirements detailed in the IEEE 802.3 Standard for 10/100 Ethernet connections for half-duplex or full-duplex and provide auto negotiation. Provide equipment with a minimum of 1 Ethernet port, which has a 10/100 Base-TX connection. Provide connectors that conform to EIA and TIA requirements.

Support, at a minimum, RTP, RTSP, UDP/IP, TCP/IP, IPv4, HTTP, IGMPv2, DHCP, NTP, IEEE 802.1x, Ethernet 802.3u, and Telnet.

Provide camera equipment that supports local and remote configuration and management. Configuration and management functions must include access to all user-programmed features, including but not limited to, network configuration, video settings, device monitoring, control setting, and security functions. Configuration

and management is achieved through serial login, telnet login, web-based interface, or manufacturer software. Provide manufacturer software with camera for local configuration, system maintenance and management control.

2.4. **Cable Assembly.** Provide camera power and communication cable assembly equipped with cables used for video feed, camera control including PTZ function, communications signaling, and power supply. Camera power and communication cable can be configured as a composite cable or series of isolated cables. The following cable functions may be required depending on the data and video communication interface requirements, as shown on the plans.

2.4.1. **Serial.** Provide shielded twisted pair serial based communication cable rated for outdoor use in conformance to EIA RS-232/422/485 Standards, governed by the Electronic Components Association (ECA). Provide serial based conversion hardware, if necessary, to achieve this function.

2.4.2. **Video.** Provide coaxial cable, rated for outdoor use, between the camera and the communications equipment interface that is a mid-range RG-59/U type with a solid center conductor with 100% shield coverage, with a cellular polyethylene dielectric, or a cable as recommended by the manufacturer of the CCTV field equipment.

2.4.3. **Ethernet.** Provide a shielded twisted pair (STP) Category 5E (or equivalent) at a minimum rated for outdoor use in conformance to TIA/EIA 568B Standard. Cable must not exceed an attenuation of 30 dB per 300 ft. of cable at 100 MHz.

2.4.4. **Power.** Provide 3-wire, insulated for 300 V minimum, 115 VAC or 24 VAC power cabling between the camera and the power supply. If 24 VAC power is required, provide needed power supply conversion equipment.

Power may be achieved through Power over Ethernet (PoE) through a power supply or mid-span PoE injector, to be subsidiary to the camera unit, and must conform to the IEEE 802.3af or IEEE 802.3at standard or latest revision.

Provide power and communication cable assembly the entire length of the camera support structure from the camera to the cabinet with an additional 25 ft. of slack in the cabinet. Determine the appropriate length required for each site. The cable assembly is subsidiary to the camera unit.

Provide any necessary data, video, or power conversion hardware necessary to successfully integrate the camera unit into the field equipment cabinet hardware components and onto the communications backbone.

2.5. **Video Encoding Interoperability.** Digital video encoders and decoders are necessary to convert the analog signal to digital, transport digital packets via UDP/IP over fiber optic, copper Ethernet, wireless, or leased line networks and convert the digital packets back to an analog signal for viewing on a display monitor. Video encoding and decoding equipment may be achieved through software or hardware means. Ensure camera's encoded video is interoperable with hardware and software decoders from other manufacturers. Ensure the camera's encoded video can be decoded by a minimum of two other manufacturer's software or hardware decoders that are currently in use by the Department. Contact the Department for decoders supported prior to procurement of camera unit.

2.6. **Camera Housing.** Provide camera housing assembly and hardware material that reflects sunlight.

Provide camera housing with a sunshield to reduce the solar heating of the camera. The total weight of the camera (including housing, sunshield, and all internal components) must not exceed 35 lb.

Construct viewing window in such a way that unrestricted camera views can be obtained at all camera and lens positions.

Provide gaskets at cable entry point to the camera housing to prevent moisture or dust entry.

When shown on the plans or identified in the general notes, provide heating or cooling functionality with temperature sensors to maintain internal temperatures within the manufacturer required operating temperature range.

2.7. **Pan-Tilt Unit.** Furnish and install a medium duty anodized aluminum weatherproof pan-tilt-unit at each camera site, conforming to National Electrical Manufacturer's Association (NEMA) 4X and IP-66 rating or better, when not integral to the camera unit and housing. Provide mounting adapter and required attachment hardware to install the pan-tilt-unit to the pole or mounting bracket. Identify the type of mounting bracket and bolt pattern on shop drawings.

Provide a unit capable of a minimum of 180° vertical range of movement and horizontal movement of 360°, full, continuous rotation movement.

Provide a unit that has a pan and tilt speed of 20° per second minimum and is user adjustable through the full speed range. Unit must be capable of simultaneous pan-tilt movements with variable pan-tilt positioning control allowing variable speeds that are proportional through the zoom range.

Provide pan-tilt unit with a drive accuracy and drive repeatability of less than 1° and has an automatic pre-position speed of 120° per second minimum to a user defined preset position that is user adjustable.

Provide a pan-tilt unit, when not integral to the camera housing, capable of maintaining static position and does not move by more than 1.0° in any direction in speeds greater than 35 mph.

Ensure that the pan-tilt unit has seals and gaskets to protect the motors, gears, and cables and that the seals and gaskets are resistant to ozone, ultraviolet radiation, and other pollutants inherent to all local environmental conditions.

When shown on the plans or identified in the general notes, provide pan-tilt unit with heater that conforms to NEMA 4X standard when not integral to the camera unit and housing.

2.8. **Preset Functions.** Provide a camera unit capable of storing a minimum 62 presets for pan, tilt, zoom, and focus settings.

Provide a camera unit capable of user programmable tours with a minimum of 4 tours of up to 32 presets per tour. Any tours may be programmed for panning tours.

Provide a camera unit capable of user programmable sector zones with a minimum of 8 zones allowing right and left pan limitations.

Provide a camera unit capable of user programmable privacy zones with a minimum of 8 zones. Capable of click and drag position control through software.

2.9. **Control Receivers.** Provide a camera unit with an integrated camera control receiver, unless otherwise directed, that will execute all camera and lens functions as well as forward communication of commands for the pan-tilt functions to the pan-tilt control receiver. Mount the pan-tilt control receiver inside the pan-tilt unit.

The control receiver receives the data from the camera controller, it decodes the digital command data signals transmitted through the communication transmission interface, checks for errors, and acts on valid data to drive the pan-tilt unit and the camera controls.

Local field control is achieved through compatible control software on a laptop or through local control unit hardware located inside the field cabinet that can be EIA 19 in. rack or shelf mountable. Document that the camera control receiver and pan-tilt control receiver will execute all camera, lens, and pan-tilt functions through a laptop interface or through use of the local control unit hardware. Provide local control unit hardware only when shown on the plans or identified in the general notes.

2.10. **Connectors.** Provide and install connectors that are compatible with the communications equipment interfaces identified in Article 2.3.3 and Article 2.4. Supply all mating connectors. Provide all connector pins and mating connectors that are plated to achieve good electrical connection and resistance to corrosion.

2.11. **Source ID Generator.** Use a built-in ID Generator to insert camera ID over each of the camera-generated videos.

Provide a minimum of 2 lines of alpha numeric, case specific, text supporting a minimum of 20 ASCII characters per line, with a minimum character height of 20 pixels, that is user programmable for displaying any combination of ID information consisting of camera, preset, privacy mask, low pressure warning, compass, and time and date at a minimum.

Allow user selectable location of text to be displayed on the video image at the extreme top or bottom. Text display on the side of the image display prohibited .

Automatically display the programmed ID with its associated video signal that can be turned on or off by user command.

In the event of loss of signal or video signal failure, ID Generator automatically passes through failure message to display over video.

Submit list of available text displays to the Department as part of documentation requirements.

2.12. **Cabinet Installation.** Install video communication equipment in a pole mounted equipment cabinet or in a ground mounted equipment cabinet as shown on the plans. Meet the following criteria:

Contains all the lightning protection devices for data and video.

Grounded to earth ground.

Provide connectors for all inputs and outputs for data and video and additional ports for testing video and communications. Use the external connectors for testing and for connections to communication devices.

2.13. **Surge Protection.** Provide surge protection for the camera meeting the following requirements:

- mounting adapter – Electrically bonded to mounting structure,
- pan-tilt mechanism – Electrically bonded to mounting adapter,
- camera housing – Electrically bonded to pan-tilt mechanism, and
- power and control cable surge protector – Integrated into cabinet surge protection system.

2.14. **Power Requirements.** Provide CCTV field equipment meeting all of its specified requirements when the input power is 115 VAC ± 20%, 60 Hz ± 3 Hz, and that maximum power required does not exceed 200 W including optional equipment.

Provide appropriate voltage conversion, power injectors, or other power supply hardware if the camera equipment or any camera-related ancillary devices requires operating voltages other than 115 VAC ± 20%, such as 24 VAC, 12 VDC from solar power systems, or rely on PoE. Appropriate voltage converters or injectors must accept an input voltage of 115 VAC or 12 VDC from solar power systems as shown on the plans.

2.15. **Primary Input Power Interruption.** Provide CCTV field equipment that meets all the requirements in Section 2.1.4., “Power Interruption” of the NEMA Standard TS2 for Traffic Control System, or most current version.

2.16. **Power Service Transients.** Provide CCTV Field Equipment that meets the requirements for Section 2.1.6., “Transients, Power Service” of the NEMA Standard TS2, or most current version.

2.17. **Power Service Protection.** Provide equipment that contains readily accessible, manually resettable or replaceable circuit protection devices (such as circuit breakers or fuses) for equipment and power source protection. Provide circuit breakers or fuses sized appropriately such that no wire, component, connector, PC board or assembly is subjected to current loads in excess of their respective design limits upon failure of any single circuit element or wiring.

2.18. **Modular Design.** Provide CCTV field equipment hardware installed inside the cabinet that is modular in design that can be either shelf mountable or EIA 19 in. rack mountable. Clearly identify modules and assemblies with name, model number, serial number and any other pertinent information required to facilitate equipment maintenance.

2.19. **Connectors and Harnesses.** Make all external connections by means of connectors that are uniquely keyed to preclude improper hookups. Color-code and appropriately label with UV resistant material all wires to and from the connectors. Provide connecting harnesses of appropriate length and terminated with matching connectors for interconnection with the communications system equipment. Provide plated pins and mating connectors to improve conductivity and are corrosion resistant. All connectors utilizing solder type connections must have each soldered connection covered by a piece of heat shrink tubing securely shrunk to protect the connection for short circuiting.

Provide a wiring diagram detailing wire function and connector pin-out.

2.20. **Environmental Design Requirements.** Provide equipment that conforms to NEMA TS2-2003 (R2008), International Electrotechnical Commission (IEC) 60529, and NEMA 250-2008, or most current version, for the following categories:

2.20.1. **Temperature.** Provide equipment that conforms to NEMA TS2 Section 2.1.5.1, or latest revision, and meets all the specified requirements during and after being subjected to any combination of the following conditions:

- ambient temperature range of -30 to 165°F,
- temperature shock not exceeding 30°F per hour,
- relative humidity of 0 to 100%,
- moisture condensation on all exterior surfaces caused by temperature changes, and
- provisions for a heater and blower function will be required to maintain internal temperatures within the manufacturer's operating temperatures for temperature ranges internal to the camera unit not conforming to NEMA TS2 Standard 2.1.5.1.

2.20.2. **Vibration.** Provide equipment that conforms to NEMA TS2 Section 2.1.9 and Section 2.2.3, or most current version, and meets all the specified requirements during and after being subjected to a vibration of 5 to 30 Hz up to 0.5 g applied in each of three mutually perpendicular planes for 30 min.

2.20.3. **Shock.** Provide equipment that conforms to NEMA TS2 Section 2.1.10 and Section 2.2.4, or most current version, and does not yield permanent mechanical deformation or any damage that renders the unit inoperable when subjected to a shock of 10 g applied in each of three mutually perpendicular planes for 30 min.

2.20.4. **Environmental Contaminants.** Provide equipment that conforms to IEC 60529 Section 14.2.6, ormost current version, for IP 66 or greater rating when providing a pressurized unit.

Provide equipment that conforms to IEC 60529 Section 14.2.7, ormost current version, for IP 67 or greater rating when providing a non-pressurized unit.

2.20.5. **External Icing.** Provide equipment that is tested to conform to NEMA 250-2003 Section 5.6, or latest revision.

2.20.6. **Corrosion.** Provide equipment that is tested to conform to NEMA 250-2003 Section 5.10, or latest revision, when located in coastal Districts. Coastal Districts are Beaumont (BMT), Corpus Christi (CRP), Houston (HOU), Pharr (PHR), and Yoakum (YKM).

2.20.7. **Wind Rating.** Operational in adverse weather conditions and able to withstand wind loads in accordance with Department's basic wind velocity zone map standard as shown on the plans without permanent damage to mechanical and electrical equipment.

3. CONSTRUCTION

3.1. **General.** Maximize standardization and consistency by utilizing industry standard techniques in equipment design and construction, with the minimum number of parts, subassemblies, circuits, cards, and modules. Design equipment for ease of maintenance.

Provide mounting bracket assemblies or apparatus to mount equipment on the following structures as detailed in the plans or on the ITS standards:

- ITS Pole,
- overhead sign bridge or cantilever overhead sign structure ,
- retaining wall, and
- concrete column or parapet.

Provide mounting bracket design with documentation submittal for approval prior to fabrication. Include all mounting plates, screws, bolts, nuts, washers, and ancillary hardware needed to fabricate the entire mounting bracket.

3.2. **Mechanical Components.** Provide stainless steel external screws, nuts and locking washers. Self-tapping screws are not acceptable.

Provide parts that are made of corrosion resistant material; examples include: plastic, stainless steel, anodized aluminum, or brass.

Protect all materials used in construction from fungus growth and deterioration due to sustained moisture.

Separate dissimilar metals by an inert dielectric material.

3.3. **Wiring.** Provide wiring that meets the requirements of the National Electrical Code (NEC) most current version. Provide wires that are cut to proper length before assembly. It is not acceptable to "double-back" wires to take up slack inside the cabinet. Lace wires neatly with nylon lacing or plastic straps. Organize cables neatly inside the cabinet and secure cables with clamps. Provide service loops at connection points when connecting to hardware inside the cabinet. No splicing of cables or exposed wiring is allowed. Clearly label all wiring.

3.4. **Relocation of CCTV Field Equipment.** Perform the relocation in strict conformance with the requirements herein and as shown on the plans. Completion of the work will present a neat, workmanlike, and finished appearance. Maintain safe construction practices during relocation.

Inspect the existing CCTV field equipment, with a representative from the Department, and document any evidence of damage prior to removal. Conduct a pre-removal test in accordance with the testing requirements contained in this Item to document operational functionality. Remove and deliver to the Department, existing CCTV field equipment that fail inspection.

Prior to removal of existing CCTV field equipment, disconnect and isolate the power cables from the electric power supply and disconnect all communication cabling from the equipment located inside the cabinet. Coil and store power and communication cabling inside the cabinet until such time that it can be relocated.

Remove existing CCTV field equipment as shown on the plans only at such time as authorized by the Engineer.

Use care to prevent damage to any support structures. Any portion of CCTV field equipment or camera pole structure damaged or lost will be replaced by the Contractor at his expense. Contractor to document and report to the Department any existing damage to equipment prior to removal.

Make all arrangements for connection to the power supply and communication source including any permits required for the work to be done under the Contract. Provide wire for the power connection at least the minimum size indicated on the plans and insulated for 600 V. Meet the requirements of the NEC most current version.

3.5. **Removal of CCTV Field Equipment.** Disconnect and isolate any existing electrical power supply prior to removal of existing CCTV field equipment,

Perform removal in strict conformance with the requirements of this Specification, and the lines, grades, details and dimensions shown on the plans. Completion of the work will present a neat, workmanlike, and finished appearance.

Any portion of the CCTV field equipment or cabinet internal components damaged or lost will be replaced by the Contractor (with items requiring the approval of the Engineer) at no cost to the Department.

All materials not designated for reuse or retention by the Department will become the property of the Contractor and be removed from the project site at the Contractor's expense. Deliver items to be retained by the Department to a location shown on the plans or general notes. The Contractor is fully responsible for any removed equipment until released by the Engineer.

3.6. **Contractor Experience Requirements.** Contractor or designated subcontractor must meet the following experience requirements:

3.6.1. **Minimum Experience.** Three years of continuous existence offering services in the installation of CCTV camera systems.

3.6.2. **Completed Projects.** Three completed projects consisting of a minimum of 5 cameras in each project where the personnel installed, tested and integrated CCTV cameras on outdoor, permanently mounted structure(s) and related camera control and transmission equipment. The completed CCTV camera system installations must have been in continuous satisfactory operation for a minimum of 1 yr.

3.6.3. **Equipment Experience.** Three projects (may be the three in the preceding paragraph) in which the personnel worked in cooperation with technical representatives of equipment suppliers to perform specific stages of work. The Contractor will not be required to furnish equipment on this project from the supplier who furnished documentation demonstrating this experience.

Submit the names, addresses and telephone numbers of the references that can be contacted to verify the experience requirements given above.

3.7. **Documentation Requirements.** Provide a minimum of 2 complete sets of operation and maintenance manuals in bound hard copy format, as well as an electronic copy in Adobe PDF format on a CD/DVD or removable flash drive that include the following:

- complete and accurate wiring schematic diagrams,
- complete installation procedures,
- compliance matrix documenting conformance to this specification,
- complete performance specifications (Functional, electrical, mechanical and environmental) on the unit,
- complete parts list including names of vendors for parts not identified by universal part number such as JEDEC, RETMA, or EIA,

- pictorial of component layout on circuit board,
- ID Generator list of text display options,
- complete maintenance and trouble-shooting procedures,
- complete stage-by-stage explanation of circuit theory and operation,
- testing procedures and blank test forms,
- recovery procedures for malfunction,
- instructions for gathering maintenance assistance from manufacturer, and
- provide the Department with certification documentation verifying conformance with environmental and testing requirements contained in the special specification. Certifications may be provided by the manufacturer or through independent labs.

Identify material which is copyrighted or proprietary in nature as part of the documentation submittal. The Department will comply with sensitive material and secure submittal documentation and not distribute without written approval.

3.8. **Testing.**

3.8.1. **New Installations.** Unless otherwise shown on the plans, perform the following tests on the applicable equipment or systems.

3.8.1.1. **Test Procedures Documentation.** Provide 5 copies of the test procedures to include tests identified in Article 5.1.2 through Article 5.1.7 inclusive and blank data forms to the Engineer for review and comment as part of material documentation requirements for each test required on this project. Include the sequence of the tests in the procedures. The Engineer will comment, approve, or reject test procedures within 30 days after Contractor submittal of test procedures. Contractor to resubmit if necessary rejected test procedures for final approval within 10 days. Review time is calendar days. Conduct all tests in accordance with the approved test procedures.

Record test data on the data forms, as well as quantitative results. No bid item measurement or payment will be made until the Engineer has verified the test results meet the minimum requirements of the specification. The data forms for all tests, except design approval tests, must be signed by an authorized representative of the Contractor.

Provide written notice to the Engineer within 48 hr. of discovery of any testing discrepancy identified during testing by the Contractor. Furnish data forms containing the acceptable range of expected results as well as the measured values.

3.8.1.2. **Design Approval Test.** Conduct a design approval test on one randomly selected unit from the prototype design manufacturing run. If only 1 design prototype is manufactured, perform this test on that unit. If supplying multiple types of the equipment, provide and test a sample of each type.

Certification from an independent testing laboratory of a successfully completed design approval test is acceptable. Ensure that the testing by this laboratory is performed in accordance with the requirements of this specification. Failure of independent tests to comply with the requirements of this specification will be grounds for rejection of any certification.

Provide a copy of the certification to the District in which this contract is executed. The data forms for the design approval tests must be signed by an authorized representative (company official) of the equipment manufacturer or by an authorized representative of an independent testing facility.

Notify the Engineer 10 working days before conducting this testing. The Department may witness all the tests. Perform the following tests:

3.8.1.2.1. **Power Service Transients.** Provide equipment that meets the performance requirements, specified in this Item, when subjected to the power service transients as specified in Section 2.2.7.2, “Transient Tests (Power Service)” of the NEMA TS2 standard, most current version.

3.8.1.2.2. **Temperature and Condensation.** Provide equipment that meets the performance requirements, specified in this Item, when subjected to the following conditions in the order specified below:

- stabilize the equipment at -30°F and test as specified in Sections 2.2.7.3, “Low-Temperature Low-Voltage Tests” and 2.2.7.4, “Low-Temperature High-Voltage Tests” of the NEMA TS2 standard, most current version
- allow the equipment to warm up to room temperature in an atmosphere having relative humidity of at least 40%. Operate the equipment for 2 hr., while wet, without degradation or failure, and
- stabilize the equipment at 165°F and test as specified in Sections 2.2.7.5, “High-Temperature High Voltage Tests” and 2.2.7.6, “High-Temperature Low-Voltage Tests” of the NEMA TS2 standard, most current version.

3.8.1.2.3. **Relative Humidity.** Provide equipment that meets the performance requirements, specified in this Item, within 30 min. of being subjected to a temperature of 165°F and a relative humidity of 18% for 48 hr.

3.8.1.2.4. **Vibration.** Provide equipment that shows no degradation of mechanical structure, soldered components, or plug-in components and operates in accordance with the manufacturer's equipment specifications after being subjected to the vibration tests as described in Section 2.2.8, “Vibration Test” of the NEMA TS2 standard, most current version.

3.8.1.2.5. **Power Interruption.** Provide equipment that meets the performance requirements, specified in this Item, when subjected to nominal input voltage variations as specified in Section 2.2.10 “Power Interruption Test” of the NEMA TS2 standard, most current version.

3.8.1.3. **Demonstration Test.** Conduct a demonstration test on applicable equipment at an approved Contractor facility. The Contractor may submit procedures and results from previous contracts in the same District as this Contract provided the materials and equipment are identical, provided results are less than 5 yr. old. Notify the Engineer 10 working days before conducting this testing. The Department may witness all the tests. Perform the following tests:

3.8.1.3.1. **Examination of Product.** Examine each unit carefully and document that the materials, design, construction, markings and workmanship comply with the requirements of this Item.

3.8.1.3.2. **Continuity Tests.** Check the wiring to determine conformance with the requirements of the appropriate paragraphs in this Item.

3.8.1.3.3. **Operational Test.** Operate each unit for at least 15 min. to permit equipment temperature stabilization and an adequate number of performance characteristics to ensure compliance with the requirements of this Item.

3.8.1.4. **Field Acceptance (Stand-Alone) Test.** Conduct a field acceptance test for each unit after installation as required by the Engineer in order to demonstrate compliance with the functional requirements with this Item. Exercise all stand-alone (non-network) functional operations. Notify the Engineer 5 working days before conducting this test. The field acceptance test may consist of the following:

3.8.1.4.1. **Physical Construction.** Document physical construction is completed in accordance with the plans and specification.

3.8.1.4.2. **Electrical and Communication.** Document that all connectors for grounding, surge suppression, and electrical distribution are tightened correctly. Document all power supplies and circuits are operating under the proper voltages. Document all power and communications cables are terminated correctly, secured inside the cabinet, and fitted with appropriate connectors.

3.8.1.4.3. **Video Signal.** For analog signal format, conduct an impedance test, through a short 75 ohm coaxial cable, to an oscilloscope waveform monitor to ensure 75 ohm output impedance to conform with NTSC standards.

Through use of a digital, hand-held, battery operated meter, conduct a test and measure the following video signal characteristics, if applicable:

3.8.1.4.3.1. **Sync.** Document the amplitude of the video synchronizing pulse and check for correct video level, coaxial cable continuity, and correct termination level is 40 IRE.

3.8.1.4.3.2. **Luminance.** Document the white level and correct brightness setting is 100 IRE.

3.8.1.4.3.3. **Composite.** Document the overall amplitude of the video signal is at 140 IRE or 1 V peak to peak.

3.8.1.4.3.4. **Color Burst.** Document color burst amplitude at 40 IRE.

3.8.1.4.3.5. **Ground-loop.** Document that no ground loop exists in the video picture. Ground loop voltages in the video signal causes bars to be present on the video picture.

Document video image is present and free from over-saturation and any other image defect in both color and monochrome modes.

Document video support of unicast and multicast video transmission modes.

Document the video signal from the camera is present and of consistent quality at all connection points between the camera, the cabinet, and any video conversion hardware.

3.8.1.4.4. **Communication.** For digital camera models, document network connection to the camera through ping or telnet session from a remote PC. For analog camera models, document serial data transmission to execute control through serial ports.

3.8.1.4.5. **Pan-Tilt Mechanism.** Exercise pan, tilt, zoom, and focus in all directions and execute a minimum of 3 other unique programming commands, specified by the Department, to ensure that the communication link between the cabinet and the camera is functioning properly.

3.8.1.5. **System Integration Test.** Conduct a system integration test on the complete functional system. Demonstrate all control and monitor functions for each system component for 72 hr. Notify the Engineer 10 working days before conducting this testing. The Department may witness all the tests.

Provide systems integration test procedures for proper adjustment and calibration of subsystem components. Proper adjustment and calibration involves documenting settings used to meet functional requirements while providing a margin for adjustment when future conditions change. Utilize the Department control software (when available) to perform subsystem testing. At a minimum, utilize this software to verify commands and confirms, as well as, detector actuations and occupancy dwell time. The Contractor is responsible for being familiar with any existing Department equipment and software.

The failure of any one component material or equipment item in a system integration test is justification for rejecting the entire subsystem. Each subsystem component must function as a complete integrated subsystem for a minimal continuous 72 hr. period during the system integration test.

3.8.1.6. **Final Acceptance Test.** Following completion of the demonstration test, standalone test, and system integration test for all subsystems, provide completed data forms containing all of the data taken, including quantitative results for all tests, a set of “as built” working drawings, and a written request to begin a data communication and final acceptance test. Provide “as built” working drawings indicating the actual material, equipment, and construction of the various subsystem components, including established and calculated XY coordinates based on project control points provided by the Engineer, when shown on the plans. Perform field surveying and calculations under the supervision of and sealed by a licensed land surveyor.

Within 10 calendar days of the request, execute a data communications test using a Department supplied software program or Contractor supplied software approved by the Department. The data communications test may be executed by the Engineer or the Contractor with the prior approval of the Engineer. The purpose of this test is to verify that the communications plant will operate with application software provided by the State.

Perform the data communications test for a period of 72 hr. If a message error or component failure occurs anywhere in the network, resume the test once repairs are completed. All components of the communications network must operate as an integral system for the duration of the test.

A message error is defined as the occurrence of a parity error, framing error, or data error in any component of the message. The error free message rate is defined as the ratio of the number of messages in which no message error occurs to the number of messages transmitted. The error free message rate must exceed 99.99% for acceptable transmission quality, both for the system as a whole, and for each component of the network.

Provide all additional test results to the Engineer for review once a successful data communications test has been completed. If all the requirements of this specification have been satisfied, contract time will stop and all subsystems will be placed into operation and operate as a complete system for a period of 90 days.

Notify the Engineer of any defects suspected in integration or function of material or equipment. Investigate any suspected defects and correct if necessary. Provide a report of finding within 2 calendar days of notice of any suspected defects. Describe the nature of the any defects reported and any corrective action taken in the report. The integrated subsystems must operate defect free as a single complete system for a minimum of 72 continuous hours during a 30 calendar day review period. If the number of defects or frequency of failures prevents any subsystems from operating as described above, the Engineer may reject the entire subsystem(s) integration test results and resume contract time. Provide any necessary corrections and resubmit subsystem(s) integration test results and a request to begin a final acceptance test which may include “as built” plans and a data communications test.

The CCTV field equipment under this Item will not be accepted until the system, inclusive of all subsystems, has operated satisfactorily for a period of 90 days and in full compliance with the plans and specifications after approval of all submitted test results and reports.

3.8.1.7. **Consequences of Test Failure.** If a unit fails a test, submit a report describing the nature of the failure and the actions taken to remedy the situation prior to modification or replacement of the unit. If a unit requires modification, correct the fault and then repeat the test until successfully completed. Correct minor discrepancies within 30 days of written notice to the Engineer. If a unit requires replacement, provide a new unit and then repeat the test until successfully completed. Major discrepancies that will substantially delay receipt and acceptance of the unit will be sufficient cause for rejection of the unit.

Failure to satisfy the requirements of any test is considered a defect and the equipment is subject to rejection by the Engineer. The rejected equipment may be offered again for retest provided all noncompliance has been corrected.

If a failure pattern develops in similar units within the system, implement corrective measures, including modification or replacement of units, to all similar units within the system as directed. Perform the corrective measures without additional cost or extension of the contract period.

3.8.1.7.1. **Consequences of Design Approval Test Failure**. If the equipment fails the design approval test, correct the fault within 30 days and then repeat the design approval test until successfully completed.

3.8.1.7.2. **Consequences of Demonstration Test Failure.** If the equipment fails the demonstration test, correct the fault within 30 days and then repeat the demonstration test until successfully completed.

3.8.1.7.3. **Consequences of Field Acceptance (Stand-Alone) Test Failure.** If the equipment fails the stand-alone test, correct the fault within 30 days and then repeat the stand-alone test until successfully completed.

3.8.1.7.4. **Consequence of System Integration Test Failure.** If the equipment fails the system integration test, correct the fault within 30 days and then repeat the systems integration test until successfully completed.

3.8.1.7.5. **Consequences of Final Acceptance Test Failure.** If a defect within the system is detected during the final acceptance test, document and correct the source of failure. Once corrective measures are taken, monitor the point of failure until a 30 consecutive day period free of defects is achieved.

If after completion of the initial test period, the system downtime exceeds 72 hr. or individual points of failure have not operated for 30 consecutive days free of defects, extend the test period by an amount of time equal to the greater of the downtime in excess of 72 hr. or the number of days required to complete the performance requirement of the individual point of failure.

3.8.2. **Relocation and Removal.**

3.8.2.1. **Pre-Test.** Provide 5 copies of the test procedures to include tests of the basic functionality of the unit and blank data forms to the Engineer for review and comment as part of material documentation requirements. Functionality tests may include, but are not limited to, physical inspection of the unit and cable assemblies, lens iris and zoom control, video signal, and pan-tilt mechanism. Include the sequence of the tests in the procedures along with acceptance thresholds. The Engineer will comment, approve, or reject test procedures within 30 days after Contractor submittal of test procedures. Contractor to resubmit if necessary rejected test procedures for final approval within 10 days. Review time is calendar days. Conduct all tests in accordance with the approved test procedures.

Conduct basic functionality testing prior to removal of CCTV field equipment. Test all functional operations of the equipment in the presence of representatives of the Contractor and the Department. Ensure that both representatives sign the test report indicating that the equipment has passed or failed each function. Once removed, the equipment becomes the responsibility of the Contractor until accepted by the Department. Compare test data prior to removal and test data after installation. The performance test results after relocation must be equal to or better than the test results prior to removal. Repair or replace those components within the system which failed after relocation but which passed prior to removal.

3.8.2.2. **Post Test.** Testing of the CCTV field equipment is for the purpose of relieving the Contractor of maintenance of the system. The Contractor will be relieved of the responsibility for maintenance of the system in accordance with Item 7, “Legal Relations and Responsibilities”, after a successful test period. The Contractor will not be required to pay for electrical energy consumed by the system.

After all existing CCTV field equipment has been installed, conduct approved continuity, stand alone, and equipment system tests. Furnish test data forms containing the sequence of tests including all of the data taken as well as quantitative results for all tests. Submit the test data forms to the Engineer at least 30 days prior to the day the tests are to begin. Obtain Engineer’s approval of test procedures prior to submission of equipment for tests. Send at least 1 copy of the data forms to the Engineer.

Conduct an approved stand-alone test of the equipment installation at the field site(s). At a minimum, exercise all stand-alone (non-network) functional operations of the field equipment with all of the equipment installed per the plans as directed by the Engineer. Complete the approved data forms with test results and turn over to the Engineer for review and either acceptance or rejection of equipment. Give at least 30 working days notice prior to all tests to permit the Engineer or his representative to observe each test.

The Department will conduct approved CCTV field equipment system tests on the field equipment with the central equipment. The tests will, as a minimum, exercise all remote control functions and display the return status codes from the controller.

If any unit fails to pass a test, prepare a report and deliver it to the Engineer. Describe in the report the nature of the failure and the corrective action needed. If the failure is the result of improper installation or damage during reinstallation, reinstall or replace the unit and repeat the test until the unit passes successfully, at no additional cost to the Department or extension of the Contract period.

3.9. **Warranty.** Warrant the equipment against defects or failure in design, materials, and workmanship for a minimum of 3 yr. or in accordance with the manufacturer's standard warranty if that warranty period is greater. The start date of the manufacturer's standard warranty will begin after the equipment has successfully passed all tests contained in the final acceptance test plan. Any CCTV field equipment with less than 90% of its warranty remaining after the final acceptance test is completed will not be accepted by the Department. Guarantee that equipment furnished and installed for this project performs according to the manufacturer's published specifications. Assign, to the Department, all manufacturer's normal warranties or guarantees on all electronic, electrical, and mechanical equipment, materials, technical data, and products furnished for and installed on the project.

CCTV field equipment will be repaired or replaced at the Contractor's expense prior to completion of the final acceptance test plan in the event of a malfunction or failure. Furnish replacement parts for all equipment within 10 days of notification of failure by the Department.

3.10. **Training.** Conduct a training class for a minimum of 24 hr., unless otherwise directed, for up to 10 representatives designated by the Department on procedures of installation, operations, programming hardware settings, IP programming, port settings, testing, maintenance, troubleshooting, and repair of all equipment specified within this specification. Submit to the Engineer for approval, 10 copies of the training material at least 30 days before the training begins. Conduct training within the local area unless otherwise authorized by the Engineer. Consider operations through Department's Lonestar software when developing training modules.

4. MEASUREMENT

This Item will be measured by each CCTV field equipment unit and mounting apparatus furnished, installed, relocated, or removed, of the types specified as shown on the plans, or as directed.

5. PAYMENT

5.1. **Furnish and Install.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit bid price for "CCTV Field Equipment (Analog)", "CCTV Field Equipment (Digital)", and "CCTV Field Controller". This price is full compensation for making fully operational CCTV field equipment including any voltage converters or injectors, cables and connectors as shown on the plans; and all documentation, testing, training, software, equipment, labor, materials, tools, and incidentals.

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" for CCTV field equipment mounting assemblies will be paid for at the unit bid price for "CCTV Mount (Pole)", "CCTV Mount (Post)", "CCTV Mount (Wall)", "CCTV Mount (Parapet)", "CCTV Mount (Pendant)", and "CCTV Mount (Mast)". This price is full compensation for furnishing and installing mounting bracket assemblies, mounting bracket hardware; and all equipment, labor, materials, tools, equipment, and incidentals necessary to mount CCTV field equipment to mounting structures as shown on the plans.

5.2. **Install Only.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit bid price for "CCTV Field Equipment (Analog) (Install Only)" and "CCTV Field Equipment (Digital) (Install Only)." This price is full compensation for making fully operational CCTV field equipment including any voltage converters or injectors, furnishing and installing additional cables and connectors as shown on the plans; and all documentation, testing, training, software, equipment, labor, materials, tools, and incidentals.

5.3. **Relocate.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" for relocation of CCTV field equipment will be paid for at the unit bid price for "Relocate CCTV Field Equipment." This price is full compensation for relocating and making fully operational existing CCTV field equipment as shown on the plans; furnishing and installing additional cables or connectors as shown on the plans; for testing, delivery and storage of components designated for salvage or reuse; and all testing, training, software, equipment, labor, materials, tools, and incidentals.

5.4. **Remove.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" for removal of CCTV field equipment will be paid for at the unit bid price for "Remove CCTV Field Equipment." This price is full compensation for removing existing CCTV field equipment as shown on the plans; removal of cables and connectors; for testing, delivery and storage of components designated for salvage; and all testing training, software, equipment, labor, materials, tools, and incidentals.

Special Specification 6016

Intelligent Transportation System (ITS) Multi-Duct Conduit

1. DESCRIPTION

Furnish and install Intelligent Transportation System (ITS) multi-duct conduit identified for fiber optic communication use of the type and size specified. Provide conduit suitable for installation in an outdoor underground environment including constant immersion in water, mounted to retaining walls, and mounted above ground on the underside of a bridge without any degradation to the conduit.

2. MATERIALS

Provide new materials that comply with the details shown on the plans, the requirements of this Item, and the requirements of the following Items:

- Item 400, “Excavation and Backfill for Structures,”
- Item 401, “Flowable Fill,”
- Item 402, “Trench Excavation Protection,”
- Item 421, “Hydraulic Cement Concrete,”
- Item 445, “Galvanizing,”
- Item 476, “Jacking, Boring, or Tunneling Pipe or Box,”
- Item 618, “Conduit,” and
- Item 620, “Electrical Conductors”.

In addition, provide ITS multi-duct conduit meeting the requirements of the following Items:

- Underwriters Laboratories (UL) 651,2420, and 2515,
- National Electrical Manufacturers Association (NEMA) Standard TC-2,
- NEMA TC-7,
- NEMA TC-14B,
- National Electrical Code (NEC), and
- Departmental Materials Specification DMS 11030, “Conduit”.

Provide underground ITS multi-duct conduit materials that have been tested and listed as defined in the NEC for the specific use to meet the following industry standards:

- Bellcore/Telcordia Technologies document GR-356,
- American Society for Testing and Materials (ASTM)-D1784, Standard Specification for Rigid (PolyVinyl Chloride) (PVC) Compounds and (Chlorinated Poly Vinyl Chloride) (CPVC) Compounds,
- ASTM-D1785, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120,
- ASTM-D2122, Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings,
- ASTM-F2160, Standard Specification for Solid Wall High Density Polyethylene (HDPE) Conduit Based in Controlled Outside Diameter,
- ASTM-D2412, Standard Test Method for Determination of External Loading, and
- ASTM-D3350, Standard Specification for Polyethylene Plastic Pipe and Fittings Materials.

Provide above ground ITS multi-duct conduit materials that have been tested and listed as defined in the NEC for the specific use to meet the following industry standards:

- ASTM-A90, Standard Test Method for Weight of Coating on Iron and Steel Articles with Zinc-Alloy Coatings,
- ASTM-D2105, Standard Test Method for Longitudinal Tensile Properties of “Fiberglass” (Glass-Fiber-Reinforced Thermoplastic-Resin) Pipe and Tube, and
- ASTM-D2444, Standard Test Method for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight).

3. EQUIPMENT

3.1. **General Requirements.**

3.1.1. **Pre-Assembled Multi-Duct.** Provide a pre-assembled multi-duct conduit system of the material type specified with a nominal 4 in. inner diameter round outer duct containing 4 factory installed 1.25 in. nominal diameter round inner ducts. Inner ducts must be held together in a square configuration by a system of spacers. The design of the spacers, which hold the individual conduits in formation, must be capable of locking them tightly together to prevent free twisting of the inner ducts.

For pre-assembled multi-duct, provide a single protective end cap for each bundled 10 ft. or 20 ft. conduit sections, factory bends, and fittings.

3.1.2. **Fittings**. Provide all required sweeps, bends, repair couplings, ground box termination kits, alternative outer ducts, adapters, preassembled split repair kits, lubrication access fittings, tug-plugs, slit-inner duct plugs, hangers, brackets, expansion joints, and accessories to complete the conduit system as incidentals.

3.1.3. **Flexural Modulus.** Do not exceed the ovality of the conduit system by 5%.

3.1.4. **Environmental Requirements.**

For underground construction, provide conduit that will perform in an ambient temperature range of -30ºF to 122ºF without degradation of material properties In accordance with the NEC.

For above ground conduit construction, provide conduit that performs in an ambient temperature range of -60ºF to 200ºF without degradation of material properties.

3.1.5. **Corrosion Resistance.** Provide a conduit system that is resistant to most harsh chemicals and protected against degradation due to oxidation or general corrosion.

3.1.6. **Direct Bury**. Provide a conduit system capable of being installed by trenching or boring as shown on the plans.

3.1.7. **Free of Defects.** Provide a conduit system free of visible cracks, holes, or other physical defects that would degrade its performance.

3.1.8. **Uniformity**. Provide conduit that is uniform as practical in respect to overall dimensions, color, density, and thickness.

3.1.9. **Stabilization.** Provide conduit with a UV light stabilizer which will protect it, for a minimum of 12 mo., from degradation due to prolonged exposure to direct sunlight.

3.1.10. **Conduit Identification.** Provide conduit with a durable identification labeling showing the name and trademark of the manufacturer, conduit size, date of manufacture and "TxDOT - Fiber Optic Cable System" identification.

3.1.11. **Grounding.** Provide a bare copper No. 8 AWG system grounding conductor, in accordance with Item 620, “Electrical Conductors”, in 1 inner duct of the conduit duct system if no other cable is to be installed in the conduit system for use as a grounding conductor between ground boxes.

3.2. **Outer Duct.**

3.2.1. **PVC Multi-Duct**. Provide heavy walled Schedule 40 polyvinyl chloride (PVC) or heavy walled Schedule 80 PVC outer duct with a nominal inside diameter (ID) of 4 in. as shown on the plans or as directed for underground construction. Provide minimum 20 ft. sections of conduit.

Incorporate a longer integral bell in place of the standard 3-1/2 in. bell to accommodate the length of the coupling body.

Provide 4 in. Schedule 40 conduit with an average outside diameter (OD) of 4.5 in. and a minimum wall thickness of 0.237 in..

Provide 4 in. Schedule 80 conduit, or equivalent with an average OD of 4.75 in. and a minimum wall thickness of 0.337 in. When providing an equivalent to Schedule 80, provide independent laboratory testing certifications showing the equivalent product meets or exceeds performance and testing requirements to that of Schedule 80.

3.2.2. **Rigid Metal Multi-Duct.** Provide galvanized rigid metal conduit (RMC) outer duct with a nominal ID of 4 in. as shown on the plans or as directed. Provide a minimum 10 ft. section of conduit.

Provide 4 in. RMC with an average OD of 4.5 in. and a minimum wall thickness of 0.225 in.

3.2.3. **Fiberglass Multi-Duct.** Provide, bullet resistant, pure, high grade, reinforced thermosetting resin conduit outer duct with a nominal ID of 4 in. as shown on the plans or as directed. Provide a minimum 10 ft. section of conduit.

Provide 4 in. fiberglass conduit with a minimum OD of 4.25 in. and a minimum wall thickness of 0.250 in.

3.3. **Inner ducts.** Provide inner duct Schedule 40 PVC or High Density Polyethylene (HDPE) conduit with a 1.25 in. nominal diameter. Extrude inner ducts in a controlled OD fashion.

3.3.1. **Spacers.** Hold together the inner ducts with spacers located throughout each section of conduit. Factory install the system of spacers to hold inner ducts in place during transport and maintain alignment within the outer duct. Mold spacers from high impact plastic, and be factory certified to withstand all handling pressures and stresses.

3.3.2. **Longitudinal Ribbing.** For HDPE inner ducts, incorporate longitudinal ribbing and permanent dry lubricant that is extruded to provide friction reduction in cable installation.

3.3.3. **Identification by Color.** Provide inner ducts that are uniquely defined by the extrusion of a different color for each of the inner ducts; colors must be orange, yellow, red, and black.

Provide black inner duct that is placed directly in line with the manufacturer's identification on the outer duct for ease of identification and installation.

Duct designated for backbone fiber will be black in color; duct designated for distribution fiber will be orange and red in color; and duct designated for drop (field cabinet) fibers cable will be yellow in color.

3.3.4. **Pull Cord.** Provide a flat pull cord in all empty inner ducts. Provide a pull cord with a tensile strength of 1,250 lb. minimum and have foot markings to determine length installed.

3.4. **Fittings.** Provide fittings with the same material to the connecting conduit unless otherwise shown on the plans.

3.5. **Coupling Body.** Provide a factory installed primary coupling body that is manufactured as a hard plastic coupling body incorporating conical shaped target areas to accommodate self-alignment of each inner duct upon field assembly.

Provide a coupling body that incorporates sealing devices to facilitate field assembly and prevent water and foreign material leakage from outside the multi-duct system and to prevent air leakage from inside the inner ducts. Assemble solely by hand without use of special tools such that no lubricant will be required for field assembly of this conduit system.

Provide the coupling body with its sealing members sealing the outer walls of the inner ducts and the inner wall of the outer duct providing an airtight seal from within the inner duct system and a watertight seal from the outside of the outer duct.

Provide the gasket or sealing members that is an anti-reversing design in such that the lengths of conduit stay joined together without the need for solvent cement.

Provide the field connection end of the internal coupling body that incorporates shaped target areas to accommodate self-alignment of the inner ducts with bore openings during field assembly.

Provide the coupling body that has one of the bore openings on the field assembly side uniquely identified to facilitate proper continuous inner duct alignment during field assembly.

The coupling body must seal the inner duct so that after the application of 100 psi to an inner duct, the inner duct must be capable of maintaining a minimum of 15 psi for 24 hr. Employ an approved independent commercial testing laboratory to perform the above test. Submit certified reports of test to Department.

3.6. **Expansion Joints.** Provide expansion joints having a material similar to the connecting conduit unless otherwise shown on the plans.

Use conduit expansion fittings at structure expansion joint crossings.

3.7. **Termination Kits.** Provide end or pass-through termination kits from the same conduit manufacturer for termination in ground boxes and junction boxes.

Ensure a watertight seal of conduit to structure wall when terminating conduit.

3.8. **Multi-Duct Sweeps.** Conduit deflection should not deviate more than 1 in. horizontally or vertically per foot (1:12) of running length of conduit. Long conduit sweeps should be used wherever possible to change conduit direction in order to reduce the pulling tension required during cable installation.

For conduit deflection at obstructions, utilities, or transitions to structures where the 1:12 deflection requirement above or long sweeps are not possible, use complete conduit manufactured minimum 36 in. radius sweeps (11-1/4º , 22-1/2º, 30º, 45º, and 90º angles) complete with bell and spigot. Do not field bend conduit.

3.9. **Fiber Optic Cable Route Markers.** Furnish tubular delineator markers, minimum 6 ft. in length and a minimum 3 in. OD, and constructed of Type III HDPE material. Provide marker assemblies that are orange in color and ultraviolet stabilized to help prevent components from color fading, warping, absorbing water, and deterioration with prolonged exposure to the elements. Refer to the Standard Details for details of the text on the decal that should be affixed to each marker. Ensure that all markers furnished on this project are new and consistent in appearance.

Install markers using a method that firmly and securely anchors the marker a minimum of 1 ft. into the ground to prohibit twisting and easy removal. When located at an ITS ground box, marker may be placed within the concrete riprap apron avoiding rebar reinforcement. Spacing between markers should not exceed 1,000 ft. or as shown on the plans and placed at significant changes in direction such as a 90º turn. Do not place markers in any roadway paved surface.

4. CONSTRUCTION

4.1. **Underground Construction.** Place conduit in accordance with the lines, grades, details and dimensions shown on the plans or as directed. Maintain constant slope to prevent water from being trapped in the conduit system.

Ream all conduit ends to remove burrs and sharp edges.

Install underground conduit system a minimum of 42 in. from ground surface to the top of the conduit unless otherwise directed or to avoid utility conflicts or field conditions. When conditions require trench depths greater than 5 ft., provide trench protection in accordance with Item 402, “Trench Excavation Protection.” Install conduit in accordance with the requirements of the NEC and USDA RUS.

Fasten all external conduit placed on structures with conduit straps or hangers as shown on the plans or as directed. Conduit straps, hanger systems, and junction boxes are incidental to this Item.

Fit the conduit terminations with bushings or bell ends with duct plugs. Seal inner ducts with duct plugs within 24 hr. of conduit placement. This includes but is not limited to intermediate or incomplete sections of conduit system prior to conduit splicing or termination in ground boxes.

Document Global Positioning System (GPS) coordinate points, in NAD83, and provide to the Department for shifts or deviations of the ITS multi-duct alignment from the plans required to avoid obstructions or utilities. GPS coordinate points to be recorded at the point of curvature and point of tangent for horizontal of vertical transitions and include installed depth.

4.1.1. **Proofing.** Prior to installation of cables or final acceptance, pull a spherical template having a diameter of not less than 75% of the inside diameter of the inner duct through the inner duct to insure that the inner duct is free from obstruction. At the conclusion of proofing, fit ends of all empty inner ducts with duct plugs or caps within 24 hr.

4.2. **Trench Construction.** Provide minimum Schedule 40 PVC conduit when conduit is installed through trenching method unless otherwise shown on the plans or as directed.

Provide a 2 in. minimum layer of sand at the bottom of the trench to serve as a bedding material for construction.

Provide conduit spacers made of a non-metallic material designed for installation underground and encased in concrete. Spacers should be of the type recommended by the conduit manufacturer and designed with an interlocking device and stackable to relive the conduit of both horizontal and vertical stress. Provide spacers sized appropriately for the conduit with a minimum height of 2 in. spaced at 5 ft. intervals throughout the trench. Set conduit spacers directly on the sand bedding. Spacers must be anchored to prevent floating of conduit system and maintain constant slope.

Conduit system will be encased in the following materials based on depth of trench:

4.2.1. **Greater than 24 in.** For trench depths greater than 24 in. from the ground surface to the top of the ITS multi-duct conduit, encase the conduits in flowable fill to an elevation of 6 in. above the top of conduit in accordance with Item 401, “Flowable Backfill,” or ClassB concrete, maximum aggregate size 5, in accordance with Item 421, “Hydraulic Cement Concrete.” Class B concrete at the discretion of the Engineer and will be shown on the plans. Backfill above encasement as defined in Section 4.2.3.

4.2.2. **Less than 24 in.** When a trench depth less than 24 in. is required, encase the conduits in Class B concrete, maximum aggregate size 5, to an elevation of 6 in. above the top of conduit in accordance with Item 421, "Hydraulic Cement Concrete." Backfill above encasement as defined in Section 4.2.3.

4.2.3. **Excavation and Backfill.** Trench, excavate, and backfill as shown on the plans and in accordance with Item 400, "Excavation and Backfill for Structures."

4.2.4. **Marking Tape.** Place a 4 in. wide detectable underground metalized mylar conduit marking tape over the ITS conduit at a minimum depth of 1 ft. below grade when no other electrical marking tape required or 8 in. below electrical marking tape when provisioned under Item 618, "Conduit".

Imprint the marking tape "TxDOT Conduit and Fiber Optic Cable System - Call TxDOT Before Proceeding" every 18 in.

4.2.5. **Restoration of Trench Areas.** Where existing surfacing is removed for placing conduit, repair by backfilling with material equal in composition and density to the surrounding areas and by replacing any removed surfacing, such as asphalt pavement or concrete riprap, with like material to equivalent condition in accordance with Item 400, "Excavation and Backfill for Structures."

4.3. **Boring Construction.** Jacking and boring when required will be in accordance with Item 476, "Jacking, Boring, or Tunneling Pipe or Box"..

When boring under pavement shallower than 48 in. from finish grade to top of conduit, provide Schedule 40 steel casing under pavement to encase the conduit system as shown on the plans unless otherwise directed. Provide steel casing of a size to accommodate all conduits in addition to 20% space capacity for pulling conduits through the steel casing. Steel casing will be furnished in accordance with this Item.

During boring operation, locate bore head every 10 ft. along the bore path and before traversing underground utilities or structures. Use digital walkover locating system to track bore head during boring operation. Ensure locating system is capable of determining pitch, roll, heading, depth, and horizontal position of the bore head and document this information at the intervals specified above for as-built information..

4.4. **Above Ground Construction**. Place conduit in accordance with the lines, grades, details and dimensions shown on the plans or as directed. Maintain constant slope to prevent water from being trapped in the conduit system.

Provide rigid metal conduit or fiberglass conduit for outer duct when system is mounted externally along a bridge or above ground structure. Provide fiberglass or other non-corrosive outer duct for coastal Districts where conduit is exposed to corrosive environments due to salt in the air.

Provide rigid metal conduit outer duct that is hot-dipped galvanized in accordance with Item 445, "Galvanizing."

Ground rigid metal conduit in accordance with the Department's Electrical Details and in accordance with the NEC.

Provide fiberglass conduit that is bullet resistant, heavy walled, pure, high grade, reinforced thermosetting resin conduit.

Provide conduit, elbows, and fittings that are manufactured from the same resin, hardener, or glass systems manufactured by the same filament wound system.

4.5. **Testing.** Perform tests in accordance with industry testing requirements identified in Article 2, "Materials."

4.5.1. **General.** Furnish certified documentation from an independent testing laboratory documenting compliance with all ASTM, NEMA, NEC, UL, and Telcordia Technologies standards as referenced in this Item.

Provide test procedures and blank test forms and conduct performance tests for all materials and equipment not previously tested and approved. If technical data is not considered adequate for approval, samples may be requested for test. The Contract period will not be extended for time lost or delays caused by testing prior to final approval of any items.

Compare the results of each test with the requirements of this Item. Failure to conform to the requirements of any test must be identified as a defect and the materials will be subject to rejection by the Engineer. Offer rejected materials again for retest provided all non-compliances have been corrected and retested by the Contractor with evidence submitted to the Engineer.

4.5.2. **Examination of Product.** Examine each conduit system component prior to installation carefully to verify that the materials, design, construction, markings, and workmanship comply with the requirements of this Item.

4.5.3. **References.** The ITS multi-duct conduit system supplier must submit 3 references, preferably State Departments of Transportation, where this supplier's conduit system has functioned successfully for a period of no less than 1 yr. Include current name and address of organization, and the current name and telephone number of an individual from the organization who can be contacted to verify system installation. Provide this information with documentation submittal. Failure to furnish the above references will be sufficient reason for rejection of the supplier's equipment.

4.6. **Documentation Requirements.** Submit documentation of the conduit system consisting of the following for Engineer approval 30 days prior to installation:

- manufacturer specifications or cut sheets for all components of the conduit duct system,
- laboratory certified material test reports documenting conformance with pertinent standards identified under Article 2, “Materials”,
- GPS coodinates,
- pre-installation test procedures,
- post-installation test procedures, and
- as-built of installed conduit system.

5. MEASUREMENT

ITS multi-duct conduit will be measured by the linear foot of the multi-duct conduit system.

Fiber optic cable road marker will be measured by each maker furnished and installed.

6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided for under “Measurement” will be paid for at the unit price bid for “ITS Multi-Duct Conduit” of the types and construction method specified. This price is full compensation for furnishing and installing conduit; for jacking, boring, steel encasement, excavating, furnishing, and placing backfill; concrete encasement; replacing pavement structure, sod, riprap, curbs, or other surface; testing of the conduit system; for furnishing and installing all fittings, clamps, sweeps, bends, repair couplings, adapters, ground box or manhole termination kits, pre-assembled split repair kits, lubrication access, fittings, hangers, brackets, junction boxes, expansion joints, concrete, and detectable underground metalized mylar conduit marking tape; pull cords, and for all labor, tools, equipment and incidentals necessary to complete the work.

The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for “Fiber Optic Cable Road Marker.” This price is full compensation for furnishing and installing all cable markers; and for materials, equipment, labor, tools, documentation, warranty, training and incidentals.

Copper grounding conductor will be paid under Item 620, “Electrical Conductors.”

This Item applies only to ITS multi-duct conduit. Any other conduit for communication or electrical use will be in accordance with and paid for under Item 618, “Conduit.”

Special Specification 6027

Preparation of Existing Conduits, Ground Boxes, or Manholes

1. DESCRIPTION

Prepare conduits, ground boxes, or manholes; replace conduits, ground boxes, or manholes, when necessary; replace conduit fittings with junction boxes; replace damaged ground box or manholes covers; adjust ground box or manholes covers; install pull lines in conduits; install cable racks in ground boxes or manholes.

2. MATERIALS

Provide new materials that comply with the details shown on the plans, the requirements of this Item, and to the pertinent requirements of the following Items:

- Item 624, “Ground Boxes”
- Item 465, “Manholes and Inlets”

When conduit replacement is required, provide conduit meeting the requirements of Item 618, “Conduit.” Use conduit of same size and type of that being replaced or as directed.

Provide 24 in. × 24 in. × 12 in. (L × W × D) minimum size NEMA 4X junction boxes with screw covers.

Provide polyester tapes or rope pull cords with a tensile strength of at least 1200 lb.

Provide heavy duty, non-metallic, non-corrosive cable racks that can support a minimum dead load of 300 lbs. Ensure cable racks are resistant to the effects of oils, hydrocarbons, common esters, ketones, ethers, or amides. Ensure cable racks are adjustable between 8 in. and 14 in. wide. Do not provide grounding or insulators for cable racks.

3. CONSTRUCTION

Check existing conduit and ground boxes.

3.1. **Preparation of Conduit, Ground Box or Manhole**. Pull a mandrel through empty conduits. Use a mandrel with a diameter greater than 70% of the inside diameter of the conduit and 2 in. length. Repair or replace conduit runs that will not allow passage of the mandrel. Replace conduit deemed impractical to repair or remains unsuitable in accordance with Item 618, “Conduit.” Clean the conduit by pulling a rubber swab slightly larger in diameter than the conduit.

Blow compressed air through conduits that contain wires. Remove debris from the conduit by pushing a fish tape through the conduit. Do not use water to clear debris. Retest the conduit by blowing compressed air.

Install 1 pull cord in each conduit for use in installing the conductors, cables, or innerduct. Leave 1 pull cord in each conduit after the conductors, cables, or innerduct have been installed.

Remove silt and debris from ground boxes or manholes prior to installing cable.

3.2. **Installation of Ground Box or Manhole**. Furnish new ground boxes or manholes as directed. Install ground boxes or manholes as shown the plans or as directed.

Backfill disturbed surface with material equal in composition and density to the surrounding area. Replace surfacing material with similar material to an equivalent condition.

3.3. **Installation or Adjustment of Ground Box or Manhole Covers**. Remove, dispose, and install ground box or manhole covers as shown on the plans or as directed. Adjust ground box or manhole covers as shown on the plans or as directed. Adjustment may include welding, raising, or lowering.

Backfill disturbed surface with material equal in composition and density to the surrounding area. Replace surfacing material with similar material to an equivalent condition.

3.4. **Installation of Junction Box**. Locate conduit fittings in conduits carrying fiber optic cables. Replace the conduit fitting and associated section of conduit with a junction box. Install junction boxes as shown on the plans.

3.5. **Installation of Cable Rack Assembly**. Install cable racks to permit coiling of conductors or cables without violating the manufacturer's minimum bending radius. Install 2 cable rack supports and 4 adjustable levels on each support, at a minimum, on each wall of the ground box or manhole as shown on plans or as directed. Anchor the cable rack support permanently to the ground box wall with mechanical or powder actuated fasteners. Use fasteners with an ultimate pull out strength of at least 2500 lb. and ultimate shear strength of at least 3000 lb. Provide sufficient cable supports for the particular number of conductors or cables coiled or passing through the ground box or manhole as shown on the plans or as directed.

4. MEASUREMENT

This Item will be measured by the foot of conduit cleared, tested, replaced and repaired, by each cable rack, junction box, ground box, or manhole installed or prepared, and by each ground box or manhole cover replaced or adjusted.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for “Conduit (Prepare),” “Junction Box (Install),” “Manhole (Install),” “Ground Box (Install),” “Manhole (Prepare),” “Ground Box (Prepare),” “Cover (Replace)” of the sizes specified, “Cover (Adjust),” and “Cable Rack Assembly (Install).” This price is full compensation for cleaning and testing conduit, ground boxes, and manholes; furnishing and installing pull cords, ground boxes, manholes, junction boxes, and cable racks; excavating and backfilling; adjusting ground boxes and manholes covers; disposal of unsalvageable material; and equipment, materials, labor, tools, and incidentals.

Repair of existing conduit will be paid for by the Department in accordance with Article 9.7., “Payment for Extra Work and Force Account Method.”

Special Specification 6028
Dynamic Message Sign System

1. DESCRIPTION

Transport, install, and test Department-furnished Dynamic Message Signs (DMS), controller, and equipment cabinets.

2. MATERIALS

Provide all materials not supplied by the Department necessary for the DMS installation. All materials provided by the Contractor must be new. Include a task in the project schedule for delivery of Department furnished materials and provide a minimum of 30 days' notice to the Department for pick-up of Department-furnished materials. Unless otherwise shown on the plans, DMS will be stored by the Department for pick up at location shown on the plans.

Ensure that all materials and construction methods necessary to complete the installation conform to the requirements of this Item, the plans and the pertinent requirements of the following Items:

- Item 432, "Riprap"
- Item 441, "Steel Structures"
- Item 445, "Galvanizing"
- Item 449, "Anchor Bolts"
- Item 618, "Conduit"
- Item 620, "Electrical Conductors"
- Item 656, "Foundations for Traffic Control Devices"

3. CONSTRUCTION

3.1. **Installation**. Perform a site survey in advance of the proposed DMS location in order to determine the horizontal and vertical angles of the sign for optimum legibility, based on the manufacturer's recommendations.

Install DMS on overhead sign structures in accordance with this Item and the lines, grades, details and dimensions as shown on the plans or as directed. Maintain safe construction practices. Ensure the mechanical execution of work complies with NEC, Article 110.12. Equipment shall be installed in a neat and workmanlike manner.

Adjustments or additions of sign attachment hardware, support brackets, and appurtenances, such as walkways, conduit, etc., may be necessary for compatibility with specified sign positioning recommended by the manufacturer, as shown on the plans, or as directed. All adjustments or additional materials will not be paid for directly but will be subsidiary to this Item.

Prevent damage to all sign components. Replace any portion of the sign assembly that is damaged or lost during transportation or installation. Do not use any materials furnished by the Department on any work which is not required by and which does not constitute a part of the contract. Materials not used which were furnished by the Department must be returned undamaged to the location from which the materials were obtained upon completion of the work. Any unused or removed material deemed salvageable by the Engineer shall remain the property of the Department and shall be delivered to a designated site. Accept ownership of unsalvageable materials and dispose of in accordance with federal, state, and local regulations.

Stockpile all materials designated for reuse or to be retained by the Department within the project limits or at a designated location as directed.

Equipment to be installed at each DMS field site shown on the plans may include, but not be limited to, the following:

- Dynamic Message Sign (DMS), controller and cabinet (provided by the Department)
- Cabling and connectors from power source to DMS connection point as specified by the DMS manufacturer (Provided by the Contractor).
- Cabling and connectors from telecommunications source to DMS connection point as specified by the DMS manufacturer when required (Provided by the Contractor).
- Communications as shown on the plans
- Power and communication cabling and connectors from controller to DMS shall follow NEMA TS4, Section 4, “Controller to Sign Interface,” (cables and termination provided by the Contractor)

Make all arrangements for connection to the power supply and telecommunications source including any required permits. Supply and install any required materials not provided by the utility companies (power or communications service provider).

Construct the foundation for DMS Controller cabinets, when required as shown on the plans, in accordance with Item 656, "Foundations for Traffic Control Devices", unless otherwise directed. Include a 6 ft. × 6 ft. × 5 in. (L × W × D) riprap maintenance pad with foundation, unless otherwise directed. Provide a 5/8-in. diameter by 8 foot copper clad steel ground rod in the foundation of each DMS Controller cabinet.

After the signs have been erected, wash the exterior of the entire sign with a biodegradable cleaning solution, approved by the Engineer, to remove all dirt, grease, oil smears, streaks, finger marks, and other foreign particles.

3.2. **Technical Assistance**. Ensure that a manufacturer's representative is available to assist the Contractor's technical personnel at each sign installation site. The manufacturer's representative must provide technical assistance in following areas:

- Site survey for horizontal and vertical angles of sign’s mounting orientation
- Sign to structure installation (final responsibility of the Contractor, see 3.3., “Working Drawings.”)
- Sign controller cabinet installation
- Sign to controller cabling
- Testing requirements given in Section 3.4., “Testing.”

Do not execute the initial powering up of the signs without the permission of the manufacturer's representative.

3.3. **Working Drawings.** Before fabrication submit for approval 5 prints of the working drawings for attachment of each DMS. Show the details of any additional sign brackets, sign support connections, and methods of attachment of the signs to the sign support. Have a licensed professional engineer sign, seal and date the working drawings.

3.4. **Testing.** Testing of the sign system is for the purpose of relieving the Contractor of maintenance of the system. The Contractor will be relieved of the responsibility for maintenance of the sign system in accordance with Item 7, “Legal Relations and Responsibilities,” after all testing is successfully completed.

After delivery of the DMS to the storage site, an approved demonstration test will be conducted prior to transporting the sign to the installation site. Have a manufacturer’s representative available to assist with making all necessary connections and preparations for this testing.

After all signs have been installed, the Department and the DMS manufacturer will conduct approved continuity, stand alone, and DMS system tests on the installed field equipment with central, remote, and

laptop equipment. A final acceptance test will be conducted to demonstrate all control, monitor, and communication requirements for 90 days. The Engineer will furnish a Letter acknowledging the final acceptance testing commencement date stating the first day of the final acceptance test. The completion of the final acceptance test occurs when system downtime due to mechanical, electrical, or other malfunctions to equipment furnished or installed does not exceed 72 hr. and any individual points of failure identified during the test period have operated free of defects. Assume responsibility only for test failures directly related to the work in accordance with this Item. Upon completion of successful final acceptance testing, permanently mark acceptance date and project identification information inside the controller cabinet. The Department will pay for electrical energy consumed by the system.

4. MEASUREMENT

This Item will be measured as each DMS system installed and tested.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Installation of Dynamic Message Sign System" of cabinet mounting type specified (pole mounted, foundation mounted or wall mounted). This price is full compensation for transportation and installation of DMS; furnishing and installing any new mounting hardware, and DMS controller cabinet foundation when required; storing the DMS when required; cleaning and testing the DMS; replacement/repair of damaged components; disposal of unsalvageable material and for all manipulations, labor, tools, working drawings, equipment and incidentals.

New overhead sign supports or relocation of existing overhead sign supports will be paid for under Item 650, "Overhead Sign Supports." New drilled shaft foundations will be paid for under Item 416, "Drilled Shaft Foundations." Sign walkways will be paid for under Item 654, "Sign Walkways."

Special Specification 6062
Intelligent Transportation System (ITS) Radio

1. DESCRIPTION

Furnish, install, remove, or relocate an Intelligent Transportation System (ITS) radio at locations shown on the plans, or as directed.

2. MATERIALS

Provide new materials that comply with the details shown on the plans and the requirements of this Item. Supply all equipment and hardware needed for a complete functioning system. Materials for equipment to be relocated will be "as-is". The Contractor will protect the existing equipment from further wear or damage.

3. EQUIPMENT

3.1. **General.** The ITS radio consists of a radio, power supply, antenna, antenna cables, lightning protection, grounding, all necessary mounting hardware, and radio configuration software.

Utilize the latest industry practiced techniques in equipment design and construction of parts, subassemblies, circuits, cards, and modules. Design equipment for ease of maintenance. Ensure that all component parts are readily accessible for inspection and maintenance, using hand tools. Provide test points for checking essential voltages, waveforms, signals, and similar data.

Ensure that all external screws, nuts, and locking washers are made of corrosion resistant material. Do not use self-tapping screws unless specifically approved by the Engineer.

Provide parts made of corrosion resistant material such as plastic, stainless steel, anodized aluminum, or brass.

Protect all materials used in construction from fungus growth and moisture deterioration.

Separate dissimilar metals by an inert dielectric material.

3.2. **Radio.** Each radio will be a point-to-point or point-to-multi-point single-band or dual-band radio operating in the license-free frequency as shown on the plans or as directed by the Engineer. Provide a radio that meets all of the following minimums:

3.2.1. **Frequency.** FCC unlicensed, 900 MHz, 2.4 GHz, or 5 GHz, as specified on the plans, or as directed;

3.2.2. **Channel Selection.** Dynamic Frequency Selection, with a manual override option;

3.2.3. **Minimum Range.** 15 mi., line of sight;

3.2.4. **Transmit Power.** User selectable, up to the maximum allowed by FCC rules, to at least 21 dBm, in 1 dBm steps (maximum step size). Maximum output power limited by FCC Part 15 rules for unlicensed frequencies;

3.2.5. **Receive Sensitivity.** Adaptive;

3.2.6. **Modulation.** Adaptive modulation and space diversity to provide maximum throughput;

3.2.7. **Forward Error Correction.** Provide forward error correction.

3.2.8. **Security.** Minimum security for the point-to-point backhaul network is the Advanced Encryption Standard, 128 bit block size (AES-128). Meet ISO/IEC 18033-3 standards. Minimum security for communications with Wi-Fi units is WPA2;

3.2.9. **Throughput.** Minimum out-of-the-box throughput of 100 Mbps for frequencies between 2.4 and 5 GHz. Minimum out-of-the-box throughput of 1 Mbps for the 900 Mhz frequency. Minimum measured throughput in the field of 50 Mbps for frequencies between 2.4 and 5 GHz;

3.2.10. **Networking Standards.** Provide at least the following:

- IEEE 802.1d – Ethernet Bridging,
- IEEE 802.1p – Traffic Prioritization,
- IEEE 802.1q – Virtual Local Area Network (VLAN),
- IEEE 802.3 – 2012 Ethernet, and
- IEEE 802.11-2009 – Wi-Fi (a/b/g/n) or most current version.

3.2.11. **Network Interface.** Minimum of one functional 10/100 Base-T RJ-45 port;

3.2.12. **On-Board Alignment** Tools. Provide a radio with on-board alignment tools for use aligning the antenna. These could be external LED indicators, audible indicators, or other approved mechanism; and

3.2.13. **FCC Certification.** Provide at least the following:

- FCC Part 15.400 (U-NII),
- FCC Part 15.247 (ISM) 20 Mbps, and
- FCC Part 15, Class B.

3.3. **Power.** Provide ITS radios meeting all specified requirements when the input power is 115 VAC ± 20%, 60 Hz ± 3 Hz, and that maximum power required does not exceed 35 W, including optional equipment.

Provide appropriate voltage conversion, power injectors, or other power supply hardware if the radio equipment or any radio-related ancillary devices require operating voltages other than 115 VAC or rely on Power over Ethernet (PoE or PoE+). Appropriate voltage converters or injectors must accept an input voltage of 115 VAC as noted above. Provide any required Power over Ethernet (PoE or PoE+) devices that are 802.3af-2003 or 802.3at-2009 compliant, meeting the power requirements of the radio equipment.

The Contractor will verify with the local power service provider to ensure that the provided equipment is compatible with the installed equipment. The Contractor will supply and install any additional equipment required for proper operation of the Radio System per the design.

Every numbered table and figure must be referenced in the accompanying text. Tables and figures should appear in the order they are referred to, no matter how fleeting the reference.

3.4. **Antennas.** Furnish and install radio antennas of the number and type specified on the plans, or as directed. These may include, but are not limited to:

- connectorized omni;
- yagi;
- sectorized (i.e. 45, 60, 90, 120 etc. degree increments);
- parabolic antennas; and
- integrated flat panel antennas.

Meet the following specifications:

- antenna gain as specified in the plans;

- minimum wind rating of 110 mph;
- Voltage Standing Wave Ratio (VSWR) value not exceeding 1.5 for the radio frequency specified on the plans;
- reflection coefficient value not exceeding 0.20;
- reflected power value not exceeding 4 %; and
- impedance matched to the impedance of the system so that voltage is in phase with the current. (Typically 50 ohms.)

3.5. **Antenna Coaxial Cables.**

3.5.1. **Nominal impedance.** Matched to the antenna's impedance to minimize the Voltage Standing Wave Ratio (VSWR). Typically 50 ohms.

3.5.2. **Maximum Attenuation.** 5 dB/100 ft. at the frequency specified on the plans.

3.5.3. **Maximum Cable Length.** 10 feet maximum length from radio to antenna when radio is mounted on an external structure. 100 feet maximum length from radio to antenna when radio is mounted in the cabinet and the antenna is mounted on the structure. Select external cable so that maximum cable attenuation is less than 5 dB total.

3.6. **Network Cable.** Provide Cat 5e shielded wire that meets the following minimum requirements:

- shielded twisted pair with drain wire;
- AWG24 solid bare copper;
- CMX outdoor rated for direct bury;
- outdoor UV rated jacket; and
- TIA/EIA-568B.2 and ISO/IEC 11801 standards.

Maximum run length for Cat 5e cable is 250 feet, or per the manufacturer's specifications.

3.7. **Lightning Protection.** Furnish and install surge protection on all coaxial cables mounted adjacent to and bonded to the cabinet ground bus. Include all mounting hardware necessary.

3.8. **Power Service Protection.** Provide equipment with readily accessible circuit protection devices (i.e. circuit breakers or fuses) for equipment and power source protection. Circuit protection devices may be resettable or replaceable.

Provide circuit breakers or fuses sized such that no wire, component, connector, PC board, or assembly will be subjected to sustained current in excess of their respective design limits upon the failure of any single circuit element of wiring.

Provide UL Listed Type 1 or Type 2 Surge Protection Device (SPD) and labeled to UL1449 Third Edition, posted at UL.com, under Certifications UL Category Code VZCA, and have a 20kA I-nominal rating. Provide SPD rated as NEMA 4. Provide a SPD with integral EMI/RFI line filtering if shown on the plans.

Provide automatic recovery from power failure within 30 sec. after resumption of power.

Provide a GFCI duplex outlet for ITS radio equipment at existing locations as shown on the plans. Provide this outlet in addition to the existing outlets within the cabinet.

3.9. **Maximum Weight.** Provide equipment with a weight not exceeding 25 lbs.

3.10. **Maximum Dimensions.**

3.10.1. **Outdoor Units.** 16 in. x 16 in. x 9 in. for integrated units, not including antenna.

3.10.2. **Used in Cabinets.** Provide equipment that easily fits on a single shelf without cabinet modifications.

3.11. **Modular Design.** Provide a modular ITS radio System design to allow components to be readily replaced in the field.

Label with UV resistant methods to identify all modules and assemblies with name, model number, serial number and any other pertinent information required to facilitate equipment maintenance.

3.12. **Network Topologies.** Point-to-Point or Point-to-Multi-Point, as shown on the plans, or as directed.

3.13. **Connectors and Harnesses.** All external connections will be made of connectors that are keyed uniquely to preclude improper hookups. Color code and label all cables to and from the connectors on both ends.

Provide connecting harnesses of appropriate length and terminated with matching connectors for interconnection with the communications system equipment.

Plate all pins and mating connectors with a minimum of 20 microns of metallic native element gold (Au). Use heat shrink tubing for all solder type connections to insure that it protects the connection from short circuiting.

Label with UV resistant methods to identify all assemblies with name, model number, serial number and any other pertinent information required to facilitate equipment maintenance.

Provide external waterproof connections that conform to IEC 60529 Section 14.2.7, or latest revision, for IP 66 or greater rating.

3.14. **Mechanical Requirements**. Provide equipment that is modular in design such that it can be easily replaced in the field.

Label with UV resistant methods to identify each unit with name, model number, serial number and any other pertinent information required to facilitate equipment maintenance.

Coat all printed circuit boards with a clear-coat moisture and fungus resistant material (conformal coating).

3.15. **Environmental Requirements.** Ensure that equipment conforms to NEMA TS2-2003 (R2008), International Electrotechnical Commission (IEC) 60529, and NEMA 250-2008, or most current version, for the following categories:

3.15.1. **Temperature and Humidity.** Provide equipment that conforms to NEMA TS2 Section 2.1.5.1, or latest revision, and meets all the specified requirements during and after being subjected to any combination of the following conditions:

- ambient temperature range of -30 to 165°F;
- temperature shock not exceeding 30°F per hour;
- relative humidity of 0% to 100%; and
- moisture condensation on all exterior surfaces caused by temperature changes.

3.15.2. **Vibration.** Provide equipment that conforms to NEMA TS2 Section 2.1.9 and Section 2.2.3, or most current version, and meets all the specified requirements during and after being subjected to a vibration of 5 Hz to 30 Hz up to 0.5 g applied in each of 3 mutually perpendicular planes for 30 min.

3.15.3. **Shock.** Provide equipment that conforms to NEMA TS2 Section 2.1.10 and Section 2.2.4, or latest revision, and does not yield permanent mechanical deformation or any damage that renders the unit inoperable when subjected to a shock of 10 g applied in each of 3 mutually perpendicular planes for 30 min.

3.15.4. **Environmental Contaminants**. Provide equipment that conforms to IEC 60529 Section 14.2.6, or latest revision, for IP 66 or greater rating when providing a pressurized unit.

Provide equipment that conforms to IEC 60529 Section 14.2.7, or latest revision, for IP 66 or greater rating when providing a non-pressurized unit.

3.15.5. **External Icing.** Provide equipment that is tested to conform to NEMA 250-2003 Section 5.6, or latest revision.

3.15.6. **Corrosion.** Provide equipment that is tested to conform to NEMA 250-2003 Section 5.10, or latest revision, when located in coastal Districts. Coastal Districts are Beaumont (BMT), Corpus Christi (CRP), Houston (HOU), Pharr (PHR), and Yoakum (YKM).

3.16. **Radio Configuration and Management Software.** Provide any and all programming and software required to make operational and support the radio system. The programming and software will be installed in the appropriate equipment at the time of acceptance testing, and will be used in the acceptance testing. Provide operations manuals, installation requirements, and licenses. Provide software with at least the following features:

3.16.1. **Radio Configuration.** Configuration is achieved through the following:

- a comprehensive configuration menu allowing the user to control all programmable radio settings;
- a network tree which automatically discovers, organizes, displays, and searches for a radio; and
- the ability to save individual radio configurations in a file that can be used to program replacement radios.

3.16.2. **Diagnostic Routines.** Provide the following diagnostic routines:

3.16.2.1. **Bandwidth Test.** For all communication links to a specific radio, including transmit and receive characteristics at the remote radios. Display signal strengths for transmit and receive. Provide client connection quality (CCQ);

3.16.2.2. **Spectrum Scan.** Determine the amount of background signal noise present for the specified frequency. Detect specific channels which experience interference to the extent that they are not adequate for the transmission or receipt of data. Include an option to exclude these frequencies from use; and

3.16.2.3. **Ping Test.** Measure and display the time it takes a packet of data to travel to and from another device in milliseconds and percent packet loss. Measure and display the variance in a minimum of seven successive ping tests (jitter).

3.16.3. **Networking Tools.** Provide the following network tools:

- provide a firewall configuration tool to manage multicast and broadcast traffic,
- provide user selection of Spanning Tree Protocol (STP) and Rapid Spanning Tree Protocol (RSTP) options,
- provide Virtual Local Area Network (VLAN) configuration tools;, and
- provide Quality of Service (QoS) selection and configuration tools.

3.16.4. **Alarms.** Provide the following alarm features:

- provide 24 hr. monitoring of user selected alarms; and
- provide option of sending email and text messages of triggered alarms.

4. CONSTRUCTION AND WORK METHODS

4.1. **General.** Provide and install all materials, including support, calibration and test equipment, to ensure an operating and functional wireless radio system. This includes installation of power and data cables, and the power grounding and lightning suppression systems. Prior to beginning installation, inspect each site to verify suitability of the design for installation, grounding and lightning protection. Provide written documentation to the Engineer for approval prior to installation. Utilize the latest available industry standard construction

techniques with a minimum number of parts, subassemblies, circuits, cards, and modules to maximize standardization and commonality. Design equipment for ease of maintenance and orient component parts to be readily accessible for inspection and maintenance.

4.2. **Radio Mounting.** Provide and install all necessary radio mounts, standoffs, brackets, hardware, and grounding assemblies for the mounting surface shown in the plans. Install all radios at specified locations as shown on the plans. Any deviation between actual mounting location and those specified must be pre-approved by the Engineer.

4.3. **Antenna Mounts.** Provide and install all antenna mounts, standoffs, brackets, hardware, transmission line, hanger kits, grounding kits, and lightning suppressors for the mounting surface shown in the plans. Install all antennas at specified center lines. Perform antenna alignment for each path and compare with path calculations. Any variation between calculated and actual values must be brought to the attention of the Engineer.

4.4. **System Power and Grounding.** Prior to installation, provide a written description of the proposed grounding and lightning protection design. Connect the equipment to the 115 V circuits provided in the equipment cabinets at the sites. Bond all equipment racks in accordance with the approved manufacturer's installation specification. Ground all equipment racks to the single-point ground for the site. Provide grounding and lightning protection for all cable runs at the top of the support structure and at the equipment cabinet entry port. If the equipment cabinet and associated entry port is not collocated on the support structure, the grounding and lightning protection will also be provided at the bottom of the support structure.

4.5. **System Optimization.** Optimize equipment alignment and settings at each site to provide a complete, operational system.

4.6. **Conductors.** Provide conductors that meet the requirements of the most current version of the National Electrical Code (NEC) Provide conductors that are cut to proper length before assembly. It is not permissible to "double-back" conductors to take up slack inside the cabinet. Lace conductors neatly with nylon lacing or plastic straps. Organize conductors neatly inside the cabinet and secure cables with clamps. When connecting to hardware inside the cabinet, provide service loops at connection points. No splicing of cables or exposed conductors are allowed. Label with UV resistant methods to identify all conductors.

4.7. **Relocation.** Perform the relocation in strict conformance with the requirements herein and as shown on the plans. Completion of the work will present a neat, workmanlike, and finished appearance. Maintain safe construction practices during relocation.

Inspect the existing radio equipment, with a representative from the Department, and document any evidence of damage prior to removal. Conduct a pre-removal test in accordance with the testing requirements contained in this Item to document operational functionality. Remove and deliver to the Department existing radio equipment that fail inspection.

Prior to removal of existing radio equipment, disconnect and isolate the power cables from the electric power supply and disconnect all communication cabling from the equipment located inside the cabinet. Coil and store power and communication cabling inside the cabinet until such time that it can be relocated. Remove existing radio equipment as shown on the plans only at such time as authorized by the Engineer.

Use care to prevent damage to any support structures. Any components of the radio equipment or support structure damaged or lost will be replaced by the Contractor at no cost to the Department. Contractor to document and report to the Engineer any existing damage to equipment prior to removal.

Make all arrangements for connection to the power supply and communication source including any permits required for the work to be done under the Contract. Provide wire for the power connection at least the minimum size indicated on the plans and insulated for 600 volts. The power connection will meet the requirements of the most current version of the NEC.

4.8. **Removal.** Disconnect and isolate any existing electrical power supply prior to removal of existing radio equipment.

Perform removal in strict conformance with the requirements herein stated and the lines, grades, details and dimensions shown on the plans. Completion of the work will present a neat, workmanlike, and finished appearance.

Any components of the radio equipment damaged or lost will be replaced by the Contractor (with items requiring the approval of the Engineer) at no cost to the Department.

All materials not designated for reuse or retention by the Department will become the property of the Contractor and be removed from the project site at the Contractor's expense. Deliver items to be retained by the Department to a location designated on the plan sheets or general notes. The Contractor is fully responsible for any removed equipment until released by the Engineer.

4.9. **Contractor Experience Requirements.** Utilize installers, testers, and integrators with at least the following requirements:

4.9.1. **Minimum Experience.** Three years continuous existence offering services in the installation of wireless communications. Experience must include the following:

4.9.1.1. Conducting radio installation studies consisting of:

- signal noise studies,
- spectrum analysis,
- antenna gain / radio power calculations,
- system attenuation, and
- measurement of standing wave ratios.

4.9.1.2. Installation, troubleshooting and repair of broadband radio systems consisting of:

- equipment installation,
- configuration of radios,
- antenna calibration, and
- cabling.

4.9.1.3. Installation, troubleshooting, and repair of interconnected Ethernet networks (LAN and WAN) consisting of:

- cabling,
- switch / router configuration, and
- network analysis.

4.9.2. **Completed Projects.** Three projects consisting of wireless communications installation, troubleshooting and repair. Each project must include transmitting signals over a minimum of 1 mile distance and installation of a minimum of 3 devices.

4.9.3. **Equipment Experience.** One project (may be one of the three in the preceding paragraph) in which the personnel worked in cooperation with technical representatives of equipment suppliers to perform specific stages of work. Contractor will not be required to furnish equipment on this project from the supplier who furnished documentation demonstrating this experience.

Submit the names, addresses and telephone numbers of the references that can be contacted to verify the experience requirements given above.

4.10. **Documentation.**

Provide all licenses, where required, for any software or hardware in the system.

Provide a medical statement as to the safety of the unit to the general public (example: Pacemakers, etc.).

Provide proof of installer qualifications.

Provide all documentation described in this specification, including written reports for:

- verification of the suitability of the design for installation, grounding and lightning protection,
- communication link throughput tests,
- equipment grounding tests,
- system level test results to include: performance charts, link summaries, climatic factors, losses and standards, and
- wiring connection diagrams for the field installation and central installation.

4.11. **Testing.**

4.11.1. **New Installations**. Unless otherwise shown on the plans, perform the following tests on the applicable equipment or systems.

4.11.1.1. **Test Procedures Documentation.** Provide 5 copies of the test plan procedures and target values, as well as blank data forms 60 days prior to testing for each test required in this specification. Include the sequence of the tests in the procedures. The Engineer will approve test procedures prior to submission of equipment for tests. Conduct all tests in accordance with the approved test procedures.

Record test data on the data forms, as well as quantitative results. No bid item measurement or payment will be made until the Engineer has verified the test results meet the minimum requirements of the specification. The data forms for all tests, except design approval tests, must be signed by an authorized representative of the Contractor.

Provide written notice to the Engineer within 48 hr. of discovery of any testing discrepancy performed in testing by the contractor. Furnish data forms containing the acceptable range of expected results as well as the measured values.

4.11.1.2. **Design Approval Test.** Conduct a design approval test on randomly selected units from the prototype design manufacturing run. If only 1 design prototype is manufactured, perform this test on that unit. If supplying multiple types of the equipment, provide and test a sample of each type.

Certification from an independent testing laboratory of a successfully completed design approval test is acceptable. Ensure that the testing by this laboratory is performed in accordance with the requirements of this specification. Failure of independent tests to comply with the requirements of this specification will be grounds for rejection of any certification.

Provide a copy of the certification to the District in which this equipment is installed. The data forms for the design approval tests must be signed by an authorized representative (company official) of the equipment manufacturer or by an authorized representative of an independent testing facility.

Notify the Engineer 10 working days before conducting this testing. The Department may witness all the tests. Perform the following tests:

4.11.1.2.1. **Power Service Transients**. Provide UL Listed Type 1 or Type 2 SPD and labeled to UL1449 Third Edition, posted at UL.com, under Certifications UL Category Code VZCA, and have a 20kA I-nominal rating. Provide SPD rated as NEMA 4. SPD with integral EMI/RFI line filtering may be required if shown on the plans.

4.11.1.2.2. **Temperature and Condensation**. Meet the performance requirements, specified in this Item, when subjected to the following conditions in the order specified below:

- stabilize the equipment at -30°F and test as specified in the NEMA TS2 standard, Sections 2.2.7.3, "Low-Temperature Low-Voltage Tests" and 2.2.7.4, "Low-Temperature High-Voltage Tests", or most current version,
- allow the equipment to warm up to room temperature in an atmosphere having relative humidity of at least 40%. Operate the equipment for 2 hr., while wet, without degradation or failure, and
- stabilize the equipment at 165°F and test as specified in the NEMA TS2 standard, Sections 2.2.7.5, "High-Temperature High Voltage Tests" and 2.2.7.6, "High-Temperature Low-Voltage Tests", or most current version.

4.11.1.2.3. **Relative Humidity**. Meet the performance requirements, specified in this Item, within 30 min. of being subjected to a temperature of 165°F and a relative humidity of 18% for 48 hr.

4.11.1.2.4. **Vibration**. Show no degradation of mechanical structure, soldered components, or plug-in components, and operate in accordance with the manufacturer's equipment specifications after being subjected to the vibration tests as described in the NEMA TS2 standard, Section 2.2.8, "Vibration Test", or most current version.

4.11.1.2.5. **Power Interruption**. Provide automatic recovery from power failure within 305 sec. after resumption of power.

4.11.1.3. **Demonstration Test.** Conduct a demonstration test on applicable equipment at an approved Contractor facility. The Contractor may submit procedures and results from previous projects in the same District as this project, provided the materials and equipment are identical. Provide previous procedures and results not more than 5 yr. old. Notify the Engineer 10 working days before conducting this testing. The Department may witness all the tests. Perform the following tests:

4.11.1.3.1. **Examination of Product.** Examine each unit carefully to verify that the materials, design, construction, markings and workmanship comply with the requirements of this Item,

4.11.1.3.2. **Continuity Tests.** Check the wiring to determine conformance with the requirements of the appropriate paragraphs in this Item, and

4.11.1.3.3. **Operational Test.** Operate each unit for at least 15 min. to permit equipment temperature stabilization and an adequate number of performance characteristics to ensure compliance with the requirements of this Item.

4.11.1.4. **Field Acceptance Test.** Following completion of equipment installation and operational optimization, submit an acceptance test plan to the Engineer for review and approval. During the official acceptance testing, provide the technical staff to conduct the measurements and adjustments called for in the testing. The Engineer will participate in the testing as the official test witness. Each page of the acceptance test document will provide for data recording of the test results, and the name of Contractor's representative conducting the test as well as a suitable field for the test date and signature of the Department’s test witness. Upon the Engineer’s approval of the test plan and the test schedule, the acceptance testing may begin.

Conduct a field acceptance test for each unit after installation as required by the Engineer in order to demonstrate compliance with the functional requirements with this Item. Exercise all stand-alone (non-network) functional operations. Provide a factory certified representative for installation and testing of the equipment. Notify the Engineer 5 working days before conducting this test. The field acceptance test will consist of at least the following:

4.11.1.4.1. **Physical Construction.** Verify physical construction is completed in accordance with the plans and specification.

4.11.1.4.2. **Electrical Connections.** Verify that all connectors for grounding, surge suppression, and electrical distribution are tightened correctly and are quality connectors. Verify all power supplies and circuits are operating under the proper voltages. Verify all power and communications cables are terminated correctly, secured inside the cabinet, and fitted with appropriate connectors.

4.11.1.4.3. **Grounding.** Field test equipment grounding for all ITS radio equipment installed in the field and provide written documentation to the engineer. Where earth ground resistance values exceed 5 ohms, develop mitigation measures for consideration. Once mitigation measures are installed, re-test that ground and update the documentation.

4.11.1.4.4. **Interference.** Conduct a test site survey and interference analysis prior to the installation of the equipment. Measure the existing signal noise levels at each installation site for the proposed radio frequency, identify potential sources of interference, and document the findings in a written report to the engineer. The purpose of this survey is to verify that the parameters measured during the design process have not substantially changed. If the new survey indicates that the proposed radio system will not function as designed, develop proposed mitigation strategies. Adjust antenna polarities and channel plans on equipment to minimize interference from other sources.

4.11.1.4.5. **Communication Link Quality.** Conduct signal tests for each communication link, including data throughput, transmit power and frequency, receiver performance and frequency, proper operation of switch over, proper operation of alarm and switches, and bit error rate (BER). Document results in a written report to the engineer. Where measured throughput drops below 50 Mbps on any link, develop mitigation measures for consideration. Once mitigation measures, if any, are implemented on a communications link, re-test that link and update the documentation.

4.11.1.4.6. **System Paths.** Include the following in testing of the installed system paths:

- measure and record the transmitter/receiver channel frequency and polarity;,
- measure and record the transmitter power,
- measuring and recording the receiver fade margin, perform a one hour Bit Error Rate Test (BERT) on the primary equipment and record results, and
- verify the operation of all local alarm and control points using the alarm and monitoring equipment provided.

4.11.1.4.7. **Alarms.** Test and verify the operation of the alarms and monitor equipment in accordance with the acceptance test criteria.

4.11.1.5. **System Integration Test.** Conduct a system integration test on the complete functional system. Demonstrate all control and monitor functions for each system component for 72 hr. Notify the Engineer 10 working days before conducting this testing. The Department may witness all the tests.

Provide Systems Integration Test procedures for proper adjustment and calibration of subsystem components. Proper adjustment and calibration involves documenting settings used to meet functional requirements while providing a margin for adjustment when future conditions change. Utilize the Department's control software (when available) to perform subsystem testing. At a minimum, utilize this software to verify communication to the Department's equipment. The Contractor is responsible for being familiar with any existing Department equipment and software.

The failure of any one component material or equipment item in a system integration test is justification for rejecting the entire subsystem. Each subsystem component must function as a complete integrated subsystem

4.11.1.6. **Final Acceptance Test.** Following completion of the demonstration test, field acceptance test, and system integration test for all subsystems, provide completed data forms containing all of the data taken, including quantitative results for all tests, a set of "as built" working drawings, and a written request to begin a data communication and final acceptance test. Provide "as built" working drawings indicating the actual material, equipment, and construction of the various subsystem components.

Within 10 calendar days of the request, execute a data communications test using a Department supplied software program. The data communications test may be executed by the Engineer or the Contractor with the prior approval of the Engineer. The purpose of this test is to verify that the communications plan will

operate with application software provided by the Department or contractor supplied software approved by the Engineer.

Perform the data communications test for a period of 72 hr. Ensure that the test can be performed for a continuous 72 hr. during a normal work week. If a message error or component failure occurs anywhere in the network, restart the 72 hr. test once repairs are completed. All components of the communications network must operate as an integral system for the duration of the test.

A message error is defined as the occurrence of a parity error, framing error, or data error in any component of the message. The error-free message rate is defined as the ratio of the number of messages in which no message error occurs to the number of messages transmitted. The error-free message rate must exceed 99.99% for acceptable transmission quality, both for the system as a whole, and for each component of the network.

Provide all additional test results to the Engineer for review once a successful data communications test has been completed. If all the requirements of this special provision have been satisfied, contract time will be suspended and all subsystems will be placed into operation and operate as a complete ITS radio communication system as intended for at least 30 calendar days.

Notify the Engineer of any defects suspected in integration or function of material or equipment. Investigate any suspected defects and correct if necessary. Provide a report of findings within 2 calendar days of notice of any suspected defects. Describe the nature of the any defects reported and any corrective action taken in the report. The integrated subsystems must operate defect free as a single complete system for at least 72 continuous hours during the 30 calendar day review period. If the number of defects or frequency of failures prevents all subsystems from operating as described above, the Engineer may reject the entire system integration test results and resume contract time. Provide any necessary corrections and resubmit system integration test results and a request to begin a final acceptance test which may include “as built” plans and a data communications test.

The project will not be accepted, notwithstanding other provisions in the Contract, until the system, inclusive of all subsystems, has operated satisfactorily for a period of 90 days and in full compliance with the plans and specifications after approval of all submitted test results and reports.

4.11.1.7. **Consequences of Test Failure.** If a unit fails a test, submit a report describing the nature of the failure and the actions taken to remedy the situation prior to modification or replacement of the unit. If a unit requires modification, correct the fault and repeat the test until successfully completed. Correct minor discrepancies within 30 days of written notice to the Engineer. If a unit requires replacement, provide a new unit and then repeat the test until successfully completed. Malfunctions that will substantially delay receipt and acceptance of the unit will be sufficient cause for rejection of the unit.

Failure to satisfy the requirements of any test is considered a defect and the equipment is subject to rejection by the Engineer. The rejected equipment may be offered again for retest provided all noncompliance has been corrected.

If a failure pattern develops in similar units within the system, implement corrective measures, including modification or replacement of units, to all similar units within the system as directed. Perform the corrective measures at no additional cost to the Department or extension of time in contract period.

4.11.1.7.1. **Consequences of Design Approval Test Failure.** If the equipment fails the design approval test, correct the fault and repeat the design approval test until successfully completed.

4.11.1.7.2. **Consequences of Demonstration Test Failure.** If the equipment fails the demonstration test, correct the fault and repeat the demonstration test until successfully completed.

4.11.1.7.3. **Consequences of Field Acceptance Test Failure.** If the equipment fails the field acceptance test, correct the fault and repeat the field acceptance test until successfully completed.

4.11.1.7.4. **Consequence of System Integration Test Failure.** If the equipment fails the system integration test, correct the fault and repeat the systems integration test until successfully completed.

4.11.1.7.5. **Consequences of Final Acceptance Test Failure.** If a defect within the system is detected during the final acceptance test, document and correct the source of failure. Once corrective measures are taken, monitor the point of failure until a consecutive 30 day period free of defects is achieved.

If after completion of the initial test period, the system downtime exceeds 72 hr. or individual points of failure have not operated for 30 consecutive days free of defects, extend the test period by an amount of time equal to the greater of the downtime in excess of 72 hr. or the number of days required to complete the performance requirement of the individual point of failure.

4.11.2. **Relocation and Removal.**

4.11.2.1. **Pre-Test**. Conduct performance testing prior to removal of radio equipment. Test all functional operations, identified in this Item, of the equipment in the presence of representatives of the Contractor and the Department. Ensure that both representatives sign the test report indicating that the equipment has passed or failed each function. Once removed, the equipment becomes the responsibility of the Contractor until accepted by the Engineer. Compare test data prior to removal and test data after installation. The performance test results after relocation must be equal to or better than the test results prior to removal. Repair or replace those components within the system which failed after relocation but which passed prior to removal.

4.11.2.2. **Post Test.** Testing of the radio equipment is for the purpose of relieving the Contractor of maintenance of the system. The Contractor will be relieved of the responsibility for maintenance of the system in accordance with Item 7, “Legal Relations and Responsibilities”, after a successful test period. The Contractor will not be required to pay for electrical energy consumed by the system.

After all existing radio equipment has been installed, conduct approved continuity, stand alone, and equipment system tests. Furnish test data forms containing the sequence of tests including all of the data recorded as well as quantitative results for all tests. Submit the test data forms to the Engineer at least 30 days prior to the day the tests are to begin. Obtain Engineer’s approval of test procedures prior to submission of equipment for tests. Provide at least 1 copy of the data forms to the Engineer.

Conduct an approved stand-alone test of the equipment installation at the field site(s). At a minimum, exercise all stand-alone (non-network) functional operations of the field equipment with all of the equipment installed per the plans as directed by the Engineer. Complete the approved data forms with test results and provide to the Engineer for review and either acceptance or rejection of equipment. Provide at least 30 working days notice prior to all tests to permit the Engineer or his representative to observe each test.

The Department will conduct approved radio system tests on the field equipment with the Department’s central control software. The tests will, as a minimum, exercise all remote control functions and display the return status codes from the equipment.

If any unit fails to pass a test, prepare a report and deliver the report to the Engineer. Describe in the report the nature of the failure and the corrective action needed. If the failure is the result of improper installation or damage during reinstallation, reinstall or replace the unit and repeat the test until the unit passes successfully, at no additional cost to the Department or extension of time to the contract period.

4.12. **Training.** Conduct a training class (minimum of 8 hr., unless otherwise noted in the plans) for up to 10 representatives designated by the Department on procedures of installation, operations, testing, maintenance and repair of all equipment specified within this specification. Submit to the Engineer for approval, 10 copies of the training material at least 30 days before the training begins. Conduct training within the local area unless otherwise authorized by the Engineer.

4.13. **Warranty.** Warrant the equipment against defects or failure in design, materials, and workmanship for a minimum of 3 years or in accordance with the manufacturer’s standard warranty if that warranty period is

greater. The start date of the manufacturer's standard warranty will begin after the equipment has successfully passed all tests contained in the final acceptance test plan. Any ITS radio equipment with less than 100% of its warranty remaining after the final acceptance test is completed will not be accepted by the Department. Guarantee that equipment furnished and installed for this project performs according to the manufacturer's published specifications. Assign, to the Department, all manufacturer's normal warranties or guarantees on all electronic, electrical, and mechanical equipment, materials, technical data, and products furnished for and installed on the project.

Repair or replace any malfunctioning ITS radio equipment at the Contractor's expense prior to beginning the final acceptance test plan.

Repair or replace, at the manufacturer's option, defective equipment during the warranty period at no cost to the Department. Any replaced units will inherit the remainder of the failed unit's warranty period.

Furnish replacement parts and all equipment, with transportation prepaid, within 10 business days of notification of failure by the Department.

During the warranty period, provide technical support from the supplier. Provide this support within 4 hr. of request, and provided by factory certified personnel or factory certified installers of the equipment.

Provide ongoing software and firmware updates during the warranty period at no cost to the Department. All updates will be tested and approved by the Department prior to installation by the Department.

The Manufacture or the Contractor will maintain an inventory of parts to support maintenance and repair of all ITS radio equipment based on the terms of the warranty.

5. MEASUREMENT

This Item will be measured by each ITS radio furnished and installed, installed, relocated, or removed, of the types specified, to provide communication and functionality.

6. PAYMENT

6.1. **Furnish and Install.** The work performed and materials furnished in accordance with this Item and measured as provided for under "Measurement" will be paid for at the unit price bid for "ITS Radio" of the various types specified.

Types are defined as ITS RADIO X1 (X2/ X3) X4 (X5) where:

- X1 = Sngl (Single Band) or Dual (Dual Band)
- (X2/X3) = Frequencies Used (i.e. 5 GHz for single or 2.4 GHz or 5 GHz for dual)
- X4 = Antenna Configuration = I (Integrated) or C (Connectorized)
- (X5) = Antenna Type = O (Omnidirectional), U (Unidirectional), S (Sector), or P (Parabolic)

This price is full compensation for making fully operational an ITS radio at locations shown on the plans; all radio equipment, voltage converters or injectors, mounting brackets, hardware, cables and connectors; and all testing, training, software, equipment, labor, materials, tools, and incidentals.

6.2. **Install Only.** The work performed and materials furnished in accordance with this Item and measured as provided for under "Measurement" will be paid for at the unit price bid for "ITS Radio (Install Only)." This price is full compensation for making fully operational an ITS radio furnished by the Department at locations shown on the plans; and all testing, training, software, equipment, labor, materials, tools, and incidentals.

6.3. **Relocate.** The work performed and materials furnished in accordance with this Item and measured as provided for under "Measurement" will be paid for at the unit price bid for "Relocate ITS Radio." This price is

full compensation for relocating and making fully operational an existing an ITS radio as shown on the plans; and all testing, training, software, equipment, labor, materials, tools, , and incidentals.

6.4. **Remove.** The work performed and materials furnished in accordance with this Item and measured as provided for under "Measurement" will be paid for at the unit price bid for “Remove ITS Radio.” This price is full compensation for removing an existing ITS radio as shown on the plans; and all testing, training, software, equipment, labor, materials, tools, and incidentals.

Special Specification 6063

Intelligent Transportation System (ITS) Solar Power System

1. DESCRIPTION

Furnish, install, relocate, or remove an integrated Intelligent Transportation System (ITS) solar power system at locations shown on the plans, or as directed.

A solar power system is co-located with and supplies operational power for designated ITS field equipment at locations as shown on the plans. The solar panel power supply system must supply power service for the field equipment. Furnish and install all of the components described in the specification and configure the equipment as indicated on the plans.

2. MATERIALS

Provide materials that comply with the details shown on the plans, the requirements of this Item, and the pertinent requirements of the following Items:

- Item 416, “Drilled Shaft Foundation,”
- Item 421, “Hydraulic Cement Concrete,”
- Item 440, “Reinforcing Steel,”
- Item 442, "Metal for Structures,"
- Item 445, "Galvanizing,"
- Item 449, “Anchor Bolts,”
- Item 618 “Conduit,”
- Item 620, "Electrical Conductors,"
- Item 624 “Ground Boxes,”
- Item 627 “Treated Timber Poles,” and
- Item 687 “Pedestal Pole Assemblies.”

3. EQUIPMENT

Provide labor, equipment and materials to employ solar-generated, battery-backed power for the assigned field equipment specified in the plans, or as directed. Install all equipment, including batteries and charge controller, in a suitably sized enclosure.

Size the enclosure to house the solar chargers, batteries, lightning protection equipment, and all co-located ITS field equipment shown on the plans or as directed.

Furnish a solar power system that supplies the design electrical load for up to 24 hr. per day with 3 or 5 days of battery backup, as described in the plans, and generally consisting of the following:

- Photovoltaic (PV) modules with mounts or racks, and mounting brackets for affixing the modules to a pole as shown on the plans. Ensure mounting and bracket assembly has all galvanized steel or heavy gauge-mill aluminum construction. Provide adjustable tilt mounts that can be repositioned to an appropriate angle to maximize seasonal solar radiation.,
- 12 VDC sealed, valve-regulated, absorbed glass mat (AGM), maintenance-free batteries,
- maximum power point tracking (MPPT) photovoltaic charge controllers and monitoring units,
- one toggle-type power switch for emergency shutoff, and

- external conduit, wiring cable and conductors (as recommended by the supplier) between the following:
- photovoltaic module to cabinet back panel,
- battery interconnect,
- batteries to cabinet back panel, and
- wiring between components in cabinet.

Pre-set the equipment, optimize photovoltaic module direction, and configure hardware components to allow automatic operation. Furnish and install a fully operational assembly with all cabling and terminations matched to support the selected components. Use the component sizing chart, Table 1 or Table 2, shown below to size the individual components based on the planned electrical load and days autonomy:

Table 1
Solar Power System Component Sizing – 3 Days Autonomy

Design Load (Watts)	100	90	80	70	60	50	40	20
Solar Array Size (Watts)[2]	1440	1296	1152	1008	864	720	576	288
Battery Capacity (AH)	750	675	600	525	450	375	300	150
Total Controller Capacity (Amps)	120	108	96	84	72	60	48	24
1. Components Sized Based On The Following Performance Requirements: - 3 Days of Autonomous Operation - Maximum Battery Discharge of 80% - Recharge to Capacity in 5 hours of sunlight after 80% battery discharge. 2. Panels to be selected using PVUSA Test Conditions (PTC)								

Table 2
Solar Power System Component Sizing – 5 Days Autonomy

Design Load (Watts)	100	90	80	70	60	50	40	20
Solar Array Size (Watts)[2]	2400	2160	1920	1680	1440	1200	960	480
Battery Capacity (AH)	1250	1125	1000	875	750	625	500	250
Total Controller Capacity (Amps)	200	180	160	140	120	100	80	40
1. Components Sized Based On The Following Performance Requirements: - 5 Days of Autonomous Operation - Maximum Battery Discharge of 80% - Recharge to Capacity in 5 hours of sunlight after 80% battery discharge. 2. Panels to be selected using PVUSA Test Conditions (PTC)								

Size the components of the system considering how many days of autonomous operation are needed and future maintenance costs. Furnish, install, and test the solar panel power supply system, and ensure it meets the following requirements:

3.1. **Solar Generator.** Ensure the system solar generator provides at least the total power output shown for the planned electrical load. Supply and install the appropriate number and size of PV modules needed to meet the minimum power requirements shown in Table 1 or 2 as required by the plans. Use photo voltaic USA (PVUSA) test conditions (PTC) ratings.

Supply industrial grade, mono-crystalline or poly-crystalline type solar modules. Consumer grade modules are not acceptable. Ensure that the PV modules meet the following minimum requirements:

- minimum output voltage of 12 VDC,
- minimum area efficiency rating of 15%,
- at least 2 bypass diodes, installed at the factory,

- include an ultraviolet (UV) resistant, Ingress Protection (IP) 66 rated junction box providing wire termination for up to No. 6 AWG wiring with the PV module,
- hail impact resistance up to 1 in. diameter at 50 mi. per hr., and
- UL 1703 listing.

Ensure PV modules, regardless of wattage size, shares common mounting holes for mounting so that a single mounting structure will accommodate the entire module line.

PV modules may be wired in "strings" of panels wired in series, which are then wired in parallel to other strings. Ensure that the open circuit voltage of any single string of PV modules does not exceed 127 V.

Construct PV modules with a tempered glass surface and an industrial grade anodized aluminum frame that completely surrounds and seals the module laminate. Ensure construction is consistent with the demands of installation near humid salt air environments.

Design and construct the photovoltaic module mounting assembly of galvanized steel (ASTM A-153 Class A) or aluminum. The mounting assembly must be of adequate design and strength to provide a means of securely attaching the PV module frame to a pole. Provide a mounting assembly capable of 360° horizontal orientation with a means of locking the bracket at an inscribed angular position about the pole. Ensure the mounting assembly is designed and installed to prevent module re-positioning during 110 mph wind conditions.

Label all PV modules with open-circuit voltage, operating (maximum power) voltage, maximum permissible voltage, operating (maximum power) current, short-circuit current, and maximum power.

Provide a warning label on all DC junction boxes warning that the active parts inside the boxes are fed by a PV array and may still be energized after isolation.

Provide a DC disconnect toggle switch to the solar array at a readily accessible location. Label with system information including maximum power current, maximum power voltage, maximum system voltage, short-circuit current, and maximum rated output current of charge controller at the DC disconnect. National Electrical Code (NEC) 690.14(C)1 and 690.31(E).

Mark each PV system disconnect as such. NEC 690.14(C)(2) and 690.14(C)(3).

Provide overcurrent protection for the PV source circuit in conformance with NEC 690.9(A); 240.

3.2. **Batteries.** Provide maintenance free, spill proof, AGM batteries with the following minimum characteristics:

- 12 VDC,
- 80% allowable depth of discharge (DOD),
- rated for a minimum of 2,000 recharge cycles, and
- capacity rated at 77ºF, 100 hr. discharge rate.

Supply appropriate number of batteries to ensure the minimum total amp-hours meets or exceeds the value in Table 1 or 2, as described in the plans, when wired in parallel. Label, with a UV resistant system, the battery bank with maximum operating voltage, equalization voltage, and polarity.

Arrange the system components so that all battery terminals are guarded and adequate working space is provided per NEC 690.71(B)(2); 480.9.

Install current-limiting fuses on battery output circuits per NEC 690.71(C).

Provide overcurrent protection for the battery circuit conductors in conformance with NEC 690.9(A); 240.

Maximum system voltage is less than 600 V. Circuits over 150 V are to be protected so as to be only accessible to qualified persons, per NEC 690.7(C) and 690.7(D).

Install battery banks of greater than 48 V nominal in non-conductive cases. Conductive racks are permissible if no materials are located within 6 in. of the top of the battery case per NEC 690.71(D).

Provide series disconnects for battery strings over 48 V nominal per NEC 690.71(E).

Provide a maintenance disconnect for the grounded conductor of each string for battery systems over 48 V nominal. Make this disconnect accessible only to qualified persons per NEC 690.71(F).

Use battery interconnections with #2/0 AWG or larger flexible cables that are listed for hard-service use and are moisture resistant

3.3. **Panel Controller/Battery Charger.** Furnish and install maximum power point tracking (MPPT) controllers to ensure proper charging on the system battery bank. Provide an appropriate number of adequately sized MPPT controllers to meet or exceed the total charging amps shown in the system sizing tables. Provide MPPT controllers listed for the application, including UL 1741.

Provide MPPT controllers rated for the appropriate input and output voltages and currents needed for a fully functioning solar power system of the size called for in the plans.

Provide MPPT controllers with integrated battery overcharge and over-discharge protection.

Provide MPPT controllers with integrated temperature compensation.

Provide a blocking diode for reverse-current protection of the charging circuit. Reverse voltage rating of the blocking diode should be at least twice the open circuit voltage rating of the PV array to which it is fitted.

Incorporate thermal compensation in the charge control circuit to adjust the battery charge rate to variances in temperature with an adjustable voltage swing above and below the ambient set point as defined by the battery manufacturer. The battery float voltage calibration shall be at a voltage defined by the battery manufacturer at 25ºC ambient temperatures.

Provide light-emitting diodes (LED) or liquid crystal displays (LCD) to indicate solar panel charging and state of charge.

Provide surge protection for lightning and power surge protection.

Provide the controller with a low voltage disconnect (LVD) circuit. This circuit disconnects the battery bank when the battery voltage reaches a voltage that is deemed critical by the manufacturer of the battery. Provide an LED to indicate when the LVD circuit is active.

3.4. **Power Inverter.** Provide a stand-alone power inverter, with UL 1741 listing, to provide 120 V, 60 Hz, AC power output.

Provide true sine wave power with less than 3% total harmonic distortion.

Size the inverter to handle the largest load the system is expected to serve.

Provide overcurrent protection, disconnects, and ground fault protection.

Protect the inverter output circuit in accordance with NEC Article 240.

Label the inverter with the appropriate markings, including maximum input and output power ratings.

3.5. **Control Cabinet.** Manufacture the control cabinet of unpainted sheet aluminum with a thickness of at least 0.125 in. Size the cabinet to provide adequate space for the control electronics, desired number of batteries, and all co-located ITS field equipment shown on the plans, or as directed. Meet National Electrical Manufacturers Association (NEMA) standards publication 250-2003.

Provide a completely weatherproof cabinet to prevent the entry of water. All exterior seams are to be continuously welded for the cabinet and door. All exterior welds are to be smooth.

Provide the door with a full length stainless steel piano hinge. The hinge will be mounted so that it is not possible to remove it from the door or cabinet without first opening the door. Provide a double flanged cabinet door opening. Provide a closed cell neoprene gasket between the door and the cabinet to act as a permanent dust and weather resistant seal. Provide a minimum of 1/4 in. thick gasket. Tightly secure the door via a latching device which pulls the door snugly against the neoprene affixed gasket forming a weather tight seal. Provide cabinet with a Corbin style #2 lock with a keyhole cover as an integral part of the door and 2 keys. Provide cabinet with provisions to hold the door open at approximately 90º and 120º positions.

Provide louvers on each side of the cabinet to allow adequate cooling of the electronic components and to prevent the accumulation of gases. Provide screen vents that prevent entry of insects.

Provide an aluminum back panel in the lower compartment with a thickness of 0.125 in. Size the back panel to provide adequate space for the control electronics and terminal strip. Provide electronic components that can be easily installed or removed with simple hand tools.

Equip the cabinet with at least two shelves of a minimum thickness of 0.125 in, with a 1 in. x 3 in. cutout in the back of the shelves for cable run. Ensure that the shelves are capable of supporting design battery weight. Provide a rubber mat installed on each shelf that supports the batteries and two 1/8 in. drain holes located in the bottom of the cabinet at opposite corners. Provide a minimum of 2 in. of separation from the top of the battery posts to the bottom of the next shelf.

Equip the cabinet with all necessary mounting equipment and hardware. Configure the cabinet for pole mounting using two aluminum "U" channel mounting brackets with stainless steel reinforcing plates on the inside of the cabinet. Include a 0.25 in. aluminum reinforcing plate mounted in the bottom of the cabinet.

Cabinets meeting the ITS equipment cabinet specification are acceptable as long as they are sized to accommodate the entire system.

3.6. **Connectors and Harnesses**. Ensure all external connections are made by means of connectors. Key the connectors to prevent improper hookups. Color code and appropriately label with an UV resistant material all cables to and from the connectors on both ends.

Provide connecting harnesses of appropriate length and terminate with matching connectors for interconnection with the communications system equipment.

Plate all pins and mating connectors with a minimum of 20 microns of metallic native element gold (Au). Use heat shrink tubing for all solder-type connections to protect the connection from short circuiting.

Label with UV resistant methods to identify all assemblies with name, model number, serial number and any other pertinent information required to facilitate equipment maintenance.

Provide external waterproof connections that conform to International Electrotechnical Commission (IEC) specification 60529 Section 14.2.7, or most current version, for IP 66 or greater rating.

Provide connectors that are polarized, non-interchangeable, guarded, latching or locking, have “first-to-make/last-to-break” contact for the grounded conductor, and are either rated for interrupting current or require a tool to open per NEC 690.33.

Provide wiring connectors that are listed for the intended use and environment. Do not over tighten screws to terminals. Use the appropriate crimping tool for crimp-on terminals per NEC 110.14.

3.7. **Grounding.**

3.7.1. **Ungrounded Systems.** Include disconnects, overcurrent protection, and gound-fault protection. Provide equipment that is listed for use with ungrounded systems per NEC 690.35.

3.7.2. **Module Grounding Connectivity.** Provide module connections such that removal of a module does not interrupt a grounded conductor to another PV source circuit per NEC 620.4(C).

3.7.3. **Ground-Fault Protection.** Provide ground fault protection for grounded arrays per NEC 690.5.

3.7.4. **PV System Grounding.** Provide one grounded DC conductor for two-wire PV systems operating above 50 V per NEC 690.41; 250.4(A).

3.7.5. **Single Point.** Provide DC grounding at a single point on the PV output circuit per NEC 690.42.

3.7.6. **Equipment Grounding.** Ground non-current-carrying metal components, including module frames, mounting structures, equipment, conduit, and boxes per NEC 690.43.

3.7.7. **Equipment Grounding Conductors.** Route equipment conductors with PV circuit conductors per NEC 690.43.

3.7.8. **Equipment Grounding Conductor Size.** If the array has ground fault protection, size the grounding conductor according to NEC 250.122. If not, size the grounding conductor to handle at least twice the de-rated circuit conductor ampacity per NEC 690.45.

3.7.9. **Grounding Electrode Systems.** Ground the AC system according to NEC 250.50 through 250.60. Ground the DC system according to NEC 250.166 through 250.169, and NEC 690.47.

3.7.10. **Common Grounding.** If the system includes both AC and DC systems, bond the grounding electrodes together. Size the bonding conductor for the larger of the AC and DC requirements per NEC 690.47(C).

3.8. **Disconnects.** Provide disconnects to disconnect equipment (inverters, batteries, charge controllers, etc.) from all ungrounded conductors of all power sources per NEC 690.15.

For fuses that are energized from both directions, provide disconnects to independently disconnect the fuse from all sources of power.

Provide disconnects to open all ungrounded conductors which are readily accessible, externally operated, have ON/OFF indications, and have appropriate interrupt ratings. Manually operated switches and circuit breakers are allowed to fulfill these requirements per NEC 690.17.

3.9. **Mechanical Requirements.** Provide equipment that is modular in design such that it can be easily replaced in the field.

Clearly identify with UV resistant material each unit with name, model number, serial number and any other pertinent information required to facilitate equipment maintenance.

Coat all printed circuit boards with a clear-coat moisture and fungus resistant material (conformal coating).

3.10. **Environmental Requirements.** Ensure that equipment conforms to NEMA TS2-2003 (R2008), IEC 60529, and NEMA 250-2008, or most current version, for the following categories:

3.10.1. **Temperature and Humidity.** Provide equipment that conforms to NEMA TS2 Section 2.1.5.1, or most current version, and meets all the specified requirements during and after being subjected to any combination of the following conditions:

- ambient temperature range of -30 to 165°F,
- temperature shock not exceeding 30°F per hour,
- relative humidity of 0 to 100%,
- moisture condensation on all exterior surfaces caused by temperature changes, and
- Housing assemblies perform to stated specifications over an ambient temperature range of -30 to 165°F in direct sunlight and a humidity range of 0 to 100% condensing. Ensure that the system will operate without sustaining damage over a temperature range of -30 to 165°F.

3.10.2. **Vibration.** Provide equipment that conforms to NEMA TS2 Section 2.1.9 and Section 2.2.3, or most current version, and meets all the specified requirements during and after being subjected to a vibration of 5 Hz to 30 Hz up to 0.5 g applied in each of 3 mutually perpendicular planes for 30 min.

3.10.3. **Shock.** Provide equipment that conforms to NEMA TS2 Section 2.1.10 and Section 2.2.4, or most current version, and does not yield permanent mechanical deformation or any damage that renders the unit inoperable when subjected to a shock of 10 g applied in each of three mutually perpendicular planes for 30 min.

3.10.4. **Environmental Contaminants.** Provide equipment that conforms to IEC 60529 Section 14.2.6, or most current version for IP 66 or greater rating.

3.10.5. **External Icing.** Provide equipment that is tested to conform to NEMA 250-2003 Section 5.6, or most current version.

3.10.6. **Corrosion.** Provide equipment that is tested to conform to NEMA 250-2003 Section 5.10, or most current version, when located in coastal Districts. Coastal Districts are Beaumont (BMT), Corpus Christi (CRP), Houston (HOU), Pharr (PHR), and Yoakum (YKM).

4. CONSTRUCTION

Give particular care to the interconnection of all of the components and the cabling.

4.1. **General.** Furnish and install all materials, including support, calibration and test equipment, to ensure an operating and functional solar power system. Install power and data cables, power grounding and lightning suppression systems. Prior to beginning installation, inspect each site to verify suitability of the design for installation, grounding and lightning protection. Provide written documentation to the Engineer for approval prior to installation.

Configure and setup the solar power system to assure connection and electric power delivery to the field equipment as indicated in the plans. Locate and mount all equipment as detailed in the plans and as directed by the Engineer.

4.1.1. **Wiring.** Provide wiring that meets the requirements of the NEC. Provide wires that are cut to proper length before assembly. Provide cable slacks to facilitate removal and replacement of assemblies, panels, and modules. It is not acceptable to “double-back” wire to take up slack. Lace wires neatly with nylon lacing or plastic straps. Secure cables with clamps. Provide service loops at connections.

Size all conductors for a de-rated ampacity of at least 125% of the maximum currents calculated. De-rating factors include high ambient temperatures and number of conductors run together within a conduit or cable, per NEC 690.8(B), 310.15(B) and 310.16. Single-conductor cables in sizes 16 AWG and 18 AWG are permitted for module interconnections if they meet the ampacity requirements.

Protect all conductors operating at more than 30 V and installed in readily accessible locations with conduit, per NEC 690.31(A).

Provide conductors rated for 194ºF (90ºC) and wet service per NEC 690.31(B).

Run PV source- and output-circuit conductors separately from conductors of other systems per NEC 690.31(B).

Color code all wiring. Mark grounded conductors white or gray. Use green, green/yellow or bare grounding conductors, per NEC 310.12.

Provide strain relief or conduit on all conductors per NEC 300.4.

4.1.2. **Battery Storage.** Store batteries in a cabinet or underground in battery ground box, in accordance with the Department's electrical details.

4.1.3. **Poles.** Mount all PV units and cabinets on poles as shown on the plans in accordance with the ITS solar power system standards. Provide aluminum pedestal poles as shown on the plans for the height specified in accordance with Item 687, "Pedestal Pole Assemblies." Provide treated timber poles as shown on the plans for the height specified in accordance with Item 627, "Treated Timber Poles."

4.1.4. **System Optimization.** Optimize equipment alignment and settings at each site to provide a complete and operational system.

4.1.5. **Relocation.** Prior to removal of the existing solar power system, inspect the poles, cabinets, solar panels, batteries, MPPT charge controller, and cables where included, with a representative from the Department, and remove any solar power system equipment, associated mounting hardware, and cabling still attached to the pole or inside the cabinet prior to commencing work. Inspect the existing poles, cabinets, PV modules, batteries, and MPPT charge controllers in place, with a representative from the Department, and document any evidence of damage to the representative prior to removal.

Prior to removal of the existing solar power system, disconnect and isolate cables (power and communication) from the equipment. Remove and coil existing cabling to the nearest ITS ground box or as identified on the plans or as directed. Cover all exposed ends of the disconnected cables with a material, rated for long term use, to prevent dust and moisture contamination.

Carefully remove the solar power system components from the pole structures. Avoid damage or injury to surrounding objects or individuals.

Inspect the existing pole structures, with a representative from the Department, and document any evidence of structural stress cracks or fatigue prior to removal. Remove and deliver to the Department, existing pole structures that fail structural inspection.

Remove the existing pole structures in a manner acceptable to the Engineer. Use a method such that no undue overstress or damage will result to the structures or appurtenances attached.

Use a crane of sufficient capacity to remove the pole. Disconnect and relocate the existing pole structures from and to the foundations as shown on the plans in a manner acceptable to the Engineer.

When the poles are laid down, place them on timber cribbing so that they lie reasonably straight to prevent any damage or deterioration.

Maintain safe construction and operation practices at all times. Handle the poles in such a manner during removal so as to prevent damage to the pole's exterior finish. The Contractor will be responsible for any damage to poles.

Remove the existing concrete foundations to a depth of at least 2 ft. below finish grade with all steel cut off. Backfill the excavation with material equal in composition and density to the surrounding area, and replace any surfacing, such as asphalt pavement, concrete riprap or brick pavers, with like material to equivalent condition as approved by the Engineer.

Careful erection and aligning of the relocated pole structures shall be considered an essential feature of the installation of the pole structure.

Supply all new anchor bolts required for the installation of pole structures. Provide bolt dimensions and lengths as shown on the plans and as directed and in accordance with all requirements contained in this Item.

Separately package each component with appropriate protection to avoid damage during transit to the new location shown on the plans. Re-install each component and associated cabling to manufacturer specifications and tolerances. Orient and align the PV modules for optimal sun exposure. Install, calibrate, and program the charge controllers to manufacturer specifications. Ensure that the installation is completely operational and optimized at the new location shown on the plans.

4.1.6. **Removal.** Use established industry and utility safety practices when removing poles and assemblies located near overhead or underground facilities. Coordinate with the appropriate utility company before beginning work.

Inspect the poles, cabinets, solar panels, batteries, MPPT charge controller, and cables where included, with a representative from the Department, and remove any solar power system equipment, associated mounting hardware, and cabling still attached to the pole or inside the cabinet prior to commencing work. Inspect the existing poles, cabinets, solar panels, batteries, and MPPT charge controller in place, with a representative from the Department, and document any evidence of damage to the representative prior to removal.

Prior to removal of the existing solar power system, disconnect and isolate cables (power and communication) from the equipment. Remove and coil existing cabling to the nearest ITS ground box or as identified on the plans or as directed. Cover all exposed ends of the disconnected cables to prevent dust and moisture contamination.

Carefully remove the solar power system components from the pole structure. Avoid damage or injury to surrounding objects or individuals. Separately package each component with appropriate protection to avoid damage during transit. Deliver the equipment to an address to be supplied by the Department.

Carefully remove the pole from the foundation. Avoid damage or injury to surrounding objects or individuals. Separate the pole at the slip-fitted connections, if applicable. If the pole cannot be separated, transport the complete pole or partially separate the pole to make it transportable. Deliver the pole structure to an address to be supplied by the Department.

Remove the existing drill shaft foundations to a depth of 2 ft. below grade with all steel cut off. Backfill the excavation with material equal in composition and density to the surrounding area, and replace any surfacing, such as asphalt pavement, concrete riprap, or brick pavers, with like material to equivalent condition as approved by the Engineer.

4.2. **Testing.** The Engineer reserves the right to inspect and factory test any completed assemblies prior to delivery of the material to the project site. Correct any deviances from these specifications that are identified during testing prior to shipment of the assembly to the project site.

4.2.1. **New Installations.** Unless otherwise shown on the plans, perform the following tests on equipment supplied through this item.

4.2.1.1. **Test Procedures Documentation.** Provide 5 copies of the test procedures and blank data forms 30 days prior to testing for each test required on this project. Include the sequence of the tests in the procedures. The

Engineer will approve test procedures prior to submission of equipment for tests. Conduct all tests in accordance with the approved test procedures.

Record test data on the data forms, as well as quantitative results. No bid item measurement or payment will be made until the Engineer has verified the test results meet the minimum requirements of the specification. The data forms for all tests, except design approval tests, must be signed by an authorized representative of the Contractor.

Provide written notice to the Engineer within 48 hours of discovery of any testing discrepancy performed in testing by the contractor. Furnish data forms containing the acceptable range of expected results as well as the measured values.

4.2.1.2. **Design Approval Test.** Conduct a design approval test on randomly selected units from the prototype design manufacturing run. If only 1 design prototype is manufactured, perform this test on that unit. If supplying multiple types of the equipment, provide and test a sample of each type. Test all equipment and document compliance with IEC standards 61215, 61646, and 61730.

Certification from an independent testing laboratory of a successfully completed design approval test is acceptable. Ensure that the testing by this laboratory is performed in accordance with the requirements of this specification. Failure of independent tests to comply with the requirements of this specification will be grounds for rejection of any certification.

Provide a copy of the certification to the District in which this contract is executed. The data forms for the design approval tests must be signed by an authorized representative (company official) of the equipment manufacturer or by an authorized representative of an independent testing facility.

Notify the Engineer 10 working days before conducting this testing. The Department may witness all the tests. Perform the following tests:

4.2.1.2.1. **Temperature and Condensation.** Provide equipment which meets the performance requirements, specified in this Item, when subjected to the following conditions in the order specified below:

- stabilize the equipment at -30°F and test as specified in the most current version of the NEMA TS2 Standard - Sections 2.2.7.3, "Low-Temperature Low-Voltage Tests" and 2.2.7.4, "Low-Temperature High-Voltage Tests",
- allow the equipment to warm up to room temperature in an atmosphere having relative humidity of at least 40%. Operate the equipment for 2 hrs., while wet, without degradation or failure, and
- stabilize the equipment at 165°F and test as specified in the most current version of the NEMA TS2 Standard - Sections 2.2.7.5, "High-Temperature High Voltage Tests" and 2.2.7.6, "High-Temperature Low-Voltage Tests".

4.2.1.2.2. **Relative Humidity.** Provide equipment meeting the performance requirements, specified in this Item, within 30 min. of being subjected to a temperature of 165°F and a relative humidity of 18% for 48 hr.

4.2.1.2.3. **Vibration.** Provide equipment that shows no degradation of mechanical structure, soldered components, or plug-in components and operates in accordance with the manufacturer's equipment specifications after being subjected to the vibration tests as specified in the most current version of the NEMA TS2 Standard - Section 2.2.8, "Vibration Test".

4.2.1.2.4. **Electrical Insulation Resistance.** Test the insulation of each unit as follows:

- apply up to 1000 V maximum system voltage to the panel, and
- measure at least 40 mega-ohms of resistance between the frame and ground for every square meter of panel.

4.2.1.2.5. **Wet Leakage Current.**

- submerse the module in water, except the cable entries,
- apply a test voltage between the shorted output connectors and the water bath solution up to the max system voltage for 2 min., and
- provide resistance at least 40 mega-ohms per square meter of module.

4.2.1.2.6. **Bypass Diode Test.**

- apply a thermocouple to the diode body,
- heat the module to 167ºF (75ºC), and
- apply a reverse current equal to the short circuit for 1 hr.

4.2.1.2.7. **Maximum Power Degradation.** Test Pmax degradation of each PV module as follows:

- pre-condition each module by exposing them to a total of 0.51 kWh per square foot (5.5 kWh per square meter),
- apply irradiance of 91.8 W per square foot (1,000 W per square meter) at 77ºF (25ºC) at air mass 1.5,
- check Pmax, and
- ensure that Pmax degraded is at least 95% of the labeled rating.

4.2.1.2.8. **Thermal Cycling (TC200).** Test each PV module for 200 Cycles per IEC 61215

- heat PV modules to 77ºF (25ºC),
- inject a current within 2% of the current measured at peak power, and
- cycle temperatures per IEC standard 61646.

4.2.1.2.9. **Humidity-Freeze Test.** Conduct this test per IEC 61646.

4.2.1.2.10. **Damp-Heat (DH1000).** Test each PV module for 1000 hr. under the following conditions:

- 185 ± 3.6ºF (85 ± 2ºC) PV temperature, and
- relative humidity of 85% ± 5%.

4.2.1.2.11. **Mechanical Load Test.** Test the ability of the PV module to withstand wind, snow, static, or ice loads as follows:

- mount the module per manufacturer instructions,
- apply 0.215 psi (equivalent wind load at 110 mph) for 1 hour on each face of the module,
- increase pressure to 0.484 psi for snow and ice,
- no intermittent open circuits permitted during test, and
- visually inspect for defects.

4.2.1.2.12. **Hail Impact Resistance.** Use a 2 in. diameter steel ball weighing 1.18 lb., dropped from a height of 51 in. onto the center of the solar panel face.

4.2.1.3. **Demonstration Test.** Conduct a demonstration test on all major components at an approved Contractor facility. The Contractor may submit procedures and results from previous contracts in the same District as this contract, provided the materials and equipment are identical. Provide previous procedures and results that are, at most, 5 years old. Notify the Engineer 10 working days before conducting this testing. The Department may witness all the tests. Perform the following tests:

4.2.1.3.1. **Examination of Product.** Examine each unit carefully to verify that the materials, design, construction, markings and workmanship comply with the requirements of this Item.

4.2.1.3.2. **Continuity Tests.** Check the electrical continuity of the wiring to verify conformance with the applicable requirements in this item.

4.2.1.3.3. **Operational Test.** Operate each unit for at least 15 min. to permit equipment temperature stabilization and an adequate number of performance characteristics to ensure compliance with the requirements of this Item. At a minimum, test the following measured values against design assumptions:

- charging voltage at charge controller,
- output current at charge controller,
- output voltage at solar array,
- output voltage at battery bank, and
- solar array disconnect switch functionality.

With a fully charged battery bank, use the toggle switch to disconnect the solar panel array. Allow the system to run without solar power for 5 days. Measure the battery bank depth of discharge at the end of the 5 day test. Ensure that no more than 80% of full capacity has been discharged.

With the battery bank discharged to an 80% depth of discharge, connect the solar array on a sunny day. A sunny day is defined as daylight full sun for a period of at least 5 hrs. At the end of the day, test battery bank charge. Ensure that the battery bank is at full charge at the end of the day.

4.2.1.4. **Field Acceptance Test.** Following completion of equipment installation and operational optimization, submit an acceptance test plan to District for review and approval. During the official acceptance testing, provide the technical staff to conduct the measurements and adjustments called for in the testing. District will participate in the testing as the official test witness. Each page of the acceptance test document will provide for data recording of the test results, and the name of Contractor's representative conducting the test as well as a suitable field for the test date and signature of District test witness. Upon District approval of the test plan and the test schedule, the acceptance testing may begin.

Conduct a field acceptance test for each unit after installation as required by the Engineer in order to demonstrate compliance with the functional requirements with this Item. Exercise all stand-alone (non-network) functional operations. Provide a factory-certified representative for installation and testing of the equipment. Notify the Engineer 5 working days before conducting this test. The field acceptance test will at least consist of the following:

4.2.1.4.1. **Visual Inspection.** Conduct a visual inspection of all PV modules to ensure that none of the following are present:

- broken, cracked, or torn external surfaces, including superstrates, substrates, frames and junction boxes, or
- bent or misaligned external surfaces, including superstrates, substrates, frames, and junction boxes to the extent that the installation or operation of the module would be impaired, or
- a crack in a cell the propagation of which could remove more than 10% of that cell's area from the electrical circuit of the module, or
- bubbles or delaminations forming a continuous path between any part of the electrical circuit and the edge of the module, or
- loss of mechanical integrity, to the extent that the installation or operation of the module would be impaired, or
- module markings (label) are no longer attached, or the information is unreadable.

Conduct a visual inspection of the overall installation to ensure the following:

- equipment is installed and used in accordance with the plans and manufacturer’s instructions,
- site drawings include descriptions and locations of major components,
- electrical diagram includes component interconnects, conductor types and sizes, conduit types and sizes, disconnects, and point of interconnection,
- appropriate conductors and wiring methods are used,
- all PV conductors are routed through their own conduits, independent of conductors for other systems, and

- junction boxes are of appropriate type and size and allow the conductors within to be accessible.

4.2.1.4.2. **Physical Construction.** Verify physical construction is completed in accordance with the plans and specification.

4.2.1.4.3. **Electrical Connections.** Verify that all connectors for grounding, surge suppression, and electrical distribution are tightened correctly and are quality connectors. Verify the following:

- all power supplies and circuits are operating under the proper voltages,
- all power and communications cables are terminated correctly, secured inside the cabinet, and fitted with appropriate connectors,
- connectors are polarized, non-interchangeable, guarded, latching or locking, and have "first-to-make/last-to-break" contact for grounded conductor,
- wiring connectors are listed for the intended use and environment. Screw terminals are tightened to recommended torque. Crimp-on terminals are installed with appropriate crimping tool,
- grounded conductors are marked white or gray and grounding conductors are green, green/yellow, or bare,
- battery interconnections are made with #2/0 AWG or larger flexible cables that are listed for hard-service use and are moisture resistant, and
- current-limiting fuses are installed on battery output circuits.

4.2.1.4.4. **Grounding.** Field test equipment grounding for all ITS solar power system equipment installed in the field and provide written documentation to the engineer. Where earth ground resistance values exceed 5 ohms, develop mitigation measures for consideration. Once mitigation measures are installed, re-test earth ground and update the documentation. Ensure that grounded conductors are marked white or gray and grounding conductors are green, green/yellow, or bare.

4.2.1.5. **Final Acceptance Test.** Following completion of the demonstration test and field acceptance Test for all subsystems, provide completed data forms containing all of the data recorded, including quantitative results for all tests, a set of "as built" working drawings, and a written request to begin a data communication and final acceptance test. Provide "as built" working drawings indicating the actual material, equipment, connections, and construction of the various subsystem components. In addition, indicate the actual location that the components were installed, providing either GPS coordinates or dimensions to other fixed objects on the plans. For pole mounted solar arrays, provide an elevation view showing pole height, location of the panels on the pole, mounting details, and orientation or azimuth of the panels.

The project will not be accepted, notwithstanding other provisions in the Contract, until the system, inclusive of all subsystems, has operated satisfactorily for a period of 90 days and in full compliance with the plans and specifications after approval of all submitted test results and reports.

4.2.1.6. **Consequences of Test Failure.** If a unit fails a test, submit a report describing the root cause of the failure and the actions taken to remedy the situation prior to modification or replacement of the unit. If a unit requires modification, correct the fault and then repeat the test until successfully completed. Correct minor discrepancies within 30 days of written notice to the Engineer. If a unit requires replacement, provide a new unit and then repeat the test until successfully completed. Malfunctions that will substantially delay receipt and acceptance of the unit will be sufficient cause for rejection of the unit.

Failure to satisfy the requirements of any test is considered a defect and the equipment is subject to rejection by the Engineer. The rejected equipment may be offered again for retest provided all noncompliance has been corrected. Multiple failures are sufficient reason for complete rejection.

If a failure pattern develops in similar units within the system, implement corrective measures, including modification or replacement of units, to all similar units within the system as directed. Perform the corrective measures without additional cost or extension of the contract period.

4.2.1.6.1. **Consequences of Design Approval Test Failure.** If the equipment fails the design approval test, correct the fault within 30 days and repeat the design approval test until successfully completed.

4.2.1.6.2. **Consequences of Demonstration Test Failure.** If the equipment fails the demonstration test, correct the fault within 30 days and repeat the demonstration test until successfully completed.

4.2.1.6.3. **Consequences of Field Acceptance Test Failure.** If the equipment fails the field acceptance test, correct the fault within 30 days and repeat the field acceptance test until successfully completed.

4.2.1.6.4. **Consequences of Final Acceptance Test Failure.** If a defect within the system is detected during the final acceptance test, document and correct the source of failure within 30 days. Once corrective measures are taken, monitor the point of failure until a 30 consecutive day period free of defects is achieved.

If after completion of the initial test period, the system downtime exceeds 72 hr. or individual points of failure have not operated for 30 consecutive days free of defects, extend the test period by an amount of time equal to the greater of the downtime in excess of 72 hr. or the number of days required to complete the performance requirement of the individual point of failure.

4.2.2. **Relocation and Removal.**

4.2.2.1. **Pre-Test.** The Contractor will prepare a pre-test report for approval by the Engineer. Conduct performance testing prior to removal of solar power system. Test all functional operations of the equipment in the presence of representatives of the Contractor and the Department. Ensure that both representatives sign the test report indicating that the equipment has passed or failed each function. Once removed, the equipment becomes the responsibility of the Contractor until accepted by the Department. Compare test data prior to removal and test data after installation. The performance test results after relocation must be equal to or better than the test results prior to removal. Repair or replace those components within the system which failed after relocation but which passed prior to removal, at no cost to the Department.

4.2.2.2. **Post Test.** Testing of solar power system is for the purpose of relieving the Contractor of maintenance of the system. The Contractor will be relieved of the responsibility for maintenance of the system in accordance with Item 7, “Legal Relations and Responsibilities”, after all tests conducted in the pre-test have passed.

4.3. **Documentation.** Submit a system report detailing the PV array, battery bank, charge controllers, and shop drawings prior to the installation of the solar power system to the Engineer for review and approval. Shop drawings to include, but not be limited to:

- details of the complete installation of the system and all components to be supplied,
- details of all connections between the solar panel power supply system components,
- cabinet layout diagrams depicting the arrangement of all equipment inside the cabinets,
- instruction sheets and wiring diagrams for the equipment to be installed, and
- the manufacturer specifications and catalog cuts and parts lists.

Provide technical operators manuals for all equipment, including the PV modules, charging controller, and batteries.

Submit shop drawings, signed, sealed, and dated by a registered professional engineer in Texas showing the fabrication and erection details for each support, including the cabinet and mounting details in accordance with Item 5, “Control of the Work.”

Provide at least 2 complete sets of operation and maintenance manuals in hard copy format and on a CD/DVD or removable flash drive that include the following:

- complete and accurate schematic diagrams,
- complete installation procedures,
- complete performance specifications (functional, electrical, mechanical and environmental) on the unit,

- complete parts list including names of vendors for parts not identified by universal part number such as JEDEC, RETMA, or EIA,
- pictorial of component layout,
- complete maintenance and trouble-shooting procedures,
- complete stage-by-stage explanation of circuit operation,
- recovery procedures for malfunction, and
- instructions for gathering maintenance assistance from manufacturer.

Provide the Department with certification documentation verifying conformance with environmental and testing requirements contained in the special specification. Certifications may be provided by the manufacturer or through independent labs.

4.4. **Warranty.** Warrant the equipment against defects and failure in design, materials, and workmanship for at least 3 years or in accordance with the manufacturer's standard warranty if that warranty period is greater. The start date of the manufacturer's standard warranty will begin after the equipment has successfully passed all tests contained in the final acceptance test plan. Any equipment with less than 90% of its warranty remaining at the completion of the final acceptance test will not be accepted by the Department. Guarantee that equipment furnished and installed for this project performs according to the manufacturer's published specifications. Assign to the Department, all manufacturer's normal warranties or guarantees on all electronic, electrical, and mechanical equipment, materials, technical data, and products furnished for and installed on the project.

Repair or replace any malfunctioning equipment at the Contractor's expense prior to beginning the final acceptance test plan.

Repair or replace defective equipment during the warranty period at no cost to the Department. Any replaced units will inherit the remainder of the failed unit's warranty period.

Return all items sent to a factory authorized repair depot (in the United States) within 2 weeks of the date of receipt at the facility. Under the warranty, provide shipping free of charge both to and from the repair site.

For each component from the designated depot repair site, issue a warranty certificate indicating the start and end dates of the warranty. Supply the certificate at the conclusion of the Solar Panel Power System Acceptance Test or the end of the construction of the project, whichever comes last and set the end date for at least 2 years after that point. Name the District as the recipient of the service. Ensure that District has the right to transfer this service to other private parties who may be contracted to perform overall maintenance of the facility.

Furnish replacement parts and all equipment, with transportation prepaid, within 10 days of notification of failure by the Department.

During the warranty period, provide free technical support from the supplier. This support is to be free of charge, offered within 4 hours of request, and provided by factory certified personnel or factory certified installers of the equipment.

Provide ongoing software and firmware updates during the warranty period, free of charge. Any updates must be tested and approved by the Department prior to installation.

Maintain an inventory of parts to support maintenance and repair of all equipment.

5. MEASUREMENT

This Item will be measured by each ITS solar power system furnished, installed, relocated, or removed.

6. PAYMENT

6.1. **Furnish and Install.** The work performed and materials furnished in accordance with this Item and measured as provided for under "Measurement" will be paid for at the unit price bid for “SPS-INS” of the total system load (in Watts), the total solar panel (in Watts), the total battery (in amp hr) capacity, number of charge controllers with amperage capacity (Amps), and cabinet installation type**.** This price is full compensation for making fully operational a solar power system; all cabinets, treated timber poles, connectors and mounting assemblies, hardware, cables and connectors; and all testing, training, software, equipment, labor, materials, tools, and incidentals. Where the cabinet type is an ITS pole mounted cabinet, the cabinet will be paid for separately in accordance with “ITS Pole with Cabinet.”

New drilled shaft foundations will be paid for in accordance with Item 416, "Drilled Shaft Foundations."

New conduit will be paid for in accordance with Item 618, "Conduit."

Type Battery ground boxes will be paid for in accordance with Item 624, “Ground Boxes.”

Treated timber poles will be paid for in accordance with Item 627, “Treated Timber Poles.”

New pedestal poles will be paid for in accordance with Item 687 “Pedestal Pole Assemblies.”

New ITS poles with cabinets will be paid for in accordance with “ITS Pole with Cabinet.”

6.2. **Relocate.** The work performed and materials furnished in accordance with this Item and measured as provided for under "Measurement" will be paid for at the unit price bid for “SPS-REL” of the total system load (in Watts), the total solar panel (in Watts), the total battery (in amp hr) capacity, number of charge controllers with amperage capacity (Amps), and cabinet installation type. This price is full compensation for relocating and making fully operational an existing solar power system; and all testing, training, software, equipment, labor, materials, tools, and incidentals. Removal of existing foundations will be paid for under this item.

New drilled shaft foundations will be paid for in accordance with Item 416, "Drilled Shaft Foundations."

New conduit will be paid for in accordance with Item 618, "Conduit."

Type Battery ground boxes will be paid for in accordance with Item 624, “Ground Boxes.”

Treated timber poles will be paid for in accordance with Item 627, “Treated Timber Poles.”

New pedestal poles will be paid for in accordance with Item 687 “Pedestal Pole Assemblies.”

New ITS poles with cabinets will be paid for in accordance with “ITS Pole with Cabinet.”

6.3. **Remove.** The work performed and materials furnished in accordance with this Item and measured as provided for under "Measurement" will be paid for at the unit price bid for “SPS-REM” of the total system load (in Watts), the total solar panel (in Watts), the total battery (in amp hr) capacity, number of charge controllers with amperage capacity (Amps), and cabinet installation type. This price is full compensation for removing an existing solar power system; and all testing, training, software, equipment, labor, materials, tools, and incidentals. Removal of existing foundations will be paid for under this item.

Special Specification 6064

Intelligent Transportation System (ITS) Pole with Cabinet

1. DESCRIPTION

Furnish, install, relocate, or remove Intelligent Transportation System (ITS) pole structures and pole mounted cabinets of the various types and sizes at locations shown on the plans, or as directed.

1.1. **ITS Equipment Application.** At a minimum, the ITS pole structure serves as the structural support for the following ITS equipment applications:

- closed circuit television (CCTV),
- fixed video,
- microwave vehicle detector (MVD) or radar vehicle sensing device (RVSD),
- bluetooth equipment,
- wireless radio equipment,
- environmental sensor station (ESS),
- solar power system, and
- pole mounted cabinets.

Ensure the equipment, design, and construction use the latest available techniques with a minimum number of different parts, subassemblies, circuits, cards, and modules to maximize standardization and commonality.

Design the equipment for ease of maintenance. All component parts must be readily accessible for inspection and maintenance. The only tools and test instruments required for maintenance by maintenance personnel must be simple hand held tools, basic meters and oscilloscopes.

2. MATERIALS

Provide materials that comply with the details shown on the plans or as directed, the requirements of this Item, and the pertinent requirements of the following Items:

- Item 416, “Drilled Shaft Foundations,”
- Item 421, “Hydraulic Cement Concrete,”
- Item 440, “Reinforcement for Concrete,”
- Item 441, “Steel Structures,”
- Item 442, “Metal for Structures,”
- Item 445, “Galvanizing,”
- Item 449, “Anchor Bolts,”
- Item 496, “Removing Structures,”
- Item 618, “Conduit,”
- Item 620, “Electrical Conductors,” and
- Item 740, “Graffiti Removal and Anti-Graffiti Coating”.

2.1. **Anchor Bolts.** Provide anchor bolts, nuts, and washers that conform with the details shown on the plans, the requirements of this Item, and in accordance with Item 449, “Anchor Bolts.”

Furnish “medium strength, mild steel” anchor bolts for anchor bolts 1 in. or less in diameter, unless otherwise shown on the plans. Furnish “alloy steel” anchor bolts for anchor bolts greater than 1 in. diameter, unless otherwise shown on the plans.

2.2. **ITS Poles.** Provide material for pole shafts that conforms to the requirements on the plans and the requirements of ASTM A1011 SS Grade 50, A572 Grade 50, A1011 HSLAS Grade 50, or A595 Grade A. Material thicknesses in excess of those stipulated under A1011 will be acceptable providing it meets all other ASTM A1011 requirements and the requirements of this specification. A595 Grade A material must have a minimum of 50 ksi yield strength adjacent to base welds after fabrication.

Fabrication plants that produce steel ITS poles must be approved in accordance with DMS-7380, “Steel Non-Bridge Member Fabrication Plant Qualification.” The Department maintains an MPL of approved ITS pole fabrication plants.

2.3. **ITS Pole Mounted Cabinet.** Provide ITS pole mounted cabinets to house ITS field equipment as shown on the plans or as directed. ITS equipment applications inside the cabinet may include, but is not limited to:

- CCTV field equipment,
- fixed video,
- radar vehicle sensing device (RVSD),
- dynamic message sign (DMS) or lane control signal (LCS) controller,
- bluetooth equipment,
- highway advisory radio (HAR),
- media conversion equipment,
- hardened ethernet switch,
- wireless radio equipment,
- environmental sensor station (ESS),
- roadway weather information system (RWIS), and
- solar power system.

Provide the cabinet with fully wired back panels, with all the necessary terminal boards, wiring, harnesses, connectors and attachment hardware for each cabinet location. Place all terminals and panel facilities on the lower portion of the cabinet walls below all shelves.

Typically, an ITS pole mounted cabinet may contain, but is not limited to, the following:

- 19-in. EIA rack,
- adjustable shelves,
- fan and thermostat,
- cabinet light,
- back panel,
- surge protection,
- terminal strips,
- interconnect harnesses with connectors,
- “Door Open” connection to back panel,
- ITS equipment hardware (as listed in Article 2.3), and
- all necessary installation and mounting hardware.

Ensure all cabinets are identical in size, shape and quality for each type as provisioned on the plans or as directed. Equip and configure the cabinet set-up as defined in this Specification and as detailed in the ITS pole with cabinet standards.

Submit details of the cabinet design and equipment layout for each cabinet to the Engineer for review and approval before fabrication.

2.4. **Electrical Requirements.**

2.4.1. **Primary Input Power Interruption.** Use material that meets all the requirements in Section 2.1.4., "Power Interruption" of the National Electrical Manufacturers Association (NEMA) Standard TS2 for traffic control system, or most current version.

2.4.2. **Power Service Transients**. Use material that meets all the requirements in Section 2.1.6., "Transients" of the NEMA Standard TS2 for traffic control system, or most current version.

2.4.3. **Power Service Protection.** Ensure that equipment contains readily accessible, manually resettable or replaceable circuit protection devices (such as circuit breakers or fuses) for equipment and power source protection. Provide circuit breakers or fuses sized such that no wire, component, connector, PC board or assembly is subjected to sustained current in excess of their respective design limits upon failure of any single circuit element or wiring.

2.4.4. **Power Distribution Panel.** Provide cabinets with a 120 VAC +/- 5 VAC power distribution panel. Provide the following components on the panel:

2.4.4.1. **Duplex Receptacles**. Provide two 120 VAC NEMA Type 5-15R duplex receptacles, or as shown on the plans, protected by a circuit breaker. Permanently label duplex receptacles "For Internal ITS Equipment Only." Install duplex receptacles in an isolated location and provide a clear 1/8 in. thick removable cover made from transparent thermoplastic material to cover the duplex receptacles. Ensure this cover is installed as not to interfere with the functional operation within the cabinet and allows enough space to plug in AC adapters and any necessary equipment. Submit alternative cover material for approval as part of the documentation submittal requirement.

2.4.4.2. **Ground Fault Circuit Interrupter (GFCI) Duplex Receptacles**. Provide at least one 120 VAC NEMA Type 5-15R GFCI duplex receptacle, or as shown on the plans, protected by a circuit breaker. This GFCI duplex receptacle is intended for maintenance personnel and is not to be used to serve equipment inside the cabinet. Permanently label GFCI duplex receptacles "For Personnel Use." Install GFCI duplex receptacles in a readily accessible location.

Provide a 120 VAC, rack mountable outlet strip with 6 NEMA Type 5-15R receptacles with surge suppression. Plug outlet strip into GFCI duplex receptacle and label for personnel use.

Circuit Breakers. Determine the ampere rating, quantity, and configuration for main, accessory, spare, and equipment circuit breakers to support ITS equipment loads as shown on the plans. Provide Underwriters Laboratories (UL) 489 listed circuit breakers capable of operating in accordance with Section 2, "Environmental Standards and Test Procedures" of NEMA TS2-2003, or most current version. Provide circuit breakers with an interrupt capacity of 5,000 A. and insulation resistance of 100 megohms at 500 VDC. Provide minimum ampere rating for the following circuit types:

2.4.4.2.1. **Main Breaker**. Size the main circuit breaker such that the load of all branch circuits is less than the main circuit breaker ampere rating in accordance with the most current version of the National Electrical Code (NEC).

2.4.4.2.2. **Accessory Breaker**. Minimum 15 A. Size accessory circuit breaker to protect lighting, door switches, fans, and GFCI duplex receptacle in accordance with the most current version of the NEC.

2.4.4.2.3. **Equipment Breakers**. Minimum 15 A. Size equipment circuit breaker to protect ITS equipment and duplex receptacles in accordance with the most current version of the NEC.

2.4.4.2.4. **Spare Equipment Breaker**. Minimum 20 A. Provide one spare equipment breaker for future use.

Furnish breakers, which are in addition to any auxiliary fuses, with the electronic equipment to protect component parts. Provide 3-terminal lightning arrestor to protect the load side of all circuit breakers. Connect

the arrestor into the circuit with size 8 AWG or larger stranded copper conductors. Connect arrestor to the line filter as recommended by the manufacturer.

2.4.4.3. **Power Line Surge Protection.** Provide and install power line surge protection devices that meet the requirements of Article 2.6.

2.4.4.4. **Power Cable Input Junction Terminals.** Provide power distribution blocks suitable for use as a power feed and junction points for 2 and 3 wire circuits. Accommodate up to No. 4 AWG conductors on the line side of each circuit. Provide appropriate sized lugs at the junction terminals for conductors larger than a No. 4 AWG when shown on the plans.

Electrically isolate the AC neutral and equipment ground wiring from the line wiring by an insulation resistance of at least 10 megohms when measured at the AC neutral. Color code the AC neutral and equipment grounding wiring white and green respectively in accordance with the most current version of the NEC.

Utilize the back panel to distribute and properly interconnect all cabinet wiring related to the specific complement of equipment called out on the plans. Each item of equipment including any furnished by the Department must have the cable harness properly terminated at terminal boards on the back panel. Ensure all functions available at the equipment connector are carried in the connector cable harness to the terminal blocks from the power distribution panel mounted on the left side panel of the cabinet.

2.4.5. **Alternative Power Option.** When shown on the plans, accommodate renewable electrical power source for the design load specified in accordance with “ITS Solar Power System” Specification. Renewable electrical power source may, or may not, be integrated with public utility electrical services, as shown on the plans or as directed. Accommodate solar system components including batteries and solar charge controller when shown on the plans.

2.4.6. **Wiring.** Ensure all cabinet wiring identified by the use of insulated pre-printed sleeving slipped over the wire before attachment of the lug or making the connection. Supply enough text on wire markers in plain words or abbreviations with sufficient level of detail so that a translating sheet will not be required to identify the type and size of wire.

Cut all wires to the proper length before assembly. Ensure no wires are doubled back to take up slack. Ensure harnesses to connectors are covered with braided cable sleeves. Secure cables with nylon cable clamps.

Provide service loops to facilitate removal and replacement of assemblies, panels and modules. Use insulated parts and wire rated for at least 600 V. Color-code harnesses and wiring.

Route and bundle all wiring containing line voltage AC separately and shield from all low voltage, i.e., control circuits. Cover all conductors and live terminals or parts, which could be hazardous to maintenance personnel, with suitable insulating material.

Provide AC internal cabinet wiring identified in accordance with the most current version of the NEC. Provide white insulated conductors for AC neutral. Provide green insulated conductors for equipment ground. Provide any color different from the foregoing on other conductors in accordance with the most current version of the NEC. For equipment that requires grounding, provide grounding conductors and do not use conduit for grounding. Provide No. 22 AWG or larger stranded conductors for internal cabinet wiring. Provide conductors that are UL-listed THHN in accordance with the most current version of the NEC. Ensure the insulation has at least a thickness of 10 mm. Ensure all wiring containing line voltage is at least size No. 14 AWG. No strands of any conductor may be trimmed to “fit” the wiring into the breaker or terminal block.

2.4.7. **Terminal Strips.** Provide terminal strips located on the back panel that are accessible to the extent that it is not necessary to remove the electronic equipment from the cabinet to make an inspection or connection.

Ensure terminal blocks are 2 position, multiple pole barrier type.

Provide shorting bars in each of the positions provided along with an integral marking strip.

Arrange terminal blocks such that they will not upset the entrance, training and connection of incoming field conductors.

Identify all terminals with legends permanently affixed and attached to the terminal blocks.

Ensure not more than 3 conductors are brought to any 1 terminal screw.

Ensure no electrically energized components or connectors extend beyond the protection afforded by the barriers.

Locate all terminal blocks below the shelves.

Ensure terminals used for field connections are secure conductors by means of a No. 10-32 nickel or cadmium plated brass binder head screw.

Ensure terminals used for interwiring connections, but not for field connections, are secure conductors by means of a No. 5-32 nickel plated brass binder head screw.

Terminate all connections to and from the electronic equipment to an interwiring type block. These blocks will act as intermediate connection points for all electronic equipment input and output.

Provide termination panels that are used to distribute and properly interconnect all cabinet wiring related to the specific complement of equipment as shown on the plans. Provide properly terminated cable harnesses for each item including any furnished by the Department. Provide all functions available at the equipment terminals that are carried in the connector cable harness.

2.4.8. **Cabinet Internal Grounding.** The cabinet internal ground consists of at least 1 ground bus-bar permanently affixed to the cabinet and connected to the grounding electrode.

Use bare stranded No. 4 AWG copper wire between bus-bars and between the bus-bar and grounding electrode when providing multiple bus-bars.

Ensure each copper ground bus-bar has a minimum of 12 connection points, each capable of securing bare conductor ranging in size from No 4 AWG to No 14 AWG.

Return AC neutral and equipment ground wiring to these bus-bars.

2.4.9. **Door Switch.** Provide door switch meeting the following requirements:

- momentary, pin-type door switch,
- installed in the cabinet or on the door, and
- connected to a terminal so that the equipment installed in the cabinet can confirm input is connected to logic ground when the cabinet door is open.

Provide 2 momentary, pin type door switches for each door provided with the cabinet. Wire 1 switch to turn on the cabinet lights when the door is open and off when the door is closed. Wire the other in parallel to a terminal block to detect a cabinet intrusion condition.

2.5. **Mechanical Requirements.**

2.5.1. **Size and Construction.** Provide ITS pole mounted cabinets meeting the configuration types detailed in the Statewide ITS pole with cabinet standards.

Table 1
Minimum Cabinet Internal Dimensions

	Depth (in.)	Width (in.)	Height (in.)
Type 1	12[1]	24	24
Type 2	18	24	36
Type 3	20	24	41

1. Minimum dimension for cabinet provided without EIA 19 in. rack assembly. Provide 18 in. minimum depth when providing EIA 19 in. rack assembly.

Determine the suitability of the listed cabinet configuration types for the equipment at each field location identified on the plans or as desired.

2.5.2. **Ventilation.** Provide the cabinet with vent openings to allow cooling of electronic components.

Locate louvered air intake vent openings on the lower portion of the cabinet doors and covered fully on the inside with a commercially available disposable 3 layer graded pleated type filter of minimum size 6 in. (high) x 12 in. (wide) for Type 1 cabinet and 12 in. (high) x 16 in. (wide) for Type 2 and 3 cabinets. Size the louvered intake area and filter to allow maximum filtered air flow and cooling, securely mounted so that any air entering the cabinet must pass through the filter. Ensure the cabinet opening for intake of air is large enough to accommodate filter size. Screen the exhaust to prevent entry of insects. Provide the screen openings no larger than 0.0125-sq. in.

Provide a, minimum of 2, thermostatically controlled fans that are adjustable with an adjustment range of 70 to 110°F. Provide a press-to-test switch to test the operation of the fan. Provide a fan with a capacity of at least 110 cfm each.

There is no opening on the roof of the cabinet.

2.5.3. **Lighting.** Provide minimum 15 W fluorescent fixtures above each door inside the cabinet, each with clear shatter proof lens. NEMA TS2 rated light-emitting diode (LED) fixtures are acceptable instead of fluorescent light fixtures. Determine the appropriate number of fixtures to achieve at least 1000 lumens to illuminate the equipment. Position the fixtures to provide illumination to the face of the equipment in the cabinet and not into a technician's eyes.

2.5.4. **Exterior Finish.** Provide cabinets with a smooth aluminum finish and the exterior in its unpainted natural color.

When shown on the plans or as directed, provide cabinets with an anti-graffiti coating in accordance with Item 740 "Graffiti Removal and Anti-Graffiti Coating."

2.5.5. **Serial Number.** Provide the cabinets with a serial number unique to the manufacturer, preceded by an assigned 2 letter manufacturer's code. Provide at least a 0.2 in. letter height. Stamp the entire identification code and number on a metal plate which is riveted to the cabinet, stamp directly on the cabinet wall, or engrave on a metalized mylar plate that is epoxied on the upper right hand cabinet side wall.

2.5.6. **Modular Design.** Provide cabinets that have a modular design and allows ITS equipment to be installed in a variety of mounting configurations as detailed on the plans or as directed.

Provide Type 1 and Type 2 cabinets with 2 unistrut or DIN rail channels on each side wall of the cabinet for mounting power panel and auxiliary ITS equipment. Provide a 19 in. EIA rack assembly only when noted on the plans or in the general notes.

Provide Type 3 cabinets with an EIA 19 in. rack assembly, sized appropriately based on cabinet type inside height dimension and is accessible from either door. Provide a rack with a minimum of one 1RU (RU = rack

unit) horizontal power strip. Provide 2 unistrut or DIN rail channels on each side wall of the cabinet for mounting power panel and auxiliary ITS equipment.

2.5.7. **Shelves.** Provide adjustable shelves in each cabinet as required to support the equipment as specified on the plans. Ensure shelf adjustment at 1 RU intervals in the vertical position. Provide shelves that can be mounted to an EIA 19 in. rack cage or unistrut channel as detailed in the standards.

Provide shelves that are removable and capable of supporting the electronic equipment. Provide a minimum of 2 in. between the back and front edge of the shelf to back inside wall and door of the cabinet respectively to allow room for the equipment cables and connectors.

Provide each cabinet type with at least 1 slide out drawer with telescoping drawer guides to allow full extension from the rack frame. Provide at least 1.75 in. (high) x 16 in. (wide), drawer sized appropriately for the cabinet with a hinged lid to allow access to storage space.

2.5.8. **Mounting Hardware.** Provide cabinets with the appropriate “U” channel mounting brackets, stiffening plates, anchor bolts, and any other necessary hardware to mount the cabinet on the ITS pole structure. Provide mounting brackets made of 0.250 in. thick steel.

Weld cabinet mounting plates to the pole. This may be done in the field for transport reasons. Do not band the cabinet or mounting plates to the pole. Design the cabinet for pole mounting and reinforce at the points of attachment to the pole

2.6. **Surge Protective Devices (SPD).** Provide SPDs to protect electronics from lightning, transient voltage surges, and induced current. Install SPDs on all power, data, video, and any other conductive circuit.

2.6.1. **120 V or 120/240 V SPD at Service and ITS Cabinet Power Distribution Panel.** Install an SPD at the closest termination or disconnection point where the supply circuit enters the cabinet. Locate the SPD on the load side of the cabinet power distribution panel breakers and ahead of any and all electronic devices. Keep leads as short as possible with all conductor bends formed to the maximum possible radius. Connect the SPD ground lead directly to the ground bus. Use of wire nuts is prohibited. Install in accordance with manufacturers recommendations.

Provide UL Listed Type 1 or Type 2 SPD and labeled to UL1449 Third Edition, posted at UL.com, under Certifications UL Category Code VZCA, and have a 20 kA I-nominal rating. Provide SPD rated as NEMA 4. SPD with integral EMI/RFI line filtering may be required if shown on the plans.

Do not exceed 700 V on the Voltage Protection Rating (VPR) on any mode (L-N, L-G, and N-G).

Do not exceed 150 V on the Maximum Continuous Operating Voltage (MCOV).

Equal or exceed 40 kA the SPD surge current rating per mode (L-N), (L-G), (N-G).

Equal or exceed 50 kA or the available short circuit current, whichever is higher for the SPD Short Circuit Current Rating (SCCR).

Provide SPD with directly connected Metal Oxide Varistors (MOV) exceeding 32 mm in diameter with thermal safety disconnectors. Gas tube and spark gap SPD are not be permitted. Ensure each MOV’s operational status can be monitored via visual indicator, including N-G mode.

Provide SPD with one set of Normally Open (NO), Normally Closed (NC) Form C contacts for remote monitoring.

Ensure the SPD utilized for AC power does not dissipate any energy and does not provide any series impedance during standby operation. Return the unit to its non-shunting mode after the passage of any surge and do not allow the shunting of AC power

2.6.2. **Parallel SPD for 120 V Equipment.** Install an SPD inside of the cabinet on the power distribution to the equipment. Keep leads as short as possible with all conductor bends formed to the maximum possible radius. Connect the SPD ground lead directly to the ground bus. Use of wire nuts is prohibited. Install in accordance with manufacturers recommendations.

Provide UL Listed Type 1 or Type 2 SPD labeled to UL1449 Third Edition, posted at UL.com, under Certifications UL Category Code VZCA, and have a 20 kA I-nominal rating. Provide SPD rated as NEMA 4.

Do not exceed 700 V on the Voltage Protection Rating (VPR) on any mode (L-N and N-G).

Do not exceed 150 V on the Maximum Continuous Operating Voltage (MCOV).

Equal or exceed 40 kA the SPD surge current rating per mode (L-N) and (N-G).

Equal or exceed 50 kA or the available short circuit current, whichever is higher for the SPD Short Circuit Current Rating (SCCR).

Provide SPD with directly connected Metal Oxide Varistors (MOV) exceeding 32 mm in diameter with thermal safety disconnectors. Gas tube and spark gap SPD are not be permitted. Ensure each MOV's operational status can be monitored via visual indicator, including N-G mode.

Provide SPD with one set of Normally Open (NO), Normally Closed (NC) Form C contacts for remote monitoring.

2.6.3. **Low-Voltage Power, Control, Data and Signal Systems SPD.** Install a specialized SPD on all conductive circuits including, but not limited to, data communication cables, coaxial video cables, and low-voltage power cables. Ensure that these devices comply with the functional requirements shown in Table 2 for all available modes (i.e., power L-N, N-G; data and signal center pin-to-shield, L-L, L-G, and shield-G where appropriate).

These specialized SPD must have an operating voltage matching the characteristics of the circuit. Ensure that these specialized SPD are UL 497B or UL 497C Listed, as applicable.

Provide the SPD with 3 stages of surge suppression in a Pi (π) configuration. The first stage (primary side) consists of parallel-connected Gas Discharge Tubes (GDTs). The second stage consists of a series connected resistor or inductor. The third stage (secondary side) consists of parallel-connected transorbs or silicone avalanche diodes (SADs).

Ground the SPD to the DIN rail and a wire terminal connection point. (Grounding solely through the DIN rail connection is not adequate and does not meet the performance or intent of this specification.)

Install coaxial SPDs in a manner that prevents ground loops and resulting signal deterioration. This is usually caused where the cable has different references to ground at either end and connecting SPDs at both ends that have only Pin to Shield protection completes a ground loop circuit through the Shield. SPDs having Pin to Shield protection, and separate Shield to Ground protection are acceptable to eliminate ground loops.

Table 2
SPD Minimum Requirements

Circuit Description	Maximum Continuous Operating Voltage (MCOV)	Frequency/ Bandwidth/ Data Rate	Surge Capacity	Maximum Let-Through Voltage
12 VDC	15-20 V	N/A	5 kA per mode (8x20 µs)	<150 Vpk
24 VAC	30-55 V	N/A	5kA per mode (8x20 µs)	<175 Vpk
48 VDC	60-85 V	N/A	5 kA per mode (8x20 µs)	<200 Vpk
Coaxial Composite Video	4-8 V	Up to 1.5 GHz	10 kA per mode (8x20 µs)	<100 Vpk
RS422/RS485	8-15 V	Up to 10 Mbps	10 kA per mode (8x20 µs)	<30 Vpk
T1	13-30 V	Up to 10 Mbps	10 kA per mode (8x20 µs)	<30 Vpk
Ethernet Data	7-12 V	Up to 100 Mbps	3kA per mode (10x1000 µs)	<30 Vpk

2.7. **Environmental Design Requirements.** Provide cabinets that meet the functional requirements of this Item during and after subjection to any combination of the following requirements:

- ambient temperature range of -30 to 165°F,
- temperature shock not to exceed 30°F per hour, during which the relative humidity does not exceed 95%,
- relative humidity range not to exceed 95% over the temperature range of 40 to 110°F, and
- moisture condensation on all surfaces caused by temperature changes.

2.8. **Vibration.** Material used must show no degradation of mechanical structure, soldered components, plug in components or satisfactory operation in accordance with the manufacturer's equipment specifications after being subjected to the vibration test as described in the NEMA standard TS2, Section 2.2.8, “Vibration Test”, or the latest revision.

3. FABRICATION

3.1. **Anchor Bolts.** Fabricate anchor bolts, nuts, and washers in accordance with the details shown on the plans and Item 449, ”Anchor Bolts.” Galvanize these items in accordance with Item 445, “Galvanization.”

Provide 2 circular steel templates as shown on the plans conforming to ASTM A36 for each assembly. Tack weld the lower anchorage nuts to the lower template in the shop. Perform this welding with an appropriate jig to ensure that the anchor bolt is perpendicular to the template. Shipping of the anchor bolt cage in its assembled condition is not required.

3.2. **ITS Poles.** Fabricate ITS poles in accordance with the details shown on the plans, this Item, and Item 441, "Steel Structures." Alternate designs are not acceptable unless approved by the Department.

Provide properly fitting components. Provide round, octagonal (8-sided), or dodecagonal (12-sided) pole shafts tapered to the heights shown on the plans.

Permanently mark, at a visible location when erected, ITS pole base plates with the design wind speed. Locate the handholes, as shown on the plans, opposite of the direction of traffic flow.

Permanently mark, at a visible location when erected, ITS pole base plates with the fabrication plant's insignia or trademark. Place the mark on the pole base plate adjacent to the handhole access compartment.

Provide circumferential welds only at the ends of the shaft. Provide no more than 2 longitudinal seam welds in shaft sections. Grind or smooth the exterior of longitudinal seam welds to the same appearance as other shaft surfaces. Ensure 100% penetration within 6 in. of circumferential base welds and 60% minimum penetration at other locations along the longitudinal seam welds. Use a welding technique that minimizes acid entrapment during later galvanizing. Hot-dip galvanize all fabricated parts in accordance with Item 445, "Galvanizing."

Fabricate air terminal and bracket assembly to serve as a lightning arrestor in accordance with ITS pole air terminal details and IEEE standards for lightning protection. Bond air terminal with air terminal bracket via clad weld or other approved bolted connection.

3.3. **Cabinet.** Continuously weld all exterior seams for cabinet and doors. Fill edges to a radius of 0.03125 in. minimum. Smooth exterior welds.

Welding on aluminum cabinets are done by the gas metal arc (MIG) or gas tungsten arc (TIG) process using bare aluminum welding electrodes. Ensure electrodes conform to the requirements of the American Welding Society (AWS) A5.10 for ER5356 aluminum alloy bare welding electrodes.

Procedures, welding machines and welding machine operators for welding on aluminum must be qualified and conform with the requirements of AWS B3.0, "Welding Procedures and Performance Qualification", and to the practices recommended in AWS C5.6.

Construct all cabinets of welded sheet aluminum with a thickness of at least 0.125 in. meeting NEMA 3R standards. Do not allow wood, wood fiber product, or flammable products in the cabinet. Seal cabinet structure to prevent the entry of rain, dust, and dirt.

Provide a sunshield on the exterior top of the cabinet to reflect solar rays and mitigate temperature build-up inside the cabinet. Construct sunshield out of 0.125 in. thick aluminum and provide a minimum of 1.25 in. clearance above the top of cabinet secured in four locations.

Attach aluminum lifting eyes or ears to the top of the cabinet to permit lifting the cabinet with a sling. Lifting eyes may be permanently fabricated to the cabinet frame as long as they do not interfere with the construction and operation of the sunshield. Manufacturer may provide removable lifting eyes that can be removed after installation. Seal any penetrations to the cabinet exterior or sunshield after removal of lifting eyes.

Ensure cabinets conform to the requirements of ASTM designation: B209 for 5052-H32 aluminum sheet.

3.3.1. **Door.** Provide sturdy and torsionally rigid cabinet doors that substantially cover the full area of the cabinet access opening. Attach cabinet doors by a minimum of 2 heavy duty hinges or full length hinge. Provide stainless steel hinge pins.

Fabricate the doors and hinges to withstand a 100 lb. per vertical ft. force applied to the outer edge of the door when open without permanent deformation or impairment of the door or cabinet body when the load is removed.

Fit the cabinet doors with Number 2 Corbin locks and aluminum or chrome plated handles with a minimum 3/8 in. drive pin and a 3 point latch. Design the lock and latch so that the handles cannot be released until the lock is released. Provide a locking ring for a padlock along with a padlock. Provide 2 keys for the door and 2 keys for the padlock with each cabinet. Locate the lock clear of the arc of the handle. Keys must be removable in the locked position only. Mount locks with 2 stainless steel machine screws. Provide cabinet doors with a catch mechanism to hold the door open at 2 positions: 90º and 120°.

Fabricate the door and door stop mechanism to withstand a simulated wind load of 5 lb. per sq. ft. applied to both inside and outside surfaces without failure, permanent deformation, or compromising of door position.

Provide cabinets without auxiliary police doors.

Provide a gasket to act as a permanent and weather resistant seal at the cabinet door facing. The gasket material must be of a non-absorbent material and maintain its resiliency after long term exposure to the outdoor environment.

Provide a gasket with a minimum thickness of 0.25 in. Locate the gasket in a channel provided for this purpose either on the cabinet or on the door. An "L" bracket is acceptable instead of this channel if the gasket is fitted snugly against the bracket to insure a uniformly dust and weather resistant seal around the entire door facing.

3.3.2. **Mechanical Components.** Ensure all external screws, nuts, and locking washers are stainless steel. Do not use self-tapping screws unless specifically approved by the Engineer.

Ensure all parts are made of corrosion resistant material, such as plastic, stainless steel, aluminum or brass.

Ensure all materials used in construction are resistant to fungus growth and moisture deterioration.

Separate dissimilar metals by an inert dielectric material.

4. CONSTRUCTION

4.1. **Installation.** Locate ITS poles as shown on the plans unless otherwise directed to secure a more desirable location or to avoid conflict with utilities. Stake the ITS pole locations for verification by the Engineer.

Use established industry and utility safety practices when working near underground or overhead utilities. Consult with the appropriate utility company before beginning such work.

Construct foundations for new ITS poles in accordance with Item 416, "Drilled Shaft Foundations," and the details shown on the plans." Orient anchor bolts as shown on the plans. Install conduit per Item 618, Conduit."

Identify all items of a shipment with a weatherproof tag. This tag minimally must identify manufacturer, contract number, and date and destination of shipment.

Erect poles after foundation concrete has attained its design strength as required on the plans and Item 421, "Hydraulic Cement Concrete." Coat anchor bolt threads and tighten anchor bolts in accordance with Item 449, "Anchor Bolts." Do not grout between the base plate and the foundation.

Mount the pole mounted cabinet to the backside of the ITS pole, with door either parallel or perpendicular to the roadway, away from the direction of traffic flow, as shown on the plans. Mount cabinet plumb in all directions.

For ITS pole sites located on slopes greater than 4H:1V, mount the pole mounted cabinet to the backside of the ITS pole, from the perspective parallel to the roadway with the door facing the direction of traffic flow as shown on the plans.

Install grounding conductor from cabinet and ITS pole air terminal inside a minimum 1 in. PVC conduit within the foundation. Bond grounding conductors to the primary ground rod as part of the grounding ring in accordance with the ITS grounding details.

Construct reinforced maintenance pad, when required, with Class A concrete in accordance with Item 421, “Hydraulic Cement Concrete.” Provide reinforcing steel in accordance with Item 440, “Reinforcing Steel.”

4.2. **Relocation.** Before removal of the existing pole structure or cabinet, disconnect and isolate the power cables from the electric power supply and disconnect all cables (power and communication) from the equipment and remove any ITS equipment, associated mounting brackets, pole mounted cabinet, and cabling from the pole structure. Remove existing pole structure as shown on the plans only at such time as authorized by the Engineer.

Inspect the existing pole structure, with a representative from the Department, and document any evidence of structural stress cracks or fatigue before removal. Remove and deliver to the Department, existing pole structures that fail structural inspection to an address to be supplied by the Department.

Remove the existing pole structure in a manner acceptable to the Engineer using a method that does not cause undue overstress or damage to the structure or appurtenances attached.

Use a crane of sufficient capacity to remove the pole. Disconnect and relocate the existing pole structure from and to the foundation as shown on the plans in a manner acceptable to the Engineer.

When the poles are laid down, place the poles on timber cribbing so that the poles lie reasonably straight to prevent any damage or deterioration.

Maintain safe construction and operation practices at all times. Handle the poles in such a manner during removal so as to prevent damage to the pole's exterior finish. The Contractor will be responsible for any damage to poles.

Unless otherwise shown on the plans, remove abandoned concrete foundations, including steel, to a depth of at least 2 ft. below final grade in accordance with Item 496, “Removing Structures.” Backfill the excavation with materials equal in composition and density to the surrounding area. Replace any surfacing material with similar material to an equivalent condition.

Supply all new anchor bolts required for the installation of the ITS pole structure. Match bolt dimensions and lengths previously used or as shown on the plans and as directed. Provide anchor bolts in accordance with Item 449, “Anchor Bolts.”

Move existing poles to the locations shown on the plans or as directed. Construct new foundations for relocated ITS poles in accordance with Item 416, "Drilled Shaft Foundations," and the details shown on the plans. Install conduit per Item 618, “Conduit.” Install existing poles on new foundations in accordance with Section 4.1, “Installation.” Do not grout between the base plate and foundation.

4.3. **Removal.** Use established industry and utility safety practices when removing poles and assemblies located near overhead or underground facilities. Consult with the appropriate utility company before beginning work.

Inspect the pole and cabinet, where included, with a representative from the Department, and remove any ITS equipment, associated mounting hardware, and cabling still attached to the pole or inside the cabinet before commencing work. Inspect the existing pole and cabinet in place, with a representative from the Department, and document any evidence of damage to the representative before removal.

Before removal of the existing pole structure or cabinet, disconnect and isolate the power cables from the electric power supply and disconnect all cables (power and communication) from the equipment. Remove and coil existing cabling to the nearest ITS ground box or as identified on the plans.

Carefully remove the cabinet from the pole structure. Avoid damage or injury to surrounding objects or individuals. Deliver the cabinet to an address to be supplied by the Department.

Carefully remove the pole from the foundation in accordance with Item 496, “Removing Structures.” Avoid damage or injury to surrounding objects or individuals. Separate the pole at the slip-fitted connections, if applicable. If the pole cannot be separated, transport the complete pole or partially separate the pole to make it transportable. Deliver the pole structure to an address to be supplied by the Department.

Unless otherwise shown on the plans, remove abandoned concrete foundations, including steel, to a depth of 2 ft. below final grade in accordance with Item 496, “Removing Structures.” Backfill the excavation with materials equal in composition and density to the surrounding area. Replace surfacing material with similar material to an equivalent condition.

4.4. **Testing.**

4.4.1. **Installation**. Unless otherwise shown on the plans, perform the following tests on cabinets supplied through this Item.

4.4.1.1. **Test Procedures Documentation**. Provide 5 copies of the test procedures to include tests identified in Article 4.4.2 through Article 4.4.4 inclusive and blank data forms to the Engineer for review and comment at least 45 days before testing for each test required on this project. Include the sequence of the tests in the procedures. The Engineer will comment, approve, or reject test procedures within 30 days after Contractor submittal of equipment for tests. Contractor to resubmit if necessary rejected test procedures for final approval within 10 days before testing. Review time is calendar days. Conduct all tests in accordance with the approved test procedures. The Department may witness all tests.

Record test data on the data forms and quantitative results. No bid item measurement or payment will be made until the Engineer has verified the test results meet the requirements of the specification. The data forms for all tests, except design approval tests, must be signed by an authorized representative of the Contractor.

Provide written notice to the Engineer within 48 hr. of discovery of any testing discrepancy performed in testing by the contractor. Furnish data forms containing the acceptable range of expected results and measured values.

4.4.1.2. **Design Approval Test**. Conduct a design approval test on 10% of the total number of cabinets supplied as part of the project, with at least one of each type of cabinet used on the project.

Certification from an independent testing laboratory of a successfully completed design approval test is acceptable. Ensure that the testing by this laboratory is performed in accordance with the requirements of this specification. Failure of independent tests to comply with the requirements of this specification will be grounds for rejection of any certification.

Provide a copy of the certification to the Engineer. The data forms for the design approval tests must be signed by an authorized representative (company official) of the equipment manufacturer or by an authorized representative of an independent testing facility.

Notify the Engineer 10 working days before conducting this testing. The Department may witness all the tests. Perform the following tests:

4.4.1.2.1. **Power Service Transients**. Provide equipment that meets the performance requirements, specified in this Item, when subjected to the power service transients as specified in NEMA TS2, Section 2.2.7.2, “Transient Tests (Power Service)”, or most current version.

4.4.1.2.2. **Temperature and Condensation**. Provide equipment that meets the performance requirements, specified in this Item, when subjected to the following conditions in the order specified below:

- stabilize the equipment at -30°F and test as specified in NEMA TS2, Sections 2.2.7.3, “Low-Temperature Low-Voltage Tests” and 2.2.7.4, “Low-Temperature High-Voltage Tests”, or most current version.
- Allow the equipment to warm up to room temperature in an atmosphere with relative humidity of at least 40%. Operate the equipment for 2 hr., while wet, without degradation or failure.
- Stabilize the equipment at 165°F and test as specified in NEMA TS2, Sections 2.2.7.5, “High-Temperature High Voltage Tests” and 2.2.7.6, “High-Temperature Low-Voltage Tests”, or most current version.

4.4.1.2.3. **Relative Humidity**. Provide equipment that meets the performance requirements, specified in this Item, within 30 min. of being subjected to a temperature of 165°F and a relative humidity of 18% for 48 hr.

4.4.1.2.4. **Vibration**. Provide equipment that shows no degradation of mechanical structure, soldered components, or plug-in components and will operate in accordance with the manufacturer's equipment specifications after being subjected to the vibration tests as described in NEMA TS2, Section 2.2.8, “Vibration Test”, or most current version.

4.4.1.2.5. **Power Interruption**. Provide equipment that meets the performance requirements, specified in this Item, when subjected to nominal input voltage variations as specified in NEMA TS2, Section 2.2.10, “Power Interruption Test”, or most current version.

4.4.1.3. **Stand-Alone Tests**. Conduct a Stand-Alone Test for each cabinet after installation. Exercise all stand-alone (non-network) functional operations consisting of the following, at a minimum:

- 19-inch EIA rack,
- adjustable shelves,
- locking mechanism,
- fan and thermostat,
- cabinet light,
- back panel,
- circuit breakers,
- surge protection,
- grounding system,
- terminal strips,
- interconnect harnesses with connectors,
- cabinet attachment to pole,
- weatherproofing, and
- “Door Open” connection to back panel.

Notify the Engineer 5 working days before conducting this test. The Engineer may witness all the tests.

4.4.1.4. **Consequences of Test Failure**. If a unit fails a test, submit a report describing the nature of the failure and the actions taken to remedy the situation before modification or replacement of the unit. If a unit requires modification, correct the fault and then repeat the test until successfully completed. Correct minor discrepancies within 30 days of written notice to the Engineer. If a unit requires replacement, provide a new unit and then repeat the test until successfully completed. Major discrepancies that will substantially delay receipt and acceptance of the unit will be sufficient cause for rejection of the unit.

Failure to satisfy the requirements of any test is considered a defect and the equipment is subject to rejection by the Engineer. The rejected equipment may be offered again for retest provided all noncompliance has been corrected.

If a failure pattern develops in similar units within the system, implement corrective measures, including modification or replacement of units, to all similar units within the system as directed. Perform the corrective measures within 30 calendar days without additional cost or extension of the contract period.

4.4.1.4.1. **Consequences of Design Approval Test Failure**. If the equipment fails the design approval test, correct the fault within 30 days and then repeat the design approval test until successfully completed.

4.4.1.4.2. **Consequences of Stand-Alone Test Failure**. If the equipment fails the stand-alone test, correct the fault within 30 days and then repeat the stand-alone test until successfully completed.

4.4.2. **Relocation.**

4.4.2.1. **Pre-Test**. Conduct performance testing before removal of ITS pole mounted cabinet. Test the following components or equipment, at a minimum, and document functional operations in the presence of representatives of the Contractor and the Department.

- locking mechanism,
- fan and thermostat,
- cabinet light,
- back panel,
- circuit breakers,
- surge protection system,
- grounding system, and
- “Door Open” connection to back panel.

Ensure that both representatives sign the test report indicating that the equipment has passed or failed each function. Once removed, the equipment becomes the responsibility of the Contractor until accepted by the State. Compare test data before removal and test data after installation.

4.4.2.2. **Post Test**. Testing of the ITS pole mounted cabinet is for the purpose of relieving the Contractor of maintenance of the system. The Contractor will be relieved of the responsibility for maintenance of the system in accordance with Item 7, “Legal Relations and Responsibilities”, after a successful test period. The Contractor will not be required to pay for electrical energy consumed by the system.

After all existing ITS equipment has been installed, perform the same functional operation test described under Article 4.4.2.1. Furnish test data forms containing the sequence of tests including all of the data taken and quantitative results for all tests. Submit the test data forms to the Engineer at least 30 days before the day the tests are to begin. Obtain Engineer’s approval of test procedures before submission of equipment for tests. Send at least 1 copy of the data forms to the Engineer.

The performance test results after relocation must be equal to or better than the test results before removal. Repair or replace those components within the system which failed after relocation but which passed before removal.

The Department will conduct approved ITS equipment system tests on the field equipment hardware with the central equipment. The tests will, as a minimum, exercise all remote control functions and display the return status codes from the controller.

If any unit fails to pass a test, prepare a report and deliver it to the Engineer. Describe in the report the nature of the failure and the corrective action needed. If the failure is the result of improper installation or damage during reinstallation, reinstall or replace the unit and repeat the test until the unit passes successfully, at no additional cost to the Department or extension of the contract period.

4.5. **Documentation.** Submit documentation for this Item consisting of the following:

4.5.1. **ITS Pole.** Shop drawings should clearly detail the following for the ITS poles submitted for the project:

- physical pole drawings,
- anchor bolts,
- material list,
- lightning suppression,
- weatherheads,
- cabinet Mounting attachments (when cabinet required), and
- grounding system.

4.5.2. **Pole Mounted Cabinet.** Shop drawings should clearly detail the following for ITS pole mounted cabinets when required as shown on the plans:

- dimensions,
- shelves,
- door,
- gasket,
- door look,
- materials list,
- exterior finish,
- ventilation,
- terminal strips,
- harnesses,
- filter,
- power distribution panel,
- surge suppression,
- back panel,
- outlets,
- circuit breakers,
- power cable terminals,
- wiring diagrams,
- cabinet grounding,
- environmental parameters, and
- connectors.

Submit shop drawings, signed, sealed, and dated by a registered professional Engineer in Texas showing the fabrication and erection details for each ITS pole including the ITS cabinet and mounting details in accordance with Item 5, “Control of the Work”.

Provide at least 2 complete sets of operation and maintenance manuals in hard copy format in addition to a CD/DVD or removable flash drive that include the following:

- complete and accurate schematic diagrams,
- complete installation procedures,
- complete performance specifications (functional, electrical, mechanical and environmental) on the unit,
- complete parts list including names of vendors for parts not identified by universal part number such as JEDEC, RETMA, or EIA,
- pictorial of component layout on circuit board,
- complete maintenance and trouble-shooting procedures,
- complete stage-by-stage explanation of circuit theory and operation,
- recovery procedures for malfunction, and
- instructions for gathering maintenance assistance from manufacturer.

Identify material which is copyrighted or proprietary in nature as part of the documentation submittal. The Department will take proper provisions to secure such material and not distribute without written approval.

Provide Department with certification documentation verifying conformance with environmental and testing requirements contained in the special specification. Certifications may be provided by the manufacturer or through independent labs.

4.6. **Warranty.** The start date of the manufacturer’s standard warranty will begin when the stand-alone test plan has been approved. Any equipment with less than 95% of its warranty remaining at the beginning of the stand-alone test will not be accepted by the Department. Guarantee that equipment furnished and installed

for this project performs according to the manufacturer's published specifications. Warrant the equipment against defects or failure in design, materials, and workmanship for a minimum of 5 years or in accordance with the manufacturer's standard warranty if warranty period is greater. Assign, to the Department, all manufacturer's normal warranties or guarantees on all electronic, electrical, and mechanical equipment, materials, technical data, and products furnished for and installed on the project. Repair or replace, at the manufacturer's option, defective equipment during the warranty period at no cost to the Department.

Repair or replace equipment at the Contractor's expense before beginning testing in the event of a malfunction or failure. Furnish replacement parts for all equipment within 30 days of notification of failure by the Department.

5. MEASUREMENT

This Item will be measured as each unit furnished, installed, relocated, or removed as shown on the plans, excluding new foundations and conduit.

6. PAYMENT

6.1. **Furnish and Install.** The work performed and materials furnished in accordance with this Item and measured as provided for under "Measurement" will be paid for at the unit price bid for "ITS Pole" of the type and height specified, including COSS/OSB extension, and "ITS Pole Mount Cabinet" of the type and configuration specified. This price is full compensation for furnishing, fabricating, and erecting ITS pole structures as shown on the plans; for furnishing, fabricating, and installing ITS pole mounted cabinets as shown on the plans; for furnishing and placing anchor bolts, nuts, washers, and templates; conducting cabinet testing; and equipment, materials, labor, tools, and incidentals necessary to provide an ITS pole structure or pole mounted cabinet complete in place and ready for the attachment of ITS equipment.

New drill shaft foundations will be paid for under Item 416, "Drilled Shaft Foundations." New conduit will be paid for under Item 618, "Conduit."

6.2. **Install Only.** The work performed and materials furnished in accordance with this Item and measured as provided for under "Measurement" will be paid for at the unit price bid for "ITS Pole (Install Only)" of the type and height specified, including COSS/OSB extension, and "ITS Pole Mount Cabinet (Install Only)" of the type and configuration specified. This price is full compensation for erecting ITS pole structures and installing ITS pole mounted cabinets furnished by the Department as shown on the plans; for installing and placing anchor bolts, nuts, washers, and templates; conducting cabinet testing; and equipment, materials, labor, tools, and incidentals necessary to provide an ITS pole structure or pole mounted cabinet, complete in place, and ready for the attachment of ITS equipment.

New drill shaft foundations will be paid for under Item 416, "Drilled Shaft Foundations." New conduit will be paid for under Item 618, "Conduit."

6.3. **Relocate.** The work performed and materials furnished in accordance with this Item and measured as provided for under "Measurement" will be paid for at the unit price bid for "ITS Pole (Relocate)" of the type and height specified, including COSS/OSB extension, and "ITS Pole Mount Cabinet (Relocate)" of the type and configuration specified. This price is full compensation for removing existing ITS pole structures or pole mounted cabinets as shown on the plans; removing existing foundations; backfilling and surface placement; hauling and erecting ITS pole structures; hauling and installing ITS pole mounted cabinets; furnishing and placing anchor bolts, nuts, washers, and templates; conducting cabinet testing; and equipment, materials, labor, tools, and incidentals necessary to relocate existing ITS pole structures or pole mounted cabinets, complete in place, and ready for the attachment of ITS equipment.

New drill shaft foundations will be paid for under Item 416, "Drilled Shaft Foundations." New conduit will be paid for under Item 618, "Conduit."

6.4. **Remove.** The work performed and materials furnished in accordance with this Item and measured as provided for under “Measurement” will be paid for at the unit price bid for “ITS Pole (Remove)” of the type and height specified, including COSS/OSB extension, and “ITS Pole Mount Cabinet (Remove)” of the type and configuration specified. This price is full compensation for removing existing ITS pole structures and pole mounted cabinets as shown on the plans; removing existing foundations; backfilling and surface placement; loading and hauling; and equipment; materials, labor, tools, and incidentals necessary to complete the removal of existing ITS pole structures and pole mounted cabinets.

Special Specification 6084
Modifying Existing Electrical Services

1. DESCRIPTION

Modify the existing electrical services as shown on the plans.

2. MATERIALS

Provide materials that comply with the details shown on the plans, the requirements of this Item, and the following items:

- Item 441, "Steel Structures"
- Item 445, "Galvanizing"
- Item 618, "Conduit"
- Item 620, "Electrical Conductors"
- Item 628, "Electrical Services"

Use new materials that meet the requirements of the National Electric Code (NEC), Underwriters Laboratories (UL), Canadian Standards Association (CSA), and National Electrical Manufacturer Association (NEMA) and that comply with DMS-11080, "Electrical Services."

3. CONSTRUCTION

Perform work in accordance with the details shown on the plans and the requirements of this Item. Ensure components of the electrical service meet the requirements of the Electrical Detail Standards. Follow the NEC and local utility company requirements when modifying the electrical equipment. Coordinate the utility companies' work for providing service.

4. MEASUREMENT

This Item will be measured by each electrical service modified.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Modification of Existing Electrical Services" of the type specified. This price is full compensation for installing and connecting breakers and conductors; and equipment, labor, tools, and incidentals.

Special Specification 6093
Existing Traffic Management Equipment

1. DESCRIPTION

Remove and relocate existing Communication Cabinets, Fiber Hubs, CCTV (Closed Circuit Television) Field Equipment, Lane Control Systems (LCS), Fiber Optic Dynamic Message Sign Systems, Video Imaging Vehicle Detection Systems (VIVDS), Radar Vehicle Sensing Devices, Wireless Ethernet Radios, and remove existing Acoustic Vehicle Sensor Systems at sites shown on plans and as specified within this specification.

2. REMOVE EXISTING COMMUNICATION CABINET

2.1. **Materials.** Remove the following equipment at each Communication Cabinet field site as shown on the plans (includes but is not limited to)

- Communication Cabinet (CC) including all internal components.
- Cabling from power source to cabinet.
- Cabling and connectors from telecommunications source to cabinet.
- Communication Cabinet Foundation. Remove to 2 ft. below existing grade and backfill and repair with material to match existing area surrounding removed foundation or as approved by the Engineer.

2.2. **Construction.** Prior to removal of the Communication Cabinet, disconnect and isolate any existing electrical power supply.

Perform removal in strict conformance with the requirements herein stated and the lines, grades, details and dimensions shown on the plans. Completion of the work will present a neat, workmanlike, and finished appearance. Maintain safe construction practices during removal.

Any portion of the Communication Cabinet, including components, damaged or lost will be replaced by the Contractor at no cost to the Department.

All materials not designated for reuse or retention by the State will become the property of the Contractor and be removed from the project site at the Contractor's expense. Deliver Items to be retained by the State to TransGuide.

Store all Communication Cabinets and associated equipment removed on this project in a secure place as approved by the Engineer until time for relocation to location shown on plans. The Contractor is fully responsible for the equipment until released by the Engineer.

3. RELOCATE EXISTING COMMUNICATION CABINET

3.1. **Materials**. Relocate the following equipment at each Communication Cabinet field site shown on the plans (includes but is not limited to):

- Communication Cabinet (CC) with all internal components.

Contractor is responsible for reconfiguring the Local Control Unit and for all provisioning and addressing changes required in the cabinet and at TransGuide.

Construct new Communication Cabinet Foundation for relocated Communication Cabinet as shown in plans and as specified in this specification

Make the relocated Communication Cabinet fully operational and integrated with the TransGuide system.

If plans show radar detectors to be connected to relocated Communication Cabinet instead of surveillance loop detectors, remove existing digital loop vehicle detection units and deliver to TransGuide to make space for radar detector cards.

3.2. **Construction.** Perform the relocation in strict conformance with the requirements herein stated and the lines, grades, details and dimensions shown on the plans. Completion of the work will present a neat, workmanlike, and finished appearance. Maintain safe construction practices during relocation. Any portion of Communication Cabinet assembly damaged or lost will be replaced by the Contractor at his expense.

Make all arrangements for connection to the power supply and telecommunications source including any permits required for the work to be done under the Contract. Furnish and install any required materials not provided by the power or telephone company in accordance with the plans. Provide wire for the power connection at least the minimum size indicated on the plans and insulated for 600 volts. Meet the requirements of the National Electrical Code (NEC).

4. REMOVE EXSITING FIBER HUB

4.1. **Materials.** Remove the following equipment at each Fiber Hub field site as shown on the plans (includes but is not limited to):

- Fiber Hub (FH) with external and internal cabinets including all internal components.
- Cabling from power source to cabinet.
- Cabling and connectors from telecommunications source to cabinet.
- LifeLink Equipment (if existing).
- Automated Vehicle Identification System (AVI) (if existing).
- Fiber Hub Foundation. Remove to 2 ft. below existing grade and backfill and repair with material to match existing area surrounding removed foundation or as approved by the Engineer.

4.2. **Construction**. Prior to removal of the Fiber Hub, disconnect and isolate any existing electrical power supply.

Perform removal in strict conformance with the requirements herein stated and the lines, grades, details and dimensions shown on the plans. Completion of the work will present a neat, workmanlike, and finished appearance. Maintain safe construction practices during removal.

Any portion of the Fiber Hub, including components, damaged or lost will be replaced by the Contractor at no cost to the Department.

All materials not designated for reuse or retention by the State will become the property of the Contractor and be removed from the project site at the Contractor's expense.

Deliver LifeLink and AVI equipment to TransGuide.

Store all Fiber Hubs and associated equipment removed on this project in a secure place as approved by the Engineer until time for relocation to location shown on plans. The Contractor is fully responsible for the equipment until released by the Engineer.

5. RELOCAT EXISTING FIBER HUB

The following are the minimum requirements to relocate existing Fiber Hub and field equipment as shown on the plans.

5.1. **Materials.** Relocate the following equipment at each Fiber Hub field site shown on the plans (includes but is not limited to):

- Fiber Hub (FH) with external and internal cabinet and all internal components.

Furnish and install all new cables, conduit, junction boxes, grounding (ground rod), mounting hardware, etc. necessary to make the associated CCTV Field Equipment fully operational.

Contractor is responsible for reconfiguring the Local Control Unit, for furnishing, installing, provisioning and making all cross connects for any additional cards (e.g. 52B, 43B, 232, etc.) necessary (both in the Fiber Hub and at TransGuide) for TMS equipment that will be communicating with the relocated Fiber Hub, and for any other provisioning and addressing changes required in the Fiber Hub and at TransGuide. Deliver any cards not needed in relocated Fiber Hubs to TransGuide.

Construct new Fiber Hub Foundation for relocated Fiber Hub as shown in plans and as specified in this specification.

Make the relocated Fiber Hub fully operational and integrated with the TransGuide system.

5.2. **Construction**. Perform the relocation in strict conformance with the requirements herein stated and the lines, grades, details and dimensions shown on the plans. Completion of the work will present a neat, workmanlike, and finished appearance.

Maintain safe construction practices during relocation. Any portion of Fiber Hub assembly damaged or lost will be replaced by the Contractor at his expense.

Make all arrangements for connection to the power supply and telecommunications source including any permits required for the work to be done under the Contract. Furnish and install any required materials not provided by the power or telephone company in accordance with the plans. Provide wire for the power connection at least the minimum size indicated on the plans and insulated for 600 volts. Meet the requirements of the National Electrical Code (NEC).

6. REMOVE EXISTING CCTV FIELD EQUIPMENT

6.1. **Materials.** Remove the following equipment at each CCTV Field Equipment site as shown on the plans (includes but is not limited to):

- CCTV Field Equipment.
- Cabling from power source to camera.
- Cabling and connectors from telecommunications source to camera.
- CCTV Tube Mount or Camera Pole.
- Lifelink Equipment and associated cabling (if existing).
- Camera Pole Foundation. Remove to 2 ft. below existing grade and backfill and repair with material to match existing area surrounding removed foundation or as approved by the Engineer.

6.2. **Construction**. Prior to removal of the CCTV Field Equipment, disconnect and isolate any existing electrical power supply.

Perform removal in strict conformance with the requirements herein stated and the lines, grades, details and dimensions shown on the plans. Completion of the work will present a neat, workmanlike, and finished appearance. Maintain safe construction practices during removal.

Any portion of the CCTV Field Equipment or Lifelink equipment damaged or lost will be replaced by the Contractor at no cost to the Department.

All materials not designated for reuse or retention by the State will become the property of the Contractor and be removed from the project site at the Contractor's expense.

Deliver LifeLink equipment to TransGuide.

See plans for those locations where removed CCTV Field Equipment is to be delivered to TransGuide.

Store all CCTV Field Equipment and associated equipment removed on this project in a secure place as approved by the Engineer until time for relocation to location shown on plans. The Contractor is fully responsible for the equipment until released by the Engineer.

7. RELOCATE EXISTING CCTV FIELD EQUIPMENT

The following are the minimum requirements to relocate existing CCTV Field Equipment as shown on the plans.

7.1. **Materials.** Relocate the following equipment at CCTV Field Equipment sites shown on the plans (includes but is not limited to):

- CCTV Field Equipment.
- CCTV Tube mount or Camera Pole.

New foundation for relocated Camera Pole will be paid for under Item 416.

Furnish and install all new conduit, cables, junction boxes, grounding (ground rod), mounting hardware, etc., to make the relocated CCTV Field Equipment fully operational with the TransGuide system.

7.2. **Construction**. Perform the relocation in strict conformance with the requirements herein stated and the lines, grades, details and dimensions shown on the plans. Completion of the work will present a neat, workmanlike, and finished appearance. Maintain safe construction practices during relocation.

Use care to prevent damage to any sign support structures. Any portion of CCTV Field equipment, Lifelink equipment, or sign support structure damaged or lost will be replaced by the Contractor at his expense.

Make all arrangements for connection to the power supply and telecommunications source including any permits required for the work to be done under the Contract. Furnish and install any required materials not provided by the power or telephone company in accordance with the plans. Provide wire for the power connection at least the minimum size indicated on the plans and insulated for 600 volts. Meet the requirements of the National Electrical Code (NEC).

8. REMOVE EXISTING LANE CONTROL SYSTEM

8.1. **Materials**. Remove the following equipment at each Lane Control System field site as shown on the plans (includes but is not limited to):

- Lane Control System (LCS) heads and mounting hardware. Remove the LCS heads from the structure immediately after the system becomes non-operational.
- LCS Controller and Cabinet.
- Cabling, conduit and connectors from LCS Controller to LCS heads.
- Cabling and connectors from power source to cabinet.
- Cabling and connectors from telecommunications source to cabinet.
- LCS Cabinet Foundation. Remove to 2 ft. below existing grade and backfill and repair with material to match existing area surrounding removed foundation or as approved by the Engineer.

8.2. **Construction.** Prior to removal of the Lane Control System, disconnect and isolate any existing electrical power supply.

Perform removal in strict conformance with the requirements herein stated and the lines, grades, details and dimensions shown on the plans. Completion of the work will present a neat, workmanlike, and finished appearance. Maintain safe construction practices during removal.

Use care to prevent damage to the sign support structure. Any portion of the Lane Control System or sign support structure, including components, damaged or lost will be replaced by the Contractor at no cost to the Department.

All materials not designated for reuse or retention by the State will become the property of the Contractor and be removed from the project site at the Contractor's expense. Deliver Items to be retained by the State to TransGuide.

Store all Lane Control System equipment removed on this project in a secure place as approved by the Engineer until time for relocation to location shown on plans. The Contractor is fully responsible for the equipment until released by the Engineer.

9. RELOCATE EXISTING LANE CONTROL SYSTEM

The following are the minimum requirements to relocate existing Lane Control System (LCS) and field equipment as shown on the plans.

9.1. **Materials.** Relocate the following equipment at each LCS field site shown on the plans (includes but is not limited to):

- Lane Control System heads with all mounting hardware. Furnish and install any additional “L” brackets necessary. Furnish and install additional LCS heads, if shown on the plans, with all necessary mounting hardware, subsidiary to this item.
- LCS Controller and Cabinet - The Contractor is responsible for configuration and for any addressing changes required.

  Furnish and install all new cable and conduit from LCS Controller to LCS heads.

  Construct new LCS Cabinet Foundation for relocated LCS cabinet as shown in plans and as specified in this specification.

  Make the relocated Lane Control System fully operational with the TransGuide system.

9.2. **Construction.** Perform the relocation in strict conformance with the requirements herein stated and the lines, grades, details and dimensions shown on the plans. Completion of the work will present a neat, workmanlike, and finished appearance. Maintain safe construction practices during relocation.

Use care to prevent damage to any sign support structures. Any portion of LCS System or sign support structure damaged or lost will be replaced by the Contractor at his expense.

Make all arrangements for connection to the power supply and telecommunications source including any permits required for the work to be done under the Contract.

Furnish and install any required materials not provided by the power or telephone company in accordance with the plans. Provide wire for the power connection at least the minimum size indicated on the plans and insulated for 600 volts. Meet the requirements of the National Electrical Code (NEC).

Mount the relocated LCS Heads and shift the existing LCS heads on structures as shown on the plans and as directed by the Engineer. Reuse existing LCS head mounting hardware as permitted by the Engineer. Provide only new and corrosion resistant materials for any additional materials installed under this Item. Any adjustment and/or addition of LCS attachment hardware, support brackets and appurtenances, conduit, etc., necessary for compatibility with LCS positioning recommended by the manufacturer or as directed by the Engineer, will be subsidiary to this Item and not be paid for directly.

Submit to the Engineer for approval, 5 prints of the working drawings for attachment of LCS heads. Show on drawings any additional L brackets, head support connections, and methods of attachment of the heads to the support.

10. REMOVE EXISTING FIBER OPTIC DYNAMIC MESSAGE SIGN SYSTEM (TYPE 2)

10.1. **Materials.** Remove the following equipment at each Dynamic Message Sign (DMS) field site shown on the plans (includes but is not limited to):

- Dynamic Message Sign with all mounting brackets. Remove the sign from the structure immediately after the system becomes non-operational.
- DMS Controller and Cabinet.
- Cabling and connectors from DMS Controller to DMS.
- Cabling and connectors from power source to cabinet.
- Cabling and connectors from telecommunications source to cabinet.
- Cabinet foundation. Remove to 2 ft. below existing grade and backfill and repair with material to match existing area surrounding removed foundation or as approved by the Engineer.

10.2. **Construction**. Prior to removal of the Dynamic Message Sign System, disconnect and isolate any existing electrical power supply.

Perform removal in strict conformance with the requirements herein stated and the lines, grades, details and dimensions shown on the plans. Completion of the work will present a neat, workmanlike, and finished appearance. Maintain safe construction practices during removal.

Use care to prevent damage to the sign support structure. Any portion of the Dynamic Message Sign System or sign support structure, including components, damaged or lost will be replaced by the Contractor at no cost to the Department.

All materials not designated for reuse or retention by the State will become the property of the Contractor and be removed from the project site at the Contractor's expense. Deliver Items to be retained by the State to TransGuide.

Store all Dynamic Message Sign System equipment removed on this project in a secure place as approved by the Engineer until time for relocation to location shown on plans. The Contractor is fully responsible for the equipment until released by the Engineer.

11. RELOCATE EXISTING FIBER OPTIC DYNAMIC MESSAGE SIGN SYSTEM (TYPE 2)

The following are the minimum requirements to relocate existing Dynamic Message Sign (DMS) and field equipment as shown on the plans.

11.1. **Materials.** Relocate the following equipment at each DMS field site shown on the plans (includes but is not limited to):

- Dynamic Message Sign with mounting hardware.
- DMS Controller and Cabinet.

Furnish and install all new cabling and conduit from the sign to controller cabinet.

Construct new Fiber Optic Dynamic Message Sign Cabinet Foundation for relocated DMS cabinet as shown in plans and as specified in this specification.

Make the relocated DMS system fully operational with the TransGuide system.

11.2. **Construction**. Perform the relocation in strict conformance with the requirements herein stated and the lines, grades, details and dimensions shown on the plans. Completion of the work will present a neat, workmanlike, and finished appearance. Maintain safe construction practices during relocation.

Use care to prevent damage to any sign support structures. Any portion of DMS System or sign support structure damaged or lost will be replaced by the Contractor at his expense.

Make all arrangements for connection to the power supply and telecommunications source including any permits required for the work to be done under the Contract. Furnish and install any required materials not provided by the power or telephone company in accordance with the plans. Provide wire for the power connection at least the minimum size indicated on the plans and insulated for 600 volts. Meet the requirements of the National Electrical Code (NEC).

Mount the relocated DMS sign and shift the existing signs on structures as shown on the plans and as directed by the Engineer. Reuse existing DMS sign mounting hardware as permitted by the Engineer. Provide only new and corrosion resistant materials for any additional materials installed under this Item. Any adjustment and/or addition of DMS attachment hardware, support brackets and appurtenances, conduit, etc., necessary for compatibility with DMS positioning recommended by the manufacturer or as directed by the Engineer, will be subsidiary to this Item and not be paid for directly.

Submit to the Engineer for approval, 5 prints of the working drawings for attachment of DMS signs, except where 2 or more signs are of identical design, in which case a drawing for only one of the signs is necessary. Show on drawings any additional sign brackets, sign support connections, and methods of attachment of the signs to the support.

12. REMOVE EXISTING VIDEO IMAGING VEHICLE DETECTION SYSTEM (VIVDS)

12.1. Materials. Remove the following equipment at each VIVDS field site as shown on the plans (may include but is not limited to):

- VIVDS sensors and all mounting brackets.
- Conduit, cables, and connectors from power source and telecommunications source to VIVDS sensors.
- Tube Mount (6 in. x 4 in. x 1/4 in. structural steel) mounted to Overhead Sign Bridge with Air Terminal.
- 40 ft. poles (Roadway Illumination Assembly) with 10 ft. arm.
- Pole drill shaft foundations. Remove to 2 ft. below existing grade and backfill and repair with material to match existing area surrounding removed foundation or as approved.
- VIVDS equipment cabinet with all internal components.
- Junction boxes used for VIVDS cables.
- VIVDS equipment inside TransGuide Communication Cabinet or Fiber Hub.
- Telephone communication link and components.

12.2. **Construction.** Prior to removal of the VIVDS, disconnect and isolate any existing electrical power supply, adhering to requirements of the National Electrical Code.

Perform removal in strict conformance with the requirements herein stated and the lines, grades, details and dimensions shown on the plans. Completion of the work will present a neat, workmanlike, and finished appearance. Maintain safe construction practices during removal.

Any portion of the VIVDS damaged or lost will be replaced by the Contractor at no cost to the Department.

All materials not designated for reuse or retention by the State will become the property of the Contractor and be removed from the project site at the Contractor's expense. Deliver Items to be retained by the State to TransGuide.

Contact Telephone Company and terminate service at locations where telephone communication is disconnected. Provide documentation of discontinuance of service.

Store all VIVDS equipment removed on this project in a secure place as approved by the Engineer until time for relocation to location shown on plans. The Contractor is fully responsible for the equipment until released by the Engineer.

13. RELOCATE EXISTING VIDEO IMAGING VEHICLE DETECTION SYSTEM (VIVDS)

The following are the minimum requirements to relocate existing VIVDS as shown on the plans.

13.1. **Materials**. Relocate the following equipment at each VIVDS field site as shown on the plans (may include but is not limited to):

- VIVDS sensors and mounting brackets.
- 40 ft. poles with 10 ft. arm.
- VIVDS equipment cabinet with all internal components.
- VIVDS junction boxes.

Furnish and install new Tube Mount (6 in. x 4 in. x 1/4 in. structural steel) mounted to Overhead Sign Bridge with Air Terminal if shown on plans. Do not reuse tube mounts removed from VIVDS sites. Relocated VIVDS sensor units must be 40 ft. above roadway, therefore new tube mounts of proper length must be furnished and installed for VIVDS being relocated to Overhead Sign Bridges.

Furnish new drill shaft foundations for relocated 40 ft. poles, paid for under Item 416, as shown on plans.

Furnish and install all new conduit, cables, junction boxes, mounting hardware, etc. to make the relocated VIVDS fully operational with the TransGuide system.

13.2. **Construction**. Perform the relocation in strict conformance with the requirements herein stated and the lines, grades, details and dimensions shown on the plans. Completion of the work will present a neat, workmanlike, and finished appearance. Maintain safe construction practices during relocation.

Use care to prevent damage to any sign support structures. Any portion of VIVDS or sign support structure damaged or lost will be replaced by the Contractor at his expense.

Where VIVDS are relocated to existing OSB's, review the structure and submit mounting details for approval.

Make all arrangements for connection to the power supply and telecommunications source including any permits required for the work to be done under the Contract. Furnish and install any required materials not provided by the power or telephone company in accordance with the plans. Provide wire for the power connection at least the minimum size indicated on the plans and insulated for 600 volts. Meet the requirements of the National Electrical Code (NEC).

Recalibrate each of the relocated VIVDS sensors for the conditions at each site (number of lanes, speeds, etc.) using radar as a control.

Provide phone numbers of new VIVDS locations where new phone service communications have been established.

14. REMOVE EXISTING FIBER OPTIC DYNAMIC MESSAGE SIGN SYSTEM (TYPE 3)

14.1. **Materials.** Remove the following equipment at each Dynamic Message Sign (DMS) field site shown on the plans (includes but is not limited to):

- Dynamic Message Sign with all mounting brackets. Remove the sign from the structure immediately after the system becomes non-operational.
- DMS Pole
- DMS Controller and Cabinet.
- Cabling and connectors from DMS Controller to DMS.
- Cabling and connectors from power source to cabinet.
- Cabling and connectors from telecommunications source to cabinet.
- Cabinet foundation. Remove to 2 ft. below existing grade and backfill and repair with material to match existing area surrounding removed foundation or as approved by the Engineer.
- DMS Pole drilled shaft foundation. Remove to 2 ft. below existing grade and backfill and repair with material to match existing area surrounding removed foundation or as approved by the Engineer.

14.2. **Construction.** Prior to removal of the Dynamic Message Sign System, disconnect and isolate any existing electrical power supply.

Perform removal in strict conformance with the requirements herein stated and the lines, grades, details and dimensions shown on the plans. Completion of the work will present a neat, workmanlike, and finished appearance. Maintain safe construction practices during removal.

Use care to prevent damage to the sign support structure. Any portion of the Dynamic Message Sign System or sign support structure, including components, damaged or lost will be replaced by the Contractor at no cost to the Department.

All materials not designated for reuse or retention by the State will become the property of the Contractor and be removed from the project site at the Contractor's expense. Deliver Items to be retained by the State to TransGuide.

Store all Dynamic Message Sign System equipment removed on this project in a secure place as approved by the Engineer until time for relocation to location shown on plans. The Contractor is fully responsible for the equipment until released by the Engineer.

15. RELOCATE EXISTING FIBER OPTIC DYNAMIC MESSAGE SIGN SYSTEM (TYPE 3)

The following are the minimum requirements to relocate existing Dynamic Message Sign (DMS) and field equipment as shown on the plans.

15.1. **Materials.** Relocate the following equipment at each DMS field site shown on the plans (includes but is not limited to):

- Dynamic Message Sign with mounting hardware.
- DMS pole.
- DMS Controller and Cabinet.

Furnish and install all new cabling and conduit from the sign to controller cabinet.

Construct new Fiber Optic Dynamic Message Sign Cabinet Foundation for relocated DMS cabinet as shown in plans and as specified in this specification.

New drilled shaft for relocated DMS pole will be paid for under Item 416, “Drilled Shaft Foundations” and constructed as shown in the plans.

Make the relocated DMS system fully operational with the TransGuide system.

15.2. **Construction**. Perform the relocation in strict conformance with the requirements herein stated and the lines, grades, details and dimensions shown on the plans. Completion of the work will present a neat, workmanlike, and finished appearance. Maintain safe construction practices during relocation.

Use care to prevent damage to any sign support structures. Any portion of DMS System or sign support structure damaged or lost will be replaced by the Contractor at his expense.

Make all arrangements for connection to the power supply and telecommunications source including any permits required for the work to be done under the Contract. Furnish and install any required materials not provided by the power or telephone company in accordance with the plans. Provide wire for the power connection at least the minimum size indicated on the plans and insulated for 600 volts. Meet the requirements of the National Electrical Code (NEC).

Mount the relocated DMS sign on the relocated pole as shown on the plans and as directed by the Engineer. Reuse existing DMS sign mounting hardware as permitted by the Engineer. Provide only new and corrosion resistant materials for any additional materials installed under this Item. Any adjustment and/or addition of DMS attachment hardware, support brackets and appurtenances, conduit, etc., necessary for compatibility with DMS positioning recommended by the manufacturer or as directed by the Engineer, will be subsidiary to this Item and not be paid for directly.

Submit to the Engineer for approval, 5 prints of the working drawings for attachment of DMS signs, except where 2 or more signs are of identical design, in which case a drawing for only one of the signs is necessary.

Show on drawings any additional sign brackets, sign support connections, and methods of attachment of the signs to the support.

16. REMOVE EXISTING RADAR VEHICLE SENSING DEVICE (RVSD)

16.1. **Materials**. Equipment to be removed at each RVSD site shown on the plans (includes but is not limited to):

- RVSD including all mounting hardware.
- Conduit, cables, connectors from Device to cabinet.
- Dual Loop emulation cards (if existing)

16.2. **Construction.** Prior to removal of the RVSD, disconnect and isolate any existing electrical power supply, adhering to requirements of the National Electrical Code.

Perform removal in strict conformance with the requirements herein stated and the lines, grades, details and dimensions shown on the plans. Completion of the work will present a neat, workmanlike, and finished appearance. Maintain safe construction practices during removal.

Any portion of the RVSD damaged or lost will be replaced by the Contractor at no cost to the Department.

Store all RVSD equipment removed on this project in a secure place as approved by the Engineer until time for relocation to location shown on plans. The Contractor is fully responsible for the equipment until released by the Engineer.

All materials not designated for reuse or retention by the State will become the property of the Contractor and be removed from the project site at the Contractor's expense. Deliver Items to be retained by the State to TransGuide.

17. RELOCATE EXISTING RADAR VEHICLE SENSING DEVICE (RVSD)

The following are the minimum requirements to relocate existing RVSD's as shown on the plans.

17.1. **Materials.** Relocate the following equipment at each RVSD field site as shown on the plans (may include but is not limited to):

- RVSD.

Furnish and install all new conduit, cables, junction boxes, mounting hardware, etc. to make the relocated RVSD fully operational with the TransGuide system.

17.2. **Construction.** Perform the relocation in strict conformance with the requirements herein stated and the lines, grades, details and dimensions shown on the plans. Completion of the work will present a neat, workmanlike, and finished appearance. Maintain safe construction practices during relocation.

Use care to prevent damage to any support structures. Any portion of RVSD or support structure damaged or lost will be replaced by the Contractor at his expense.

Where RVSD is relocated to existing OSB or other structure, review the structure and submit mounting details for approval.

Mounting height and angle of relocated RVSD must be as recommended by manufacturer of RVSD.

Connect RVSD to communication network as shown in plans.

Make all arrangements for connection to the power supply and telecommunications source (if shown in plans) including any permits required for the work to be done under the Contract. Furnish and install any required materials not provided by the power or telephone company in accordance with the plans. Provide wire for the power connection at least the minimum size indicated on the plans and insulated for 600 volts. Meet the requirements of the National Electrical Code (NEC).

Recalibrate the relocated RVSD for the conditions at each site (number of lanes, speeds, etc.) using radar as a control.

17.3. Provide phone numbers if necessary of new RVSD locations where new phone service communications have been established.

18. REMOVE EXISTING WIRELESS ETHERNET RADIO (WER) LINK

18.1. **Materials.** Remove the following equipment at each WER Link as shown on the plans (includes but is not limited to):

- Wireless Ethernet Radios (1 at each end of link).
- Mounting brackets at each end of link.
- Cables, conduit and connectors from network and power connections to wireless Ethernet radios.
- Wireless Ethernet radio external antennas and mounting brackets (if existing).

18.2. **Construction**. Prior to removal of the Wireless Ethernet Radio Link, disconnect and isolate any existing electrical power supply.

Perform removal in strict conformance with the requirements herein stated and the lines, grades, details and dimensions shown on the plans. Completion of the work will present a neat, workmanlike, and finished appearance. Maintain safe construction practices during removal.

Any portion of the Wireless Ethernet Radio Link damaged or lost will be replaced by the Contractor at no cost to the Department.

All materials not designated for reuse or retention by the State will become the property of the Contractor and be removed from the project site at the Contractor's expense.

See plans for those locations where removed WER Equipment is to be delivered to TransGuide.

Store all WER equipment and associated equipment removed on this project in a secure place as approved by the Engineer until time for relocation to location shown on plans. The Contractor is fully responsible for the equipment until released by the Engineer.

19. RELOCATE EXISTING WIRELESS ETHERNET RADIO (LINK)

19.1. **Materials.** Relocate the following equipment at each WER Link as shown on the plans (includes but is not limited to):

- Wireless Ethernet Radios (1 at each end of link).
- Wireless Ethernet radio external antennas and mounting brackets (if existing).

Furnish and install all new conduit, cables, junction boxes, mounting hardware, etc. to make the relocated WER Link fully operational with the TransGuide system.

19.2. **Construction**. Perform the relocation in strict conformance with the requirements herein stated and the lines, grades, details and dimensions shown on the plans. Completion of the work will present a neat, workmanlike, and finished appearance. Maintain safe construction practices during relocation.

Use care to prevent damage to any support structures. Any portion of the WER Link or support structure damaged or lost will be replaced by the Contractor at his expense.

Where WER Link is relocated to existing or other structures, review the structures and submit mounting details for approval.

Mounting height and angle of relocated WER must be as recommended by manufacturer of WER.

Provide an interference analysis for each WER Link to identify potential sources of interference. Adjust antenna polarities and channel plans on equipment to minimize interference from other sources.

Ensure that a manufacturer's technical representative is available on site to assist with the installation of the WER Link and communication system configuration. Alignment and configuration of WER radios is critical to obtain maximum throughput.

Connect WER to communication network as shown in plans.

Make all arrangements for connection to the power supply and telecommunications source (if shown in plans) including any permits required for the work to be done under the Contract. Furnish and install any required materials not provided by the power or telephone company in accordance with the plans. Provide wire for the power connection at least the minimum size indicated on the plans and insulated for 600 volts. Meet the requirements of the National Electrical Code (NEC).

Provision the relocated WER Link for the conditions at each site.

19.3. **Testing**. Test the WER Link after installation and provide all test results to the Engineer. Tests will include the following:

- Measure and record transmitter/receiver channel frequency and polarity
- Measure and record transmitter power
- Measure and record receiver fade margin
- Perform a 1 hour Bit Error Rate Test (BERT) and record the results
- Prior to above testing, provide Engineer with a copy of test procedure as well as test date.

20. REMOVE EXISTING ACOUSTIC VEHICLE SENSOR SYSTEM

20.1. **Materials.** Equipment to be removed at each Acoustic Vehicle Sensor System site shown on the plans includes the following:

- All Acoustic Vehicle Sensors including all mounting hardware.
- Controller Card or Cards.
- Cabling and connectors from sensor to cabinet.

20.2. **Construction**. Perform the removal in strict conformance with the requirements herein stated. Completion of the work will present a neat, workmanlike, and finished appearance. Maintain safe construction practices during removal.

Any portion of the Acoustic Vehicle Sensor System, including components, damaged or lost will be replaced by the Contractor at no cost to the Department.

Deliver all materials designated to be removed to TransGuide.

21. COMMUNICATION CABINET FOUNDATION

21.1. **Materials**. Construct new Communication Cabinet Foundation for relocated Communication Cabinet as shown on "Cabinet Foundation Details" layout.

21.2. **Construction**. Construct the foundation in strict conformance with the requirements herein stated and the location, details and dimensions shown on the plans. Completion of the work will present a neat, workmanlike, and finished appearance. Maintain safe constructions practices.

21.3. Construct the foundation in accordance with Item 656, "Foundations for Traffic Control Devices".

22. FIBER HUB FOUNDATION

22.1. **Materials.** Construct new Fiber Hub Foundation for relocated Fiber Hub as shown on "Fiber Hub Details" layout.

22.2. **Construction**. Construct the foundation in strict conformance with the requirements herein stated and the location, details and dimensions shown on the plans. Completion of the work will present a neat, workmanlike, and finished appearance. Maintain safe constructions practices.

22.3. Construct the foundation in accordance with Item 656, "Foundations for Traffic Control Devices".

23. LCS CABINET FOUNDATION

23.1. **Materials.** Construct new LCS Cabinet Foundation for relocated LCS Cabinet as shown on "Cabinet Foundation Details" layout.

23.2. **Construction.** Construct the foundation in strict conformance with the requirements herein stated and the location, details and dimensions shown on the plans. Completion of the work will present a neat, workmanlike, and finished appearance. Maintain safe constructions practices.

Construct the foundation in accordance with Item 656, "Foundations for Traffic Control Devices".

24. FIBER OPTIC DYNAMIC MESSAGE SIGN CABINET FOUNDATION

24.1. **Materials.** Construct new DMS Cabinet Foundation for relocated DMS Cabinet as shown on "Cabinet Foundation Details" layout.

24.2. **Construction.** Construct the foundation in strict conformance with the requirements herein stated and the location, details and dimensions shown on the plans. Completion of the work will present a neat, workmanlike, and finished appearance. Maintain safe constructions practices.

Construct the foundation in accordance with Item 656 “Foundations for Traffic Control Devices”.

25. TESTING

25.1. **Pre-Test.** Conduct performance testing prior to removal of the equipment. Test all functional operations of the equipment in the presence of representatives of the Contractor and TxDOT. Ensure that both representatives sign the test report indicating that the equipment has passed or failed each function. Once removed, the equipment becomes the responsibility of the Contractor until accepted by the State. Compare test data prior to removal and test data after installation. The performance test results after relocation must be equal to or better than the test results prior to removal. Repair or replace those components within the system which failed after relocation but which passed prior to removal.

25.2. **Post Test.** Testing of the TMS system is for the purpose of relieving the Contractor of maintenance of the system. The Contractor will be relieved of the responsibility for maintenance of the system in accordance with Item 7, “Legal Relations and Responsibilities”, after a successful test period. The Contractor will not be required to pay for electrical energy consumed by the system.

After all TMS equipment has been installed, conduct approved continuity, stand alone, and TMS equipment system tests. Furnish test data forms containing the sequence of tests including all of the data taken as well as quantitative results for all tests. Submit the test data forms to the Engineer at least 30 days prior to the day the tests are to begin.

Obtain Engineer’s approval of test procedures prior to submission of equipment for tests. Send at least 1 copy of the data forms to the Engineer.

Conduct an approved stand-alone test of the equipment installation at the field site(s). At a minimum, exercise all stand-alone (non-network) functional operations of the field equipment with all of the equipment installed per the plans as directed by the Engineer. Complete the approved data forms with test results and turn over to the Engineer for review and either acceptance or rejection of equipment. Give at least 30 working days notice prior to all tests to permit the Engineer or his representative to observe each test.

The State will conduct approved TMS equipment system tests on the field equipment with the TransGuide central equipment. The tests will, as a minimum, exercise all remote control functions and display the return status codes from the controller.

If any unit fails to pass a test, prepare a report and deliver it to the Engineer. Describe in the report the nature of the failure and the corrective action needed. If the failure is the result of improper installation or damage during reinstallation, reinstall or replace the unit and repeat the test until the unit passes successfully, at no additional cost to the Department or extension of the contract period.

26. TMS EXPERIENCE REQUIREMENTS

The Contractor or subcontractor must meet the following experience requirements prior to removal and/or relocation of TMS Equipment.

26.1. Two years continuous existence by the Contractor or the subcontractor offering services in the installation of Fiber Optic Dynamic Message Signs (DMS), Lane Control Systems (LCS), Fiber Hubs, Communication Cabinets, VIVDS, and Closed Circuit Television cameras (CCTV).

26.2. Two completed projects for each of the following items: A minimum of 2 DMS, 2 LCS, 5 CCTV-cameras, 5 VIVDS, 1 Fiber Hub, 1 Communication Cabinet, 5 Radar Vehicle Sensing Devices, and 2 Wireless Ethernet Radio Links where the Contractor or the subcontractor's personnel installed and tested this equipment. All

components listed above need not be part of the same project, however, additional project references may be required in order to meet the minimum number of installed equipment items listed above. The DMS and LCS must have been installed outdoors, permanently mounted on overhead structure(s) with related sign and LCS equipment. The VIVDS, RVSD's, and WER's must have been installed outdoors, permanently mounted with related communication equipment.

The CCTV cameras must have been installed outdoors, permanently mounted on overhead structure(s) with related camera control and transmission equipment. The completed system installations must have been in continuous satisfactory operation for a minimum of 1 year.

Prior to removal and/or relocation of TMS equipment, furnish a statement which outlines contractor or subcontractor's qualifications on system installation experience. Information on system installation experience must include specific projects, locations, and dates for beginning and completion of installation. The statement must also include the name, telephone number, and address of a representative of the agency or business owning the system, who will be contacted by the Department. If requested by the State, demonstrate to the Engineer's satisfaction a working computerized control system with the various equipment items as described above.

Demonstrate a system similar in design to the system proposed. The demonstration must be performed within the state of Texas. The Contractor will not be required nor expected to pay any associated travel or living expenses of the State's representatives to witness the demonstration. Failure to meet the above requirements will be sufficient reason for not being approved for the removal and/or relocation of the TMS equipment.

If any approved subcontractors fail to complete the entire project, qualification material for other subcontractors will have to be submitted and approved before work can be continued.

Any qualification statements which do not correctly address all specified items will be rejected for the reason of insufficient data. Submit the statement 2 weeks prior to removal and/or relocation of TMS equipment to allow the Department adequate time to review and respond to the Contractor for additional information if required. Failure to submit a complete and satisfactory statement will be sufficient reason for not being approved for the removal and/or relocation work. Submit all statements required by this Special Specification to the Traffic Management Engineer located at 3500 N.W. Loop 410, San Antonio, Texas.

27. MEASUREMENT

Remove Existing Communication Cabinet (CC) will be measured as each Communication Cabinet with all internal components removed in accordance with this specification and as shown on the plans.

Relocate Existing Communication Cabinet (CC) will be measured as each Communication Cabinet with all internal components relocated, tested and made fully operational with the TransGuide system in accordance with this specification and as shown on the plans.

Remove Existing Fiber Hub (FH) will be measured as each Fiber Hub, including external and internal cabinets with all internal components including but not limited to LifeLink, AVI and camera equipment removed in accordance with this specification and as shown on the plans.

Relocate Existing Fiber Hub (FH) will be measured as each Fiber Hub including external and internal cabinets with all internal components including but not limited to LifeLink, AVI and camera equipment relocated, tested and made fully operational with the TransGuide system in accordance with this specification and as shown on the plans.

Remove existing CCTV Field Equipment will be measured as each CCTV Field Equipment removed in accordance with this specification and as shown on the plans.

Relocate existing CCTV Field Equipment will be measured as each CCTV Field Equipment relocated, tested and made fully operational with the TransGuide system in accordance with this specification and as shown on the plans.

Remove Existing Lane Control System will be measured as each Lane Control System, including field equipment to operate the Lane Control System, removed in accordance with this specification and as shown on the plans.

Relocate Existing Lane Control System will be measured as each Lane Control System, including field equipment to operate the Lane Control System, relocated, tested and made fully operational with the TransGuide system in accordance with this specification and as shown on the plans.

Remove Existing Fiber Optic Dynamic Message Sign System (Type 2) will be measured as each sign, including field equipment to operate the sign, removed in accordance with this specification and as shown on the plans.

Relocate Existing Fiber Optic Dynamic Message Sign System (Type 2) will be measured as each sign, including field equipment to operate the sign, relocated, tested and made fully operational with the TransGuide system in accordance with this specification and as shown on the plans.

Remove Existing Video Imaging Vehicle Detection System will be measured as each VIVDS with all associated components, removed in accordance with this specification and as shown on the plans.

Relocate Existing Video Imaging Vehicle Detection System will be measured as each VIVDS with all associated components relocated, tested, and made fully operational with the TransGuide system in accordance with this specification and as shown on the plans.

Remove Existing Fiber Optic Dynamic Message Sign System (Type 3) will be measured as each sign with pole, including field equipment to operate the sign, removed in accordance with this specification and as shown on the plans.

Relocate Existing Fiber Optic Dynamic Message Sign System (Type 3) will be measured as each sign with pole, including field equipment to operate sign, relocated, tested and made fully operational with the TransGuide system in accordance with this specification and as shown on the plans.

Remove Existing Radar Vehicle Sensing Device will be measured as each RVSD with all associated components, removed in accordance with this specification and as shown on the plans.

Relocate Existing Radar Vehicle Sensing Device will be measured as each RVSD with all associated components relocated, tested, and made fully operational with the TransGuide system in accordance with this specification and as shown on the plans.

Remove Existing Wireless Ethernet Radio (Link) will be measured as each WER Link with all associated components, removed in accordance with this specification and as shown on the plans.

Relocate Existing Wireless Ethernet Radio (Link) will be measured as each WER Link with all associated components relocated, tested, and made fully operational with the TransGuide system in accordance with this specification and as shown on the plans.

Remove Existing Acoustic Vehicle Sensor System will be measured as each system removed in accordance with this specification and as shown on the plans.

Communication Cabinet Foundation will be measured as each foundation installed as shown on plans.

Fiber Hub Foundation will be measured as each foundation installed as shown on plans.

LCS Cabinet Foundation will be measured as each foundation installed as shown on plans.

Fiber Optic Dynamic Message Sign Foundation will be measured as each foundation installed as shown on plans.

28. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement", will be paid for at the unit price bid for "Remove Existing Communication Cabinet", "Relocate Existing Communication Cabinet", "Remove Existing Fiber Hub", "Relocate Existing Fiber Hub", "Remove Existing CCTV Field Equipment", "Relocate Existing CCTV Field Equipment", "Remove Existing Lane Control System", "Relocate Existing Lane Control System", "Remove Existing Fiber Optic Dynamic Message Sign System (Type 2)", "Relocate Existing Fiber Optic Dynamic Message Sign System (Type 2)", "Remove Existing Video Imaging Vehicle Detection System", "Relocate Existing Video Imaging Vehicle Detection System", "Remove Existing Fiber Optic Dynamic Message Sign System (Type 3)", "Relocate Existing Fiber Optic Dynamic Message Sign System (Type 3)", "Remove Existing Radar Vehicle Sensing Device", "Relocate Existing Radar Vehicle Sensing Device", "Remove Existing Wireless Ethernet Radio Link", "Relocate Existing Wireless Ethernet Radio Link", "Remove Existing Acoustic Vehicle Sensor System", "Communication Cabinet Foundation", "Fiber Hub Foundation", "LCS Cabinet Foundation", "DMS Cabinet Foundation", and "Fiber Optic Dynamic Message Sign Foundation". This price is full compensation for removing and relocating as shown on the plans; for testing, delivery and storage of components designated for retention or reuse; and for all manipulations, materials, labor, tools, equipment, and incidentals.

Special Specification 6123
Ethernet Switch

1. DESCRIPTION

Transport, install, and test Department-furnished Cisco IE3000 or equivalent Ethernet Switch and Power Module.

2. MATERIALS

Provide all materials not supplied by the Department necessary for the Ethernet Switch installation. All materials provided by the Contractor must be new. Provide a minimum of 30 days' notice to the Department for pick-up of Department-furnished materials. Unless otherwise shown on the plans, Ethernet Switch will be stored by the Department for pick up at location identified by the Engineer.

Ensure that all materials and construction methods necessary to complete the installation conform to the requirements of this Item, the plans and the pertinent requirements of the following Items:

- Item 618, "Conduit"
- Item 620, "Electrical Conductors"

3. CONSTRUCTION

3.1. **Installation**. Install Ethernet Switch in equipment cabinets in accordance with this Item and details and dimensions as shown on the plans or as directed. Maintain safe construction practices. Equipment shall be installed in a neat and workmanlike manner.

Adjustments or additions of attachment hardware, support brackets, and appurtenances may be necessary for compatibility, as shown on the plans, or as directed. All adjustments or additional materials will not be paid for directly but will be subsidiary to this Item.

Prevent damage to all components. Do not use any materials furnished by the Department on any work which is not required by and which does not constitute a part of the contract. Materials not used which were furnished by the Department must be returned undamaged to the location from which the materials were obtained upon completion of the work. Any unused or removed material deemed salvageable by the Engineer shall remain the property of the Department and shall be delivered to a designated site. Accept ownership of unsalvageable materials and dispose of in accordance with federal, state, and local regulations.

Stockpile all materials designated for reuse or to be retained by the Department within the project limits or at a designated location as directed.

Equipment to be installed at each CCTV, Vehicle Detector field site or HUB building shown on the plans may include, but not be limited to, the following:

- Ethernet Switch (provided by the Department).
- Cabling and connectors from power source to Ethernet Switch connection point as specified by the manufacturer (Provided by the Contractor).
- Cabling and connectors from telecommunications source to Ethernet Switch connection point as specified by the Ethernet Switch manufacturer when required (Provided by the Contractor).
- Communications as shown on the plans.

Make all arrangements for connection to the power supply and telecommunications source including any required permits. Supply and install any required materials not provided by the utility companies (power or communications service provider).

3.2. **Working Drawings.** Before fabrication submit for approval 5 prints of the working drawings for attachment of each Ethernet Switch. Show the details of any additional brackets, connections, and methods of attachment.

3.3. **Testing.** Testing of the Ethernet Switch is for the purpose of relieving the Contractor of maintenance of the system. The Contractor will be relieved of the responsibility for maintenance of the Ethernet Switch in accordance with Item 7, "Legal Relations and Responsibilities," after all testing is successfully completed.

After all switches have been installed, the Department will conduct approved continuity, stand alone, and Ethernet Switch tests on the installed field equipment with central, remote, and laptop equipment. A final acceptance test will be conducted to demonstrate all control, monitor, and communication requirements for 90 days. The Engineer will furnish a Letter acknowledging the final acceptance testing commencement date stating the first day of the final acceptance test. The completion of the final acceptance test occurs when system downtime due to mechanical, electrical, or other malfunctions to equipment furnished or installed does not exceed 72 hr. and any individual points of failure identified during the test period have operated free of defects. Assume responsibility only for test failures directly related to the work in accordance with this Item.

4. MEASURMENT

This Item will be measured as each Ethernet Switch system installed and tested.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Installation of Ethernet Switch." This price is full compensation for transportation and installation of Ethernet Switch; furnishing and installing any new mounting hardware; storing the Ethernet Switch when required; testing the Ethernet Switch; replacement/repair of damaged components; disposal of unsalvageable material and for all manipulations, labor, tools, working drawings, equipment and incidentals.

Special Specification 6125
Terminal Server

1. DESCRIPTION

Transport, install, and test Department-furnished DIGI TS 4H ME1 or equivalent Terminal Server and Power Supply.

2. MATERIALS

Provide all materials not supplied by the Department necessary for the Terminal Server installation. All materials provided by the Contractor must be new. Provide a minimum of 30 days' notice to the Department for pick-up of Department furnished materials. Unless otherwise shown on the plans, Terminal Server will be stored by the Department for pick up at location identified by the Engineer.

Ensure that all materials and construction methods necessary to complete the installation conform to the requirements of this Item, the plans and the pertinent requirements of the following Items:

- Item 618, "Conduit"
- Item 620, "Electrical Conductors"

3. CONSTRUCTION

3.1. **Installation**. Install Terminal Server in equipment cabinets in accordance with this Item and details and dimensions as shown on the plans or as directed. Maintain safe construction practices. Equipment shall be installed in a neat and workmanlike manner.

Adjustments or additions of attachment hardware, support brackets, and appurtenances may be necessary for compatibility, as shown on the plans, or as directed. All adjustments or additional materials will not be paid for directly but will be subsidiary to this Item.

Prevent damage to all components. Do not use any materials furnished by the Department on any work which is not required by and which does not constitute a part of the contract. Materials not used which were furnished by the Department must be returned undamaged to the location from which the materials were obtained upon completion of the work. Any unused or removed material deemed salvageable by the Engineer shall remain the property of the Department and shall be delivered to a designated site. Accept ownership of unsalvageable materials and dispose of in accordance with federal, state, and local regulations.

Stockpile all materials designated for reuse or to be retained by the Department within the project limits or at a designated location as directed.

Equipment to be installed at each CCTV, or Vehicle detector field site shown on the plans may include, but not be limited to, the following:

- Terminal Server (provided by the Department).
- Cabling and connectors from power source to Terminal Server connection point as specified by the manufacturer (Provided by the Contractor).
- Cabling and connectors from telecommunications source to Terminal Server connection point as specified by the Terminal Server manufacturer when required (Provided by the Contractor).
- Communications as shown on the plans.

Make all arrangements for connection to the power supply and telecommunications source including any required permits. Supply and install any required materials not provided by the utility companies (power or communications service provider).

3.2. **Working Drawings.** Before fabrication submit for approval 5 prints of the working drawings for attachment of each Terminal Server . Show the details of any additional brackets, connections, and methods of attachment.

3.3. **Testing.** Testing of the Terminal Server is for the purpose of relieving the Contractor of maintenance of the system. The Contractor will be relieved of the responsibility for maintenance of the Terminal Server in accordance with Item 7, "Legal Relations and Responsibilities," after all testing is successfully completed.

After all terminal servers have been installed; the Department will conduct approved continuity, stand alone, and Terminal Server tests on the installed field equipment with central, remote, and laptop equipment. A final acceptance test will be conducted to demonstrate all control, monitor, and communication requirements for 90 days. The Engineer will furnish a Letter acknowledging the final acceptance testing commencement date stating the first day of the final acceptance test. The completion of the final acceptance test occurs when system downtime due to mechanical, electrical, or other malfunctions to equipment furnished or installed does not exceed 72 hr. and any individual points of failure identified during the test period have operated free of defects. Assume responsibility only for test failures directly related to the work in accordance with this Item.

4. MEASUREMENT

This Item will be measured as each Terminal Server system installed and tested.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Installation of Terminal Server." This price is full compensation for transportation and installation of Terminal Server; furnishing and installing any new mounting hardware; storing the Terminal Server when required; testing the Terminal Server; replacement/repair of damaged components; disposal of unsalvageable material and for all manipulations, labor, tools, working drawings, equipment and incidentals.

Special Specification 6155
Radar Detector and Communication Cable

1. DESCRIPTION

Install radar detector and communication cable at existing or new traffic signal location(s) as shown on the plans.

2. MATERIALS

Unless otherwise noted on the plans, materials are to be furnished to the Contractor at no charge. Pick up materials at location(s) shown on plans.

Submit a material list for required materials to the Engineer. Designate in writing, person(s) authorized to pick up material at location(s) shown on plans.

Assume responsibility for all materials furnished by the Department or City. Use materials furnished by the Department or City for this Contract only.

Upon completion of the work and prior to final payment, return any unused or removed material deemed salvageable by the Engineer to the Department or City.

3. EQUIPMENT AND LABOR

Furnish all equipment and labor necessary to install the materials. This will include, but not be limited to an aerial device capable of installing radar detector, tools and incidentals necessary to complete the work.

If, at any time, the Contractor's equipment is determined to be defective to the point that it may affect the quality of work, that equipment must be repaired or replaced immediately.

4. SCOPE OF WORK

Install and make operational radar detector(s) as shown on plans or as directed. A radar detector includes the radar detector, mounting hardware, and other interface equipment. Aim radar detector as shown on plans and as directed by Engineer.

Install radar detector interface equipment in the controller cabinet as shown on plans.

Install radar communication cable as shown on plans. Leave 5 ft. coiled inside the nearest ground box or controller cabinet as applicable. Identify each cable as shown on the plans (i.e. RS1, etc.) with permanent marking labels at each ground box, pole base, and controller cabinet. Cable must be installed as a continuous home-run cable with no splices allowed between the radar unit and the controller cabinet unless approved by the Engineer. Cable end connectors will be furnished by the Department or City.

Remove existing loop lead-in or video detection cables from existing signals.

Department or City personnel will be present to test and confirm the operation of the supplied radar equipment. The performance period will be in accordance with Item 680, "Highway Traffic Signals."

5. MEASUREMENT

Radar detector will be measured by the each.

Radar communication cable will be measured by the foot.

6. PAYMENT

The work performed in accordance with this item and measured as provided under “Measurement” will be paid for at the unit price bid for “Radar Detector” or “Radar Communication Cable.” This price is full compensation for picking up and delivering the radar equipment and cable from the Department or City, installing material; and equipment, labor, tools and incidentals. Removal of existing loop lead-in or video detection cables from existing signals will not be paid for separately and will be considered subsidiary to the installation of the radar communication cable.

Special Specification 6185

Truck Mounted Attenuator (TMA) and Trailer Attenuator (TA)

1. DESCRIPTION

Furnish, operate, maintain and remove upon completion of work, Truck Mounted Attenuator (TMA) or Trailer Attenuator (TA).

2. MATERIALS

Furnish, operate and maintain new or used TMAs or TAs. Assure used attenuators are in good working condition and are approved for use. A list of approved TMA/TA units can be found in the Department's Compliant Work Zone Traffic Control Devices List. The host vehicle for the TMA and TA must weigh a minimum of 19,000 lbs. Host vehicles may be ballasted to achieve the required weight. Any weight added to the host vehicle must be properly attached or contained within it so that it does not present a hazard and that proper energy dissipation occurs if the attenuator is impacted from behind by a large truck. The weight of a TA will not be considered in the weight of the host vehicle but the weight of a TMA may be included in the weight of the host vehicle. Upon request, provide either a manufacturer's curb weight or a certified scales weight ticket to the Engineer.

3. CONSTRUCTION

Place or relocate TMA/TAs as shown on the plans or as directed. The plans will show the number of TMA/TAs needed, for how many days or hours, and for which construction phases.

Maintain the TMA/TAs in good working condition. Replace damaged TMA/TAs as soon as possible.

4. MEASUREMENT

4.1. **Truck Mounted Attenuator/Trailer Attenuator (Stationary).** This Item will be measured by the each or by the day. TMA/TAs must be set up in a work area and operational before a calendar day can be considered measurable. When measurement by the day is specified, a day will be measured for each TMA/TA set up and operational on the worksite.

4.2. **Truck Mounted Attenuator/Trailer Attenuator (Mobile Operation).** This Item will be measured by the hour. The time begins once the TMA/TA is ready for operation at the predetermined site and stops when notified by the Engineer. A minimum of 4 hr. will be paid each day for each operating TMA/TA used in a mobile operation.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Truck Mounted Attenuators/Trailer Attenuators (Stationary)," or "Truck Mounted Attenuators/Trailer Attenuators (Mobile Operation)." This price is full compensation for furnishing TMA/TA: set up; relocating; removing; operating; fuel; and equipment, materials, tools, labor, and incidentals.

Special Specification 6186

Intelligent Transportation System (ITS) Ground Box

1. DESCRIPTION

Construct, furnish, install or remove Intelligent Transportation System (ITS) ground boxes for fiber optic communication infrastructure complete with lids.

2. MATERIALS

Provide new materials that comply with the details shown on the plans, the requirements of this Item, and the requirements of the following items:

- Item 420, "Concrete Substructures,"
- Item 421, "Hydraulic Cement Concrete,"
- Item 432, "Riprap,"
- Item 440, "Reinforcement for Concrete,"
- Item 471, "Frames, Grates, Rings, and Covers,"
- Item 618, "Conduit", and
- Item 620, "Electrical Conductors."

Provide new ITS ground boxes constructed of precast concrete or polymer concrete in accordance with the National Electrical Code (NEC) and National Electrical Manufacturers Association (NEMA) standards, most current version. Faulty fabrication or poor workmanship in materials, equipment, or installation will be justification for rejection. Provide manufacturer's warranties or guarantees when offered as a customary trade practice.

2.1. **Precast Concrete.** Provide precast concrete ground boxes and aprons that comply with the details shown on the plans, the requirements of this Item, and in accordance with the following:

- construct ground boxes with Class A concrete in accordance with Item 421, "Hydraulic Cement Concrete," unless otherwise directed,
- provide American Society for Testing and Materials (ASTM) A 615 Grade 60 reinforcement steel in accordance with Item 440, "Reinforcing Steel," and
- provide steel for the frames and covers in accordance with Item 471, "Frames, Grates, Rings, and Covers," unless otherwise approved by the Engineer.

2.1.1. **Loading Requirements.** Designed to withstand American Association of State Highway and Transportation Officials (AASHTO) H-20 loading. Manufacturer must furnish certification of conformance with H-20 loading.

2.2. **Polymer Concrete.** Manufacture ground box and ground box cover from polymer concrete reinforced with 2 continuous layers of fiberglass fabric. Provide fabricated precast polymer concrete ground boxes and aprons that comply with the details shown on the plans, the requirements of this Item, and in accordance with American Standards Institute (ANSI)/Society of Cable Telecommunications Engineers (SCTE) - ANSI/SCTE 77, most current version.

- **Polymer Concrete.** Construct polymer concrete from catalyzed polyester resin, sand, and aggregate. Polymer concrete containing chopped fiberglass or fiberglass-reinforced plastic is prohibited. Ensure a minimum compressive strength of 11,000 psi.

- **Fiberglass Fabric.** The base glass on the fiberglass fabric must be alumina-limeborosilicate type "E" glass. The reinforcing fabric must line the entire inner and outer surfaces. Obtain approval for the fabric prior to production.

2.2.1. **Loading Requirements.** All polymer concrete boxes and covers must meet all test provisions of the ANSI/SCTE 77 Tier 22 requirements. All polymer concrete boxes and covers will be UL Listed or manufacture must provide a certification from an NRTL or factory-testing documentation witnessed and certified by professional engineer licensed in Texas.

Ensure ground box withstands 800 lb. per sq. ft. of force applied over the entire sidewall with less than 1/4 in. deflection per foot length of box. Ensure ground box and ground box cover withstand a test load of 33,750 lb. over a 10 in. x 20 in. area centered on the cover with less than 1/2 in. deflection at the design load of 22,500 lb.

3. EQUIPMENT

3.1. **Size.** Provide ITS ground boxes meeting the configuration types detailed in Table 1.

Table 1
Ground Box Inside Dimensions

Type	Width (Inches)	Length (Inches)	Depth (Inches)
Type 1 (Precast)	24	36	36, 48, or 60
Type 2 (Precast)	36	60	36, 48, or 60
Type 1 (Polymer)	24	36	24, 36, or 48
Type 2 (Polymer)	36	60	24, 36, or 48

3.2. **Shape.** Provide ITS ground boxes rectangular in shape.

3.3. **Aprons.** Provide concrete aprons for ground boxes installed in native ground as shown on the plans. Aprons will be omitted when the ground boxes are located in riprap, sidewalk, or landscape pavers.

3.4. **Bolts.** Provide stainless steel penta bolts or special keyed bolts, as required by Department, with associated hardware as shown on plans. Provide self-draining bolt holes. Washers must be provided with all bolts.

3.5. **Accessories.** Include all necessary provisions for knockouts, cable racking, adapters and terminators for proper conduit and cable installation.

3.5.1. **Knockouts.** Provide knockouts at the factory to accommodate the appropriate number and size of conduits entering the ground box as shown in the plans. Within the factory, score or provide indention on each outside wall identifying additional conduit entry points for future expansion that does not impact the rebar structure. Place a bell fitting on the end of each conduit to ensure a flush fit inside the ground box. Place concrete grout in the knockout (inside and out), around the conduit and bell fitting to ensure a neat and watertight fit. Ensure that the grout does not enter the inside of the conduit.

3.5.2. **Cable Racking.** Provide steel (ASTM A-153), non-metallic glass reinforced nylon, or equivalent cable rack assemblies with the dimensions shown on the plans.

3.5.3. **Terminators.** Terminators must be appropriately sized for the conduits indicated on plans and must be an airtight and watertight connection.

Terminators for the PVC conduits should be placed symmetrically about the centerline of the box at the depth shown on plans.

Terminators that do not have conduits attached must be capped and sealed as shown on the plans.

Install the quantity, size, and location of terminators as shown on plans.

3.6. **Cover Requirements.**

3.6.1. **Type of Cover.** Provide the following types of covers based on the type of ground box:

- Precast concrete ground box: Provide a 1-piece or 2-piece galvanized steel or cast iron cover depending on the ground box type. Provide a torsion assisted cover for Type 2 ground box with lids that can open freely a minimum 90º each and lock in place with locking latches or a pin-lock inserted in the hinge. Covers must be grounded in accordance with the requirements of the most current version of the NEC. Provide the cover with drop handles.
- Polymer concrete ground box: Provide a 1-piece or 2-piece cover depending on the ground box type, bolted to the ground box. Cover must have a minimum of 2 lifting eyes.

3.7. **Label.** Permanently mark all ground boxes and covers with the manufacturer's name or logo and model number. Legibly imprint each cover with a permanently marked logo in letters at least 1 in. high as follows: "DANGER—HIGH VOLTAGE TRAFFIC MANAGEMENT", unless otherwise directed. Glue in logos are prohibited.

3.8. **Security.** Equip all ground box covers with a stainless steel penta head or keyed bolting system that will securely hold the cover in place. Provide an appropriate means to secure or lock the cover in place as required by the plans.

3.9. **Skid Resistance.** All ground box covers must be skid resistant and should have a minimum coefficient of friction of 0.50 on the top surface of the cover. Provide certification minimum coefficient of friction value is met as part of material documentation.

3.10. **Strength Requirements.** The following ground box strengths are required based on the following 2 applications.

3.10.1. **Deliberate Roadway Traffic.** Precast concrete ground boxes with steel covers must be used in locations that may experience deliberate, continuous vehicular traffic, such as near the shoulder or an auxiliary lane, or immediately adjacent to the unprotected edge of pavement. Do not place ground boxes in the paved travel lanes or shoulder of highways, frontage roads, streets, bridges, or driveways.

Ground boxes and covers located in these areas must be rated for heavy-duty traffic loading and meet an AASHTO H-20 design loading.

Precast concrete ground boxes and covers located in non-deliberate heavy vehicular traffic must still meet AASHTO H-20 design loading.

3.10.2. **Non-Deliberate Heavy Vehicular Traffic.** Polymer concrete ground boxes and covers may be used in off roadway applications subject to occasional non-deliberate heavy vehicular traffic, such as driveways, along sidewalks, parking lots and behind non-mountable curb. Polymer ground boxes and covers located in these areas must meet ANSI/SCTE Tier 22 loading requirements.

4. CONSTRUCTION

Perform work in accordance with the details shown on the plans and the requirements of this Item.

Use established industry and utility safety practices when installing or removing ground boxes located near underground utilities. Consult with the appropriate utility company before beginning work.

4.1. **Installation.** Install ground boxes as shown on the plans. Maintain spacing as shown on the plans.

Ground box locations may be revised to fit existing field conditions or to better facilitate the installation of the conduit system with approval by the Engineer.

Field-locate ground boxes to avoid steep slopes and low-lying locations with poor drainage.

Construct ground box cover to fit properly on ground box.

When installing ground boxes in surfaced areas, make the tops of the ground boxes flush with the finished surface.

4.1.1. **Gravel at Base of Ground Box.** Install all ground boxes on a bed of crushed rock at the base of the excavation as shown on the plans. Place 12 in. of washed, crushed stone (1.5 in. nominal) which extends 6 in. in all directions from the perimeter of the box. Lightly tamp the gravel immediately prior to the placement of the ground box to reduce settlement. Crushed gravel will not be paid directly, but be considered subsidiary to this Item.

4.1.2. **Cable Racking Installation.** Provide and locate cable rack assemblies designed to support up to 25 ft. of slack for each fiber optic cable inside each Type 1 ground box, 100 ft. of slack for each fiber optic cable inside each Type 2 ground box, slack associated with other communication cabling, and any splice enclosure as shown on the plans or as directed. Cable racks may be installed at the factory or in the field. Place the racks in a manner so as not to impede access in and out of the ground box.

Ground metallic cable rack assemblies to grounding system inside ground box in accordance with the most current version of the NEC.

Use fasteners with an ultimate pull out strength of at least 2500 lb. and ultimate shear strength of at least 3000 lb. When securing cable racks to side walls of ground box in the field, seal all penetrations to the side wall to prevent moisture and contaminant penetration. Sufficient cable supports must be provided for the particular of conductors or cables coiled or passing through the ground as shown on the plans or directed by the Engineer.

4.1.3. **Buried Installation.** When shown in the plans or identified in the General Notes, bury ground boxes for security measures. When burying ground boxes, provide polymer concrete ground boxes meeting ANSI/SCTE Tier 22 loading requirements.

Provide 12 in. cover between ground surface and top of ground box lid. Prior to backfilling, provide a 30 lb. felt paper over the entire ground box extending a minimum of 2 in. from either side to prevent backfill materials from entering ground box.

4.2. **Excavation and Backfill.** Ensure excavation and backfill for ground boxes meets the requirements as set forth by Item 400, “Excavation and Backfill for Structures.” For buried ground boxes, compact backfill material in order to prevent depressions in ground surface from occurring over the ground box.

4.3. **Testing.** Ground box and cover must be tested by a laboratory independent of the manufacturer to meet loading requirements. Certificate of such tests must be submitted to the Engineer for approval.

4.4. **Documentation Requirements.** Submit documentation for this Item consisting of the following for Engineer approval prior to installation:

- record Global Positioning System (GPS) coordinates using NAD83 datum for all ground boxes prior to backfill. Identify location to obtain coordinates on drawing detail,
- shop drawings,

- concrete mix design,
- material specifications for ground box, lid, cable racks, bolts, and skid resistance for cover
- testing certification for loading requirements,
- hot, cold, and wet weather plan, and
- backfill material composition.

Shop drawings should clearly detail the following for ground boxes, at a minimum:

- dimensions
- knockouts
- cable racks
- terminators
- adapters
- bolts
- cover
- load rating
- cover lock

4.5. **Removal.** Remove existing ground boxes and concrete aprons to at least 6 in. below the conduit level. Uncover conduit to a sufficient distance so that 90º bends can be removed and conduit reconnected. Clean the conduit in accordance with Item 618, "Conduit." Replace conduit within 5 ft. of the ground box. Remove old conductors and install new conductors as shown on the plans. Backfill area with material equal in composition and density to the surrounding area. Replace surfacing material with similar material to an equivalent condition.

5. MEASUREMENT

This Item will be measured by each ground box installed or removed.

6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "ITS Ground Box (Precast Concrete)" of the various types and sizes specified" or "ITS Ground Box (Polymer Concrete)" of the various types and sizes specified and for "Remove ITS Ground Box".

6.1. **Furnish and Install.** This price is full compensation for excavating and backfilling; constructing, furnishing and installing the ITS ground boxes and concrete aprons when required; and all labor, tools, equipment, materials, transportation, accessories, documentation, testing and incidentals.

Conduit will be paid for under Item 618, "Conduit" and Special Specification 6016, "ITS Multi-Duct Conduit."

Electrical conductors will be paid for under Item 620, "Electrical Conductors."

6.2. **Remove.** This price is full compensation for removing and disassembling ground boxes and concrete aprons; excavation, backfilling, and surface placement; removing old conductors; disposal of unsalvageable materials; and materials, equipment, labor, tools, and incidentals. Cleaning of conduit is subsidiary to this Item. Conduit replaced within 5 ft. of the ground box will be subsidiary to this Item.

Special Specification 6263
Bluetooth Detection System

1. DESCRIPTION

Furnish, install, and removal of Bluetooth Detection System as shown in the plans, as detailed in the special specifications and as directed.

Ensure after the setup, there are no external tuning controls of any kind, which will require an operator.

2. MATERIALS

The Bluetooth Detection System will consist of a UV-protected, IP65 housed sensor, 2 external Bluetooth antennas, a CAT5e cable for Power over Ethernet, and a non-corrosive fixing bracket.

Provide documentation on the auto-configuration and auto-calibration processes.

Provide a Bluetooth Detection System that does not cause interference or alter the performance of any known equipment.

Furnish all new equipment and component parts in an operable condition at the time of delivery and installation.

Provide design to prevent reversed assembly or improper installation of connectors, fasteners, etc. Design each item of equipment to protect personnel from exposure to high voltage during equipment operation, adjustments, and maintenance.

Include licenses for all equipment, where required, for any software or hardware in the Bluetooth Detection System.

Provide all Bluetooth Detection Systems from the same manufacturer.

Provide Bluetooth Detection System firmware that is upgradeable by external local or remote download.

2.1. **Sensor Performance**. Ensure the Bluetooth Detection System maintains accurate performance in all weather conditions, including rain, freezing rain, snow, wind, dust, fog and changes in temperature and light.

2.2. **Performance Maintenance.** Provide Bluetooth Detection System that does not require cleaning or adjustment to maintain performance. Ensure it does not rely on battery backup to store configuration information. Ensure the Bluetooth Detection System, once calibrated, does not need recalibration to maintain performance over entire operational temperature range unless the roadway configuration changes. Provide remote connectivity to the Bluetooth Detection System to allow operators to change the unit's configuration, update the unit's firmware programming and recalibrate the unit automatically from a centralized facility. The sensor can be accessed remotely through both TCP/IP and GPRS (both dynamic and static).

The sensor must be configurable through a web browser and at TransVista through the centralized Traffic Management Software System.

2.3. **Cabling.** Supply the Bluetooth Detection System with a connector cable of the appropriate length for each installation site.

The Bluetooth antennas must be connected with the sensor through standard SMA-connectors.

2.4. **Communication.** The Bluetooth Detection System sensor must operate with two directional antennas for optimized detection of traffic in multiple lanes. The antennas must be optimized for detection across multiple lanes; they have a narrow vertical angle of 30º, and a wide horizontal (azimuth) angle of 110º, and have a 90º difference in the polarization to avoid interference. Each of the receiving channels must have the ability to capture signals as weak as -102dBm or more. The antennas are attached to the body of the sensor with stainless steel brackets.

The sensor must have an internal GPS for automatic clock synchronization and positioning. If a GPS signal is not available the sensor will capture its clock synchronization signal via NTP (Network Time Protocol). Once the clock signal has been captured it must start detecting Bluetooth® devices automatically. It must be possible to view real time scans to verify operations. The sensor must have diagnostics data recording reboots, GPS reception, data transfers and error messages related with GPRS and TCP/IP. The GPRS antenna must be inside the sensor housing.

For security purposes the sensor must have a configurable firewall; and thereby only admit connections from computers that have pre-selected IP-addresses or a subnet of pre-selected IP-addresses.

Ensure that the Bluetooth Detection System provides communication options that include RS-232, RS-485 or TCP/IP.

2.5. **Operating System Software.** The operator must be able to upload new firmware into non-volatile memory of the Bluetooth Detection System over any supported communication channel including TCP/IP networks.

2.5.1. **Software.** Provide any and all programming and software required to support the Bluetooth Detection System. Install the programming and software in the appropriate equipment at the time of acceptance testing. Complete and pass acceptance testing using a stable release of the programming and software provided.

Provide software update(s) free of charge during the warranty period.

2.6. **Manufacturing Requirements.** Ensure the assembly of the units adheres to industrial electronic assembly practices for handling and placement of components.

The Bluetooth Detection System must undergo a rigorous sequence of operational testing to ensure product functionality and reliability. Include the following tests:

- functionality testing of all internal subassemblies,
- unit level burn-in testing of 24 hr. duration or greater, and
- final unit functionality testing prior to shipment.

Provide test results and all associated data for the above testing, for each purchased Bluetooth Detection System by serial number. Additionally, maintain and make available manufacturing data for each purchased Bluetooth Detection System by serial number.

Externally, the Bluetooth Detection System must be modular in design to facilitate easy replacement in the field. Ensure the total weight of the Bluetooth Detection System does not exceed 5 lb.

Ensure all external parts are protected against corrosion, fungus growth and moisture deterioration.

2.7. **Support.** Ensure installers and operators of the Bluetooth Detection System are fully trained in the installation, auto-configuration and use of the device.

The manufacturer must train installers and operators to correctly perform the tasks required to ensure accurate Bluetooth Detection System performance. The amount of training necessary for each project will be

determined by the manufacturer (not less than 4 hr.) and must be included, along with training costs, in the manufacturer's quote. In addition, provide technical support to provide ongoing operator assistance.

2.8. **Power Requirements**. Provide the Bluetooth Detection System that operates at 12 to 24 VDC from a separate power supply to be provided as part of the bid item and ensure it does not draw more than 2W of power each.

Provide the separate power supply or transformer that operates from 115 VAC ±10%, 60 Hz ±3 Hz.

Provide equipment operations that are not affected by the transient voltages, surges and sags normally experienced on commercial power lines. Check the local power service to determine if any special design is needed for the equipment. The extra cost, if required, must be included in the bid of this item.

2.9. **Wiring**. Provide wiring that meets the requirements of the National Electric Code. Provide wires that are cut to proper length before assembly. Provide cable slacks to facilitate removal and replacement of assemblies, panels, and modules. Do not double-back wire to take up slack. Lace wires neatly into cable with nylon lacing or plastic straps. Secure cables with clamps. Provide service loops at connections.

2.10. **Transient Suppression**. Provide DC relays, solenoids and holding coils that have diodes or other protective devices across the coils for transient suppression.

2.11. **Power Service Protection**. Provide equipment that contains readily accessible, manually re-settable or replaceable circuit protection devices (such as circuit breakers or fuses) for equipment and power source protection.

Provide and size circuit breakers or fuses such that no wire, component, connector, PC board or assembly must be subjected to sustained current in excess of their respective design limits upon the failure of any single circuit element or wiring.

2.12. **Fail Safe Provision**. Provide equipment that is designed such that the failures of the equipment will not cause the failure of any other unit of equipment. Ensure automatic recovery from power failure will be within 15 sec. after resumption of power.

2.13. **Mechanical Requirements**. Enclose the Bluetooth Detection System in a rugged, water-tight NEMA 4X & IP 67 polycarbonate enclosure.

Do not use silicone gels or any other material for enclosure sealing that will deteriorate under prolonged exposure to ultraviolet rays. Ensure the overall dimensions of the box, including fittings, do not exceed 8 in. x 8 in. x 6 in. Ensure the overall weight of the box, including fittings, does not exceed 6.5 lbs.

Coat all printed circuit boards with a clear-coat moisture and fungus resistant material (conformal coating).

Ensure external connection for telecommunications and power be made by means of a single military style multi-pin connector, keyed to preclude improper connection.

2.13.1. **Modular Design.** Provide equipment that is modular in design to allow major portions to be readily replaced in the field. Ensure modules of unlike functions are mechanically keyed to prevent insertion into the wrong socket or connector.

Identify modules and assemblies clearly with name, model number, serial number and any other pertinent information required to facilitate equipment maintenance.

2.13.2. **Connectors and Harnesses**. Provide external connections made by means of connectors. Provide connectors that are keyed to preclude improper hookups. Color code and appropriately mark wires to and from the connectors.

Provide connecting harnesses of appropriate length and terminated with matching connectors for interconnection with the communications system equipment.

Provide pins and mating connectors that are plated to improve conductivity and resist corrosion. Cover connectors utilizing solder type connections by a piece of heat shrink tubing securely shrunk to insure that it protects the connection.

2.13.3. **Environmental Requirements**. Provide Bluetooth Detection System capable of continuous operation over a temperature range of –22°F to +165°F and a humidity range of 5% to 95% (non-condensing).

2.14. **Removal**. Remove the Bluetooth unit for the structure. This includes disconnecting all mounting hardware and the cabling from the cabinet to the Bluetooth unit.

Salvage Bluetooth unit and associated materials and return to District Maintenance Yard. Store all Bluetooth in a secure place as approved by the Engineer. Any Bluetooth units damaged or lost must be replaced by the Contractor at no cost to the Department.

3. CONSTRUCTION

3.1. **General.** Provide equipment designed and constructed with a minimum number of parts, subassemblies, circuits, cards, and modules to maximize standardization and commonality.

Design the equipment for ease of maintenance. Provide component parts that are readily accessible for inspection and maintenance. Provide test points that are for checking essential voltages and waveforms.

3.2. **Mounting and Installation.** Install the Bluetooth Detection System according to manufacturer's recommendations to achieve the specified accuracy and reliability.

Verify, with manufacturer assistance, the final Bluetooth Detection System placement if the Bluetooth Detection System is to be mounted near large planar surfaces (sound barrier, building, parked vehicles, etc.) that run parallel to the monitored roadway.

Include, at a minimum, Bluetooth Detection unit, enclosures, connectors, cables, junction box, mounting equipment and hardware, controller interface boards and assemblies, local and remote software, firmware, power supply units and all other support, calibration, and test equipment for the Bluetooth Detection System.

Furnish the Bluetooth Detection System with bracket or band designed to mount directly to a pole or overhead mast-arm or other structure. Ensure the mounting assembly has all stainless steel, or aluminum construction, and supports the load of the Bluetooth Detection System. Incorporate for the mounting assembly a mechanism that can be tilted in three axes, and then locked into place, to provide the optimum area of coverage. Ensure the mounting bracket is designed and installed to prevent sensor re-positioning during 80 mph wind conditions.

Proper placement, mounting height and orientation of the Bluetooth Detection System systems must conform to the manufacturer's published requirements for the system provided. Install the Bluetooth Detection System units as shown on the plans. Analyze each proposed pole location to assure that the Bluetooth Detection System installation will comply with the manufacturer's published installation instructions. Advise the Engineer, before any trenching or pole installation has taken place, of any need to move the pole from the location indicated in the plans in order to achieve the specified detector performance. Confirm equipment placement with the manufacturer before installing any equipment.

Ensure alignment, configuration and any calibration of the Bluetooth Detection System takes less than 15 min. per lane once mounting hardware and other installation hardware are in place. Install Bluetooth Detection System units such that each unit operates independently and that detectors do not interfere with other Bluetooth Detection System units or other equipment in the vicinity.

3.3. **Electronic Components.** Provide electronic components in accordance with Special Specification 6006, "Electronic Components."

3.4. **Mechanical Components.** Provide external screws, nuts and locking washers that are stainless steel. Provide parts made of corrosion resistant material, such as plastic, stainless steel, anodized aluminum or brass. Protect materials from fungus growth and moisture deterioration. Separate dissimilar metals by an inert dielectric material.

3.5. **Documentation Requirements.** Provide documentation in accordance with, Special Specification 6005, “Testing, Training, Documentation, Final Acceptance, and Warranty.”

Provide documentation ensuring emissions from the Bluetooth Detection System equipment are not harmful to the public

Provide additional test reports, for each of the following requirements:

3.5.1. **NEMA 4X Testing.** The Bluetooth Detection System enclosure must conform to test criteria set forth in the NEMA 250 Standard for Type 4X enclosures. Provide third party enclosure test results for each of the following specific Type 4X criteria:

- external Icing (NEMA 250 Clause 5.6);
- hose-down (NEMA 250 Clause 5.7);
- 4X Corrosion Protection (NEMA 250 Clause 5.10); and
- gasket (NEMA 250 Clause 5.14).

3.6. **Testing**. Perform testing in accordance with, Special Specification 6005, “Testing, Training, Documentation, Final Acceptance, and Warranty.” Test all Bluetooth Detection System to ensure that they comply with all FCC and Department specifications.

Ensure the Bluetooth Detection System meets functional performance requirements of Section 2.1, “Sensor Performance,” by the following methods:

3.7. **Experience Requirements**. The contractor or subcontractor involved in the installation and testing of the Bluetooth Detection System must, as a minimum, meet the following experience requirements:

One installed Bluetooth Detection System where system must been in continuously satisfactory operation and integrated into a Traffic Management Center providing accurate travel time results for at least 3 mo. Submit as proof, photographs or other supporting documents, and the names, addresses and telephone numbers of the operating personnel of the business or agency owning the system who can be contacted by the Department regarding the system.

Provide necessary documentation of contractor or subcontractor qualifications pursuant to contract award.

3.8. **Technical Assistance**. Ensure that a manufacturer's technical representative is available on site to assist the Contractor's technical personnel at each installation site and with Bluetooth Detection System equipment installation and communication system configuration.

Do not execute the initial powering up of the Bluetooth Detection System without the permission of the manufacturer's representative.

3.9. **Training**. Provide training in accordance with, Special Specification 6005, “Testing, Training, Documentation, Final Acceptance and Warranty.”

3.10. **Warranty**. Provide a warranty in accordance with, Special Specification 6005, “Testing, Training, Documentation, Final Acceptance and Warranty.”

4. MEASUREMENT

This item will be measured as each Bluetooth Detection System and Bluetooth Detection System (Remove).

5. PAYMENT

5.1.1. **Install.** The work performed and material furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Bluetooth Detection System." This price is full compensation for furnishing all equipment described under this Item with all cables, connectors, mounting assemblies, interface devices; all documentation and testing; all labor, materials, tools training, warranty, equipment, and incidentals.

5.1.2. **Removal.** The work performed and material furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Bluetooth Detection System (Remove)." This price is full compensation for removing the exiting Bluetooth unit and all equipment, materials, tools, hauling, labor, and incidentals.

Special Specification 6304

Intelligent Transportation System (ITS) Radar Vehicle Sensing Device

1. DESCRIPTION

Furnish, install, relocate, or remove Intelligent Transportation System (ITS) radar vehicle sensing device (RVSD) system at locations shown on the plans, or as directed.

2. MATERIALS

2.1. General. Except as allowed for relocation of RVSD equipment, ensure all equipment and component parts are new and in an operable condition at time of delivery and installation. Ensure all RVSD within the project are from the same manufacturer. RVSD are further classified by the type of functions they can perform. The primary classifications are RVSD (Data Collection Only) and RVSD (Data Collection and Wrong-way alarm).

Provide RVSD field equipment that is compatible with existing infrastructure and software located in the Department's Traffic Management Centers (TMCs) across the state or as directed.

RVSD system equipment must include the following:

- Radar vehicle sensing devices
- Mounting assembly and hardware
- All cabling and connector assemblies
- Associated devices required to integrate into communication system

RVSD must be a roadside sensor, or group of sensors, that accurately provides volume, speed, occupancy, and classification data for the roadway segment where they are installed.

Ensure sensor is designed and constructed with subassemblies, circuits, cards, and modules to maximize standardization and commonality. Ensure all external parts and surfaces are designed to protect against corrosion, fungus and moisture deterioration.

Design the equipment for ease of maintenance. Provide component parts that are readily accessible for inspection and maintenance. Provide test points for checking essential voltages and waveforms.

RVSD must self-recover from power failure once power is restored.

Sensor must be provided with a mounting bracket designed to mount directly to a pole, mast-arm, or other structure. Ensure bracket is designed such that the sensor can be tilted both vertically and horizontally for alignment and then locked into place after proper alignment is achieved. All hardware must be designed to support the load of the RVSD sensor and mounting bracket.

2.2. Configuration. Each RVSD system consists of roadside sensors as shown on the plans. Ensure the RVSD system detects a minimum of eight lanes. Ensure lane width, medians, and geometry are configurable. Traffic barriers must not interfere with detection.

Ensure RVSD does not require tuning or recalibration to maintain performance once initial calibration and configuration is complete. RVSD must not require cleaning or adjustment to maintain performance.

Ensure RVSD can detect vehicles within a range of 10 to 200 feet from the sensor and can simultaneously detect vehicles in all lanes within the detection range of the radar.

2.3. Automatic Detection. Once installed and aligned, ensure the sensor automatically detects vehicle volume, speed, and occupancy. Ensure only minor operator input is required for setup, such as verification of lane configuration and distance from sensor. Ensure the sensor tunes out stationary objects to omit false readings.

2.4. Data Collection. The RVSD must automatically calibrate vehicle speed, detection level, and sensitivity. Ensure RVSD provides accurate, real-time volume, average speed, and occupancy for each lane detected.

RVSD must provide user configurable settings for collection and polling intervals. Interval configurations must include options ranging from twenty seconds to 15 minutes or more.

RVSD must be able to correctly categorize detected vehicles into a minimum of three user definable length-based classification bins.

Ensure RVSD sensor performance is not affected by environmental conditions such as shadows, glare, wind, rain, heat, or snow. Ensure speed detection is accurate without requiring vehicle length for calculations.

Ensure RVSD system includes remote connection capabilities allowing an operator to update configuration and firmware as well as download interval data. In the event of communication loss, ensure RVSD stores and transfers data upon communication restoration and subsequent request for data.

Ensure RVSD sensor provides non-volatile memory for configuration settings and for local storage. The sensor must store a minimum of 3 hours of data for all data collected over eight travel lanes at twenty-second intervals. Ensure local storage data is overwritten in a first-in first-out manner.

Ensure RVSD supports the Department's Transportation Sensor System Protocol Document (TSS-Protocol) as detailed in the *TSS Tools* link on the Department's website (http://www.txdot.gov/business/resources/engineering-software.html).

2.5. Accuracy. Ensure RVSD accuracy meets or exceeds the following requirements during nominal conditions:

- Sensor volume data accuracy is within 5 percent of actual per direction of travel.
- Sensor average speed data is accurate within 5 mph per direction of travel.
- Individual lane speed accuracy is within 10 mph of actual.
- Individual vehicle speed accuracy is within 5 mph for 90% of measurements.
- Vehicle classification data is accurate for 90% of detected vehicles.

2.6. Functional Requirements for RVSD with Wrong-way Alarms. RVSD with wrong-way alarms must be capable of detecting and reporting direction of travel for each vehicle detected as well as include all features and functions required for Data Collection RVSD.

The RVSD sensor must automatically determine if a vehicle is traveling in the opposite direction for which the lane is configured.

Ensure the RVSD can detect real-time vehicle direction of travel.

2.7. Cabling. Supply the RVSD with all cabling of the appropriate length for each installation site.

2.8. Communication. RVSD must be remote accessible and provide communication options including RS-232, RS-485 and TCP/IP.

RVSD communication through RS-232 or RS-485 must include an internal RS-232, RS-485 communication port. Each serial communication port must support the following baud rates: 9600, 19200, 38400, 57600 and

115200. Additionally, the RS-232 port must be full-duplex and must support true Request to Send / Clear to Send (RTS/CTS) hardware handshaking for interfacing to various communication devices.

RVSD system must produce interval data packets containing all available criteria as detailed in TSS-Protocol.

2.9. Software. Ensure the RVSD manufacturer includes all software required to configure and monitor operation of RVSD field equipment locally and remotely. RVSD software must be a stable production release.

Software must allow the user to configure, operate, exercise, diagnose, and read current status of all RVSD features and functions using a laptop computer.

RVSD system computer software must be able to communicate with RVSD field devices using TCP/IP and serial connections, including cellular modem connections. The software must provide for local and remote configuration and monitoring, including a graphical user interface (GUI) that displays all configured lanes and provides visual representation of all detected vehicles.

System software must provide the user complete control over the configuration and setup process for RVSD devices and allow the user to load new firmware into non-volatile memory of RVSD field devices locally and over any supported communication channel including TCP/IP networks.

Software must include the ability to save a local copy of RVSD field device configurations, and load saved configurations to RVSD field devices.

Ensure the software allows the operator to change the baud rate via a drop-down list, add response delays for the communication ports to allow for communication stabilization, switch between data pushing and data polling, and change the RVSD's settings for Flow Control between none and RTS/CTS. Ensure the software automatically selects the correct baud rate and serial communication port from up to 15 serial communication ports.

The software must include the ability to retrieve and store data collected by RVSD field devices.

Ensure all licenses required for operation and use of software are included at no additional cost.

Software updates must be provided at no additional cost during the warranty period.

2.10. Mechanical. Ensure that all parts are fabricated from corrosion resistant materials, such as plastic, stainless steel, aluminum, or brass.

Ensure that all screws, nuts, and locking washers are stainless steel. Do not use self-tapping screws.

Ensure equipment is clearly and permanently marked with manufacturer name or trademark and part number as well as date of manufacture or serial number.

Ensure RVSD system is modular in design for ease of field replacement and maintenance. Ensure cable connector design prohibits improper connections. Cable connector pins are plated to improve conductivity and resist corrosion. RVSD sensor dimensions must not exceed 14 in. by 11 in. by 7 in.

Ensure the RVSD housing is a weather resistant, ultraviolet (UV) resistant material. RVSD sensor must meet NEMA 250 4X requirements. Ensure all gasket and sealant materials are UV resistant and intended to be used in outdoor environment with exposure to the sun.

All printed circuit boards (PCB) must have conformal coating.

2.11. Electrical. Ensure the RVSD system operates on nominal 120 V_{AC}. Provide a transformer with any system device that requires a nominal operating voltage other than 120 V_{AC}. Ensure RVSD sensor operates between

12 V_{DC} and 28 V_{DC} utilizing ten watts or less. Ensure equipment is designed to protect personnel from exposure to high voltage during installation, operation, and maintenance.

2.12. Environmental. All RVSD system components must operate properly during and after being subjected to the environmental testing procedures described in NEMA TS2, Section 2. RVSD sensor must be able to withstand the maximum wind load defined in the Department's basic wind velocity zone map standard without any damage or loosening from structure.

2.13. Connectors and Harnesses. External connections exposed to the outdoor environment must be made with weatherproof connectors. Connectors must be keyed to ensure correct alignment and mating.

Ensure all conductors are properly color coded and identified. Ensure that every conductive contact surface or pin is gold-plated or made of a noncorrosive, nonrusting, conductive metal.

Ensure power and data cable connectors exposed to the elements are IP 67 compliant. Ensure all conductors that interface with the connector are encased in one jacket.

RS-485 and RS-232 communication cables must:

- be shielded, twisted pair cable with a drain wire,
- have a nominal capacitance conductor to conductor @ 1Khz ≥ 26pF/ ft.,
- have nominal conductor DC resistance @ 68°F ≤ 15 ohms/1000 ft.,
- be one continuous run with no splices, and
- be terminated only on the two farthest ends of the cable.

2.14. Documentation. Provide hardcopy operation and maintenance manuals, along with a copy of all product documentation on electronic media. Include the following documentation for all system devices and software:

- operator manuals,
- installation manuals with installation procedures,
- maintenance and troubleshooting procedures, and
- manufacturer's specifications (functional, electrical, mechanical, and environmental).

Provide certification from an independent laboratory demonstrating compliance with NEMA TS2 environmental requirements for temperature, humidity, transients, vibration, and shock.

RVSD system must transmit in the 10.50 – 10.55 GHz or 24.00 – 24.25 GHz frequency band and meets the power transmission and frequency requirements of CFR 47. Ensure FCC certification is displayed on each device according to FCC rules. Provide third party test results for CFR 47, Part 15 (Section 15.245 or 15.249).

The RVSD enclosure must conform to criteria set forth in the NEMA 250 Standard for Type 4X enclosures. Provide third party enclosure test results demonstrating the sensor enclosure meets Type 4X criteria.

Ensure the RVSD system manufacturer has a quality assurance program for manufacturing RVSD as described in this specification. Manufacturer of the RVSD must be ISO 9001 certified, or provide a copy of the company quality manual for review.

The RVSD must pass testing to ensure functionality and reliability prior to delivery. These include functional tests for internal subassemblies, a 24 hr. minimum unit level burn-in test, and a unit functionality test. Test results and supporting documentation, including serial number tested, must be submitted for each RVSD. If requested, manufacturing data per serial number must be provided for each RVSD.

2.15. Warranty. Warrant the equipment against defects or failure in design, materials, and workmanship for a minimum of 5 yr. or in accordance with the manufacturer's standard warranty if that warranty period is greater. The start date of the manufacturer's standard warranty will begin after the equipment has successfully passed all tests contained in the final acceptance test plan. Any equipment with less than 90%

of its warranty remaining after the final acceptance test is completed will not be accepted by the Department. Guarantee that equipment furnished and installed for this project performs according to the manufacturer's published specifications. Assign, to the Department, all manufacturer's normal warranties or guarantees on all electronic, electrical, and mechanical equipment, materials, technical data, and products furnished for and installed on the project.

Malfunctioning equipment must be repaired or replaced at the Contractor's expense prior to completion of the final acceptance test plan. Furnish replacement parts for all equipment within 10 days of notification of failure by the Department.

During the warranty period, technical support must be available via telephone within 4 hr. of the time a call is made by a user, and this support must be available from factory certified personnel.

2.16. Training. Conduct a training class for a minimum of 8 hr., unless otherwise directed, for up to 10 representatives designated by the Department on installation, configuration, operation, testing, maintenance, troubleshooting, and repair. Submit a training session agenda, a complete set of training material, the names and qualifications of proposed instructors, and proposed training location for approval at least 30 days before the training. Conduct training within the local area unless otherwise directed. Provide 1 copy of course material for each attendee. Ensure that training includes:

- "Hands-on" operation of system software and equipment;
- explanation of all system commands, their function and usage; and
- system "troubleshooting," operation, and maintenance.

3. CONSTRUCTION

3.1. System Installation. Install RVSD system devices according to the manufacturer's recommendations to achieve the specified accuracy and reliability. Completion of the work must present a neat, workmanlike, and finished appearance.

If the RVSD is to be mounted near large planar surfaces (sound barrier, building, parked vehicles, etc.), verify the final placement meets manufacturer recommendations for installation and clearance.

Ensure installation and configuration of software on Department computers is included with the RVSD system.

3.2. Mechanical Components. Ensure that all fasteners, including bolts, nuts, and washers with a diameter less than 5/8 in. are Type 316 or 304 stainless steel and meet the requirements of ASTM F593 and ASTM F594 for corrosion resistance. Ensure that all bolts and nuts 5/8 in. and over in diameter are galvanized and meet the requirements of ASTM A307. Separate dissimilar metals with an inert dielectric material.

3.3. Wiring. All wiring and electrical work supplying the equipment must meet the requirements of the most current version of the National Electrical Code (NEC). Supply and install all wiring necessary to interconnect RVSD sensors to the field cabinet and incidentals necessary to complete the work. If additional cables are required, the Contractor must furnish and install them at no additional cost to the Department. Provide conductors at least the minimum size indicated on the plans and insulated for 600 V.

Cables must be cut to proper length prior to assembly. Provide cable slack for ease of removal and replacement. All cable slack must be neatly laced with lacing or straps in the bottom of the cabinet. Ensure cables are secured with clamps and include service loops.

3.4. Electrical Service. The Contractor is responsible for checking the local electrical service to determine if a modification is needed for the equipment.

3.5. Grounding. Ensure all RVSD system devices, cabinets, and supports are grounded in accordance with the NEC and manufacturer recommendations.

3.6. Relocation of RVSD Field Equipment. Perform the relocation in strict conformance with the requirements herein and as shown on the plans. Completion of the work must present a neat, workmanlike, and finished appearance. Maintain safe construction practices during relocation.

Inspect the existing RVSD field equipment with a representative from the Department and document any evidence of damage prior to removal. Conduct testing in accordance with 4.9. Remove and deliver equipment that fails inspection to the Department.

Prior to removal of existing RVSD field equipment, disconnect and isolate the power cables from the electric power supply and disconnect all communication cabling from the equipment located inside the cabinet. Coil and store power and communication cabling inside the cabinet until such time that it can be relocated. Remove existing RVSD field equipment as shown on the plans only at such time as authorized by the Engineer.

Use care to prevent damage to any support structures. Any equipment or structure damaged or lost must be replaced by the Contractor (with items approved by the Engineer) at no cost to the Department.

Make all arrangements for connection to power and communications including any permits required for the work to be done under the Contract. Provide wire for the power connection at least the minimum size indicated on the plans and insulated for 600 V.

3.7. Removal of RVSD Field Equipment. Perform the removal in strict conformance with the requirements herein and as shown on the plans. Completion of the work must present a neat, workmanlike, and finished appearance. Maintain safe construction practices during removal.

Inspect the existing RVSD field equipment with a representative from the Department and document any evidence of damage prior to removal. Conduct testing in accordance with 4.9.

Disconnect and isolate any existing electrical power supply prior to removal of existing field equipment.

Use care to prevent damage to any support structures. Any equipment or structure damaged or lost must be replaced by the Contractor (with items approved by the Engineer) at no cost to the Department.

All materials not designated for reuse or retention by the Department will become the property of the Contractor and be removed from the project site at the Contractor's expense. Deliver items to be retained by the Department to a location shown on the plans or general notes. The Contractor is fully responsible for any removed equipment until released by the Engineer.

3.8. Contractor Experience Requirements. Contractor or designated subcontractor must meet the following experience requirements:

3.8.1. Minimum Experience. Three years of continuous existence offering services in the installation of RVSD systems. Experience must include freeway and arterial management, forward fire and side fire applications, single zone and dual beam detection, and equipment setup, testing, and troubleshooting.

3.8.2. Completed Projects. Three completed projects where personnel installed, tested and integrated RVSD field equipment. The completed installations must have been in continuous satisfactory operation for a minimum of 1 yr.

3.8.3. Equipment Experience. One project (may be 1 of the 3 projects in the preceding paragraph) in which the personnel worked in cooperation with technical representatives of the equipment supplier to perform installation, integration, or acceptance testing of the work. The Contractor will not be required to furnish equipment on this project from the same supplier who was referenced in the qualification documentation.

Submit the names, addresses and telephone numbers of the references that can be contacted to verify the experience requirements given above.

4. TESTING

Ensure that the following tests are performed on equipment and systems unless otherwise shown on the plans. The Department may witness all the tests.

4.1. Test Procedures Documentation. Provide an electronic copy of the test procedures and blank data forms 60 days prior to testing for each test required on this project. Include the sequence of the tests in the procedures. The Engineer will approve test procedures prior to submission of equipment for tests. Conduct all tests in accordance with the approved test procedures.

Record test data on the data forms, as well as quantitative results. Ensure the data forms are signed by an authorized representative (company official) of the equipment manufacturer.

4.2. Design Approval Test. Ensure that the RVSD has successfully completed a Design Approval Test that confirms compliance with the environmental requirements of this specification.

Provide a certification and test report from an independent testing laboratory as evidence of a successfully completed Design Approval Test. Ensure that the testing by this laboratory is performed in accordance with the requirements of this specification.

4.3. Demonstration Test. Conduct a Demonstration Test on applicable equipment at an approved Contractor facility. Notify the Engineer 10 working days before conducting this testing. Perform the following tests:

4.3.1. Examination of Product. Examine each unit carefully to verify that the materials, design, construction, markings and workmanship comply with the requirements of this specification.

4.3.2. Continuity Tests. Check the wiring to determine conformance with the requirements of this specification.

4.3.3. Operational Test. Operate each unit for at least 15 min. to permit equipment temperature stabilization and observation of a sufficient number of performance characteristics to ensure compliance with this specification.

4.4. Stand-Alone Test. Conduct a Stand-Alone Test for each unit after installation. The test must exercise all stand-alone (non-network) functional operations. Notify the Engineer 5 working days before conducting this test.

4.4.1. Performance Test. Ensure the RVSD meets functional performance requirements of Section 2.5 by using the following test methods:

Verify volume and classification accuracy by performing a manual count on each lane of detection. Volume and classification data reported by the sensor must meet the volume and classification data accuracy requirements in Section 2.5 when compared with data collected manually.

Verify speed accuracy by comparing sensor speed data to speeds data collected with a laser speed gun, radar speed gun, or by video speed trap using frame rate as a time reference. Vehicle speeds must be collected and averaged over a minimum of 10 vehicles. Speed data must meet the speed data accuracy requirements in Section 2.5 when compared to average speeds collected using laser, radar, or video.

Verify wrong-way detection accuracy by reversing the configured direction of travel for at least one travel lane. Verify vehicles detected in a reversed lane are classified as wrong-way vehicles and properly counted. Volume reported for vehicles classified as wrong-way must meet the volume data accuracy requirement in Section 2.5.

4.5. System Integration Test. Conduct a System Integration Test on the complete functional system. Demonstrate all control and monitor functions for each system component for 72 hr. Supply 2 copies of the System Operations manual before the System Integration Test. Notify the Engineer 10 working days before conducting this testing.

4.6. Consequences of Test Failure. If a unit fails a test, submit a report describing the nature of the failure and the actions taken to remedy the situation prior to modification or replacement of the unit. If a unit requires modification, correct the fault and then repeat the test until successfully completed. Correct minor discrepancies within 30 days of written notice to the Engineer. If a unit requires replacement, provide a new unit and then repeat the test until successfully completed. Major discrepancies that will substantially delay receipt and acceptance of the unit will be sufficient cause for rejection of the unit.

If a failure pattern develops in similar units within the system, implement corrective measures, including modification or replacement of units, to all similar units within the system as directed. Perform the corrective measures without additional cost or extension of the Contract period.

4.7. Final Acceptance Test. Conduct a Final Acceptance Test on the complete functional system. Demonstrate all control, monitoring, and communication requirements and operate the system for 90 days. The Engineer will furnish a Letter of Approval stating the first day of the Final Acceptance Test. The completion of the Final Acceptance Test occurs when system downtime due to mechanical, electrical, or other malfunctions to equipment furnished or installed does not exceed 72 hr. and any individual points of failure identified during the test period have operated free of defects.

4.8. Consequences of Final Acceptance Test Failure. If a defect within the system is detected during the Final Acceptance Test, document and correct the source of failure. Once corrective measures are taken, monitor the point of failure until a consecutive 30 day period free of defects is achieved.

If after completion of the initial test period, the system downtime exceeds 72 hr. or individual points of failure have not operated for 30 consecutive days free of defects, extend the test period by an amount of time equal to the greater of the downtime in excess of 72 hr. or the number of days required to complete the performance requirement of the individual point of failure.

4.9. Relocation and Removal

4.9.1. Pre-Test. Tests may include, but are not limited to, physical inspection of the unit and cable assemblies. Include the sequence of the tests in the procedures along with acceptance thresholds. Contractor to resubmit, if necessary, rejected test procedures for final approval within 10 days. Review time is calendar days. Conduct all tests in accordance with the approved test procedures.

Conduct basic functionality testing prior to removal of RVSD field equipment. Test all functional operations of the equipment in the presence of representatives of the Contractor and the Department. Ensure that both representatives sign the test report indicating that the equipment has passed or failed each function. Once removed, the equipment becomes the responsibility of the Contractor until accepted by the Department. Compare test data prior to removal and after installation. The performance test results after relocation must be equal to or better than the test results prior to removal. Repair or replace those components within the system that failed after relocation but passed prior to removal.

4.9.2. Post-Test. Testing of the RVSD field equipment is to relieve the Contractor of system maintenance. The Contractor will be relieved of the responsibility for system maintenance in accordance with Item 7, “Legal Relations and Responsibilities” after a successful test period. The Contractor will not be required to pay for electrical energy consumed by the system.

After all existing RVSD field equipment has been installed, conduct approved continuity, stand alone, and performance tests. Furnish test data forms containing the sequence of tests including all the data taken as well as quantitative results for all tests. Submit the test data forms to the Engineer at least 30 days prior to the day the tests are to begin. Obtain Engineer’s approval of test procedures prior to submission of equipment for tests. Send at least 1 copy of the data forms to the Engineer.

Conduct an approved stand-alone test of the equipment installation at the field sites. At a minimum, exercise all stand-alone (non-network) functional operations of the field equipment installed per the plans as directed by the Engineer. Complete the approved data forms with test results and turn over to the Engineer for review and either acceptance or rejection of equipment. Give at least 30 working days notice prior to all tests to permit the Engineer or his representative to observe each test.

The Department will conduct approved RVSD field equipment system tests on the field equipment with the central equipment. The tests will, as a minimum, exercise remote control functions and confirm communication with field equipment.

If any unit fails to pass a test, prepare and deliver a report to the Engineer. Describe the nature of the failure and the corrective action needed. If the failure is the result of improper installation or damage during reinstallation, reinstall or replace the unit and repeat the test until the unit passes successfully, at no additional cost to the Department or extension of the Contract period.

5. MEASUREMENT

RVSD for data collection only will be measured by each unit furnished and installed, installed, relocated or removed. RVSD for data collection and wrong-way alarm will be measured by each system furnished and installed, installed, relocated or removed.

6. PAYMENT

6.1. Furnish and Install. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit bid price for "ITS RVSD (Data Collection Only) System" and "ITS RVSD (Data Collection and Wrong-way alarm) System." This price is full compensation for furnishing, installing, configuring, integrating, and testing the completed installation including RVSD equipment, voltage converters or injectors, cables, connectors, associated equipment, and mounting hardware; and for all labor, tools, equipment, any required equipment modifications for electrical service, documentation, testing, training, software, warranty and incidentals necessary to complete the work.

6.2. Install Only. The work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "ITS RVSD (Data Collection Only) (Install Only)" and "ITS RVSD (Data Collection and Wrong-way alarm) (Install Only)." This price is full compensation for installing, configuring, integrating, and testing the completed installation including RVSD equipment, voltage converters or injectors, cables, connectors, associated equipment, and mounting hardware; and for all labor, tools, equipment, any required equipment modifications for electrical service, documentation, testing, training, software, and incidentals necessary to complete the work.

6.3. Relocate. The work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "ITS RVSD (Data Collection Only) (Relocate)" and "ITS RVSD (Data Collection and Wrong-way alarm) (Relocate)." This price is full compensation for relocating and making fully operational existing RVSD field equipment; furnishing and installing additional cables or connectors; for testing, delivery and storage of components designated for salvage or reuse; and all testing, training, software, equipment, any required equipment modifications for electrical service, labor, materials, tools, and incidentals necessary to complete the work.

6.4. Remove. The work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "ITS RVSD (Data Collection Only) (Remove)" and "ITS RVSD (Data Collection and Wrong-way alarm) (Remove)." This price is full compensation for removing existing RVSD equipment; removal of cables and connectors; for testing, delivery and storage of components designated for salvage; and all testing, training, software, equipment, labor, materials, tools, and incidentals necessary to complete the work.

Special Specification 6319
LED Wrong Way Driver System

1. DESCRIPTION

Furnish, install, relocate, or remove LED Wrong Way Driver System WWDS at locations shown on the plans, or as directed.

2. MATERIALS

2.1. **General**. Except as allowed for relocation of LED Wrong-Way Driver System (WWDS) equipment, ensure all equipment and component parts are new and in an operable condition at time of delivery and installation. Ensure all WWDS within the project are from the same manufacturer. WWDS equipment is further classified by the type of functions they can perform.

Provide WWDS that is compatible with existing infrastructure and software located in the Department's Traffic Management Centers (TMCs) across the state or as directed.

Provide materials that comply with the details shown on the plans, the requirements of this Item, and the pertinent requirements of the following Items:

- Item 620, "Electrical Conductors,"
- Item 644, "Small Roadside Sign Supports and Assemblies",
- Item 656 "Foundations for Traffic Control Devices,"
- Item 687 "Pedestal Pole Assemblies,"
- Item 6006 "Electronic Components,"
- Item 6062 "Intelligent Transportation System (ITS) Radio"
- Item 6063 "Intelligent Transportation System (ITS) Solar Power System," and
- Item 6304 "Intelligent Transportation System (ITS) Radar Vehicle Sensing Device."

2.1.1. **Components**. The system is composed of these principal items as shown on the plans, or as directed:

- WRONG WAY sign (R5-1a);
- LED strips for flashing red lights when a wrong way driver is detected;
- Detector(s) for detecting wrong way drivers;
- Flash Controller;
- Power Source for powering any lights and equipment;
- Sign Support and Foundation;
- Communications for system status / configuration and wrong way driver alerts; and
- Camera for visual confirmation of wrong way driver event.

2.2. **Functional Requirements**. Furnish a WWDS that provides a highly visible, enhanced warning for the purpose of alerting WWDS. Upon activation by radar detection of a wrong way driver, the WWDS flash controller will activate and flash all red lights simultaneously. The light will flash synchronously and then cease operation after a programmable timeout. When shown on the plans, or as directed, the WWDS equipment will also send alerts including visual confirmation.

Ensure equipment is designed to protect personnel from exposure to high voltage during installation, operation, and maintenance. If 120 V AC /60 Hz power is not available and solar power must be used, ensure all components can operate on DC power, so a power inverter is not needed.

2.2.1. **Sign**. Provide a WRONG WAY sign (R5-1a) of appropriated size in accordance with Standard Highway Sign Designs for Texas (SHSD) and Texas Manual on Uniform Traffic Control Devices (TMUTCD)

2.2.2. **Flashing Red Lights**. As shown on the plans, or as directed, provide flasher controller that turns on the LEDs. Active vehicle warning indications must be visible in a direct line of sight at distances over 1000 feet during the day, and over 1 mile at night.

2.2.2.1. **LEDs**. Mounted around the entire border of the sign.

2.2.3. **Detector**. Program the detector to provide trigger outputs only when a wrong way driver is detected traveling between 2 to 100 miles per hour. Unless otherwise shown on the plans, or as directed, provide Radar Vehicle Sensing Device (RVSD) in accordance with Intelligent Transportation System (ITS) Radar Vehicle Sensing Device Statewide Special Specification.

Ensure RVSD does not require tuning or recalibration to maintain performance once initial calibration and configuration is complete. RVSD must not require cleaning or adjustment to maintain performance. RVSD must self-recover from power failure once power is restored.

2.2.4. **Flash Controller**. The programmable flash controller with Integrated Solar Charger is housed within the NEMA Type 4 Control Cabinet, and must:

- Must have a contact-closure point to accept a trigger from the detector;
- Include integrated constant-current LED drivers with a minimum of two-channel output for driving one or two lights;
- Flash the LEDs 50 to 60 flashes per minute;
- Have multiple programmable function options:
  - Run 24 hours per day, 7 days per week,
  - Run from dusk to dawn,
  - Run for a programmable time period when activated via switch, button contact closure or when triggered from an external detector such as a wireless transmitter, RVSD, presence detector or loop detector with a compatible sensor output,
  - Run on a timeclock schedule that is programmed to the controller and determines days of the week and times of the day that the sign flashes, and
  - Run a “fail safe” operation when the detector fails and will remain in this state until communication is re-established with the detector;
- Provide multiple levels of LED brightness through LED drive current control;
- Automatically adjust the LED drive current control to optimize brightness for the ambient lighting conditions;
- Automatically adjust the LED duty cycle to save battery during nighttime operation;
- Have the LED drive outputs reach the full output current as programmed within the duration of the 100ms on-time;
- Include an integrated Real Time Clock (RTC) with on-board battery or supercapacitor backup;
- Have the capability of TCP/IP communications for programming with Windows-based software or web browser;
- Be capable of solar charging the system battery, including a completely drained battery pack;
- Automatically provide Low Voltage Disconnect (LVD) to protect batteries when needed;
- Automatically provide Load-Reconnection once battery levels have been restored to an acceptable value;
- Include a minimum of two General Purpose Inputs and Outputs (GPIO);
- Be internally housed in its own NEMA Type 6 enclosure;
- Be independently replaceable of other control panel components; and
- Be able to monitor internal temperature.

2.2.5. **Power Source**. If 120 V AC /60 Hz power is not available, provide a solar power system that must power for all the entire WWD System. Unless otherwise shown on the plans, or as directed, size solar power system with batteries for a 3-Day Autonomy in accordance with Item 6063 "Intelligent Transportation System (ITS) Solar Power System." Ensure maximum solar insolation regardless of installation location. If a post-top mounting system is used, provide 360° of rotational direction adjustment.

Battery must be replaceable independently of other components.

2.2.6. **Sign Support and Foundation**. If mounting the WWDS on an existing sign support, ensure the system is sized appropriately and is able to withstand the maximum wind load defined in the Department's basic wind velocity zone map standard without any damage or loosening from structure.

2.2.7. **Communications**. If communications and remote accessible is required, provide TCP/IP options over a radio in accordance with Item 6062 "Intelligent Transportation System (ITS) Radio" or that are compatible with a Department-furnished cell modem.

2.2.8. **Camera**. If visual confirmation is required, provide a camera.

2.3. **Mechanical**. Ensure that all parts are fabricated from corrosion resistant materials, such as plastic, stainless steel, aluminum, or brass.

Ensure that all screws, nuts, and locking washers are stainless steel. Do not use self-tapping screws.

Ensure equipment is clearly and permanently marked with manufacturer name or trademark and part number as well as date of manufacture or serial number.

Ensure WWDS is modular in design for ease of field replacement and maintenance.

All printed circuit boards (PCB) must have conformal coating.

2.4. **Cabling**. Supply the WWDS with all cabling of the appropriate length for each installation site.

2.5. **Connectors and Harnesses.** External connections exposed to the outdoor environment must be made with weatherproof connectors. Connectors must be keyed to ensure correct alignment and mating.

Ensure all conductors are properly color coded and identified. Ensure that every conductive contact surface or pin is gold-plated or made of a noncorrosive, nonrusting, conductive metal.

Ensure power and data cable connectors exposed to the elements are IP 67 compliant. Ensure all conductors that interface with the connector are encased in one jacket.

2.6. **Environmental**. All WWDS components must operate properly during and after being subjected to the environmental testing procedures described in NEMA TS2, Section 2.

Provide a WWDS with a design will minimize weight and wind loading when mounted on a sign support. WWDS must be able to withstand the maximum wind load defined in the Department's basic wind velocity zone map standard without any damage or loosening from structure.

2.7. **Documentation**. Provide hardcopy operation and maintenance manuals, along with a copy of all product documentation on electronic media. Include the following documentation for all system devices and software:

- Operator manuals;
- Installation manuals with installation procedures;
- Maintenance and troubleshooting procedures; and
- Manufacturer's specifications (functional, electrical, mechanical, and environmental).

2.8. **Warranty**. Warrant the equipment against defects or failure in design, materials, and workmanship for a minimum of 3 yr. or in accordance with the manufacturer's standard warranty if that warranty period is greater. The start date of the manufacturer's standard warranty will begin after the equipment has successfully passed all tests contained in the final acceptance test plan. Any equipment with less than 90% of its warranty remaining after the final acceptance test is completed will not be accepted by the Department. Guarantee that equipment furnished and installed for this project performs according to the manufacturer's published specifications. Assign, to the Department, all manufacturer's normal warranties or guarantees on all electronic, electrical, and mechanical equipment, materials, technical data, and products furnished for and installed on the project.

Malfunctioning equipment must be repaired or replaced at the Contractor's expense prior to completion of the final acceptance test plan. Furnish replacement parts for all equipment within 10 days of notification of failure by the Department.

During the warranty period, technical support must be available via telephone within 4 hr. of the time a call is made by a user, and this support must be available from factory certified personnel.

3. CONSTRUCTION

3.1. **Installation**. Before installation of any equipment, perform a site survey of the proposed locations to determine the optimal positioning of the signs and radar units to achieve proper operation based on the manufacturer's recommendations. Test wireless links to assure they provide optimal communication between transmitters and receivers. Adjust locations as approved by the Engineer if necessary. If required, remove any existing Wrong Way signs from their mounts to allow the installation of the new signs. Mount WRONG WAY sign in accordance with Section 2B.41 Wrong-Way Traffic Control at Interchange Ramps of the TMUTCD, or shown on the plans, or as directed.

Install equipment in accordance with this Item and the lines, grades, details and dimensions as shown on the plans or as directed. Maintain safe construction practices. Ensure the mechanical execution of work complies with NEC, Article 110.12. Equipment must be installed in a neat and workmanlike manner.

Provide all mounting hardware and cabling necessary to install and make operational all equipment. Provide only new and corrosion resistant materials. Consider all mounting hardware and cables as subsidiary to this item with no direct payment.

Adjustments and/or addition of sign attachment hardware, mounting components and hardware for radar/solar panels, support brackets and appurtenances, such as conduit, etc., may be necessary for compatibility with specified positioning recommended by the manufacturer, as shown on the plans, or as directed. All adjustments and/or additional materials will not be paid for directly but will be subsidiary to this Item.

Replace any portion of the equipment that is damaged or lost during transportation or installation. Any unused or removed material deemed salvageable by the Engineer will remain on the property of the Department or be delivered to a designated site. Accept ownership of unsalvageable materials and dispose of in accordance with federal, state and local regulations.

The Contractor must complete vendor-provided training on the installation of all equipment before any work begins. The Contractor will provide documentation that they have completed the required training from the equipment manufacturer prior to final testing of the equipment.

Once installation is complete, contractor will coordinate with equipment manufacturer to ensure radars are properly positioned and the Wrong Way driver detection zones are accurate. Ensure that all equipment is functioning properly and communicating with manufacturer's cloud server. Testing will begin once proper system functionality is proven.

Stockpile all materials designated for reuse or to be retained by the Department within the project limits or at a designated location as directed.

3.2. **Mechanical Components**. Ensure that all fasteners, including bolts, nuts, and washers with a diameter less than 5/8 in. are Type 316 or 304 stainless steel and meet the requirements of ASTM F593 and ASTM F594 for corrosion resistance. Ensure that all bolts and nuts 5/8 in. and over in diameter are galvanized and meet the requirements of ASTM A307. Separate dissimilar metals with an inert dielectric material.

3.3. **Wiring**. All wiring and electrical work supplying the equipment must meet the requirements of the most current version of the National Electrical Code (NEC). Supply and install all wiring necessary to interconnect WWDS equipment to the field cabinet and incidentals necessary to complete the work. If additional cables are required, the Contractor must furnish and install them at no additional cost to the Department. Provide conductors at least the minimum size indicated on the plans and insulated for 600 V.

Cables must be cut to proper length prior to assembly. Provide cable slack for ease of removal and replacement. All cable slack must be neatly laced with lacing or straps in the bottom of the cabinet. Ensure cables are secured with clamps and include service loops.

3.4. **Electrical Service**. When shown in the plans, the Contractor is responsible for checking the local electrical service (if available) to determine if a modification is needed for the equipment

3.5. **Grounding.** Ensure all WWDS devices, cabinets, and supports are grounded in accordance with the NEC and manufacturer recommendations.

3.6. **Relocation of WWDS Field Equipment**. Perform the relocation in strict conformance with the requirements herein and as shown on the plans. Completion of the work must present a neat, workmanlike, and finished appearance. Maintain safe construction practices during relocation.

Inspect the existing WWDS field equipment with a representative from the Department and document any evidence of damage prior to removal. Conduct testing in accordance with 4.5. Remove and deliver equipment that fails inspection to the Department.

Prior to removal of existing WWDS field equipment, disconnect and isolate the power cables from the electric power supply and disconnect all communication cabling from the equipment located inside the cabinet. Coil and store power and communication cabling inside the cabinet until such time that it can be relocated. Remove existing WWDS field equipment as shown on the plans only at such time as authorized by the Engineer.

Use care to prevent damage to any support structures. Any equipment or structure damaged or lost must be replaced by the Contractor (with items approved by the Engineer) at no cost to the Department.

Make all arrangements for connection to power and communications including any permits required for the work to be done under the Contract. Provide wire for the power connection at least the minimum size indicated on the plans and insulated for 600 V.

3.7. **Removal of WWDS Field Equipment**. Perform the removal in strict conformance with the requirements herein and as shown on the plans. Completion of the work must present a neat, workmanlike, and finished appearance. Maintain safe construction practices during removal.

Inspect the existing WWDS field equipment with a representative from the Department and document any evidence of damage prior to removal. Conduct testing in accordance with 4.5.

Disconnect and isolate any existing electrical power supply prior to removal of existing field equipment.

Use care to prevent damage to any support structures. Any equipment or structure damaged or lost must be replaced by the Contractor (with items approved by the Engineer) at no cost to the Department.

All materials not designated for reuse or retention by the Department will become the property of the Contractor and be removed from the project site at the Contractor's expense. Deliver items to be retained by the Department to a location shown on the plans or general notes. The Contractor is fully responsible for any removed equipment until released by the Engineer.

3.8. **Contractor Experience Requirements**. Contractor or designated subcontractor must meet the following experience requirements:

3.8.1. **Minimum Experience.** Two years of continuous existence offering services in the installation of WWDS. Experience must include equipment setup, testing, and troubleshooting.

3.8.2. **Completed Projects.** Two completed projects where personnel installed, tested and integrated WWDS field equipment. The detectors and radios must have been installed outdoors and permanently mounted. The completed installations must have been in continuous satisfactory operation for a minimum of 1 yr.

3.8.3. **Equipment Experience**. One project (may be 1 of the 3 projects in the preceding paragraph) in which the personnel worked in cooperation with technical representatives of the equipment supplier to perform installation, integration, or acceptance testing of the work. The Contractor will not be required to furnish equipment on this project from the same supplier who was referenced in the qualification documentation.

Submit the names, addresses and telephone numbers of the references that can be contacted to verify the experience requirements given above.

4. TESTING

Testing of the installed equipment locations is for the purpose of relieving the Contractor of maintenance of the equipment. The Contractor will be relieved of the responsibility for maintenance of the equipment in accordance with Item 7, "Legal Relations and Responsibilities"; after all testing is successfully completed.

4.1. Ensure that the following tests are performed on equipment and systems unless otherwise shown on the plans, or as directed. The Department may witness all the tests.

4.2. **Performance Test**. Conduct a Performance Test for each unit after installation. Ensure the WWDS meets functional performance requirements of Section 2 by using the following test methods:

Testing of the equipment will consist of the following procedure: once the equipment has been installed and activated, the exit ramp will be closed to traffic. A test vehicle will then be driven the wrong way down the ramp a minimum of ten times. Once a maximum of ten successful detections and notifications of the wrong way vehicle are received, the equipment will be accepted as fully tested and ready for operation. To be accepted the last five successful tests must be consecutive.

After each equipment location has been installed, the Department and the contractor will conduct approved continuity, stand alone, and system tests on the installed field equipment with laptop equipment.

4.3. **Final Acceptance Test**. Conduct a Final Acceptance Test on the complete functional system. Demonstrate all control, monitor, and communication requirements for 60 days. The Engineer will furnish a letter acknowledging the final acceptance testing commencement date stating the first day of the final acceptance test.

The completion of the final acceptance test occurs when less than two false calls have occurred, the system downtime due to mechanical, electrical, or other malfunctions to equipment furnished or installed does not exceed 72 hr. and any individual points of failure identified during the test period have operated free of defects. Assume responsibility only for test failures directly related to the work in accordance with this Item. Upon completion of successful final acceptance testing, document the acceptance date and project identification information and provide 2 copies to the Engineer.

4.4. **Consequences of Test Failure**. If a unit fails a test, submit a report describing the nature of the failure and the actions taken to remedy the situation prior to modification or replacement of the unit. If a unit requires modification, correct the fault and then repeat the test until successfully completed. Correct minor discrepancies within 30 days of written notice to the Engineer. If a unit requires replacement, provide a new unit and then repeat the test until successfully completed. Major discrepancies that will substantially delay receipt and acceptance of the unit will be sufficient cause for rejection of the unit.

If a failure pattern develops in similar units within the system, implement corrective measures, including modification or replacement of units, to all similar units within the system as directed. Perform the corrective measures without additional cost or extension of the Contract period.

4.5. **Relocation and Removal**

4.5.1. **Pre-Test**. Tests may include, but are not limited to, physical inspection of the unit and cable assemblies. Include the sequence of the tests in the procedures along with acceptance thresholds. Contractor to resubmit, if necessary, rejected test procedures for final approval within 10 days. Review time is calendar days. Conduct all tests in accordance with the approved test procedures.

Conduct basic functionality testing prior to removal of WWDS field equipment. Test all functional operations of the equipment in the presence of representatives of the Contractor and the Department. Ensure that both representatives sign the test report indicating that the equipment has passed or failed each function. Once removed, the equipment becomes the responsibility of the Contractor until accepted by the Department. Compare test data prior to removal and after installation. The performance test results after relocation must be equal to or better than the test results prior to removal. Repair or replace those components within the system that failed after relocation but passed prior to removal.

4.5.2. **Post-Test**. Testing of the WWDS field equipment is to relieve the Contractor of system maintenance. The Contractor will be relieved of the responsibility for system maintenance in accordance with Item 7, "Legal Relations and Responsibilities" after a successful test period. The Contractor will not be required to pay for electrical energy consumed by the system.

After all existing WWDS field equipment has been installed, conduct approved continuity and performance tests. Furnish test data forms containing the sequence of tests including all the data taken as well as quantitative results for all tests. Submit the test data forms to the Engineer at least 30 days prior to the day the tests are to begin. Obtain Engineer's approval of test procedures prior to submission of equipment for tests. Send at least 1 copy of the data forms to the Engineer.

Conduct an approved performance test of the equipment installation at the field sites. At a minimum, exercise all stand-alone (non-network) functional operations of the field equipment installed per the plans as directed by the Engineer. Complete the approved data forms with test results and turn over to the Engineer for review and either acceptance or rejection of equipment. Give at least 30 working days notice prior to all tests to permit the Engineer or his representative to observe each test.

The Department will conduct approved with field equipment system tests on the field equipment with the central equipment. The tests will, as a minimum, exercise remote control functions and confirm communication with field equipment.

If any unit fails to pass a test, prepare and deliver a report to the Engineer. Describe the nature of the failure and the corrective action needed. If the failure is the result of improper installation or damage during reinstallation, reinstall or replace the unit and repeat the test until the unit passes successfully, at no additional cost to the Department or extension of the Contract period.

5. MEASUREMENT

5.1. This Item will be measured by each furnished, installed, relocated, or removed of the types specified, to provide communication and functionality.

6. PAYMENT

6.1. **Furnish and Install**. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit bid price for "LED Wrong Way Driver System."

This price is full compensation for furnishing, installing, configuring, integrating, and testing the completed installation including WWDS equipment, voltage converters or injectors, cables, connectors, associated equipment, and mounting hardware; and for all labor, tools, equipment, any required equipment modifications for electrical service, documentation, testing, software, warranty and incidentals necessary to complete the work.

6.2. **Install Only**. The work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "LED Wrong Way Driver System (Install Only)." This price is full compensation for installing, configuring, integrating, and testing the completed installation including WWDS equipment, voltage converters or injectors, cables, connectors, associated equipment, and mounting hardware; and for all labor, tools, equipment, any required equipment modifications for electrical service, documentation, testing, software, and incidentals necessary to complete the work.

6.3. **Relocate**. The work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "LED Wrong Way Driver System (Relocate)." This price is full compensation for relocating and making fully operational existing WWDS field equipment; furnishing and installing additional cables or connectors; for testing, delivery and storage of components designated for salvage or reuse; and all testing, software, equipment, any required equipment modifications for electrical service, labor, materials, tools, and incidentals necessary to complete the work.

6.4. **Remove**. The work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "LED Wrong Way Driver System (Remove)." This price is full compensation for removing existing WWDS equipment; removal of cables and connectors; for testing, delivery and storage of components designated for salvage; and all testing, software, equipment, labor, materials, tools, and incidentals necessary to complete the work.

Special Specification 6438

Mobile Retroreflectivity Data Collection for Pavement Markings

1. DESCRIPTION

Furnish mobile retroreflectivity data collection (MRDC) for pavement markings on roadways as shown on the plans or as designated by the Engineer. Conduct MRDC on dry pavement only. Provider is defined as the Contractor or Subcontractor who collects the MRDC data.

2. EQUIPMENT AND PERSONNEL

2.1. **Mobile Retroreflectometer**. Provide a self-propelled, mobile retroreflectometer certified by the Texas A&M Transportation Institute (TTI) Mobile Retroreflectometer Certification Program.

2.2. **Portable Retroreflectometer**. Provide a portable retroreflectometer that uses 30-meter geometry meeting the requirements described in ASTM E 1710. Maintain, service, and calibrate all portable retroreflectometers according to the manufacturer's instructions.

2.3. **Operating Personnel for Mobile Retroreflectometer**. Provide all personnel required to operate the mobile retroreflectometer and portable retroreflectometer. Ensure MRDC system operator has a current certification from the TTI Mobile Retroreflectometer Certification Program to conduct MRDC with the certified mobile retroreflectometer provided.

2.4. **Additional Personnel**. Provide any other personnel necessary to compile, evaluate, and submit MRDC.

2.5. **Safety Equipment**. Supply and operate all required safety equipment to perform this service.

3. MRDC DOCUMENTATION AND TESTING

Document all MRDC by county and roadway or as directed by the Engineer. Submit all data to the Department and to the TTI Mobile Retroreflectometer Certification Program no later than three working days after the day the data is collected. Submit all raw data collected in addition to all other data submitted. Provide data files in Microsoft Excel format or a format approved by the Engineer. Provide measurement notification and field tests as specified. Verification and referee testing may be conducted at the Department's discretion.

3.1. **Preliminary Documentation Sample**. Submit a sample data file, video, and map of MRDC data in the required format 10 working days before beginning any work. The format must meet specification and be approved by the Engineer before any work may begin.

3.2. **Initial Documentation Review and Approval**. The Department will review documentation submitted for the first day of MRDC, and if it does not meet specification requirements, will not allow further MRDC until deficiencies are corrected. The Department will inform the Provider no later than three working days after submittal if the first day of MRDC does not meet specification requirements. Time charges will continue unless otherwise directed by the Engineer.

3.3. **Data File**. Provide data files with the following:

- date;
- district number;

- county;
- Project CSJ number;
- name of mobile retroreflectometer operator;
- route number with reference markers or other reference information provided by the Engineer to indicate the location of beginning and end data collection points on that roadway;
- cardinal direction;
- line type (single solid, single broken, double solid, etc.);
- line color;
- file name corresponding to video;
- data for each centerline listed separately;
- average reading taken for each 0.1-mi. interval (or interval designated by the Engineer);
- accurate GPS coordinates (within 20 ft.) for each interval;
- color-coding for each interval indicating passing or failing, unless otherwise directed by the Engineer (passing and failing thresholds provided by the Engineer);
- graphical representation of the MRDC (y-axis showing retroreflectivity and x-axis showing intervals) corresponding with each data file;
- distance in miles driven while measuring the pavement markings;
- event codes (pre-approved by the Engineer) indicating problems with measurement;
- portable retroreflectometer field check average reading and corresponding mobile average reading for that interval when applicable; and
- upper validation threshold (may be included separately with the raw data but must be clearly identified with the data collected using that threshold).

3.4. **Map**. Provide a map in an electronic format approved by the Engineer with each MRDC submission that includes the following information:

- date;
- district number;
- county;
- color-coded 1-mi. intervals (or interval length designated by the Engineer) for passing and failing retroreflectivity values or retroreflectivity threshold values provided by the Engineer; and
- percentage of passing and failing intervals, if required by the Engineer.

3.5. **Video**. Provide a high-quality DVD or electronic video file with the following information:

- date and corresponding data file name on label;
- district number;
- county;
- route number with reference markers or other designated reference information to indicate the location of beginning and end collection points on that roadway; and
- retroreflectivity values presented on the same screen with the following information:
  - date;
  - location;
  - starting and ending mileage;
  - total miles;
  - retroreflectivity readings; and
  - upper validation thresholds (may be included separately with the raw data but must be clearly identified with the data collected using that threshold).

3.6. **Field Comparison Checks with a Portable Retroreflectometer**. Take a set of field comparison readings with the portable retroreflectometer at least once every 4 hr. while conducting MRDC or at the frequency designated by the Engineer. Take a minimum of 20 readings, spread out over the interval measured. List the average portable retroreflectometer reading next to the mobile average reading for that interval with the

reported MRDC data. Request approval from the Engineer to take field comparison readings on a separate roadway, when measuring a roadway where portable retroreflectometer readings are difficult to take. Take the off-location field comparison readings at no additional cost. Submit the portable retroreflectometer printout of all the readings taken for the field comparison check with the corresponding MRDC data submitted. The mobile average reading must be within ±15% of the portable average reading. The Engineer may require new MRDC for some or all of the pavement markings measured in a 4-hr. interval before a field comparison check not meeting the ±15% range. Provide the new MRDC at no extra cost to the Department. The Engineer may take readings with a Department portable retroreflectometer to ensure accuracy at any time. The Department's Materials and Tests Division (MTD) will take comparison readings and serve as the referee if there is a significant difference between the Engineer's portable readings and the Provider's mobile and handheld readings. For best results, take field comparison readings on a fairly flat and straight roadway when possible.

3.7. **Periodic Field Checks at Pre-Measured Locations**. When requested by the Engineer, measure with the mobile unit and report to the Engineer immediately after measurement the average retroreflectivity values for a designated pre-measured test location. The Engineer will have taken measurements at the test location within 10 days of the test. The test location will not include pavement markings less than 30 days old. If the measured averages do not fall within ±15% of the pre-measured averages, further calibration and comparison measurements may be required before any further MRDC. Submit the results of the field check with the MRDC report for that day.

3.8. **Measurement Notification**. Provide notification via email to Mobileretro@tamu.edu with a carbon copy to the Engineer a minimum of 24 hr. before mobile retroreflectivity data collection to allow for scheduling verification testing when needed.

3.9. **Verification Testing.** The Engineer or a third party may perform retroreflectivity verification testing within seven days of the Provider's retroreflectivity readings. The Provider-submitted retroreflectivity data will be compared to the verification test data to determine acceptability of the Provider's mobile retroreflectometer data. Comparison of the data will result in one of the two scenarios below:

- Provider's Data is Validated – if the difference between Provider's and Engineer-third party data is 20% or less, then the Provider's data is validated. The Provider's data will be used for acceptance.

- Provider's Data is not Validated – if the difference between Provider's and Engineer-third party data is more than 20%, then the Provider's data is not validated. The Engineer-third party data will be used for acceptance and the Provider will be required to take corrective action before additional Provider data collection and may require re-certification of the mobile retroreflectometer. If the Engineer determines that the Provider's data might be correct then, referee testing may be requested by the Engineer.

3.10. **Referee Testing.** MTD will perform referee testing using portable retroreflectometers to determine if the markings need to be restriped to meet the required retroreflectivity level. The referee test results will be final. Referee testing will be conducted on the verification test sections using the method for portable retroreflectometers specified in Item 666, "Reflectorized Pavement Markings."

4. FINAL REPORT

Submit a final report in the format specified by the Engineer to the Department's Traffic Engineering representative within one calendar week after the service is complete. The final report must contain a list of all problems encountered (pre-approved event codes) and the locations where problems occurred during MRDC.

5. MEASUREMENT

When mobile retroreflectivity data collection for pavement markings is specified on the plans to be a pay item, measurement will be by the mile driven while measuring pavement markings.

6. PAYMENT

Unless otherwise specified on the plans, the work performed, materials furnished, equipment, labor, tools, and incidentals will not be paid for directly, but will be considered subsidiary to bid items of the Contract. When mobile retroreflectivity data collection for pavement markings is specified on the plans to be a pay item, the work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Mobile Retroreflectivity Data Collection." This price is full compensation for providing summaries of readings to the Engineer, equipment calibration and prequalification, equipment, labor, tools, and incidentals.

Special Specification 7194
Sanitary Sewer

1. DESCRIPTION

1.1. Scope of Work. Provide and install complete sanitary sewer construction and adjustments in conformity with the details shown on the plans or as directed, as described herein, in compliance with the Department's Utility Accommodation Policy (UAP)(Title 43, T.A.C., Sections 21.31—21.55) or as directed.

Reference specifications of the American Society for Testing and Materials (ASTM), American Water Works Association (AWWA) and American National Standards Institute (ANSI) will mean the latest standard in effect on the date of the proposal.

1.2. Definitions.

1.2.1. Sanitary Sewer Main. Sanitary Sewer Main is defined as that portion of the sanitary sewer system which collects the wastewater from the service laterals, including stub outs from the nearest manhole, to the point of final destination.

1.2.2. Sanitary Sewer Force Main. Sanitary Sewer Force Main is defined as that portion of the sanitary sewer system which moves wastewater under pressure using a lift station to the point of final destination.

1.2.3. Service Lateral. Service Lateral is defined as that portion of the sanitary sewer system beginning at a customer property line or other establishment property line which is the point of origin of the wastewater being carried by the system to the sanitary sewer main, including the connection into the sanitary sewer main system.

1.2.4. Point Repair. Point Repair is defined as the repair of a small length of pipe section of an existing sewer line which has deteriorated due to settlement or corrosion, or is falling, missing, crushed or broken, or has offset joints. Point repairs are to be completed before rehabilitation by trenchless methods between two adjacent manholes is initiated.

1.2.5. Rehabilitation. Rehabilitation is defined as the rehabilitation of existing sanitary sewer mains by an approved trenchless method including Cured-In-Place-Pipe (CIPP) method or by sliplining with Centrifugally Cast Fiberglass Pipe (ASTM D-3262) or by sliplining with hollow Core I-Beam construction Closed Profile PVC Pipe (ASTM D-F794).

1.2.6. Cured-In-Place-Pipe. This method consists of inverting a resin-impregnated flexible sewn felt tube into the original conduit by use of hydrostatic head. The resin is cured by circulating hot water within the tube. The Cured-In-Place-Pipe (CIPP) will be continuous and tight fitting. The work must be completed with the Department's schedule. Contractors may, when appropriate, elect to use any material that is considered to be equal (i.e. a product that has structural physical properties that are equal or greater than those of the specified products), however, submittal to the design Engineer is required no later than 10 days before bid opening.

1.2.7. Television Inspection. Television Inspection is defined as televising and videotaping of sewer lines utilizing a color closed circuit television inspection unit to determine the condition of the lines.

Television Inspection is part of the acceptance requirements for new sewer lines. All new sewer mains will not carry flow until the Engineer and Inspector approve and accept the mains for service.

1.2.8. Cleaning Manholes and Mains. Cleaning Manholes and Mains is defined as cleaning of existing sanitary sewer manholes and mains to facilitate the TV inspection and rehabilitation of the sanitary sewer mains.

The designated sanitary sewer manhole sections and the manholes themselves should be cleaned using mechanical, hydraulically propelled or high velocity sewer cleaning equipment. Debris generated by the cleaning process should be removed from the manhole, transported and disposed of.

1.2.9. Bypass Pumping. Bypass Pumping is defined as the installation of pumping equipment and temporary piping for the purpose of redirecting sewage flow to prevent interference with the rehabilitation of the sanitary sewer manholes and mains as well as providing reliable sewer service to the buildings being served.

1.2.10. Pipe Bursting or Crushing Replacement Process. The pipe bursting or crushing process is defined as the reconstruction of existing sanitary sewers by the simultaneous insertion (breaking and expanding the old pipe) of liner pipe within the bore of the existing pipe. The pipe bursting or crushing process involves the rehabilitation of deteriorated gravity sewer pipe by installing new pipe material within the enlarged bore created by the use of using s static, hydraulic, or pneumatic hammer “moling” device, suitably sized to break the existing pipe or by using a modified boring “knife” with a flared plug that crushes the existing sewer pipe. Forward progress of the “mole” or the “knife” may be aided by hydraulic equipment or other apparatus. Replacement pipe is either pulled or pushed into the bore. Sewer services are reconnected to the new pipe through small excavations from the surface. Sewage flows from the upstream line and from the services are pumped as required to prevent overflows and provide continual service. All excavations required for reconnecting and pumping service flows, entry pits, exit pits, obstruction removal, point repairs, among others, are to be kept to a minimum and all damage to surface and underground features, facilities, utilities and improvements are to be repaired.

1.2.11. Sliplining. Sliplining is accomplished by pulling or pushing liner pipe into existing sewers by use of mechanical or hydraulic equipment. Once in place, liner pipe is allowed time to normalize and is then cut to fit between the manholes. Manhole inverts and benches are re-worked and re-shaped. Existing sewers remain in operation during slip lining process, with sewage flow diverted around operations in progress.

1.2.12. Grouting of Sewer Mains. This item will govern the grouting of existing sewer mains with diameter of larger than 4 in. for the purposes of abandonment underneath roadways, paved areas, and at other designated locations. The location of this Work is as shown on the Contract Document plans and as encountered in the field during construction. The Contractor must, unless otherwise specified, furnish all labor, materials, equipment, tools and all other appurtenances necessary to abandon sewer lines segments in place by filling them with flowable cementitious low strength grout including plugs, bulkheads, excavation and backfill at locations as required to completely fill the line to be abandoned in place to protect against future collapse of the line.

2. MATERIALS

All materials furnished for this project will be new. A manufacturer’s certificate of compliance will be acceptable for quality control.

2.1. Sanitary Sewer Pipe. Materials for sanitary sewer pipe may be either rigid or flexible unless a specific type pipe is called for on the plans. All pipe not listed will be subject to pre-approval by the Engineer.

2.1.1. Rigid Pipe. Ductile iron pipe will, for the purpose of this specification, be known as rigid pipe.

2.1.2. Flexible Pipe. Pipe consisting of materials other than those listed above.

Any flexible pipe with a deflection of the inside diameter greater than 5% after 30 days of installation as determined by a mandrel test, will not be accepted.

Unless directed otherwise by the Engineer, a "GO, NO-GO" Deflection Testing Mandrel built in conformance with the detail drawing, as shown on the plans, and in accordance to 30 TAC § 217, will be furnished at the

Contractor's expense and will be used in testing pipe deflection for acceptance. Refer to “Air and Deflection testing,” section of this specification for more information about mandrel deflection testing.

The working room for flexible pipe will be a minimum of 6 in.

Pipe stiffness is to be in accordance with ASTM 3034 SDR 26 [115 psi] or ASTM 2241 SDR 26 [160 psi].

At waterline crossings and where water and sewer mains are parallel and separation distance cannot be achieved as per 30 TAC§ 217.53, use extra stiff pipe SDR 26 PVC (ASTM D2241-09) with a pressure rating of at least 150 psi. This will include all lateral piping as well.

All sanitary sewer piping must pass the low pressure test, as described in 30 TAC § 217.57.

2.1.3. Concrete Pipe. Concrete pipe must not be used.

2.1.4. Asbestos-Cement (AC) Pipe. AC pipe must not be used. For any work requiring the removal of AC pipe, the Contractor will comply with the requirements of Item 6 of the Department’s Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges. Excavate to the top of the AC water line to allow a separate contractor hired by the State to remove the AC water line. The excavation for the AC water line removal is subsidiary to the work that created the need for the removal (excavation for structures, roadway, a new line, tie-ins, etc.). The third party contractor will remove whole sections of AC pipe.

2.1.5. Fiberglass Reinforced Pipe, For Large Diameter Gravity Sanitary Sewer. This item will govern the designing, fabricating, furnishing, installing, and joining of large dimeter (18 in. or greater) fiberglass sewer piping for gravity-flow conveyance of wastewater. The pipe size, centerline alignment, and grades are presented in the project Drawings. All materials and construction will be in accordance with the Texas Commission on Environmental Quality (TCEQ) rules to include: Design Criteria for Sewerage systems 30 TAC 217.1, 30 TAC 217.2, 30 TAC 217.3, and 30 TAC 217.13, or any revision thereto as applicable.

The work to be performed in this section includes design calculations, detailing, and fabrication of FRP for the conveyance of raw sanitary sewage. Pipe design calculations will be required for open-trench and tunneling installation methods. All pipes must be manufactured specifically for this project and no pipe should be furnished from stock unless approved by the Owner.

2.1.5.1. Performance / Design Criteria. Design in accordance with ASTM D3262 including the appendix and subsequent specifications. Depths must comply with requirement of ASTM D3681. Design pipe for service loads that include external groundwater and earth loads, jacking/pushing loads, allowable jacking/pushing capacity must not exceed 40% of the ultimate compressive strength or the maximum allowable compressive strength recommended by the manufacturer, whichever is less, and traffic loads.

Design is to be conducted under the supervision of a Professional Engineer licensed in the State of Texas, who must seal and sign the design. Standard lay length of 20 ft, except for special fittings or closure pieces necessary to comply with the Plans.

Design of pipe is to include the determination of design pressures up to 25 psi, stresses, external loads, pressure class (PN), and pipe stiffness class (SN).

Stiffness (SN) class that satisfies design requirement on the Plans, or not less than 115 psi when used in direct bury operations.

All lines must be able to withstand a high-velocity cleaning with a water jet capable of producing a minimum volume of 50 gpm with a pressure of 1,500 psi at the nozzle. Install a gauge to indicate working pressure on the discharge of high-pressure water pumps. The jet angle of the outlet must be no greater than 30º relative to the pipe axis. A video of pipe before and after line cleaning must be submitted of all installed lines. No delamination should occur.

In no case should pipe be installed deeper than its design allows.

Pipe markings must meet the minimum requirements of ASTM 3236. Minimum pipe markings will be as follows:

- Manufacturer
- Manufacturer Number (identifies factory, location, date manufactured, shift and sequence)
- Nominal diameter
- Beam load
- Laying length
- ASTM designation

2.1.5.2. Gaskets. Supply from approved gasket manufacturer in accordance with ASTM F477 and suitable for service intended. Affix gaskets to pipe by means of suitable adhesive or install in a manner so as to prevent gasket from rolling out of pre-cut groove in pipe or sleeve coupling.

Provide the following gaskets in potentially contaminated areas.

- Petroleum (diesel, gasoline) – Viton
- Other contaminants – Manufacturer recommendation

2.1.5.3. Fittings. All bends exceeding a two-degree horizontal or vertical deflection will consist of a manufacturer fabricated fitting meeting the same requirements as the pipe material. Provide tolerance of laying length of fittings to +/- 2 in. Use only manufactured fittings. Flanges, elbows, reducers, tees, wyes, laterals and other fittings will be capable of withstanding all operating conditions when installed. They may be contact molded or manufactured from mitered sections of pipe joined by glass-fiber reinforced overlays. For pipe diameters 18 in. or larger, lateral openings 6 in. or greater in size must be made using insert a-tee conforming to ASTM D3034 service connections, approved by Engineer.

2.1.5.4. Couplings. Unless otherwise specified, the pipe must be field connected with fiberglass sleeve couplings that use elastomeric sealing gaskets as the sole means to maintain joint water tightness. Elastomeric sealing gaskets should be recommended by the manufacturer for application with sanitary sewage. Chemical grout, epoxy grout, or internal repair boots will not be accepted as long-term watertight seals. The joints must meet the performance requirements of ASTM D4161.

2.1.5.5. Structure Conditions. Provide an FRP water stop flange (wall pipe) or raised rib for water-tight connection to a concrete cast-in-place structure/manhole.

2.1.5.6. Dimensional Tolerances.

- Inside diameter Pipe must not vary more than 1/8 in. from the nominal inside diameter.
- Roundness The difference between the major and minor outside diameters must not exceed 0.1%of the nominal outside or 1/4 in., whichever is less.
- Wall thickness Provide minimum single point thickness at least 98% of stated design thickness.
- End Squareness Provide pipe ends square to pipe axis with maximum tolerance of 1/8 in.
- Fittings - Provide tolerance of angle of elbow and angle between main and leg of wye or tee to ±2 degrees. Provide tolerance of laying length of fitting to ±2 in.

2.1.5.7. Acceptable Manufacturer. Vendors must have approval through SAWS Standards Committee before product use.

2.1.6. PSM Polyvinyl Chloride Pipe. Polyvinyl Chloride (PVC) pipe will be made from class 12454-B materials as prescribed in ASTM D-1784. For pipes 4 in. to 15 in. in diameter PSM pipe, fittings and joints must conform to ASTM D-3034 with elastomeric gasket joints meeting ASTM D-3212, or ASTM D-2241 and ASTM D-3139 where applicable, with the exception that solvent cement joints must not be used. All pipe that is 18 in. to 36 in. in diameter must meet requirements of ASTM F-679.

2.1.7. PVC Pressure Pipe/Force Mains. Pipe must be made from Class 12454-A or 12454-B, as defined in ASTM D1784-11. All pipe, fittings, and joints must meet or exceed the requirements of ASTM D2241-09, with the exception that solvent cement joints must not be used. The pressure rating, size, and pressure class will be as shown in the contract documents. Pipe must have an integral bell and gasket seal with the locked-in type gasket reinforced with a steel band or other rigid material conforming to ASTM F477-10. The joint must comply with the requirements of ASTM D3139-98(2011). All required joint restraint must be approved by the Engineer before the work being accepted. Pressure pipe/Force mains are required to have modified grade 5 material used as bedding. Pipes also must be hydrostatically tested at a minimum of 100 psi after their construction to ensure proper construction.

2.1.8. High Density Polyethylene Pipe. High Density Polyethylene Pipe (HDPE) and fittings must be made of high density extra high molecular weight (EHMW) polyethylene with a standard thermoplastic material designation code of PE3408 and with a cell classification of 345464E per ASTM D3350. The molecular weight category will be extra high (250,000 to 1,500,000) as per the Gel Permeation Chromatography determination procedure with a typical value of 300,000 to 330,000. The pipe must be manufactured in accordance with ASTM F714 or ASTM D3035.

All HDPE piping must have identifiable green striping (dual) every 120°. The pipe will be color grey and must meet the Utility Location and Coordination Council, “Uniform Color Code,” for sewer lines per APWA/ULCC Standards Committee.

The pipe and fittings must have product traceability. The manufacturer will include a print line on the pipe. This will notate the manufacturer’s name, date of manufacture, the lot and supplier of raw material, plant location, and production shift. The ASTM standard must also appear as ASTM F714 with the material designation as PE3408.

The polyethylene pipe manufacturer must provide certification that the stress regression testing has been performed on the specific product. The said certification will include a stress life curve per ASTM D2837. The stress regression testing must have been performed in accordance with ASTM D2837, and the manufacturer must provide a product supplying a minimum Hydrostatic Design Basis (HDB) of 1,600 psi as determined by ASTM D2837.

The material will be listed by the Plastics Pipe Institute (PPI), a division of The Society of the Plastics Industry in PPI TR-4. The pipe material must have a Hydrostatic Design Basis of 1,600 psi at 73 degrees and 800 psi at 140 degrees. The PPI listing must be in the name of the pipe manufacturer and testing and validation of samples of the pipe manufacturer’s production pipe must be based upon ASTM D2837 and PPI TR-3.

The manufacturer’s certification must state that the pipe was manufactured from one specific resin in compliance with these specifications. The certificate must state the specific resin used and its source.

HDPE pipe manufactured from materials meeting the specifications of this section must have an Environmental Stress Crack Resistance of no failures in 10,000 hrs. (ESCR: FO>10,000) when tested in accordance with ASTM F1248.

Pipe and fittings must be manufactured from material meeting the requirements of this section. Pipe supplied under this specification must have a nominal IPS (Iron Pipe Size) outside diameter unless otherwise specified. The Dimension Ration (DR) and pressure rating of the pipe at 73 degrees will be as indicated on the drawings.

Both pipe and fittings must carry the same pressure rating. All fittings must be pressure rated to match the system piping to which they are joined. At the point of fusion, the outside diameter and minimum wall thickness of the fitting must match the outside diameter and minimum wall thickness specifications of ASTM F714 for the same size pipe. Fittings must be manufactured by the manufacturer of the pipe. Ells, tees, wyes must be manufactured by mitered fabrication.

Clamps and Gaskets: Clamps must be stainless steel, including bolts and lugs as manufactured by JCM Industries Type 108 or equal. Furnish full circle, universal clamp couplings with a minimum 3/16 inch thick neoprene, grid-type gasket. Select clamps to fit outside diameter of pipe. Use minimum clamp length of 30 in for replacement pipes O.D. of 10.75 in. (10 in. nominal) or greater and 18 in. for replacement pipe O.D. less than 10.75 in.

Terminal sections pipe that are joined within the insertion pit will be connected with a full circle pipe repair clamp. The butt gap between pipe ends will not exceed ½ inch.

Force Mains: Where applicable, solid wall pipe for sanitary sewer force mains must have a minimum working pressure rating of 150 psi, and an inside diameter equal to or greater than the nominal pipe size indicated on the drawings.

For force mains or pressure rated fittings, all fittings must be de-rated according to the manufacturer's written specifications, and clearly labeled on the fittings as such. For direct bury or insertion lining; fittings will be fully pressure rated. All fittings will have a quality control label as approved by the manufacturer.

High density polyethylene pipe (HDPE) is related to pipe bursting or pipe crushing for sanitary sewer or related pipe line rehabilitation.

Yard Piping: DR 9 only, no more than two splices, and must use long inserts for connections.

Heat fusion joining systems: Pipe and fittings must be thermal butt fusion, saddle fusion, or socket fusion according to manufacturer recommended procedures.

2.1.9. Mechanical or Compression Joints. Mechanical or compression joints, concrete jointing collars, or non-reinforced rubber adaptors must not be used unless as approved by the Engineer.

2.1.10. Ductile Iron Pipe and Fittings. Ductile iron pipe must be centrifugally cast of 60-42-10 iron and must conform to the requirements of the latest revision of ANSI A21.51/American Water Works Association (AWWA) C151-09. Ductile iron pipe may be "thickness designed" in accordance with requirements of the latest revision of ANSI A21.50/AWWA C150-08. Thickness design should be based on standard laying conditions 4 or 5 in accordance with conditions at the site. Fittings for ductile iron pipe must have not less than the thickness, class, or pressure rating specified for ductile iron pipe. Fittings must be furnished with all necessary glands, gaskets, bolts, etc. as may be required to complete the joints.

Rubber gasket joints for mechanical joints or push on type joints must conform to the requirements of ANSI A21/AWWA C111-12.

All ductile iron pipe and fittings used for sewer applications must have the interior lined with a non-corrosive lining material consisting of polyurethane, ceramic epoxy, or calcium aluminate. The lining material should be applied per the manufacturer's written instructions and at thicknesses recommended by the pipe manufacturer for sewer applications. The type and brand of interior lining should be clearly marked on the outside of the pipe and fittings. Only one type and brand of lining should be used for pipe on a project.

Where ductile iron pipe is to be installed in a casing, the pipe should be thoroughly cleaned down to the coal-tar enamel pipe coating by approved methods. Where damaged, a prime coat, compatible to the polyvinyl tape to be used, should then be applied to the pipe. Following the application of the prime coat, the pipe must be wrapped with Scotchrap, Trantex V-10 polyvinyl tape, or other approved equal product. The tape must not be applied until the prime coat is completely dry. The tape must be spirally and tightly wrapped on each section of the pipe with a 50% lap. The wrap must be made to the bell on the bell end and to a point 6 in from the spigot end. The joint must be protected with tape 6 in. in width on pipe 12 in. or less in size and with tape 8 in. in width on pipe greater than 12 in. in size.

Ductile iron pipe to be installed in a trench must be protected in the following manner. Each pipe joint must be covered with a 4 mil thick polyethylene sleeve that is 2 ft. longer than the pipe joint. The sleeve must cover the full length of the pipe joint, lap over 1 foot on each end of the adjoining pipe joints, and be secured

with a minimum of two circumferential turns of pressure sensitive polyvinyl tape. Excess material should be neatly drawn up around the pipe barrel, folded into an overlap on top of the pipe, and held in place by means of pieces of pressure sensitive tape at approximately 5 ft. intervals. After assembling the joint, the polywrap tube from the previously installed pipe must be pulled over the joint and secured by the Contractor. The polywrap tube from the new joint must be pulled over the first tube and secured by the Contractor to provide a double seal.

Cast iron and ductile iron fittings and valves must be completely wrapped in 8 mil thick polyethylene film with a minimum of a 1 ft. overlap on each end and appropriately taped. Laps must cover joints with adjoining pipe joints or fittings when installed. Also, the fire Hydrant barrel, from the surface to the valve, must be wrapped as specified herein.

Any damaged areas in the polyethylene film must be repaired by covering the area with a sheet of polyethylene film large enough to lap over the damaged area 1 ft. minimum in any direction and appropriately taped. Extreme care should be taken at service tap locations to ensure that the tape extends beyond the corporation and onto the service line pipe by a minimum of 1 ft.

Before placing pipe in the trench, a cushion of approved materials must be placed in the trench as required herein. Backfill material must be carefully placed on the pipe so as to avoid any damage to the polyethylene sleeve.

The Contractor should use care to protect and preserve the polyethylene wrap around ductile iron water mains when installing service corporations. The required method is to wrap pipe tape around the pipe over the polywrap in the area to be tapped. The tap is to be made through the tape and polywrap. It is not necessary to remove and replace poly wrap. All exposed pipe, the corporation, and the first 3 ft. of the service must be wrapped and taped to achieve a complete seal. In addition, a sand envelope must extend over and around the connection to a depth of 8 in. above the main.

2.1.10.1. Polyethylene Wrapping Material. Polyethylene wrapping material will be used to encapsulate all ductile and cast-iron fittings. Polyethylene wrapping for ductile and cast-iron fittings will consist of a 4 mil tubular section of cross-laminated high-density polyethylene, which has a high dielectric and tensile strength, for use in insulating cast-iron and ductile-iron pipe from the electrolytic action encountered in highly active soils. All iron pipe, fittings, and accessories must be wrapped with edges overlapped and taped securely with duct tape to provide a continuous wrap to prevent contact between the pipe and the surrounding backfill. Repair all punctures with duct tape to restore the continuous protection before backfilling.

Polyethylene wrapping is to consist of opaque cross-laminated high-density polyethylene sheet continuously thermally bonded to form a tubular section. The tubes may be supplied in bulk length on rolls or in individual pre-cut lengths. See Table 1 for size and length chart, in accordance with AWWA C-105 (Table 1) for minimum requirements. When supplied in specific pipe lengths, the tubes are to contain a minimum of 4 ft. over the actual pipe length to allow for overlap.

The polyvinyl sheet of film for the tubular wrapping is to be of virgin resins meeting raw and physical properties of ASTM D-1248 and AWWA C-105, latest edition. The material is to be 4 mil cross-laminated high-density polyethylene of uniform film thickness and be free of imperfections such as pin holes, etc., after being thermally seamed into tubular form. The finished product will have a nominal thickness of 4 mils, with tolerances of minus 10%.

The material is to have no volatile constituents, the loss of which may affect ductility. The material is also to have the following properties:

- Mechanical: The polyethylene film is to have a tensile strength per latest ASTM D-882 test, of 6300 psi min. The film is to have an elongation of not less than 100% of the test strip per latest ASTM D-882 test. The film is to have an impact resistance 800 gram min per (ASTM D-1709 Method B). The film is to have a propagation tear resistance of 250 gf minimum in machine and transverse direction (ASTM D1922).
- Dielectric: The film is to have a dielectric strength of 800 volts per mil thickness per ASTM D-149.

Inspection and Certification by Manufacturer:

- *Quality control and inspection*. The manufacturer must establish the necessary quality control and inspection practice to ensure compliance with this standard.
- *Manufacturer's statement*. The manufacturer must provide a sworn statement on each lot purchased that the inspection and all applicable material requirements of Article 2 have been met and that all results comply with the requirements of this standard.
- *Freedom from defects*. All polyethylene film must be clean, sound, and without defects that could impair service.

The polyethylene film supplied should be clearly marked, at a minimum of every 2 ft. along its length, containing the following information.

- Manufacturer's name or trademark
- Year of manufacture
- ANSI/AWWA C-105/A21.5
- Minimum film thickness and material type.
- Applicable range of nominal pipe diameter sizes.
- Warning-Corrosion Protection-Repair any Damage.

The San Antonio Water System may at no cost to the Contractor, subject random testing by an independent laboratory for compliance with this Specification. Any visible defect of failure to meet the quality standards herein will be grounds for rejecting the entire order.

Table 1
4 mil Polyethylene Wrapping Materials

Size (in.) & Length (All sizes lay flat size)	
Pipe Size (in.)	Product Size Width (in.) x Length
4, 6 & 8	20 x 200/500
8, 10 & 12	27 x 200/500
16 & 18	37 x 200/500
20	41 x 200/500
24	54 x 200/500
30	67 x 140/500
36	81 x 120/500
48	95 x 100/500
54	108 x 100/500

2.1.11. Concrete Steel Cylinder Pipe. Concrete Steel Cylinder Pipe must not be used.

2.1.12. Pipe Testing. All sanitary sewer pipe and fittings produced within the jurisdiction of the SAWS must be tested by SAWS-approved laboratory method at the source of supply. All shipments of pipe not so tested must be accompanied by a certificate of compliance to these specifications prepared by an independent testing laboratory and signed by a Texas licensed professional Engineer.

2.1.13. Steel Casing Pipe. Steel casing pipe must conform to ASTM A134 with a minimum thickness of 3/8 in.; actual thickness should be as indicated on the plans.

2.1.14. Stainless Steel Casing Spacer/Insulators. This section covers casing spacers for use in wastewater collection. Casing spacers are used to facilitate installing a sewer pipe inside a casing pipe or tunnel. Casing spacers should consist of two or more segments of circular steel that bolt together forming a shell around the carrier pipes. Casing spacers should protect the carrier pipe and any protective coating or wrapping from

damage during the installation, and properly support and electrically isolate the carrier pipes within the casing or tunnel. On occasion multiple carrier pipes may be installed in one casing or tunnel.

2.1.14.1. General Requirements. Please see the SAWS website for a list of approved stainless steel casing spacer manufacturers - http://www.saws.org/business_center/specs/product_submittal/, providing such casing spacers conform to the provisions contained herein.

Casing spacers should be 8 in. long for carrier pipes up to 16 in. diameter and 12 in. long for larger carrier pipe sizes. Manufacturer's approval in writing will be required for installations exceeding 300 ft. in length, carrier pipes in excess of 48 in. diameter or multiple carrier pipes in one casing or tunnel.

Casing spacers must have a minimum 14-gauge type 304 stainless steel band and 10-gauge steel riser when required. The band, risers and connecting studs must be welded and cleaned at the factory before the application of a fluidized bed fusion bonded PVC coating.

The fluidized bed fusion bonded PVC coating must be between 10-16 mils thickness. The PVC coating must provide good resistance to acids and alkalize and excellent resistance under ASTM B117 salt spray tests. The coating must have a minimum 1380volts/mil per ASTM D149-61 short time 0.010" test and a Durometer-shore A@ (10 sec) of 80 per ASTM D1706-61T. Epoxy coatings are not an acceptable alternative.

The spacers must have a flexible PVC liner of 0.09 in. thickness with Durometer "A" 85-90 hardness and a minimum 58,000- volt dielectric strength (60,000 volt. minimum Surge Test.) Moisture absorption must not exceed 1%.

The runners must be of high pressure molded glass reinforced polyester with a minimum compressive strength of 18,000 psi per ASTM D695, flexural strength of 25,300 psi per ASTM D790, tensile strength of 17,600 psi per ASTM D638 and Rockwell hardness (M) of 90 per ASTM D785. The riser should be designed and fabricated to place the runner (skid) in full contact with the inside surface of the casing pipe. This evenly distributes the load force to all support members. The ends of all runners must be shaped to resist hanging or sticking inside casing during installation of the carrier pipe. Polyethylene runners are not acceptable.

Runners should be a minimum of 1 in. in width and a minimum of 7 in. long for carrier pipes up to 16 in., and a minimum of 2 in. in width and 11 in. long for larger carrier pipes. Bolts on runners are not acceptable. The runners should be attached to the band or riser by 3/8 the wearing surface on the runner. The recess should be filled with a corrosion inhibiting filler. There must be 4 runners per casing spacer for carrier pipes up to 12 in. diameter, 6 runners for 14 in. through 36 in. and 8 or more runners for carrier pipes over 36 in. diameter. Number of bottom runners should be multiples of 2. Number of top runners should be multiples of 2.

Stainless steel casing spacers must be furnished with stainless steel studs, nuts and washers.

Casing spacers must have ample riser height to limit vertical movement of the carrier pipe in the casing. A minimum of 1 in. to 2 in. clearance should be provided between the top runner and the ID of the casing or tunnel.

Continuous operating temperatures for the PVC Coated Casing Spacers should not exceed 150°F. Stainless steel casing should be used in applications where continuous operating temperatures exceed 150° F.

Unless noted otherwise, casing spacers will be required on all carrier pipes installed in casing or tunnel applications.

2.1.14.2. Quality Assurance. All casing spacers are to be manufactured in accordance to NACE International Recommend Practice RP 0286 (Isolation Spacers). Each casing spacer must be manufactured in the USA at a facility that has a Registered ISO 9002 Quality Management System or be in the process of achieving this certification by March 2005. Non-compliance to this registered commercial quality system requirement by March 2005 will result in removal of the manufacturer's product from approved manufacturers.

If on receipt of casing spacers they are found to be non-compliant, the manufacturer must replace the defective casing spacer with a casing spacer that meets the San Antonio Water System's specifications, at no charge to San Antonio Water System.

If San Antonio Water System audits, product inspection and performance data review in accordance to these specifications determine excessive casing spacer Noncompliance, the manufacturer will be subject to removal by the Products Standard Committee. Copy of the current ISO 9002 registration (or written documentation of being "in the process of achieving ISO registration," before March 2005) must be provided with material submittal.

2.1.15. Water Main Crossings. Gravity or force main sewers constructed in the vicinity of water mains will comply with the requirements of the "Criteria for Domestic Wastewater Systems," 30 TAC 217.53, as adopted by The Texas Commission on Environmental Quality, latest revision.

2.2. Manholes. This item should govern the construction of standard sanitary sewer manholes complete in place and the materials therein, including manhole rings and covers. All material and construction work must be in accordance with current Texas Commission on Environmental Quality (TCEQ) rules to include: Design Criteria for Sewage Systems (30 TCEQ § 217). All constructed manholes must be watertight and equipped with pre-tested and approved low leakage frames and lids. Sewer manhole ring and cover castings must meet the current requirements of AASHTO Designation M306-10.

2.2.1. For new concrete manholes, all concrete manhole components (cast-in-place or precast manhole base, precast risers, precast cone sections, cast-in-place or precast flat tops, and concrete "throat rings" as applicable) for new manholes must conform to the applicable requirements of ASTM Designation C478, except as modified in this Specification.

All concrete grout used for patching or other similar fill-in work will be of non-shrink type made with the Komponent® admixture specified above, or approved alternate, in accordance with the manufacturer's recommended formulation with Portland cement, fine aggregate, water, and water reducer to produce a compressive strengths of approximately 4,800 psi within 7 days and 7,250 psi within 28 days at a 70^{o}F baseline temperature.

Unless otherwise shown in the Contract documents or approved by the Engineer, standard sanitary sewer manholes should be constructed with influent and effluent piping less than or equal to 24 in. in diameter with precast reinforced concrete manhole sections. A standard sanitary sewer manhole must be a single entrance cylindrical structure, with a minimum internal diameter of 4 ft. between the cone and base sections. The base of the structure must include the load bearing portion beneath and exterior of the structure, invert channels and the fill or bench portions adjacent to the lower sewer pipes within the structure. The maximum vertical height of the diameter adjustment section or cone will be 36 in. Adjustment or throat rings may be used for final elevation adjustment of the manhole ring and cover. Concrete encasement of the manhole's ring will be as shown on the plans. Specifically, they must attach the ring and cover to the diameter adjustment section or cone. Manholes which differ from the above description will be identified as "Manhole Structures" or "Doghouse Manholes."

An internal drop manhole will be required when sewer lines enter a manhole more than 24 in. above the manhole invert, while an external drop manhole will be provided for a sewer entering a manhole more than 30 in. above the invert. Both conditions will require prior approval by the Engineer.

2.2.2. Manhole Structures. Cast in place concrete structures or pre-cast concrete structures, as detailed on the plans, will be installed where any pipe intercepted is larger than 24 in. in diameter. All material and construction work must be in accordance with the Texas Commission on Environmental Quality (TCEQ) rules to include: Design Criteria for Sewerage Systems (30 TAC § 217), or any revisions thereto as applicable. All structures must be watertight and coated with a SAWS-approved sewer coating.

2.2.3. Doghouse Manholes. Material for manholes will conform to the requirements of this specification and as shown on the plans. All material and construction work must be in accordance with current Texas Commission on Environmental Quality (TCEQ) rules to include: Design Criteria for Sewage Systems (30

TCEQ § 217). All constructed manholes must be watertight and equipped with pre-tested and approved low leakage frames and lids. Sewer manhole ring and cover castings must meet the current requirements of AASHTO Designation M306-10.

The intent of the doghouse manhole is to construct the base of the manhole, cast in place, on existing sewer mains, in order to keep the main active during construction and reduce the time needed for bypass pumping. A section with a "doghouse" is to be installed on the base, unless otherwise shown on the construction documents, and remaining sections of manhole to be installed. All requirements of standard manholes are applicable to doghouse manholes. Testing requirements within the EARZ are the same as those for standard manholes, as described in the specifications and the construction documents.

2.2.4. Precast Reinforced Concrete Manhole Sections. Precast reinforced concrete manhole sections must conform to the requirements of ASTM Designation C478-12a.

2.2.5. Manhole Ring and Cover. The manhole ring and cover must be of ductile iron or gray cast iron construction. The cover must be solid with no vent or pick holes; hinged with underlying special hinge area leakage protection; the cover secured with 4 stainless steel bolts; and must have a recessed "pick bar" for cover opening. Cam lock type covers will not be allowed. Approved SAWS manufactures, have previously completed required inflow leakage shop testing and have met a maximum allowable leakage rate criterion of 1 gal. per minute at 12 in. of water submergence above the manhole cover. Rings and covers must be furnished from the SAWS approved manufacturers list with the specified features. Please see SAWS website for a list of approved manufacturers and required features - http://www.saws.org/business_center/specs/product_submittal/.

All covers must have the words "SAN ANTONIO WATER SYSTEM Sanitary Sewer" cast thereon. Ring and cover must have the specified foundry's name, part number, country of origin preceded by "Made in" (example: MADE IN USA) in compliance with the country of origin law of 1984, and production date (example: mm/dd/yy) for tracking purposes. Each casting must be marked with DI (ductile iron) and ASTM A536 or A536-80-55-06 or CI (cast iron) and ASTM A-48, Class 35B to verify the materials used. Castings without proper markings will be rejected.

Four (4) bolts of 1/2 in. diameter x 13 thread pitch will be used to secure the cover. Bolts must be of stainless steel, grade 304 or better. The top of the cover must have a recessed area around each bolt assembly to accommodate the washer diameter and thickness and bolt head height so that the bolting assembly does not exceed the top of the manhole cover. Where cover bolts directly thread into the underlying cast iron frame, the bolt threads must be thoroughly coated with Nikal Jet Lube product, as manufactured by CSW Industrials Company or approved alternate before insertion to avoid subsequent "seize up" from dissimilar metals. If such bolts are removed for any purpose, the threads must be recoated. Stainless steel bolts that are threaded into stainless steel nuts within recessed slots in the underlying frame optionally do not require an anti-seize coating of the bolt threads.

2.2.6. Throat Rings. Throat rings must be made of either HDPE or reinforced concrete and have a maximum thickness of 2 in. The internal diameter must match that of the ring and cover's opening. Concrete must conform to the provisions of Concrete (Class "A"), Item No. 421, "Hydraulic Cement Concrete." If concrete throat rings are to be used, they must be used in conjunction with a UV stabilized polyethylene liner for the purpose of providing an infiltration/inflow (I/I) barrier. The I/I barrier must be as manufactured by Strike Tool Products of Cannon Falls, MN and must meet the following ASTM standards: ASTM D790 for flexural properties; ASTM D1505 for density; ASTM D1238 for Melt Flow Index; ASTM D638 for tensile strength at yield (50mm/mm); ASTM D790 for flexural modulus; ASTM D648 for heat deflection temperature at IGEPAL; and ASTM D693 for EsCR, 100% IGEPAL/10% IGEPAL.A minimum of two and a maximum of six "throat rings" may be used at each adjusted manhole. "Throat rings" are limited to a minimum of two and a maximum of four rings for new manhole construction.

2.2.7. Bitumastic Joint Sealant. To be applied between cones, risers, adjustment rings, flat tops, and between the ductile or gray cast iron ring (frame) and the uppermost adjustment ring or flat top: RAM-NEK, as manufactured by Henry, Inc.; Kent Seal, as manufactured by Hamilton Kent, Inc.; Encapseal, as manufactured by Miller Pipeline Corporation; or approved alternate.

2.2.8. Interior Coating. All manholes must be watertight and coated with a SAWS approved sewer coating. Before coating, all manholes must be vacuum tested, and approved. For new and rehabilitated manholes, apply a combination of both products with the cementitious coating first, followed by the epoxy coating. Please see SAWS website for a list of approved manufacturers and required features - http://www.saws.org/business_center/specs/product_submittal/.

2.3. Glass-Fiber Reinforced Polyester (FRP) Manholes. This item must govern the construction of FRP sanitary sewer manholes, complete in place and the materials therein, including manhole ring and covers. All material and construction work must be in accordance with current Texas Commission on Environmental Quality (TCEQ) rules to include: Design Criteria for Sewage Systems (30 TCEQ § 217), or any revisions thereto as applicable. All constructed FRP manholes must be watertight. Sewer manhole ring and cover castings, throat rings, and miscellaneous specifications and details must meet the current requirements of AASHTO Designation M306- 10 and "Manholes" section of this specification.

All manholes must be watertight. Glass-Fiber Reinforced Polyester Manholes must be a one-piece monolithic designed unit constructed of glass-fiber reinforced, supplier-certified, unsaturated isophthalic polyester resin containing chemically enhanced silica to improve corrosion resistance, strength and overall performance. FRP manholes must be manufactured in strict accordance with ASTM D3753- 12.

For a UV inhibitor, the resin on the exterior surface of the manhole must have gray pigment added for a minimum thickness of 0.125 in.

Manholes must be a circular cylinder, reduced at the top to a circular manway not smaller than 30-in (inside diameter). Manholes must also be produced in whole foot increments of length +/- 2 in. Nominal inside diameter must be 48 in. Tolerance on the inside diameter must be +/- 1%. The minimum wall thickness for all FRP manholes (all depths) must be 0.50 in. Unless otherwise shown in the Contract documents or approved by the Engineer, standard sanitary sewer FRP manholes must be constructed on influent or effluent pipes less than 24 in. in diameter. The maximum vertical height of the diameter adjustment section or cone must be 36 in.

The manway reducer must provide a bearing surface on which a standard ring and cover may be supported and adjusted to grade. The reducer must be joined to the barrel section at the factory with resin and glass fiber reinforcement, thus providing the required monolithic design to prevent infiltration or exfiltration through the manhole.

Manholes must be manufactured in one class of load rating. This class must be AASHTO H-20 wheel load.

Several methods exist that may be used to connect primary and secondary lines to manholes, and these must be performed per the Engineer's request. The most common of these methods include: installation of SDR PVC sewer pipe stub-outs to the manhole, Kor-N-Seal boots, or Insert-a-Tee fittings in the manhole wall. Installation of SDR PVC sewer pipe must be performed by sanding, priming, and using resin fiber-reinforced hand lay-up. The resin and fiberglass must be the same type and grade as used in the fabrication of the fiberglass manhole. Kor-N-Seal boots may be installed by the manhole manufacturer using fiberglass reinforced pipe stub-out for Kor-N-Seal boot sealing surface. Insert-a-Tee fittings maybe installed only with the approval of the Engineer, and must be installed per the manufacturers' instructions.

Manholes are required to have a resin fiber-reinforced bottom. Deeper manholes (> 6 ft.) may require a minimum of two 1-1/2 in. deep x 3-1/2 in. wide stiffening ribs, completely enclosed with resin fiber-reinforcement. All fiberglass manholes with a fiberglass bottom will have a minimum 3 in. anti-flotation ring. Manhole bottoms must be a minimum 1/2 in. thick.

All manholes must be marked in letters at least 1 in. in height with the manufacturer's name or trademark, manufacturer's factory location, manufacturer's serial number, manhole length, ASTM designation, and installation assist marks (vertical lines 90 degrees apart at base of manhole).

Manhole ring and covers must be as described in these specifications for new manholes.

Mortar must be composed of 1 part Portland Cement, 2 parts sand and enough potable water to produce a working mixture.

All membrane curing compound must conform to the provisions of DMS-4650, "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants."

2.4. Existing Manhole Adjustments. This item will govern the adjustment of all existing manholes, to include the replacing of existing manhole covers and rings regardless of type shown in the Contract documents and in conformity with the provisions of these specifications or as directed. All material and construction work must be in accordance with current Texas Commission on Environmental Quality (TCEQ) rules to include: Design Criteria for Sewage Systems (30 TCEQ § 217), or any revision thereto as applicable. All manholes must be watertight and coated with a SAWS-approved sewer coating. The context of this specification is limited to replacing the existing manhole ring and covers and adjusting the final elevation of the manhole by the maximum or minimum number of throat rings. All manholes requiring adjustments beyond the maximum or minimum number of throat rings (described herein), will be subject to reconstruction under the "Existing Manhole Reconstruction" section.

2.4.1. Manhole Rings and Covers (if replaced). As described in this Specification.

2.4.2. Concrete Throat Rings (if needed). As described in this Specification, including infiltration/inflow barrier.

2.4.3. Bitumastic Joint Sealant. As described in this Specification.

2.5. Reconstruction of Existing Manholes. This item will consist of the reconstruction of all existing manholes, all types and sizes, to include the replacement of manhole ring and covers, the cones, manhole sections required regardless of type shown in the Contract documents and in conformity with the provisions of these specifications. All material and construction work must be in accordance with current Texas Commission on Environmental Quality (TCEQ) rules to include: Design Criteria for Sewage Systems (30 TCEQ § 217). All reconstructed manholes must be watertight and coated with a SAWS-approved sewer coating. Existing Monolithic Manholes are not to be reconstructed, but fully replaced with a new manhole in accordance with this Specification.

Materials used in manhole reconstruction (concrete, precast reinforced concrete manhole sections, grout, manhole ring and cover, throat rings, bitumastic joint sealant, and interior coating) must be per the requirements for new manholes described in this Section.

2.6. Existing Manhole Adjustments. This item will govern the adjustment of all existing manholes, to include the replacing of existing manhole covers and rings regardless of type shown in the Contract documents and in conformity with the provisions of these specifications or as directed. All material and construction work must be in accordance with current Texas Commission on Environmental Quality (TCEQ) rules to include: Design Criteria for Sewage Systems (30 TCEQ § 217), or any revision thereto as applicable. All manholes must be watertight and coated with a SAWS-approved sewer coating. The context of this specification is limited to adjusting the final elevation of the manhole by the maximum or minimum number of throat rings. Manhole rings and covers must be in conformance with these specifications. Sewer manhole ring and cover castings must meet the current requirements of the American Association of State Highway and Transportation Officials (AASHTO) Designation M306-10. All manholes requiring adjustments beyond the maximum or minimum number of throat rings (described herein), will be subject to the requirements of "Existing Manhole Reconstruction."

Manhole ring and covers will be replaced with new ring and covers under this item. Concrete throat rings with liners, joint sealant, and other materials described under manholes in this specification will be used as necessary to adjust the manholes.

2.7. Reconstruction of Existing Manholes. This item will consist of the reconstruction of all existing manholes, all types and sizes, to include the replacement of manhole ring and covers, the cones, manhole sections required regardless of type shown in the Contract documents and in conformity with the provisions of these specifications. All material and construction work must be in accordance with current Texas Commission on

Environmental Quality (TCEQ) rules to include: Design Criteria for Sewage Systems (30 TCEQ § 217). All reconstructed manholes must be watertight and coated with a SAWS-approved sewer coating. Sewer manhole ring and cover castings must meet the current requirements of AASHTO Designation M306-10. Existing Monolithic Manholes are not to be reconstructed, but fully replaced.

Manhole ring and covers, cover gaskets, concrete throat rings with liners, joint sealant, interior coating, and other materials described under manholes in this specification will be used as necessary in the reconstruction of existing manholes item.

2.8. Sanitary Sewer System Cleaning. The Contractor must furnish all labor, equipment, and materials necessary for cleaning the sanitary sewer system, including the removal of all debris/solids, sand, grease, grit, rock, etc. from the sewer mains, manholes, or structures to facilitate television inspection.

2.8.1. Preparation. The Contractor must only use the type of cleaning identified in Article 4 of this Specification for Cleaning Manholes and Mains to perform the necessary removal of all material which will not create hazards to health, property, affect downstream treatment plant processes, or damage to the sanitary sewer system.

2.9. Concrete. All concrete is to meet the requirements of Item 421, “Hydraulic Cement Concrete.” Unless otherwise shown on the plans or required by this specification, all concrete will be Class A.

2.10. Mortar. Mortar must be composed of 1 part Portland Cement, 2 parts sand and enough water to produce a workable mixture. When used to plaster manholes, it may be composed of 1 part cement to 3 parts sand. Lime up to 10% may be used. It will have a consistency such that it can be easily handled and spread.

2.11. Reinforcing Steel. Reinforcing steel and the placing thereof is to conform to the requirements of Item 440, “Reinforcing Steel,” except where welded wire is called for on the plans, the material will be welded wire flat sheets meeting A.S.T.M. A-185. Welded wire rolls will not be used.

2.12. Cement Stabilized Backfill. Cement stabilized backfill is to be in accordance with Item 400, “Excavation and Backfill for Structures.”

2.13. Flowable Backfill. When indicated on the plans, the trench is to be backfilled to the dimensions shown with flowable backfill. The flowable backfill with fly ash will be Mix Design Type B in accordance with Item 401, “Flowable Backfill,” or an acceptable mix as approved.

2.14. Grout. When shown on the plans for various applications, the grout is to be a cement/sand/water mixture as approved. It will have a consistency such that it will flow into and completely fill all voids.

2.15. Sewer Main Television Inspection. The Contractor must furnish all labor, materials, equipment, and incidentals to provide the televising and a NASSCO-(PACP) standard video, recorded in MPEG-1 format and written to DVD video of sewer lines and manholes utilizing a color, closed-circuit television inspection unit to determine their condition. The video should include an inclinometer, visible on the video being viewed, noting the slope of the main being televised.

After completion of the work specified in the Contract documents, and before placement of the final course of asphalt or other final surface, the newly constructed or rehabilitated sanitary sewer main must be televised immediately upon cleaning. Televising must be observed by the Inspector or Engineer and Contractor, as the camera is run through the system. Any abnormalities such as, but not limited to, misaligned joints, cracked/defected pipe, rolled gaskets, must be repaired by the Contractor solely at his expense. Sections requiring repair must be re-televised to verify condition of repair. No additional compensation will be provided for all needed repairs, re-cleaning, or re-televising efforts.

The Contractor must provide a DVD and log of the televised system for review and approval by the Inspector. If the Contractor provides a DVD of such poor quality that it cannot be properly evaluated, the Contractor must re-televise as necessary and provide a DVD of good quality at no additional cost to SAWS. If the Contractor cannot provide a DVD of such good quality that can be reviewed by SAWS, SAWS may elect to televise the line at the Contractor's expense.

The television unit must also have the capability of displaying in color, on DVD, pipe inspection observations such as pipe defects, sags, points of root intrusion, offset joints, service connection locations, and any other relevant physical attributes. Each DVD must be permanently labeled with the following:

- Project Name
- Date of Television Inspection
- Station to Station Location and Size of Sanitary Sewer
- Street/Easement Location
- Name of Contractor
- Date DVD Submitted
- DVD Number
- SAWS Inspector Name

The Contractor must provide a line diagram area sketch and written log for each completed segment of DVD sewer main describing the section being televised, flow and camera direction, position of service connections, description and location of failures, pipe condition, weather conditions, and other significant observations.

The television inspection equipment must have an accurate footage counter which displays on the monitor the exact distance of the camera from the center of the starting manhole. A camera with rotating and panning lens capabilities is required. The camera height should be centered in the conduit being televised. The speed of the camera through the conduit must not exceed 40 ft. per minute. The produced video must also have an inclinometer that displays the slope of the sewer main being televised.

The Contractor will be required to have all materials, equipment, and labor force necessary to complete all videotaping on the jobsite before isolating the sewer manhole segment and beginning videotaping operations.

Television inspection will be done one section between two manholes at a time. Also, the flow in the section being televised must be bypassed if the line is in service and the flow exceeds 25% of the internal pipe diameter. When the depth of flow at the upstream manhole of the manhole section being worked is above the maximum allowable for television inspection, the flow can be reduced to allowable levels by performing bypass pumping, as approved by the Inspector.

The Contractor will not be allowed to float the camera. There may be occasions during the televised inspection of a manhole section when the camera will be unable to pass an obstruction. At that time, and before proceeding, the Contractor must contact the Inspector. If the length of sewer line cannot be televised because of obstructions, the Contractor must clean the system as is necessary. If, in the opinion of the Inspector, the obstruction is attributed to a collapsed main or pipe deflection, televising will be suspended, payment will be made based on the actual televised length, and the remaining televising of the sewer line will be continued upon successful correction of the blockage by the Contractor at his expense. No additional payment will be made for additional setups required due to obstructions encountered during televising.

No lateral connections should be made to the sanitary sewer main at the “12 o’clock” position. All lateral connections should clearly indicate which side of the sanitary sewer main it was installed from.

The Contractor is solely responsible for any damage of sewer mains as a direct result of televising operations. Any repair will also be the responsibility of the Contractor.

The methods used for securing passage of the camera is at the discretion of the Contractor, and as approved by the Inspector.

No sanitary sewer main televising effort will commence until all pertinent permits or required approvals have been obtained by SAWS.

No separate or additional payment will be made for any excavation, man entry, or any other method which may be required to retrieve video equipment that may have been hung up, destroyed, or lost during the operation.

2.16. Air Release Assemblies for Wastewater. Valves furnished under this specification must conform to ANSI/NSF Standard 60 for direct additives and ANSI/NSF Standard 61 for indirect additives. Cast Iron Valve Body and cover must be in accordance with ASTM A48-35 or ASTM A126 class B. Non-Metallic Valve Body must be fabricated from fiberglass reinforced nylon. Inlet sizes through 2 in must be screwed (NPT). Pipe sizes 3" and above must have flanged inlets (125# ASNSI B 16.1). A protective hood or cowl must be installed on the outlet of flange-bodied valves.

Metallic Internal seat trim float arm and pivot pin must be stainless steel type 303, 304 or 316. Metallic Floats must be stainless steel ASTM A 240. Other stainless steel metal internal parts must be stainless steel ASTM A240 or ASTM A276.

Non-metallic floats will be foamed polyethylene with stainless steel type 316 fasteners.

Valves requiring Internal seats or orifice buttons must be Buna-N rubber compounded for water service. For valves requiring cover gaskets, the cover gasket must be composition type, equal to Armstrong CS-231, Garlock 3000, or Lexide NK-511. If an O-Ring is used to seal the cover, it must be on NSF 61 certified rubber. Cover bolts must be alloy steel. Rolling seals must be furnished for non-metallic valves 2" and below.

Valve Body will have a test pressure rating of 300 psi and working pressure rating of 150 psi.

The air release valve should be designed to vent accumulated air automatically. The outlet orifice must be properly sized to facilitate valve operation at pressures up to 150 psi. The air release valve must be simple-lever, compound-lever, ball and orifice or rolling seal depending upon volume requirements and the design of the valve.

The air and vacuum valve should be designed with the inlet and outlet of equal cross-sectional area where applicable. The valve must be capable or automatically allowing large quantities of air to be exhausted during the filling cycle an also capable of automatically allowing air to re-enter the system to prevent a negative pressure at water column separation or during the draining cycle. The float must be guided to minimize premature closure by air and to provide proper alignment for normal closure by floating on the water surface.

Combination air and vacuum relief valves should provide for both automatic air release under system pressure and to allow air movement during filling or draining operations, or water column separation. The combination valve may be housed in a single casting. The housing must be designed to incorporate conventional or kinetic flow principles to properly vent the air without premature closure. Flanged sized (4 inch and larger) may be furnished in a dual housing. When dual casings are used a bronze manual isolation valve must be installed if indicated by the manufacturer. This will allow the air release valve to be serviced when the system is under pressure. Field service of the valve may also be performed by closing the isolation valve between the air valve and the pipe connection.

The San Antonio Water System may, at no cost to the manufacturer, subject random valves to testing by an independent laboratory for compliance with these standards. Any visible defect or failures to meet the quality standards herein will be grounds for rejecting the entire order.

The manufacturers must provide certification that products furnished under this specification are manufactured in an ISO 9001 certified facility or documentation from an accredited facility that ISO 9001 certification is in process.

2.17. Point Repairs & Obstruction Removals. Repair of sanitary sewer lines by replacing short lengths of failed pipe with new pipe. Repair of service laterals located within the utility easement or street right of way, when replacing short lengths of failed pipe with new pipe. Obstruction removal by remote device or excavation. Use pipe material for repairs in accordance with "Sanitary Sewer Pipe" of this Specification. If point repair is located at a service connection, use a full-bodied fitting for the service connection. No field fabrication of

fittings allowed. For joining to existing pipe, use flexible adapters secured with 1/2 inch stainless steel bands, as manufactured by Fernco, or approved equal. All flexible adapters must be concrete encased to prevent movement or breakage of the steel bands.

2.18. Rehabilitation of Sanitary Sewer by Cured-In-Place Pipe (CIPP) (Hot Water or Steam Cured).

This specification includes requirements to rehabilitate existing sanitary sewers by the installation of a resin-impregnated flexible tube, which is formed to the original conduit. The lining is inserted via an existing manhole or other access and, depending on the system selected, is installed using one of the following insertion methods:

- Water inversion – where the lining is inverted under the pressure of water, and cured by circulating hot water.
- Winched insertion – where the lining is winched into place and inflated against the sewer wall by either a removable bladder inverted into the lining under the pressure of water or a pre-positioned bladder, which is simply inflated. Curing is accomplished using circulated hot water.
- Air inversion – where the lining is inverted under the pressure of air and cured by introducing steam.

2.18.1. Tube.

The tube must consist of one or more layers of absorbent needled felt fabric or an equivalent non-woven or woven material, or a combination thereof which meets the requirements of ASTM F1216 or ASTM F1743, Section 5. The tube must be constructed to withstand installation pressures and curing temperatures, have enough strength to bridge missing pipe, and stretch to fit irregular pipe sections.

The impregnated tube must have a uniform and homogenous thickness that when compressed at installation pressures will meet or exceed the design thickness.

The tube must be sized that when installed will tightly fit the internal circumference and length of the original pipe. Allowance should be made for circumferential stretching during inversion.

The outside layer of the tube (before wet out) must be coated with an impermeable, flexible membrane that will contain the resin and facilitate monitoring of resin saturation during the resin impregnation (wet out) procedure.

The tube must be homogeneous across the entire wall thickness containing no intermediate or encapsulated elastomeric layers. No material should be included in the tube that may cause delamination in the cured CIPP. No dry or unsaturated layers should be evident.

The wall color of the interior pipe surface of CIPP after installation should be a light reflective color so that a clear detailed examination with closed circuit television inspection equipment may be made.

Seams in the tube must be stronger than the un-seamed felt and meet the requirements of ASTM D5813.

The outside of the tube must be marked for distance at regular intervals along its entire length, not to exceed 5 ft. Such markings must include the manufacturer's name or identifying symbol. The tubes must be manufactured in the USA.

2.18.2. Resin.

The resin system must be a corrosion resistant polyester, vinyl ester, or epoxy and catalyst system. When properly cured, the tube composite meets the requirements of ASTM F1216, ASTM F1743 and ASTM F2019, the physical properties herein, and those that are to be used in the design of the CIPP for this project. The resin must produce CIPP that will comply with the structural and chemical resistance requirements of this specification.

2.18.3. Structural Requirements

The CIPP must be designed as per ASTM F1216, Appendix X1. The CIPP design should assume no bonding to the original pipe wall.

The Contractor must have performed long-term testing for flexural creep of the CIPP pipe material installed by his Company. Such testing results are to be used to determine the long-term, time dependent flexural modulus to be used in the product design. This is a performance test of the materials (Tube and Resin) and general workmanship of the installation and curing. A percentage of the instantaneous flexural modulus value (as measured by ASTM D790 testing) will be used in design calculations for external buckling. The percentage, or the long- term creep retention value used, will be verified by this testing. Values in excess of 50% will not be applied unless substantiated by qualified third party test data. The materials used for the contracted project must be of a quality equal to or better than the materials used in the long-term test with respect to the initial flexural modulus used in design.

The layers of the cured CIPP must be uniformly bonded. It must not be possible to separate any two layers with a probe or point of a knife blade so that the layers separate cleanly or the probe or knife blade moves freely between the layers. If separation of the layers occurs during testing of field samples, new samples will be cut from the work. Any reoccurrence may cause rejection of the work.

The CIPP must be classified as conforming to the following minimum structural properties for a cured composite:

- Modulus of Elasticity (per ASTM D790 - short term) – 250,000 psi
- Flexural Strength (per ASTM D790) – 4,500 psi
- Compressive Strength (per ASTM D695) – 6,500 psi
- Tensile Strength (per ASTM D638) – 3,500 psi

The required structural wall thickness must be based as a minimum on the physical properties listed above, the design equations in ASTM F1216, Appendix X1 (as referenced by ASTM F2019), and the following design parameters:

- Pipe condition: Fully deteriorated.
- Minimum design safety factor: 2.0.
- Percentage ovality of original pipe: 2.0%.
- Soil density: 120 lbs/cf.
- Traffic Loads: HS-20-44 per AASHTO highway loading.
- Soil Modulus: 500 psi.
- Groundwater depth must be ground surface at a minimum or the elevation of the 100 year floodplain water surface, whichever is greater," in order to account for all reasonable anticipated future loadings.
- Long Term Flexural Modulus Retention: 50%
- Soil depth: maximum distance in feet measured between the crown of the pipe and the highest point of soil cover over the length of continuous CIPP section.
- The liner must be designed for a minimum fifty-year service life under continuous loading conditions.

Contractor must submit design calculations in accordance with ASTM F1216 that substantiate the CIPP wall thickness for each continuous length of CIPP installed. The required CIPP wall thickness must be uniform from CIPP start point to CIPP finish point with no deviation in thickness.

Acceptable manufacturers must have approval through SAWS Standards Committee before product use and must meet all requirements set forth in this Specification.

2.19. By-Pass Pumping – Small Diameter Sanitary Sewers. The work covered by this item consists of bypass pumping operations for existing sanitary sewers less than 24 in. in diameter in order to temporarily reroute sanitary sewer flows to prevent a sanitary sewage overflow (SSO) and to provide adequate and reliable sanitary sewer flow at all times during construction, while the tasked scope of work is executed. The work also covered in this item is for the use of inflatable and mechanical pipe plugs. The use of inflatable / mechanical plugs in the water and sewer industry is the standard method to temporarily plug a pipe where

permanent flow control devices are not available or are not operating as designed. An inherent danger exists with all inflatable products. If any conditions with this equipment exist that may jeopardize the safety of workers or others, do not use it.

This item includes all requirements for implementing a temporary pumping system for the purpose of diverting sanitary sewage flow around any construction-related activity to an approved reintroduction point within the sanitary sewer system. The Contractor must minimize the health, safety, and regulatory risks by taking all reasonable measures to avoid an SSO. Therefore, SAWS requires the Contractor to manage the flow of wastewater in a planned and proactive manner. Contractor will be fully responsible for all damages and costs related to the installation, modification of existing manholes/structures, operation, and maintenance of Contractor's bypass pumping operations including damages, clean up, fines, penalties, and other related costs.

Bypass pumping systems must be stationary systems consisting of portable pumps, piping, and appurtenances unless a "pump and haul" bypass system is accepted by SAWS. Pump and haul bypass systems can use a relay system of vacuum trucks using a pump and haul approach to bypass sewage flows. Where pump and haul bypass systems are allowed the Contractor may elect to submit using a pump and haul bypass system for these locations or to use a stationary bypass system. All bypass systems must comply with all the requirements of this section unless specifically noted otherwise.

The Contractor will be responsible for the design of the bypass pumping plan and system. Contractor's bypass pumping system design must be developed based upon the requirements of the Contract Documents.

The bypass system must meet the requirements of all codes and regulatory agencies with jurisdiction

Pump and haul bypass systems will not be allowed within the Edwards Aquifer Recharge Zone (EARZ) or for larger sanitary sewers with significant sewage bypass flows. Contractor must provide for temporary measures to convey sewage flows and avoid sewage spills should a storm event occur that generates sanitary sewer flows in excess of Contractor's bypass pumping system.

2.19.1. Submittals. All submittals must be in accordance with Owner's requirements and must be acknowledged by Owner before delivery.

For all projects requiring bypass pumping, the Contractor must prepare and submit a Bypass Pumping Plan (BPP). The BPP must be submitted a minimum of two weeks before commencing any portion of the proposed scope of work and must be acknowledged by SAWS before beginning Work. The BPP must be signed and sealed by a professional Engineer licensed in the State of Texas (Contractor's Engineer).

Contractor must submit manufacturer's product data, instructions, recommendations, shop drawings, and necessary certifications in order for the proposed BPP to be reviewed and acknowledged.

The following must be submitted as part of the BPP:

- A cover letter containing the following information. The project name and job number. The name and address of the Contractor. Contact information of the Contractor's project manager, superintendent, foreman/supervisor, safety professional, etc. A description and location of the planned bypass pumping work to be performed; include data for stationary and pump and haul bypass systems as applicable.
- Emergency ("24/7") contact information for the bypass pumping Sub-Contractor, if applicable. Make sure to include the name, cell phone number, and title of the persons' onsite responsible for the bypass pumping operation.
- The name, phone number, title, signature, and PE seal of the Contractor's Engineer preparing the BPP.
- Copies of permits or other documents showing the Contractor has obtained all clearances necessary for installation and operation of the BPP.
- If Contractor elects to use a combination of stationary bypass pumping and pump and haul for his bypass system, Contractor's BPP must identify the quantity of flows that will be pumped and pumped

and hauled for each type of bypass system along with the points where flows will be removed and reintroduced into the sanitary sewer system.

- Certificate of Compliance that the BPP complies with all SAWS and regulatory requirements and that all components have been designed by a professional Engineer licensed in the State of Texas. The Contractor's Engineer will review all components of the submitted BPP for adequacy to the Contractor's selected design flow conditions and insure that all bypass pumping system components are of adequate size, strength, meet the reliability criteria specified herein.
- A description of the maximum amount of sanitary sewer flows to be bypassed by the Contractor's bypass pumping system and how the flow conditions will be monitored during system operations (including all flow measurement devices, calculations, equipment, or other sources of how data was obtained). If the bypass plan is not based on the maximum wet weather flow in the sanitary sewer, this description must include an explanation for how the Contractor plans to monitor the weather for potential flows exceeding his bypass system capacity and how he will avoid having to bypass during wet weather events exceeding his bypass system capacity.
- Descriptions of all proposed bypass pumping components to be used. If applicable, describe all different bypass pumping phases. Include bypass pumps sizes and capacity, as well as the sizes and capacity of the suction/discharge piping. The description should also include manholes/structures depths and sizes that will be used during the bypass pumping operation, sanitary sewer plugging method and type of plugs to be used, flowmeter installation locations, etc. Contractor must provide SAWS with adequate prior notification to allow SAWS to witness installation and removal of all plugs.
- The date and time the bypass pumping is expected to begin and be completed. Indicate if bypass pumping will take place outside normal work hours which are between 8 am to 5 pm Mondays through Fridays (except for SAWS observed holidays). Contractor must reimburse SAWS for the overtime costs required by his bypass pumping testing outside of SAWS normal work hours.
- The pump curves, showing operating range. This must include the proposed system curve, addressing the pump operation in relation to the suction/discharge piping's alignment with respect to restriction or elevations.
- Suction and discharge piping materials and capacity to be used for the bypass pumping operation, including the materials for any bends and valves that will be used.
- A sketch showing the location of the pumps and the route of the suction, and discharge piping. If Contractor elects to use locations outside of the easements obtained by SAWS, Contractor will be solely responsible for obtaining the required easements and written documentation required for use of these locations. The sketch should be dimensioned and all-inclusive showing all SAWS manhole numbers that will be used for suction and discharge operations. If any other structure will be used for suction or discharge operations, then the nearest manholes should be labeled. The sketch should include the name of any streets or major intersection in the area. All features possibly affected by the alignment of the BPP's components (driveways, vehicular traffic, residential or commercial dwellings (due to noise) should likewise be addressed. For pump and haul systems the sketch should show the location of all system components along with the staging areas, haul routes, and an explanation of the expected cycle time of all aspects of the operation.
- Clear photographs of the manholes interior that will be used for the bypass pumping operation, including pole camera photographs of pipes where plugs will be installed. All photographs will be labeled with the manhole number, date, and intended use of the manhole by the Contractor's BPP.
- A Traffic Control Plan that pertains solely to the bypass pumping operations. This may differ than the project's traffic control plan for the overall scope of work. The Traffic Control Plan should include all required permits including street cut permits. Contractor must maintain pedestrian and vehicular traffic and comply with ADA regulations for access to all residential and commercial property unless written approval is otherwise obtained from the property owner allowing for reduced access.
- An Emergency Plan detailing procedures to be followed in the event any portion of the bypass operation fails and causes either surcharging or an actual SSO. Contractor is herein advised that:

- The existing sanitary sewer system may surcharge during certain storm events. The Contractor's BPP must recognize this potential and accommodate it with enough bypass capacity, restoration of flow through the sanitary sewer system, or other measures acceptable to SAWS during these flow events. These measures must be included in the submitted BPP.
- The Contractor's BPP cannot cause any excess surcharging (beyond that normally occurring within the existing sanitary sewer system at that flow event) that results in damage or SSOs.
- Any damage or SSOs during bypass pumping operations resulting from Contractor's bypass system will be deemed a failure of BPP, and the Contractor must re-propose an improvement to their BPP for review and acknowledgment. A sanitary sewer surcharge is herein defined as any flows entering the manhole or structure (above the crown of the pipe). Excessive sanitary sewer surcharges are higher than normally occurring levels of surcharge levels resulting from the Contractor's BPP that result in damage or SSOs. Contractor will be fully responsible for all damages and costs related to the installation, operation, and maintenance of Contractor's bypass pumping operations including damages, clean up, fines, penalties, and other related costs.
- Contractor to include minimum equipment on hand for implementing and emergency plan. (i.e. spare pump, emergency power source.)

- Where bypass piping is installed within the floodplain of waterways subject to flooding, the Contractor must submit an anchorage plan and calculations to ensure that piping is properly anchored. The pipe must be capable of remaining in place during a 100-year storm event. Anchorage plan and calculations must be designed and sealed by a professional Engineer licensed in the State of Texas (Contractor's Engineer). This must be the same PE that sealed the BPP Certificate of Compliance.
- For pump and haul system, submit copy of Hauler's Transporter Registration as issued by TCEQ under 30 TAC Chapter 312, Subchapter G.
- For pump and haul system, submit information on licensed disposal site to be used by the Contractor
- Submit the checklist found at the end of this document confirming that all items required by this section are included in the BPP submittal.

2.19.2. Equipment & Materials. The Contractor must provide all necessary pumping equipment, piping and all other necessary appurtenances in order to maintain adequate and reliable sanitary sewer flow in the sanitary sewer system (including any temporary manholes) at all times during construction for stationary pumping and pump and haul bypass pumping systems. All materials, equipment, etc., must be in good condition, and should not have visible damage such as cracks, holes, foreign material, blisters, etc.

Plugs must be selected and installed according to the size of the line to be plugged. Plugs must be adequately secured and anchored to prevent plug movement or escape into the adjoining sanitary sewers should the plug fail. An additional plug (for each size of plug used) must be onsite and ready to be installed in the event a plug fails or becomes dislodged. Plugs will be visually examined by the Inspector or Engineer for defects that might lead to failure before being installed. Contractor must immediately locate and remove any plug that has shifted its position, slipped within the pipe, dislodged, moved, or otherwise provided an indication that its suitability for use in plugging may be suspect or compromised. Contractor must notify SAWS of any plug that has provided an indication that its suitability for use in plugging may be suspect or compromised and allow SAWS to observe plug removal and replacement. It is also imperative that the Contractor notify the Inspector at the completion of the work in order to verify that all plugs have been removed from the system.

- The Contractor must provide all necessary equipment, plugs, hoses, gauges and necessary appurtenances to install the plug, maintain the plug during use and remove the plug at completion.
- All plugs must be in good condition, and must not have visible damage such as cracks, holes, tears, cuts, punctures, abrasions, loose or damaged fittings, cracks in castings and excessive wear.
- All plugs 15 in. and larger must have an air release valve for rupture protection.
- If the plug is damaged, it must be immediately removed from the job-site.
- Contractor must be aware of the limitations associated with plugs.

Stationary bypass pumping systems must consist of:

- High-Density Polyethylene (HDPE) is the preferred pipe material for all bypass piping. HDPE must be used when bypass discharge pipe will be going through streams, storm water culverts, the Edward's Aquifer Recharge Zone, or environmentally sensitive areas. At other locations, not within the Edward's Aquifer Recharge Zone, flexible discharge hose that is in good condition and does not leak, may be allowed subject to it acceptably passing testing.
- HDPE pipe must be assembled and joined using couplings, flanges or fusion welding in order to avoid joint leakage.
- HDPE fusion welding must be performed by personnel certified as fusion technicians by the manufacturer of HDPE pipe or fusing equipment. SAWS will examine welds before use in BPP operation.
- BPP must indicate the proposed DR of the pipe to be used.
- Rigid suction hose that is in good condition and does not leak may be allowed for withdrawal of flows from the suction point into the bypass pumps. Pipe material other than HDPE must be submitted to SAWS for approval. Neither "Irrigation type" pipe nor glued PVC pipe will be permitted.
- Any hoses or pipes that leak must be removed and replaced with non-leaking hoses or pipes.
- Pumps must be fully automatic self-priming units that do not require the use of foot valves or vacuum pumps to prime the system. No electric pumps will be allowed; all pumps must be diesel powered. Contractor must provide suitable spill control and containment measures to avoid environmental contamination by pumps, fuels, or lubricants. All pumps must be open impeller solids handling type pumps, capable of passing a minimum of 3 in. diameter solids. Contractor must have one backup pump, equal in capacity to the largest pump in the system, connected into the bypass pumping system, and ready for operation in case any of the primary pumps fail. The backup pump must not be used in Contractor's calculations for determining the pumping capacity requirements for the stated flow conditions above. Sound-attenuated pump enclosures will be required on all projects where the bypass pumps are located within 50 ft. of any residence, business, park, or other presence of people. Contractor must provide enough sound attention measures to comply with City of San Antonio noise limitation requirements.

Pump and haul bypass pumping systems must use good-quality vacuum trucks, equipment, and materials from manufacturers commonly engaged in the manufacture, service, and repair of these types of sanitary sewer service trucks and equipment. All equipment must be designed and manufactured for sanitary sewer service, must function acceptably, be reliable, and free from leaks or other deleterious environmental impacts. All equipment proposed for use in pump and haul bypass pumping must have been maintained per the manufacture's recommendations. Equipment service records must be made available at SAWS request. Any hoses or pipes that leak must be removed and replaced with non-leaking hoses or pipes.

2.20. Bypass Pumping – Large Diameter Sanitary Sewers. The work covered by this item consists of bypass pumping operations for existing sanitary sewers 24 in. and larger in diameter in order to temporarily reroute sanitary sewer flows to prevent a sanitary sewage overflow (SSO) and to provide adequate and reliable sanitary sewer flow at all times during construction, while the tasked scope of work is executed. The work also covered in this item is for the use of inflatable and mechanical pipe plugs. The use of inflatable or mechanical plugs in the water and sewer industry is the standard method to temporarily plug a pipe where permanent flow control devices are not available or are not operating as designed. An inherent danger exists with all inflatable products. If any conditions with this equipment exist that may jeopardize the safety of workers or others, do not use it.

This item includes all requirements for implementing a temporary pumping system for the purpose of diverting sanitary sewage flow around any construction-related activity to an approved reintroduction point within the sanitary sewer system. The Contractor must minimize the health, safety, and regulatory risks by taking all reasonable measures to avoid an SSO. Therefore, SAWS requires the Contractor to manage the flow of wastewater in a planned and proactive manner. Contractor will be fully responsible for all damages and costs related to the installation, modification of existing manholes/structures, operation, and

maintenance of Contractor's bypass pumping operations including damages, clean up, fines, penalties, and other related costs.

Bypass pumping systems must be stationary systems consisting of portable pumps, piping, and appurtenances unless a flow diversion bypass system is allowed on the Bypass Pumping Plan (BPP) sheet. Flow diversion bypass systems can use temporary gravity sewers (installed and removed by Contractor) to divert flows into an existing manhole identified in the BPP sheet. Where flow diversion bypass systems are allowed the Contractor may elect to submit using a flow diversion bypass system for these locations or to use a stationary bypass system. All bypass systems must comply with all the requirements of this section unless specifically noted otherwise.

The Contractor will be responsible for the design of Contractor's bypass pumping plan and system. Contractor's bypass pumping system design must be developed based upon the data and requirements of the Contract Documents. The bypass system must meet the requirements of all codes and regulatory agencies with jurisdiction. SAWS will furnish data on the BPP sheet which will include average daily flows and maximum peak flows.

Contractor may rely upon the data provided in the Contract Documents for designing Contractor's bypass pumping system. Contractor must provide for temporary measures to convey sewage flows and avoid sewage spills should a storm event occur that generates sanitary sewer flows in excess of Contractor's bypass pumping system. Contractor to include an emergency response plan in submittals. Plan should include measures for handling excess flows due to storm events. Plan needs to include additional emergency equipment, diversion plans and what measures will be taken to handle excess flows.

2.20.1. Submittals. All submittals must be in accordance with Owner's requirements and must be acknowledged by Owner before delivery.

For all projects requiring bypass pumping, the Contractor must prepare and submit a BPP. The BPP must be submitted a minimum of two weeks before commencing any portion of the proposed scope of work and must be acknowledged accepted by SAWS before beginning Work. The BPP must be signed and sealed by a professional Engineer licensed in the State of Texas (Contractor's Engineer).

Contractor must submit manufacturer's product data, instructions, recommendations, shop drawings, and necessary certifications in order for the proposed Bypass Pumping Plan (BPP) to be reviewed and acknowledged.

The following must be submitted as part of the BPP:

- A cover letter containing the following information. The project name and job number. The name and address of the Contractor. Contact information of the Contractor's project manager, superintendent, foreman/supervisor, safety professional, etc. A description and location of the planned bypass pumping work to be performed; include data for stationary and flow diversion bypass systems as applicable.
- Emergency ("24/7") contact information for the bypass pumping sub-Contractor, if applicable. Make sure to include the name, cell phone number, and title of the persons' onsite responsible for the bypass pumping operation.
- The name, phone number, title, signature, and PE seal of the Contractor's Engineer preparing the BPP.
- Copies of permits or other documents showing the Contractor has obtained all clearances necessary for installation and operation of the BPP.
- If flow diversion to existing sewers is proposed by Contractor all diversion flows must be contained within pipes, use of excavated trenches are not allowable for diverting sanitary sewer flows.
- If Contractor elects to use a combination of stationary bypass pumping and flow diversion for his bypass system, Contractor's BPP must identify the quantity of flows that will be pumped and flows diverted for each type of bypass system along with the points where flows will be removed and reintroduced into the sanitary sewer system.

- Certificate of Compliance that the BPP complies with all SAWS and regulatory requirements and that all components have been designed by a professional Engineer licensed in the State of Texas. The Contractor's Engineer must review all components of the submitted BPP for adequacy to the Contractor's selected design flow conditions and insure that all bypass pumping system components are of adequate size, strength, meet the reliability criteria specified herein.
- A description of the maximum amount of sanitary sewer flows to be bypassed by the Contractor's bypass pumping system and how the flow conditions will be monitored during system operations (including all flow measurement devices, calculations, equipment, or other sources of how data was obtained). If the bypass plan is not based on the maximum wet weather flow in the sanitary sewer, this description must include an explanation for how the Contractor plans to monitor the weather for potential flows exceeding his bypass system capacity and how he will avoid having to bypass during wet weather events exceeding his bypass system capacity.
- Descriptions of all proposed bypass pumping components to be used. If applicable, describe all different bypass pumping phases. Include bypass pumps sizes and capacity, as well as the sizes and capacity of the suction/discharge piping. The description must also include manholes/structures depths and sizes that will be used during the bypass pumping operation, sanitary sewer plugging method and type of plugs to be used, flowmeter installation locations, etc. Where plugs greater than 24 in. are required, submit a Plug Use Plan (PUP) according to the requirements of Special Provision to this section. Contractor must provide SAWS with adequate prior notification to allow SAWS to witness installation and removal of all plugs.
- Description of procedure for locating and recovering any lost plug using the required radio transmitter and receiver system.
- Description of minimum equipment on hand should an emergency plan be implemented, i.e. spare pump, emergency generator.
- The date and time the bypass pumping is expected to begin and be completed. Indicate if bypass pumping will take place outside normal work hours which are between 8 am to 5 pm Mondays through Fridays (except for SAWS observed holidays).
- The pump curves, showing operating range. This must include the proposed system curve, addressing the pump operation in relation to the suction/discharge piping's alignment with respect to restriction or elevations.
- Suction, discharge, and diversion piping materials and capacity to be used for the bypass pumping operation, including the materials for any bends and valves that will be used.
- A sketch showing the location of the pumps and the route of the suction, discharge, and diversion piping. If Contractor elects to use locations outside of the easements obtained by SAWS or locations that are not indicated for use on the BPP plan sheet, Contractor will be solely responsible for obtaining the required easements and written documentation required for use of these locations, a copy must be provided to SAWS before Contractor's use. A sketch detailing proposed restoration of the suction and discharge points if the Contractor proposed to make openings in the existing pipes or structures.
- If different than shown in contract documents, the new sketch must be dimensioned and all-inclusive showing all SAWS manhole numbers that will be used for suction and discharge operations. If any other structure will be used for suction or discharge operations, then the nearest manholes must be labeled. The sketch must include the name of any streets or major intersection in the area. All features possibly affected by the alignment of the BPP's components (driveways, vehicular traffic, residential or commercial dwellings (due to noise) must likewise be addressed.
- Clear photographs of the manholes interior that will be used for the bypass pumping operation, including pole camera photographs of pipes where plugs will be installed. All photographs will be labeled with the manhole number, date, and intended use of the manhole by the Contractor's BPP.
- A Traffic Control Plan that pertains solely to the bypass pumping operations. This may differ than the project's traffic control plan for the overall scope of work. The Traffic Control Plan must include all required permits including street cut permits. Contractor must maintain pedestrian and vehicular traffic

and comply with ADA regulations for access to all residential and commercial property unless written approval is otherwise obtained from the property owner allowing for reduced access.

- An Emergency Plan detailing procedures to be followed in the event any portion of the bypass operation fails and causes either surcharging or an actual SSO. Contractor is herein advised that:
  - The existing sanitary sewer system may surcharge during certain storm events. The Contractor's BPP must recognize this potential and accommodate it with enough bypass capacity, restoration of flow through the sanitary sewer system, or other measures acceptable to SAWS during these flow events. These measures must be included in the submitted BPP.
  - The Contractor's BPP cannot cause any excess surcharging (beyond that normally occurring within the existing sanitary sewer system at that flow event) that results in damage or SSOs.
  - Any damage or SSOs during bypass pumping operations resulting from Contractor's bypass system will be deemed a failure of BPP, and the Contractor must re-propose an improvement to their BPP for review and acknowledgment. A sanitary sewer surcharge is herein defined as any flows entering the manhole or structure (above the crown of the pipe). Excessive sanitary sewer surcharges are higher than normally occurring levels of surcharge levels resulting from the Contractor's BPP that result in damage or SSOs. Contractor will be fully responsible for all damages and costs related to the installation, operation, and maintenance of Contractor's bypass pumping operations including damages, clean up, fines, penalties, and other related costs.
- Where bypass piping is installed within the floodplain of waterways subject to flooding, the Contractor must submit an anchorage plan and calculations to ensure that piping is properly anchored. The pipe must be capable of remaining in place during a 100-year storm event. Anchorage plan and calculations must be designed and sealed by a professional Engineer licensed in the State of Texas (Contractor's Engineer). This must be the same PE that sealed the BPP Certificate of Compliance.
- Submit the checklist found at the end of this document confirming that all items required by this section are included in the BPP submittal.

For all projects requiring the use of pipe plugs on pipes the Contractor must furnish a submittal containing manufacturer's product data, instructions, recommendations and a project Plug Use Plan (PUP). The PUP must be submitted a minimum of two weeks before commencing any portion of the proposed scope of work.

The following must be submitted with the PUP:

- A cover letter containing the following information. The project name and job number. The name and address of the Contractor. Contact information of the Contractor's project manager, superintendent, foreman/supervisor, safety professional, etc. Emergency (24/7) contact information for the staff responsible for operating and maintaining the plug. Include the name, phone number, email address and the persons' onsite who is responsible for the project. The name and contact information for the PUP preparer.
- Plug plan that must show where on the project site the Contractor intends to use pipe plugs, including the following information. Manhole numbers; the upstream and downstream pipe diameters and pipe materials; pipe slopes; pipe depth; pipe flow direction; known peak or surcharge flow data; types of plugs to be used; types of restraint used; type of radio transmitting device.
- Provide calculations of the maximum anticipated head pressure on the plug and the resultant tensile force required to restrain the plug before plug inflation and during plug removal. Provide calculations of the required inflation pressure of the plug. Calculations must be sealed and signed by a professional Engineer licensed in the state of Texas in civil or mechanical Engineering.
- Detail the plug selection for each installation including given conditions, pipe size and anticipated pressure requirements. Include in this plan whether sleeves will be used.
- Provide an inspection form detailing manufacturer's recommendations for plug inspection of plug condition before and after use; form to be signed by Contractor staff responsible for plug installation before and after plug installation.

- Provide a monitoring plan for observing the plug inflation pressure gauge and hoses. Monitoring must be for 24 hr. per day during the plug use duration. Provide a written response plan for when the plug loses pressure. Provide a plug retrieval plan.
- Provide means and methods for anchoring, support and bracing appropriate for anticipated operating pressure conditions. Size restraint (cable or chain) based on calculated loads using a safety factor of 4. Provide multiple tie-off locations for chain or wire cable restraint. Rope of any kind is not an acceptable material for plug restraint.
- Provide manufacturer's literature on proper plug use and safety precautions, including available on-line training.

2.20.2. Equipment and Materials. The Contractor must provide all necessary pumping equipment, piping and all other necessary appurtenances in order to maintain adequate and reliable sanitary sewer flow in the sanitary sewer system (including any temporary manholes) at all times during construction for stationary pumping and flow diversion bypass pumping systems. All materials, equipment, etc., must be in good condition, and should not have visible damage such as cracks, holes, foreign material, blisters, etc.

Plugs must be selected and installed according to the size of the line to be plugged. Plugs must be adequately secured and anchored to prevent plug movement or escape into the adjoining sanitary sewers should the plug fail. All plugs must be equipped with a radio transmitter that will be used to locate any plug that has escaped in the adjacent system. The radio transmitter must be designed for environment that it will be installed. The Contractor must also provide and keep on site the matching radio receiver that will be used to locate any plug that is lost in the adjacent system.

An additional plug (for each size of plug used) must be onsite and ready to be installed in the event a plug fails or becomes dislodged. Plugs will be reviewed by the Inspector or Engineer for defects that might lead to failure before being installed. Contractor must immediately locate and remove any plug that has shifted its position, slipped within the pipe, dislodged, moved, or otherwise provided an indication that its suitability for use in plugging may be suspect or compromised. Contractor must notify SAWS of any plug that has provided an indication that its suitability for use in plugging may be suspect or compromised and allow SAWS to observe plug removal and replacement. It is also imperative that the Contractor notify the Inspector at the completion of the work in order to verify that all plugs have been removed from the system.

- The Contractor must provide all necessary equipment, plugs, hoses, gauges and necessary appurtenances to install the plug, maintain the plug during use and remove the plug at completion.
- All plugs must be in good condition, and must not have visible damage such as cracks, holes, tears, cuts, punctures, abrasions, loose or damaged fittings, cracks in castings and excessive wear.
- All plugs 15 in. and larger must have an air release valve for rupture protection.
- All plugs 24 in. in diameter and larger must be equipped with a radio transmitter locating device that is activated by the plug losing air pressure. The locating transmitter device must be effective to a depth of 65 ft, and have a battery life of 1,000 hr. when operated in pulse mode after activation.
- All plugs 24 in. in diameter and larger must have a protective sleeve.
- If the plug is damaged, do not use the plug and remove it from the jobsite.
- Contractor must be aware of the limitations associated with plugs.

Stationary bypass pumping systems must consist of:

- High-Density Polyethylene (HDPE) is the required pipe material for all bypass piping. HDPE must be used when bypass discharge pipe will be going through streams, storm water culverts, the Edward's Aquifer Recharge Zone, environmentally sensitive areas, and all other locations.
- HDPE pipe must be assembled and joined using couplings, flanges or fusion welding in order to avoid joint leakage. SAWS must be notified in enough time to allow them to inspect the pipe joints during assembly. SAWS must be notified a minimum of 48 hr. in advance of all fusing/joining operations

- HDPE fusion welding must be performed by personnel certified as fusion technicians by the manufacturer of HDPE pipe or fusing equipment. SAWS will examine welds before use in BPP operation.
- BPP must indicate the proposed DR of the pipe to be used.
- Any hoses or pipes that leak must be removed and replaced with non-leaking hoses or pipes.
- Neither "Irrigation type" pipe nor glued PVC pipe will be permitted.
- Disinfect and drain the entire BPP system in accordance with approved submittal.
- Pumps must be fully automatic self-priming units that do not require the use of foot-valves or vacuum pumps to prime the system. No electric pumps will be allowed; all pumps must be diesel powered. Contractor must provide suitable spill control and containment measures to avoid environmental contamination by pumps, fuels, or lubricants. All pumps must be open impeller solids handling type pumps, capable of passing a minimum of 3 in. diameter solids. Contractor must have one backup pump, equal in capacity to the largest pump in the system, connected into the bypass pumping system, and ready for operation in case any of the primary pumps fail. The backup pump must not be used in Contractor's calculations for determining the pumping capacity requirements for the stated flow conditions above. Sound-attenuated pump enclosures will be required on all projects where the bypass pumps are located within 50 ft. of any residence, business, park, or other presence of people. Contractor must provide enough sound attenuation measures to comply with City of San Antonio noise limitation requirements.

2.21. Reconstruction of Sanitary Sewer by Pipe Bursting Replacement Process. The pipe bursting process involves the replacement of deteriorated gravity sewer pipe by installing a new sanitary sewer pipe within the burst/enlarged excavation of the existing sewer created using a static, hydraulic, or pneumatic hammer bursting head device, suitably sized to break the existing sewer main. Forward progress of the bursting head is aided by hydraulic equipment or other apparatus. The new replacement pipe is attached to the back of the bursting head and is pulled into the excavation during the bursting process. The Contractor must provide equipment, planning, and job execution necessary to accomplish the work in an efficient manner and consistent with the objectives of these specifications, including preventing damage to existing infrastructure, maintaining pedestrian and vehicular access, and providing continual sewer service to customers.

2.21.1. High Density Polyethylene Pipe (HDPE). High Density Polyethylene Pipe (HDPE) related to pipe bursting or pipe crushing for a sanitary sewer or related pipe line rehabilitation:

Solid wall HDPE pipe that is in conformance with ASTM F714 and ASTM requirements stated herein. HDPE pipe will further be required to have a minimum pipe stiffness of 46 psi for 12 in. to 48 in. diameter pipe and 115 psi for 8 in. to 10 in. diameters as required by SAWS and TCEQ.

2.21.2. Pipe Manufacturer. All pipe and fittings will be high density polyethylene pipe and made of virgin material. No re-work except that obtained from the manufacturer's own production of the same formulation will be used. The liner material will be manufactured from a High Density High Molecular weight polyethylene compound which conforms to ASTM D 1248 and meets the requirements for Type III, Class C, Grade P-34, Category 5, and has a Plastic Pipe Institute rating of PE 3408.

The pipe produced from this resin will have a minimum cell Classification of 345434C (Inner wall will be light in color) under ASTM D 3350. A higher number cell classification limit which gives a desirable higher primary property, per ASTM D 3350 may also be accepted by the Engineer at no extra cost to SAWS. The value for the Hydrostatic Design basis will not be less than 1600 psi (11.03 MPA) per ASTM D 2837. Pipe will have ultraviolet protection.

2.21.3. Pipe Color and Quality. For television inspection purposes, the polyethylene pipe will have light-colored interior achieved with a homogenous, light-colored material throughout or with a fully bonded light-colored interior liner meeting specifications indicated above. All pipe will be free of visible cracks, holes, foreign material, foreign inclusions, blisters, or other deleterious or injurious faults or defects. Pipe and fittings must be as uniform as commercially practical in color, opacity, density, and other physical properties.

For interior lined pipe, the liner will be a minimum of 10 mils thick and co-extruded. The bond between the layers will be strong and uniform. It will not be possible to separate the two layers with a probe or point of a knife blade so that the layers separate cleanly at any point, nor will separation of the bond occur, between layers, during testing performed under the requirements of this specification.

2.21.4. Pipe Diameter. Polyethylene Plastic Pipe will meet the applicable requirements of ASTM F 714 Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter, ASTM D 1248, and ASTM D 3550. Internal diameter of the pipe indicated on the plans will be the minimum allowable pipe size.

2.21.5. Pipe Dimension Ratios. The minimum wall thickness of the polyethylene pipe will meet the following requirements in Table 2 as based on the deepest portion of a particular pipe pull, typically between manholes:

Table 2
Minimum Pipe Wall Thickness

Depth of Cover (ft.)	Minimum SDR of Pipe
0-16.0	19
>16.1	17

Wall thickness must be as indicated on the plans and will be in accordance with manufacturer.

2.21.6. Force Mains. Where applicable, solid wall pipe for sanitary sewer force mains must have a minimum working pressure rating of 150 psi, and an inside diameter equal to or greater than the nominal pipe size indicated on the Drawings.

2.21.7. Augering Pipe. HDPE pipe is not approved in applications requiring auguring of sewer pipe.

2.21.8. Pipe Marking. Each standard and non-standard length of pipe or fitting must be clearly marked with pipe size, pipe class, production code, material designation and other relevant identifying information.

2.21.9. Pipe Inspections. The Engineer reserves the right to inspect pipes or witness pipe manufacturing. Such inspection will in no way relieve the manufacturer of the responsibilities to provide products that comply with the applicable standards and these Specifications. Should the Engineer wish to witness the manufacture of specific pipes, the manufacturer must provide the Engineer with adequate notice of when and where the production of those specific pipes will take place. Approval of the products or tests is not implied by the Engineer's decision not to inspect the manufacturing, testing, or finished pipes.

2.21.10. Acceptable Manufacturer. Vendors must have approval through SAWS Standards Committee before product use and must meet all requirements set forth in this Specification.

2.22. Sliplining. Sliplining sanitary sewer pipe is accomplished by pulling or pushing liner pipe into existing sewers by use of mechanical or hydraulic equipment. Once in place, liner pipe is allowed time to normalize and is then cut to fit between manholes. Annular spaces between liners and existing sewers are sealed at each manhole. Manhole inverts and benches are reworked and reshaped. Existing sewers remain in operation during slip lining process, with sewage flow diverted around operations in progress.

2.22.1. Manufacturers. Liner pipe systems must be fiberglass reinforces plastic (FRP) or T-Lock Liner concrete pipe, as approved by the SAWS.

Acceptable manufacturer for FRP liner pipemust conform to the current Standard Material Specifications accepted by SAWS. Please see the SAWS website for a list of approved FRP pipe manufacturers - http://www.saws.org/business_center/specs/product_submittal/.

Acceptable manufacturer for Amer-Plate T-Lock pipe: Ameron Protective Linings.

2.22.2. FRP Liner Pipe and Fittings. Pipe, joint and fitting; ASTM D 3262 Type 1, Liner 2, Grade 3.

FRP Liner Pipe: Reinforced plastic mortar pipe manufactured by centrifugal casting process resulting in dense, nonporous, corrosion-resistant, consistent, composite structure. Minimum Stiffness: 72 psi, measured in accordance to ASTM D2412. Use with a stiffness of 72 psi where specified or shown on the drawings.

Resin Systems: Thermosetting polyester epoxy resin, with or without filler, meeting ASTM D3262.

Reinforcing Glass Fibers: Commercial Grade E-type glass filaments, with binder and sizing compatible with impregnating resins.

Filler: Sand with at least 98% silica content, and maximum moisture content of 0.2%.

Joints: Low-profile FRP jacking bell-and-spigot joints or flush bell and spigot joints, with elastomeric sealing gaskets for watertight joints meeting ASTM D4161.

Dimensions and Tolerances:

- Pipe outside diameters and tolerances: Comply with ASTM D3262, Cast Iron Pipe Equivalent Outside Diameters, and Table 3 below.
- When possible, supply pipe in nominal lengths of 20 ft. Where radius curves in existing pipe or limitations in entry pit dimensions restrict pipe length, shorter lengths may be used. Engineer must first approve of all proposed pipe joints that are shorter than 20 ft.
- FRP pipe minimum outside diameters and minimum wall thickness as shown in Table 3:

Table 3
FRP Diameter and Thickness

Minimum Existing Sewer Nominal Diameter	Minimum Wall Liner O.D.	Minimum Wall Thickness 46 psi Stiffness	Thickness 72 psi Stiffness
(in.)	(in.)	(in.)	(in.)
21	19.50	0.42	0.48
24	21.60	0.46	0.53
30	25.80	0.54	0.63
36	32.00	0.66	0.77
42	38.30	0.78	0.91
48	44.50	0.90	1.05
54	50.80	1.02	1.19
60	57.10	1.14	1.33
66	62.90	1.26	1.47
72	69.20	1.38	1.61
78	75.40	1.50	1.75

- Fabricate pipe ends square to pipe axis plus or minus 0.25 in., or plus or minus 0.5% of nominal diameter, whichever is greater.
- Flanges, elbows, reducers, tees, wyes, and other fittings: Capable of withstanding operating conditions.
- Fabrication: Contact-molded or manufactured from mitered sections of pipe joined by glass-fiber-reinforces overlays.

2.22.3. Liner Pipe Seals at Manholes. Sealer for annular spaced between liner pipes and host sewers at manholes: Oakum strips soaked in Scotchseal 5600 as manufactured by 3M Corporation, or approved equal.

Non-Shrink Grout: Strong Seal's QSR patching material or approved equal.

2.22.4. Clamps and Gaskets. Clamps: Stainless steel, including bolts and lugs, as manufactured by JCM Industries, Type 108, or equal. Furnish full circle, universal clamp couplings with at least 3/16 in. thick neoprene grid-type gaskets. Select clamps to fit outside diameter of liner pipe as follows in Table 4.

Table 4
Clamp Length

Liner Pipe O.D. (in.)	Minimum Clamp Length (in.)
7.125	15
8.625	18
10.750 or greater	30

2.22.5. Bedding Material. Make point repair and remove obstructions, such as roots, rocks and other debris, before installing liner pipe. Comply with excavation, trenching, and backfill requirements of this specification.

2.23. Sliplining Grout. Slip-lining grout is installed in the annular space between the sliplining pipe and the host sewer. Completely fill the annular space without deflecting the pipe. Test grout equipment and procedures in accordance with approved submittals. Perform testing on the first pipeline segment to be grouted. Testing must be performed under observation by the Inspector. If the grout does not totally fill the annular space, adjust the procedure or the mix, and rerun the test on the first pipeline segment.

2.23.1. Manufacturers/Application. The applicator of the grout mix must be certified by the grout mix manufacturer and approved by the SAWS Engineer. The certified applicator must be regularly engaged in the placement of grout, including completion of pipeline grouting installations with at least 1,000 cu. yd. in the past 3 yr.

2.23.2. Materials.

2.23.2.1. Cement. Comply with ASTM C150. Pozzolans and other cementitious materials are permitted.

2.23.2.2. Fly Ash. Comply with ASTM C618; either Type C or Type F must be used.

2.23.2.3. Sand. If provided, conform to ASTM C144, except as modified in Table 5 below:

Table 5
Sand Gradation

U.S. Standard Sieve Size	% Passing By Weight
No. 16	100
No. 30	60 – 85
No. 50	10 – 35
No. 100	5 – 25
No. 200	- 10

2.23.2.4. Water. Use potable water free from deleterious amounts of alkali, acid, and organic materials which would adversely affect the setting time or strength of the sliplining grout.

2.23.2.5. Admixtures. Admixtures should be selected by the sliplining grout manufacturer to meet performance requirements, improve pumpability, control set time and reduce segregation.

2.23.2.5.1. Compressive Strength. The grout must have a minimum penetration resistance of 100 psi in 24 hr. when tested in accordance with ASTM C 403 and a minimum compressive strength of 300 psi in 28 days when tested in accordance of ASTM C495 or C109.

2.23.2.5.2. Performance Requirements. The Contractor must submit the proposed grout mixes, methods, plans and criteria of the grouting operations. The grouting system must have enough gauges, monitoring devices, and test to determine the effectiveness of the grouting operation and to ensure compliance with the liner pipe specifications and design parameters.

2.23.2.5.3. Mix Designs. One or more mixes must be developed to completely fill the annular space based, but not restricted to, the following requirements:

- Size of annular void
- Void (size) of the surround soil
- Absence or presence of groundwater
- Enough strength and durability to prevent movement of the line pipe.
- Provide adequate retardation, and
- Provide less than 1% shrinkage by volume.

2.23.2.5.4. Density/Viscosity. The Contractor must design a grout mix with a density to prevent floating of the liner pipe. The apparent viscosity must not exceed 20 seconds in accordance with ASTM C939 unless otherwise approved by the SAWS Engineer.

2.24. Bedding and Backfill. Backfilling for sanitary sewers is divided into three (3 separate zones: (a) bedding: the material in trench bottom in direct contact with the bottom of the pipe; (b) initial backfill: the backfill zone extending from the surface of the bedding to a point 1 foot above the top of the pipe; and (c) secondary backfill: the backfill zone extending from the initial backfill surface to the top of the trench. Materials and placement for each of the zones must be as described herein.

2.24.1. Bedding.

2.24.1.1. Stable Material. Existing stable material present during excavation including:

Trench bottom free of water, muck, debris;

Rock in boulder, ledge or coarse gravel (particle size not larger than 1- 3/4 inch) formations;

Coarse sand and gravels with maximum particle size of 1-3/4 inch, various graded sands and gravels containing small percentages of fines, generally granular and non-cohesive either wet or dry; and

Fine sands and clayey gravels; fine sand, sand-clay mixtures, clay and gravel-clay mixtures.

2.24.1.2. Unstable Material. Existing unstable materials are: Silt, muck, trash or debris in the trench bottom bearing level; rock, in ledge or boulder, or coarse gravel (minimum particle size larger than 1- ¾ inch) formations.

2.24.1.3. Bedding Material. The existing material at the bearing level must be removed and replaced to a minimum depth of 6 in. or 1/8 of the outside diameter of the pipe, whichever is greater, with bedding material. The bedding material must extend up the sides of the pipe enough to embed the lower quadrant of the pipe. The bedding material must be composed of well-graded, crushed stone or gravel conforming to the requirements of Table 6 unless modified by the Engineer in writing.

Table 6
Gravel Gradation

Sewer Gravel 100	%Passing 1-1/2 in. sieve
Passing 1 in. sieve	95 – 100
Passing 1/2 in. sieve	25 – 60
Passing No. 4 sieve	0 – 10
Passing No. 8 sieve	0 – 5

2.24.2. Over Excavation. Where the trench bottom has been over excavated beyond the limits as defined in Item No. 848, "Sanitary Sewers," due to removal of unstable material, the pipe must be concrete-encased. Encasement must extend from the trench wall to trench wall and be a minimum of 6 in. above the top of pipe. No separate pay item.

2.24.3. Reduced Excavation. Where the trench bottom is not excavated in accordance with the specification due to rock or other hard under lying materials, then the pipe must be concrete encased. No separate pay item.

2.24.4. Consolidating Backfill Material. The Initial Bedding material must be consolidated to assure it is incorporated from the bottom of the trench up to the pipe centerline. A hand-held vibrator, commonly used for concrete work, can be used for this purpose. The vibrator must be inserted every 3 ft. on each side of the pipe.

2.24.5. Initial Backfill. Initial backfill is defined as backfill with a thickness in its compacted state from the surface of the bedding to a point 1 ft. above the top of the pipe.

Initial backfill must consist of gravel which conforms to the requirements for bedding material.

2.24.6. Secondary Backfill. Secondary backfill is defined as backfill from 1 ft. above the top of the pipe to the top of the trench or bottom of pavement section. Secondary backfill must be constructed in accordance with details shown in the construction documents.

Secondary backfill must generally consist of materials removed from the trench and must be free of brush, debris and trash. Rock or stones with a dimension larger than 6 in. at the largest dimension must be sifted out and removed before the material is used in the secondary backfilling zone. Secondary backfill material must be primarily composed of compactible soil materials.

2.25. Grouting of Sewer Mains.

2.25.1. Submittals.

- Proposed Mix Design Report for grout
- Submit manufacturers data for proposed plugs and detail of bulkhead
- Technical information for equipment and operations procedures including projected injection rate, grout pressure, method of controlling grout pressure, bulkhead and vent design and number of stages of grout application.
- Submit project specific plan for abandonment at least 15 days before commencing grouting activities, describe proposed sequence, access points and other information pertinent for completion of Work.

2.25.2. Materials.

- Cement-based grout/flowable fill with self-leveling and non-shrink characteristics.
- Unconfined compressive strength: Minimum 100 psi at 56 days as determined based on average of three tests for same placement. Present at least three acceptable strength tests for proposed mix design in mix design report.

3. CONSTRUCTION

3.1. Excavation. Excavation as required to complete the work as outlined herein will be performed in accordance with Item 400, “Excavation and Backfill for Structures.”

3.1.1. Trench Excavation Protection. Excavation greater than 5 ft. in depth is to be protected as specified in Item 402, “Trench Excavation Protection,” or Item 403, “Temporary Special Shoring.”

3.1.2. Trench Excavation Protection must be applied to all protections and shoring for excavations where the width of a trench or excavation is not greater than 15 ft. (measure at the bottom of the excavation). If forms or other structures are installed or constructed in an excavation so as to reduce the dimension measured from the forms or structure to the side of the excavation to 15 ft. or less (measure at the bottom of the excavation), the excavation is also considered to be a trench. All required shoring for Jacking, Boring and Receiving pits will be paid under Section 3.1.1. “Trench Excavation Protection.” In addition, “Trench Excavation Protection” will not be limited to these applications but may be used whenever deemed expedient and proper to ensuing work.

3.1.3. Trenches. Trench walls must be vertical. The practice of undercutting at the bottom or flaring at the top will not be permitted except where it is justified for safety or at the Engineer’s or Inspector’s direction. In special cases, where trench flaring is required, the trench walls must remain vertical to a depth of at least 1 ft. above the top of the pipe.

The trench bottom must be square or slightly curved to the shape of the trenching machine cutters. The trench must be accurately graded along its entire length to provide uniform bearing and support for each section of pipe installed upon the bedding material. Bell holes and depressions for joints must be dug after the trench bottom has been graded and bedding installed. The pipe must rest upon the new bedding material for its full length.

Where over-excavation occurs and when not as directed, the under-cut trench must be restored to grade at no cost to SAWS by replacement with a material conforming to the requirements of the bedding material or a material approved by the Engineer.

3.2. Width of Trench.

Minimum Width of Trench. The minimum width of pipe trenches, measured at the crown of the pipe, must be not less than 12 in. greater than the exterior diameter of the pipe, exclusive of bells. The minimum base width of such trench must be not less than 12 in. greater than the exterior diameter of the pipe, exclusive of special structures or connections. Such minimum width must be exclusive of trench supports and not greater than the width at the top of the trench.

Maximum Width of Trench. The maximum allowable width of trench for pipelines measured at the top of the pipe must be the outside diameter of the pipe (exclusive of bells or collars) plus 24 in. A trench wider than the outside diameter plus 24 in. may be used without special bedding if the Contractor, at his expense, furnishes pipe of the required strength to carry additional trench load. Such modifications must be submitted to the Inspector and approved in writing. Whenever such maximum allowable width of trench is exceeded, except as provided for in the contract documents, or by written approval of the Engineer, the Contractor, at his expense, must encase the pipe in concrete from trench wall to trench wall, or with other approved pipe bedding material. Any excavation wider than this maximum width or subsequent surface or paving work, will be done at the Contractor's expense.

3.2.1. Classification of Excavated Materials. No classification of excavated materials will be made. Excavation and trench work is to include the removal and subsequent handling of all materials excavated in accordance with Item 400, "Excavation and Backfill for Structures."

3.2.2. Grade of Trench Bottom. The trench is to be over-excavated to a depth of 6 in. below the grade line established for the bottom of the pipe, regardless of the type of pipe. The grade line of the pipe is to then be met by the addition of a layer of approved bedding material as directed.

3.2.3. Excavation Below Grade. Any part of the bottom of the trench excavated below the limits specified in Section 3.2.2., "Grade of Trench Bottom," is to be corrected with approved material and compacted as directed. Should excessive over-excavation occur, except at bell holes, the grade is to be restored in accordance with the methods described in Section 3.2.4., "Unstable Conditions at Grade," at no cost to the Department.

3.2.4. Unstable Conditions at Grade. Where the bottom of the trench at grade is found to be unstable or to include ashes, cinders, any type of refuse, vegetable or other organic material, or large pieces of fragments or inorganic materials which in the judgment of the Engineer should be removed, the Contractor is to excavate and remove such unsuitable material to a depth at least 6 in. below the pipe. Before the pipe is laid, the grade is to be restored by backfilling with an approved material in layers of 3 in. before compaction. The layers are to be slightly moistened and thoroughly compacted so as to provide a uniform and continuous bearing and support for the pipe at every point between bell or collar holes. The finished grade is to be accurately graded to provide uniform bearing and support for each section of pipe at every point along its entire length except for the portions of the pipe sections where it is necessary to excavate for bell holes and for the proper seating of pipe joints.

3.2.5. Caution in Excavation. The Contractor is to proceed with caution in the excavation and preparation of the trench so that the exact location of underground structures and utilities may be determined whether shown on the plans or not. Machine excavation is not permitted closer than 12 in. on either side of other existing underground utilities. The Contractor is to be responsible for the repair of such structures and utilities when

broken or damaged. He is also to be responsible for adjusting alignment and trench grades with reference to such structures to obtain specified clearance for the sewer main construction.

Whenever the Engineer determines that it is necessary to explore and excavate to determine the location of existing underground structures and utilities, the Contractor is to make explorations and excavations for such purposes at his expense. Backfill Material Derived from Excavation.

Any excess excavated material, not used after all fill requirements have been met, will become the responsibility of the Contractor. The Contractor must dispose of it by hauling and wasting outside the limits of the rights-of-way or easements of this project and of public thoroughfares and water courses, in conformity with pertinent City, County, State and Federal codes and ordinances and in a manner meeting the approval of the Engineer.

3.2.6. Trench Surface Restoration. The surface of the backfilled trench must be restored to match the previous existing conditions. This will include final grading, placement of topsoil and seeding, placement of sod (such as at homes or businesses that had maintained grass), or other unprepared and prepared surfaces.

Trenches in alleys actively being used by vehicles (such as trash pickup, vehicle parking, etc.) must be restored by grading and compacting to 98% or higher with a minimum of 4 in. of flex base materials for the entire width of the alley. Asphaltic materials must have a compaction density of 95%. Alleys not actively used by vehicles must be graded and compacted to 98% or higher from the top of the initial backfill to the bottom of the pavement section, then spread grass seed for entire width of the alley.

Trenches in paved streets must be covered with a temporary all weather surface to allow for vehicular traffic until the final asphalt/concrete paving is complete. This surface must be a minimum of 4 in. compacted and rolled asphaltic black base, either hot-mix or cold-mix applied. It is the Contractor's responsibility to maintain this surface until the final street restoration is complete. Temporary street striping may also be required. This surface must be removed before final asphalting.

All street work must be done in accordance with the latest Department specifications. Included in this requirement is replacement of any curbs or sidewalks damaged or removed during the construction.

No separate payment for the surface restoration is permitted. The cost for this work must be included in the appropriate bid item.

3.2.7. Pavement. The Contractor is to remove pavement and surfaces as a part of the trench excavation. The removal of pavement and surfaces and their restoration is to be based on the minimum trench widths as specified, plus 6 in. either side or as otherwise provided herein. The Contractor is to use such methods as sawing, drilling, or chipping to assure the breaking of the pavement along straight lines.

If the Contractor removes or damages pavement or surfaces beyond the limits specified above, such pavement and surfaces are to be restored at the expense of the Contractor.

Where water line construction necessitates cutting through existing streets outside the limits of new street construction, said streets are to be replaced in kind as directed. Where, in the opinion of the Engineer, it is necessary to maintain traffic across a trench, the Contractor is to install temporary metal bridges as necessary to facilitate the movement of traffic.

The street surface adjacent to the trench is to be kept free of surplus spoil. Construction materials are to be placed at locations that will minimize interference with the traveling public.

3.2.8. Concrete Sidewalks, Driveways, Etc. All concrete sidewalks, driveways, etc., are to be cut with a concrete saw. When transverse expansion or "dummy" joints are encountered, the concrete is to be removed to the nearest transverse joint on each side of the trench and restored. The depth of cut is to be such that upon removal of the concrete, the sides of the cut are to be straight and square.

Existing reinforcing wire fabric or bars are to be cut and removed to permit completion of trench excavation, pipe laying, and backfill operations. When the backfill operations have been completed, the existing reinforcement is to be replaced in its original position and satisfactorily spliced before the replacement of concrete over the new trench alignment.

Transverse expansion joints are to be made by a jointing tool or other means acceptable, and are to match in depth and thickness in the existing transverse joints.

Expansion joint material is to be provided where new construction abuts the existing curb or driveway if the Engineer deems it necessary.

Concrete is to be spaded, tamped, and thoroughly compacted until mortar entirely covers the surface and has a monolithic finish. The top surface is to be floated, troweled, and finished to match the existing concrete surface.

Immediately after finishing, the concrete surface is to be protected by a membrane compound curing agent, or by wetted cotton or burlap mats. Either method is to be subject to approval.

3.2.9. Dewatering. Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding areas.

The Contractor must not allow water to accumulate in excavations or at subgrade level. Remove water to prevent softening of foundation bottoms and soil changes detrimental to stability of subgrades and foundations. Provide and maintain dewatering system components necessary to convey water from excavations.

Convey water removed from excavation and rainwater to collecting or runoff areas away from buildings and other structures. Establish and maintain temporary drainage ditches and other diversion outside excavation limits. Do not use trench excavations as temporary drainage ditches.

Dewatering devices must be provided by the Contractor with filters to prevent the removal of fines from the soil. Should the pumping system draw fines from the soil, the Engineer will order immediate shutdown, and remedial measures will be responsibility of the Contractor.

Upon completion of the dewatering work, the Contractor must remove all equipment and leave the construction area in a neat, clean, condition that is acceptable to the Owner.

The Contractor must maintain ground water table at least 12 in. below the finished excavation subgrade.

Performances of the dewatering system for lowering ground water should be measured by observation wells on piezometers installed I conjunction with the dewatering system, and these must be documented at least daily. The Contractor must maintain a log of these readings and submit them to the Owner.

No direct payment will be made for costs associated with dewatering. All costs in connection therewith should be included in the applicable contract price for the item to which the work pertains.

3.2.10. Bedding and Backfill.

3.2.10.1. General. Trenches must not be backfilled until the construction structures or appurtenances, as installed, conform to the requirements specified. Where specified, only the secondary backfilling may incorporate excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand and gravel, soft shale or other approved materials, free from large clods of earth or stones. Where pipe is specially coated, sleeve wrapped, or tape wrapped for protection against corrosion, care should be taken not to damage the coating, sleeve wrap, or tape wrap.

Where a trench has been improperly backfilled, or where settlement occurs, the identified section must be excavated to a depth and length 50 ft. beyond the failed area, then refilled and compacted to the grade and compaction level required. The use of sand backfill will not be allowed. All compaction within the secondary backfill zone will be such that the apparent dry density of each layer must be not less than 98% from the top of the initial backfill to the bottom of pavement section. The pavement (asphalt) section must have 95% compaction density with a maximum dry density at + or – 2% optimum moisture content as determined by tests on samples as outlined in the latest provisions of TX-DoT Testing Method TEX 113-E or most applicable approved equal provisions, unless otherwise shown on the contract documents. At the time of compaction, the water content must be at optimum moisture content, + or - 2% points.

3.2.10.2. Initial Backfill. Before laying the pipe, the normal or select bedding material will be shaped to conform to the outside diameter of the pipe as shown on the plans. Bedding material must be consolidated to assure it is incorporated from the bottom of the trench up to the pipe centerline. A hand-held vibrator, commonly used for concrete work, can be used for this purpose. The vibrator must be inserted every 3 ft. on each side of the pipe.

For sewer lines up to 24 in. in diameter initial backfill material must be placed in two lifts above the bedding material the pipe is set on. The first lift must be spread uniformly and simultaneously on each side and under the bottom quadrant of the pipe to the midpoint or spring line of the pipe. Consolidate the Initial Backfill material as specified for bedding.

Placement of the first lift of initial backfill will be subject to inspection and approval before placement of second lift, which must extend from the spring line of the pipe to a minimum of 1 ft. above the top of the pipe. The second lift must be evenly spread in a similar manner as the first lift.

For diameters 24 in. and larger, initial backfill material must be evenly and simultaneously spread alongside, under the lower quadrant the pipe and over the pipe in 12 in. lifts to a point enough to a minimum of 1 ft. above the top of the pipe. Consolidate the Initial Backfill material as specified for bedding.

3.2.10.3. Secondary Backfill. The secondary backfill material must be placed in maximum 12 in. loose lifts or as directed by the Design Engineer or Inspector.

3.3. Pipe Installation.

3.3.1. General. All sanitary sewer mains must be constructed in accordance with the specifications herein outlined and in conformity with the required lines, grades, and details shown on the plans and as directed. Successful passage of the air and mandrel test (for flexible pipe, 30 days after installation), as described under TCEQ Criteria, will be required for the acceptance of the mains.

3.3.2. Water Main Crossings. Where gravity or force main sewers are constructed in the vicinity of water mains, the requirements of the TCEQ 30 TAC 217.53 must be met.

3.3.3. Pipe Installation. The Inspector will inspect all pipe before it is placed in the trench and will reject any sections found to be damaged or defective to a degree that would affect the structural integrity of the pipe. Rejected pipe must be immediately removed from the site of the work and replaced with new acceptable pipe. The Contractor must commence installation of the pipe at the downstream end of the sanitary sewer line and proceed nonstop in a forward upstream direction. No pipe should be laid within 10 ft. of any point where excavation is in progress. Pipe installation should precede upgrade with the bell pointing in the upstream direction of flow. Pipe must be lowered into the trench without disturbing the prepared foundation or the trench sides. The drilling of lifting holes in the field will not be permitted. Pipe must be installed by means of a concentric pressure being applied to the pipe with a mechanical pipe puller. Pulling or pushing a joint of pipe in place by using a crane, bulldozer, or backhoe will not be permitted. Pipe must be “pulled home” in a straight line with all parts of the pipe on line and grade at all times. No side movement or up and down movement of the pipe will be permitted during or after the pulling operation. Should coupled joints of pipe be out of line or off grade, they must be removed one joint at a time in the presence of the Inspector and brought to the proper line and grade. The lifting or moving of several joints of coupled pipe at one time to close a partially open joint or to fine grade under laid joints of pipe will not be permitted. Also, Contractor

must ensure that all existing or proposed manholes or structures must remain visible and accessible at all times. No manhole or structure covers must be covered by pavement, equipment, or other obstructions other than a removable, temporary lid provided for safety. Inspector will cause all work to be suspended until this requirement is met without any valid claims of costs or schedule delays.

3.3.4. Laser Beams. The use of laser Beams for vertical control will be required provided the Contractor makes available to the Inspector, when requested, a level and rod of enough sensitivity to accurately determine differences in elevation between points 300 ft. apart with one instrument set-up. Contractor must provide a written summary to the Inspector of all elevations that all installed, repaired, or replaced sewer main enter and exit a manhole or structure.

No pipe should be installed in tunnels except as provided on the plans, or with the permission of the Engineer. If the Contractor finds it necessary to install pipe in tunnels not provided on the plans, he must submit to the Engineer, before commencement of work, a detailed outline of procedures, methods, and use of materials depending on existing soil conditions.

No horizontal or vertical curves will be permitted in conformance with appropriate regulatory agency requirements.

Before leaving the work unattended, the upper ends of all pipelines must be securely closed with a tight fitting plug or closure. The interior of laid pipe must be kept free from dirt, silt, gravel, or foreign material at all times. All pipes in place must be approved before backfilling.

When replacing an existing system in place, Contractor must maintain screens to prevent the entrance of construction debris into the sewer system.

3.3.5. Sanitary Sewer Laterals. Sanitary sewer laterals, fittings and appurtenances must conform to these specifications and must be installed by the Contractor as specified herein, or as directed by the Construction Inspector or the Engineer and in accordance with the plans. Where the lateral is within the Edwards Aquifer Recharge Zone then it must be installed in accordance with details.

3.3.5.1. Designation of Lateral. A sewer pipe located between the sanitary sewer main and the customer's premise, is designated as a "sanitary sewer lateral."

3.3.5.2. Lateral Installation. All service line installations must be performed in accordance with this specification. For sanitary sewer mains that are 12 in. in diameter or smaller, all laterals must be connected using the appropriate size tee or wye placed in line with the main line. For mains larger than 12 in., insert a tee conforming to ASTM 3034-88 or approved or equal may be used. Where waterline crossings with sanitary sewer laterals are less than the regulated separation distances, all lateral piping must be SDR-26 PVC pipe (ASTM D 2241-09) with a pressure rating of 150 psi.

Connection to the customer's end of the lateral must be performed using a flexible coupling, or pre-approved equal. All flexible couplings must be concrete-encased to prevent movement or breakage of the steel bands. All cleanouts at jobsites must have installed an approved heavy duty sanitary sewer cap.

Cutting, excavation, and backfill will be as specified herein.

3.3.6. Fiberglass Reinforced Pipe for Large Diameter Gravity Sanitary Sewer Installation. All sanitary sewer mains must be constructed in accordance with the specification herein outlined and in conformity with the required lines, grades, and details shown in the contract documents and as directed.

3.3.6.1. Quality Control. All project pipes must be provided by a single manufacturer. Only the pipe and fittings that will be installed during a single work day will be allowed to be stored within the barricaded work area. Pipe manufacturing operations must be performed under the control of the manufacturer. All pipe furnished must be in conformance with this Specification and ASTM D 3262.

3.3.6.2. Delivery of Materials. Provide adequate stulling during transport to prevent damage to the pipe, fittings and appurtenances in accordance with manufacturer's recommendations.

3.3.6.3. Storage Requirements. Gravity pipe must be stored and handled in accordance with the manufacturer's guidelines or Engineers recommendations.

All products must be stored above the ground upon platforms, pallets, skids, or other supports supplied by the Contractor and approved by SAWS. Products must be kept free from dirt and other foreign matter.

All products must be stored to permit ready access for identification and inspection by the Inspector.

If new pipe and fittings become damaged before or during installation, it must be repaired as recommended by the manufacturer or replaced as required by the Engineer at the Contractor's expense, before proceeding further. Deliver, store, and handle other materials as required to prevent damage.

Pipe laid directly on the ground must be placed on an area free of loose stones or sharp objects in accordance with manufacturer's recommendations and approved by the SAWS.

3.3.6.4. Pipe Handling.

The Contractor must abide by the required handling techniques specified by the Manufacturer.

The Contractor must provide suitable quantities of all lifting equipment to handle the pipe. In no case will any equipment be used that is not rated to handle the intended loading or conditions of use to which it will be subjected, or which will damage or gouge the pipe.

Dragging or dropping the pipe will not be allowed.

Haul and distribute pipe and fittings at the project site.

Handle piping with care to avoid damage.

Inspect each joint of pipe and reject or repair any damaged pipe before lowering into the trench.

Use only nylon ropes, slings or other lifting devices that will not damage the surface of the pipe for handling pipe.

3.3.6.5. Pipe Installation.

Engineer or Inspector may request to inspect pipe before installation.

Install pipe, fittings, specials and appurtenances as specified herein, and in accordance with the pipe manufacturer's recommendations or Engineers requirements.

Must follow manufacture recommendation for initial and bedding.

Lay pipe to the lines and grades as indicated on the Plans. Clean ends of pipe and coupling components. Apply manufacturer approved joint lubricant to pipe ends and to the elastomeric seals of coupling. Use suitable equipment and end protection to push or pull the pipes together, applying a uniform seating force across the entire pipe and coupling circumference. Do not exceed forces recommended by the manufacturer for coupling pipe. Join pipes in straight alignment then deflect to required angle. Do not allow the deflection angle to exceed the deflection permitted by the manufacturer, and not more that 2-degrees unless approved by the Engineer. Excavate and backfill trenches in accordance with this specification.

Pipe Separation: Sewer pipe separation distances must be maintained in accordance with TCEQ rules 30 §217.53.

Laser Beams: The use of laser beams for vertical control will be required.

Contractor must also make available to the Inspector, when requested, a level and rod, of enough sensitivity, to accurately determine differences in elevation between points 300 ft. apart with one instrument set-up.

Contractor must provide a written summary to the Inspector of all elevations that all installed, repaired, or replaced sewer main enter and exit a manhole or structure.

No pipe should be installed in tunnels except as noted in the contract documents or by approval of the Engineer. If the Contractor finds it necessary to install pipe in tunnels not provided in the contract documents, he must submit to the Engineer a detailed outline of procedures, methods, and use of materials depending on existing soil conditions. This information requires review and approval before the commencement of work. Only SAWS Product Standards Committee approved pipe manufacturer will be allowed for tunneling.

No horizontal or vertical curves will be permitted in conformance with appropriate regulatory agency requirements.

Before leaving the work unattended, the upper ends of all pipelines must be securely closed with a tight-fitting plug or closure in accordance with manufacturers' recommendations and approved by the SAWS.

The interior of laid pipe must be kept free from dirt, silt, gravel, or foreign material at all times.

All pipes in place must be approved by the Inspector before backfilling.

All fabricated bends must be encased with reinforced concrete, with #4 Bars at 12 in. on center each way completely around pipe, approximately centered in the encasement thickness, and extending longitudinally one pipe diameter each direction along trench measured from the pipe interior bend point. Concrete encasement must extend across the full width of the trench to both trench walls. Encasement requirement may be waived by the Engineer if manufacturer certifies that fabricated bends have been designed and constructed to withstand all static and dynamic loads imposed by the service conditions

When replacing an existing system in place, Contractor must maintain screens to prevent the entrance of construction debris into the sewer system. Ensure properly temporarily connected or maintain continuous bypass.

At the close of each operating day, keep the pipe clean and free of debris, dirt, animals and trash – during and after the laying operation. Effectively seal the open end of the pipe using a gasketed night cap. When not temporarily connected. Cap must be in accordance with manufacturer's recommendations.

3.3.7. HDPE Pipe. Pipe and fittings must be thermal butt fusion, saddle fusion, or socket fusion according to manufacturer recommended procedures. The butt-fused joint will be true alignment and will have uniform roll back beads resulting from the use of proper temperature and pressure. The joint surfaces will be smooth. The fused joint will be watertight and will have tensile strength equal to that of the pipe. All joints will be subject to acceptance by the Engineers or his representative before insertion. All defective joints will be cut out and replaced. Any section of the pipe with a gash, blister, abrasion, nick, scar, or other deleterious fault greater in depth than 10% of the wall thickness, will not be used and must be removed from the site. In addition, if in the opinion of the Engineers or his representative any section of pipe has other defects, including those hereinafter listed, that may indicate damaged, improperly manufactured, faulty, or substandard pipe, said pipe will be discarded and not used. Defects warranting pipe rejection include the following: concentrated ridges, discoloration, excessive spot roughness, and pitting; insufficient or variable wall thickness; pipe damage from bending, crushing, stretching or other stress; pipe damage that impacts the pipe strength, the intended use, the internal diameter of the pipe, internal roughness characteristics; or any other defect of manufacturing or handling.

The manufacturer must provide fusion training. The contractor (actual installers) and the onsite joint inspector must be trained by the manufacturer or manufacturer's authorized representative.

It will not be permitted to join unlike DR's to one another. Transition from unlike SDR's must be accomplished by mechanical couplings capable of identical pressure ratings or machined polyethylene nipples where a thicker wall polyethylene has been matched to the companion pipe wall.

Mechanical joining systems: Polyethylene pipe and fittings must be connected by means of a polyethylene flange adapter and backup ring. The polyethylene flange adapter will be of the same specifications as the Light View except will be made from black plate stock. This method is also approved to join to another piping system or valves. Mechanical compression couplings or full circle encasement clamps may be used depending on the test specification.

Mechanical couplings must be installed in accordance with the mechanical coupling manufacturer's recommended procedures.

The fusion equipment and operator must be required to demonstrate successful field experience. Regarding fusion over 36 in. capability, the fusion unit must be field tested for a period of five years and the fusion operator must have pipe size experience of the same pipe on the project for five years or longer.

3.3.8. Protective Coating and Wrapping on Joints. All bolts and nuts installed for underground service on cast-iron mechanical joint fittings and other ferrous metal appurtenances will be packed in an approved protective coating material after installation. After the joint has been made and bolts drawn to proper tension, the joint including glands, flanges, bolt heads, and nuts must be covered with an approved SAWS coating. Coating and wrapping of joints will be considered subsidiary to this item and will not be paid for directly. Asphaltic material such as Talcote must not be used.

3.4. Bypass Pumping – Small Diameter Sanitary Sewers. For sanitary sewers less than 24 in. in diameter. During construction, it will be the Contractor's responsibility to maintain a safe and secure environment at all times. All provisions and requirements of the BPP must be followed throughout the course of any bypass flow operations. Contractor must notify the SAWS' Inspections Department 72 hr. before commencing the bypass pumping operations.

The Contractor must have full time (24 hour), onsite qualified pump personnel including supervision for monitoring the entire bypass installation while it is in operation. The entire length of bypass piping must be walked and inspected hourly to monitor for leaks. High-level alarm notification to cell phones must not eliminate this requirement. Where bypass pumping systems exceed 1,500 ft. in length or cannot be completely observed from the bypass pump location, at least one attendant must be assigned to the pump operation, and one additional attendant must be assigned to walk and monitor the pipeline.

Before installing any plugs, the Contractor and SAWS will inspect the existing pipe using a pole camera, for imperfections that might cause damage to the plug, cause the plug to not seal or function properly, or compromise the integrity of the pipe when the plug is inflated. The results of this inspection will directly impact the planned plugging locations. Afford SAWS an opportunity to confirm that the location of plugs is acceptable.

Lines inserted into any manholes or structures must be constructed with elbows, or be otherwise angled, to direct discharge along the most efficient path for entry into the downstream line without causing unnecessary turbulence of flow. The termination point of the discharge piping must extend to the crown of the pipe housed within the manhole or structure receiving the bypassed flows.

Contractor must provide continuous supply on-site fuel storage enough for 24 hr. operation of the bypass pumping installation.

Contractor must protect all components of the bypass operations from vandalism and vehicular damage by making the site secure.

Contractor must minimize sanitary sewer odors by using lids, shroud covers, or any method accepted by the Engineer.

Contractor will be solely responsible for any and all damages to private or public property caused by, or during, the installation, operation, or removal of the bypass pumping system. Contractor will be fully responsible for all damages and costs related to the installation, operation, and maintenance of Contractor's bypass pumping operations including damages, clean up, fines, penalties, and other related costs.

Once all work is completed and the bypass pumping operation is no longer required, the Contractor must disinfect and drain the entire BPP system in accordance with approved submittal.

SAWS will not be responsible for additional traffic control measures that might be required by CoSA, Bexar County, The Department, or any other public entity with jurisdiction of the project location.

Flow Tracking logs must be downloaded from the SAWS website (saws.org) to continuously track all flows being bypassed.

Plug installation:

- The Contractor will be solely responsible for the safe and effective use of plugs, including the proper combination of inflatable or mechanical plugs to block the sewer flow at both the upstream and downstream ends of a sewer bypass.
- Inflatable plugs should be used only after receiving training as recommended by the manufacturer.
- An inherent danger exists with all inflatable products. If any conditions with this equipment exist that may jeopardize the safety of workers or others corrective actions should be taken before the equipment use.
- Plugs must be selected and installed in accordance with the manufacturers recommendations.
- Plugs must also be selected and installed according to the size of the line to be plugged.
- Spare plugs – Provide spare plugs on-site ready to be installed in the event a plug fails or becomes dislodged.
- Plugs will be in good condition and reviewed by the Contractor for defects that might lead to failure before being installed. The Contractor must sign the Plug Inspection form.
- Plugs must be removed from the system upon completion of the work.
- Damages – The Contractor will be responsible for damages due to plugs being left in place or dislodged, including but not limited to: Damages to SAWS infrastructure or private property. Costs associated with sanitary sewer overflows including: regulatory fines; sewage and debris cleanup; debris disposal at an appropriate landfill; disinfection of all surfaces which have come in contact with the sewage. Costs associated with locating and retrieving lost or dislodged plugs.

3.5. Bypass Pumping – Large Diameter Sanitary Sewer. For sanitary sewers 24 in. in diameter or greater. During construction, it will be the Contractor's responsibility to maintain a safe and secure environment at all times. All provisions and requirements of the BPP must be followed throughout the course of any bypass flow operations. When working inside manhole or force main, the Contractor should exercise caution and comply with OSHA requirements when working in the presence of sewer gases, combustible or oxygen-deficient atmospheres, and confined spaces. Contractor must notify the SAWS' Inspections Department 72 hr. before commencing the bypass pumping operations. The Contractor must ensure that the temporary pumping system is properly maintained and a responsible operator must be on hand at all times when pumps are operating.

The Contractor must have full time (24 hr.), onsite qualified pump personnel including supervision for monitoring the entire bypass installation while it is in operation. The entire length of bypass piping must be walked and inspected hourly to monitor for leaks. High-level alarm notification to cell phones must not eliminate this requirement. Where bypass pumping systems exceed 1,500 ft. in length or cannot be completely observed from the bypass pump location, at least one attendant must be assigned to the pump operation, and one additional attendant must be assigned to walk and monitor the pipeline.

Before installing any plugs, the Contractor and SAWS will inspect the existing pipe using a pole camera, for imperfections that might cause damage to the plug, cause the plug to not seal and function properly, or

compromise the integrity of the pipe when the plug is inflated. The results of this inspection will directly impact the planned plugging locations. Afford SAWS an opportunity to confirm that the location of plugs is acceptable.

After installation of the plug, the Contractor must monitor on daily basis the radio transmitter battery and radio signal strengths. If either are found to be below the manufacturer's requirements the radio transmitter must be immediately replaced.

Lines inserted into any manholes or structures must be constructed with elbows, or be otherwise angled, to direct discharge along the most efficient path for entry into the downstream line without causing unnecessary turbulence of flow. The termination point of the discharge piping must extend to the crown of the pipe housed within the manhole or structure receiving the bypassed flows.

Contractor must provide continuous supply on-site fuel storage enough for 24 hr. operation of the bypass pumping installation.

Contractor must protect all components of the bypass operations from vandalism and vehicular damage by making the site secure.

Contractor must minimize sanitary sewer odors by using lids, shroud covers, or any method accepted by the Engineer.

Contractor will be solely responsible for any and all damages to private or public property caused by, or during, the installation, operation, or removal of the bypass pumping system. Contractor will be fully responsible for all damages and costs related to the installation, operation, and maintenance of Contractor's bypass pumping operations including damages, clean up, fines, penalties, and other related costs.

Once all work is completed and the bypass pumping operation is no longer required, the Contractor must drain the entire sanitary sewer system flows into an existing SAWS sanitary sewer manhole before disassembly and removal of the system from the construction site. The intent is to prevent spillage of sewage.

SAWS will not be responsible for additional traffic control measures that might be required by CoSA, Bexar County, The Department, or any other public entity with jurisdiction of the project location.

Flow tracking logs must be downloaded from the SAWS website (saws.org) to continuously track all flows being bypassed.

Plug Installation:

- The Contractor will be solely responsible for the safe and effective use of plugs, including the proper combination of inflatable or mechanical plugs to block the sewer flow at both the upstream and downstream ends of a sewer bypass.
- Inflatable plugs should be used only after receiving training as recommended by the manufacturer.
- An inherent danger exists with all inflatable products. If any conditions with this equipment exist that may jeopardize the safety of workers or others corrective actions should be taken before the equipment use.
- Plugs must be selected and installed in accordance with the manufacturers recommendations.
- Plugs must also be selected and installed according to the size of the line to be plugged.
- Spare plugs – Provide spare plugs on-site ready to be installed in the event a plug fails or becomes dislodged.
- Plugs will be in good condition and reviewed by the Contractor for defects that might lead to failure before being installed. The Contractor must sign the Plug Inspection form.
- Plugs must be removed from the system upon completion of the work.

- Damages – The Contractor will be responsible for damages due to plugs being left in place or dislodged, including but not limited to: Damages to SAWS infrastructure or private property. Costs associated with sanitary sewer overflows including: regulatory fines; sewage and debris cleanup; debris disposal at an appropriate landfill; disinfection of all surfaces which have come in contact with the sewage. Costs associated with locating and retrieving lost or dislodged plugs. If the plug is damaged, it must be immediately removed from the worksite.

3.6. Manhole Construction. Manholes must be constructed of materials and workmanship as prescribed by these specifications, at such places shown in the contract documents or as designated by the Engineer, and in conformity with the typical details and sketches shown.

Footings or bases of manholes must be a minimum of 6 in. in depth below the bottom of the pipe.

All invert channels of manholes are to be constructed and shaped accurately so as to be smooth, uniform and cause minimum resistance to flow. The bench is to be finished smooth with a slope of 1/2 in./ft. from the manhole walls to the edges of the invert. The top half of all sewer pipes within the invert channel or bench zone are to be removed flush to the inside manhole walls.

Joints on sewer pipes are not to be cast or constructed within the wall sections of manholes.

Concrete cradles are required for new pre-cast manholes Concrete cradles are to be provided for all influent and effluent pipes on new monolithic manhole and sewer pipe systems. Concrete cradles are to extend beyond the outside walls of the manhole a minimum of 36 in.

Voids between exterior pipe walls and manhole walls at all pipe connections in manholes must be filled with a non-shrink grout, concrete or mortar, as approved by the Engineer or as shown in the contract documents and inspected before backfilling.

Where connections to existing manholes are required, the adjacent pipe bedding is to be prepared to proper grade, the existing manhole neatly cut and the new pipe inserted so that the end is projecting 2 in. from the inside wall. The invert is then to be reshaped to properly channel new flows. Debris of any kind is to be kept out of new or existing manholes or mains.

Joints between cones, risers, adjustment rings, flat tops, and between the ductile cast iron ring and the uppermost adjustment ring or flat top, as applicable, must be thoroughly sealed in accordance with manufacturer's recommendations with strongly adhesive bitumastic products as specified. Where precast concrete risers are used, any gaps in the outer joint surfaces must be additionally coated with non-shrink grout to a minimum thickness of 1/4 in.

After adjustment ring joints have been sealed as specified above and before the placement of final backfill and pavement, the Contractor must apply the specified heat shrink wrap around the outer perimeter of the adjustment "throat rings." All receiving surfaces must first be thoroughly cleaned to allow proper adhesion of the heat shrink wrap. Installation of the wrap must be in strict accordance with manufacturer's instructions and using the proper hot air equipment under suitable temperature and dry weather conditions. Provide enough vertical overlaps of the wrap around the base of the manhole ductile cast iron ring and the top of the manhole cone as applicable to the finished manhole geometry. Final backfill and pavement work must be conducted in a careful manner to avoid damaging the plastic wrap, as further specified below.

No more than 6 throat rings of 2 in. thickness, or no more than 4 throat rings of 3 in. thickness may be used on any new manhole.

3.6.1. Manhole Ring Encasement. All manhole rings are to be encased with 4,000 psi reinforced Class B concrete as shown on the plans or approved by the Engineer. Manhole ring encasements are to extend 6 in. below the top of the cone and have a minimum thickness when measured at the manhole ring of 1 ft. The surface of the encasement is to be 4 1/2 in. below the top of the manhole ring as shown on the plans or as approved.

Where manholes are constructed in existing streets and where directed by the Engineer or shown in the contract documents, the exterior exposed surfaces of the ring, mortar; throat rings and manhole surface must be coated with a 1/8 in. minimum thickness of heat shrink wrap plastic before placement of concrete.

3.7. Glass-Fiber Reinforced Polyester (FRP) Manholes. Fiberglass manholes must be installed according to manufacturer's installation instructions. In addition to these instructions, local codes may apply and should be consulted as applicable in manhole installation. Correct manhole installation requires proper concrete foundation, good backfill and proper handling to prevent manhole damage and insure long term corrosion resistant service.

Prepare excavation at manhole location should be at least wide enough to accommodate the slab specified and to provide working room around manhole. Ensure the depth of manhole is enough to allow between two and four concrete rings for adjustment of ring and cover at top of final grade. Quarter marks have been provided on barrel to facilitate alignment.

To lift manhole, insert 4 in. x 4 in. timber crosswise inside the manhole to the underside of the collar with a rope or woven fabric slings attached to backhoe or other lifting device and lower the manhole. Level manhole and connect sewer lines to manhole. A concrete base encasement must be placed at least 12 in. from the manhole and must come over the top of the anti-flotation ring a minimum of 12 in.

Initial backfill material must be used for backfill around the manhole for a minimum distance of one foot from the outside surface and extending from the bottom of the excavation to the top of the reducer section. Secondary backfill material may be used for the remainder of the backfill, subject to pre-approval by the Engineer. An approved flowable fill material may also be used for backfilling operations.

Backfill material must be placed in layers of not more than 12 in. loose and mechanically tamped to 98% Standard Proctor Density. Flooding will not be permitted. Backfill must be placed in such a manner as to prevent any wedging action against the fiberglass manhole structure.

3.8. Sanitary Sewer System Cleaning

The sanitary sewer mains, manholes, and structures must be cleaned using mechanical, hydraulically propelled, and high velocity sewer cleaning equipment. The cleaning process must remove all debris, grease, sand, silts, solids, rags, rock, etc. from each sewer segment, including the manholes or structures. Selection of cleaning equipment and the method for cleaning must be based on the condition of the sanitary sewer lines at the time work commences and will be subject to SAWS' pre-approval. All cleaning equipment and devices must be operated by experienced personnel. Satisfactory precautions must be taken to protect the sanitary sewer lines, manholes, or structures from damage that might be inflicted by the improper use of the cleaning process or equipment. Any damages done to a sewer line manhole, or structure by the Contractor must be repaired by the Contractor at no additional cost and to the satisfaction of SAWS. Cleaning must also include the manhole or structure wall washing by a high pressure water jet.

3.8.1. Hydraulic Cleaning. Hydraulic propelled devices which require a head of water to operate must use a collapsible dam. The dam must be easily collapsible to prevent damage to the sewer line, property, etc. When using hydraulically propelled devices, precautions must be taken to ensure that the water pressure created does not cause damage or flood public or private property. The Contractor must not increase the hydraulic gradient of the sanitary sewers beyond the elevation that could cause overflow of sewage into area waterways or laterals. The flow of wastewater present in the sanitary sewer line must be used to provide necessary fluid for hydraulic cleaning devices whenever possible.

3.8.2. High Velocity Cleaning. Cleaning equipment that uses a high velocity water jet for removing all debris must be capable of producing a minimum volume of 50 gpm, with a pressure of 1,500 psi, for the sanitary sewer main and 3,500 psi for the (manhole) structure at the pump. Any variations to this pumping rate must be pre-approved by the Inspector. To prevent damage to older sewer lines and property, a pressure less than 1,500 psi can be used. A working pressure gauge must be used on the discharge of all high pressure water pumps. The Contractor must use, in addition to conventional nozzles, a nozzle which directs the cleaning force to the bottom of the pipe for sewers 18 in. and larger in diameter. The Contractor must operate the

equipment so that the pressurized nozzle continues to move at all times. The pressurized nozzle must be turned off or reduced anytime the hose is on hold or delayed to prevent damage to the line.

3.8.3. Mechanical Cleaning. Mechanical cleaning, in addition to normal cleaning when required, must be with approved equipment and accessories driven by power winching devices. The Contractor must submit the equipment manufacturer's operational manual and guidelines to the Inspector, which must be followed strictly unless modified by the Inspector. All equipment and devices must be operated by experienced operators so that they do not damage the pipe in the process of cleaning. Buckets, scrapers, scooters, porcupines, kites, heavy duty brushes, and other debris-removing equipment and accessories must be used as appropriate and necessary in the field, in conjunction with the approved power machines. The use of cleaning devices such as rods, metal pigs, porcupines, root saws, snakes, scooters, sewer balls, kites, and other approved equipment, in conjunction with hand winching device, or gas, electric rod propelled devices, must be considered normal cleaning equipment.

In addition to the requirements specified herein, the Contractor must maintain a clean work area and surrounding premises within the work limits so as to comply with Federal, State, and local environmental and anti-pollution laws, ordinances, codes, and regulations when cleaning and disposing of waste materials, debris, and rubbish. The Contractor must also keep the work and surrounding premises within work limits free of accumulations of dirt, dust, waste materials, debris, and rubbish. Suitable containers for storage of waste materials, debris, and rubbish must be provided until time of disposal. It is the responsibility of the Contractor to secure a licensed legal dump site for the disposal of this material. Under no circumstances must sewage or solids removed from the main or manhole be dumped on the ground, streets, ditches, catch basins, storm drains, or sanitary sewers. Cost for this item will be included in the price bid for sanitary sewer system cleaning.

In addition to the requirements specified herein, the Contractor must maintain a clean work area and surrounding premises within the work limits so as to comply with Federal, State, and local environmental and anti-pollution laws, ordinances, codes, and regulations when cleaning and disposing of waste materials, debris, and rubbish. The Contractor must also keep the work and surrounding premises within work limits free of accumulations of dirt, dust, waste materials, debris, and rubbish. Suitable containers for storage of waste materials, debris, and rubbish must be provided until time of disposal. It is the responsibility of the Contractor to secure a licensed legal dump site for the disposal of this material. Under no circumstances will sewage or solids removed from the main or manhole be dumped on the ground, streets, ditches, catch basins, storm drains, or sanitary sewers. Cost for this item will be included in the price bid for sanitary sewer system cleaning.

The Contractor, when instructed, will be required to demonstrate the performance capabilities of the cleaning equipment proposed for use. If the results obtained by the proposed sanitary sewer cleaning equipment are not satisfactory, the Contractor must use different equipment or attachments, as required, to meet specification. More than one type of equipment or attachments may be required at a location. When hydraulic or high velocity cleaning equipment is used, a suitable sand trap, weir, dam or suction must be constructed in the downstream manhole in such a manner that all solids and debris are trapped for removal.

Whenever hydraulically propelled cleaning tools which depend upon water pressure to provide their cleaning force, or any tool which retard the flow of water in the sanitary sewer lines are used, precautions must be taken to ensure that the water pressure created does not cause any damage or flooding to public or private property being served by the manhole section involved. Any damage of property, as a result of flooding, will be the liability and responsibility of the Contractor. The flow of wastewater present in the sanitary sewer main must be used to provide necessary fluid for hydraulic cleaning devices whenever possible. When additional quantities of water from fire hydrants are necessary to avoid delay in normal working procedures, the water must be conserved and not used unnecessarily. No fire hydrant must be obstructed or used when there is a fire in the area. The Contractor will be responsible for obtaining the water meter and all related charges for the setup, including the water usage bills from respective water purveyor agency. All expenses will be considered incidental to the cleaning of the existing sanitary sewer system.

3.9. Jacking, Boring, or Tunneling Pipe. Jacking: Suitable pits or trenches must be excavated for the purpose of jacking operations for placing end joints of the pipe. When trenches are cut in the side of embankment,

such work must be securely sheeted and braced. Jacking operations must in no way interfere with the operation of railroads, streets, highways or other facilities and must not weaken or damage such facilities. Barricades and lights must be furnished as directed.as directed. to safeguard traffic and pedestrians.

The pipe to be jacked must be set on guides to support the section of pipe being jacked and to direct it in the proper line and grade. Embankment material must be excavated just ahead of the pipe and material removed through the pipe, and the pipe forced through the opening thus provided.

The excavation for the underside of the pipe, for at least ⅓ of the circumference of the pipe, must conform to the contour and grade of the pipe. A clearance of not more than 2 in. may be provided for the upper half of the pipe.

The distance that the excavation must extend beyond the end of the pipe will depend on the character of the material, but it must not exceed 2 ft. in any case.

Generally, the pipe should be jacked from the downstream end. Permissible lateral or vertical variation in the final position of the pipe from line and grade will be as shown in the contract documents or as determined by the Engineer. Any pipe that cannot be repaired to its original condition or is damaged in jacking operations must be removed and replaced at the Contractor's expense. Jacking pits must be backfilled immediately upon completion of jacking operations.

Excavation for “Boring” pits and installation of shoring will be as outlined under “Jacking.” Boring operations may include a pilot hole which must be bored the entire length of crossing and must be used as a guide for the larger hole to be bored. Water or drilling fluid may be used to lubricate cuttings. Variation in line and grade will apply as specified under “Jacking.”

Tunneling: Tunneling may be used when the size of the proposed pipe or the use of a monolithic sewer would make the use of tunneling more satisfactory than “Jacking” or “Boring.” The excavation for pits and the installation of shoring will be as specified under “Jacking.” The lining of the tunnel must be of the material shown on the plans.

Access holes for grouting annular space must be spaced a maximum of 10 ft.

Joints: Joints for pipe for “Jacking,” “Boring,” or “Tunneling,” will be as specified in these specifications, or as shown on the project plans or shop drawings as per pipe manufacturer's recommendation.

Grouting of Bores or Tunnels: Annular Space between casing pipe and limits of excavation (borehole) must be pressure grouted, unless otherwise specified on the plans.

3.10. Concrete Encasement, Cradles, Saddles and Collars. Concrete Encasement. When concrete encasement is shown on the plans or when directed, the trench is to be excavated and fine graded to a depth conforming to the details and sections shown on the plans. The main must be supported by precast concrete blocks of the same strength as the concrete for encasement and securely tied down to prevent floatation. Encasement must then be placed to a depth and width conforming to the details and sections shown in the contract documents or per the referenced standard drawings.

3.10.1. Concrete Cradles. When concrete cradles are shown on the plans or when directed, the trench is to be prepared and the pipe supported in the same manner as described in Concrete Cradles, of this section. The cradle must be constructed in accordance with details and sections shown on the plans. Straps and Tie Downs must be No. 4 rebar diameter minimum or better as determined by the Water System Inspector.

3.10.2. Concrete Saddles. When shown on the plans or when directed, pipe to receive concrete saddle is to be backfilled in accordance with this specification to the spring line and concrete placed for a depth and width conforming to details and sections shown on the plans.

3.10.3. Concrete Collars. When shown on the plans or when directed, concrete collars are to be constructed in accordance with details and sections shown on the plans.

3.11. Existing Manhole Adjustments. Existing manholes are to be adjusted or abandoned in accordance with Item 479, "Adjusting Manholes and Inlets," and as specified herein.

Manholes must be lowered below street subgrade before placing base materials, and openings must be protected by temporary hatch covers. Manholes adjusted in non-paved areas must be set per proposed final grade.

Existing manhole rings and covers which are determined by the Inspector to be in an unacceptable condition, will be removed and replaced with new rings and covers. If the cone section is removed, the Contractor is to upgrade it to a 30 in. opening as required by 30 TAC § 217. All manhole openings upgraded to 30 in. will then be considered Reconstruction of Manholes and subjected to all provisions contained under the appropriate section in this specification. Contractor should take all necessary measures to prevent damage to existing or new rings, covers, or cones from equipment and materials used in, or taken through, the work area. If an existing or new manhole cover, ring, or cone is damaged by the Contractor, it must be replaced (as directed by the Inspector) by the Contractor at his own expense. If concrete throat rings are to be installed, they must be used in conjunction with a UV stabilized polyethylene liner and I/I barrier. I/I barrier must meet the following ASTM standards: ASTM D 790/1505 Density of Polyethylene Materials, ASTM D 1238-10 Melt Flow Index, ASTM 638-10 Tensile Strength @ Yield (50 mm/mm), ASTM 790 Flexural Modulus, ASTM 648 Heat Deflection Temperature @ IGEPAL, ASTM 1693-12 EsCR, 100% IGEPAL/10% IGEPAL.

Manholes should be adjusted after the street's base material has been laid and before placing of the final surface course. Manholes that are going to be adjusted on an existing surface course (not planned for replacement) will be in accordance with the plans. All manholes should then be raised, or lowered enough height so as to be level with the finished surface course. Adjustment in height will be made by the addition or removal of "throat rings" above the manhole cone, where feasible. A minimum of two and a maximum of six throat rings may be used at each adjusted manhole.

Joints between cones, risers, adjustment "throat rings," flat tops, and between the ductile cast iron ring and the uppermost adjustment ring or flat top must be thoroughly sealed in accordance with manufacturer's recommendations with strongly adhesive bitumastic products: RAM-NEK, as manufactured by Henry, Inc.; Kent Seal, as manufactured by Hamilton-Kent, Inc.; Encapseal, as manufactured by Miller Pipeline Corporation; or approved alternate. Where precast concrete risers are used, any gaps in the outer joint surfaces must be additionally coated with quick-set, non-shrink grout.

Material excavation from around the manholes must be replaced with flowable fill in accordance with these specifications, and select materials from the excavation (as shown in the contract documents). All excess materials must be disposed of by the Contractor at his own expense and in an approved location. The Contractor also has the option of backfilling with approved secondary materials, subject to the provisions in this specification.

Manholes existing on sewer lines replaced by new sewer piping and which are no longer needed for the revised sewer network are to be classified as "Abandon Manhole." Work required on an abandoned manhole is to consist of installing a permanent concrete plug on all pipes within the manhole, removing the top of the manhole to an elevation of 2 ft. below proposed subgrade or existing grade, whichever is the lower elevation, and backfilling the manhole with a grout material as specified. The ring and cover of the manholes are to be removed and delivered to Sanitary Sewer Owners facility designated by the Engineer. If directed, drainage holes are to be drilled in the bottom of manhole walls before backfilling.

3.12. Reconstruction of Existing Manholes. Manholes must be raised or lowered by replacing the existing cone and manhole section or sections as required for installation to the finished surface course. All openings must be protected by hatch covers or the necessary steel plates. The Contractor will be required to backfill all manholes with an approved flowable fill (in accordance with all requirements of the right of way owner with jurisdiction over the project scope) up to 1 ft. above the cone section. The Contractor also has the option of

backfilling with approved secondary materials, subject to the provisions of this specification. All excess materials (of any type) must be disposed of by the Contractor at his own expense, and in an approved location.

Reconstructed manholes must also be cleaned of any debris as required by the Inspector. If a new manhole cover, ring, or reconstructed manhole is damaged by the Contractor, it must be replaced (as directed by Inspector) by the Contractor at his own expense. All installed concrete throat rings must be used in conjunction with a UV stabilized polyethylene liner and I/I barrier as specified above. Coat all interior concrete surfaces with a SAWS approved coating system as specified above.

Voids between exterior pipe walls and manhole walls at all pipe connections in manholes must be filled with a non-shrink grout, as specified above, or as approved by the Engineer, or as shown in the contract documents and inspected before backfilling.

Joints between cones, risers, adjustment rings, flat tops, and between the ductile cast iron ring and the uppermost adjustment ring or flat top, as ductile cast iron ring and the uppermost adjustment ring or flat top, as applicable, must be thoroughly sealed in accordance with manufacturer's recommendations with strongly adhesive bitumastic products as specified above. Where precast concrete risers are used, any gaps in the outer joint surfaces must be additionally coated with non-shrink grout to a minimum thickness of 1/4 in.

3.12.1. Manhole Ring Encasement. All manhole rings must be encased with 4,000 psi reinforced concrete as shown in the contract documents or as approved by the Engineer.

Concrete manhole ring encasement must extend 6 in. below the top of the cone and have a minimum width when measured at the manhole ring of 1 ft. The surface of the encasement must be flush with the top of the manhole ring.

Where manholes are reconstructed in existing streets and where directed by the Engineer or shown in the contract documents, the exterior exposed surfaces of the ring, mortar; throat rings and manhole surface must be coated with a ⅛ inch minimum thickness of heat shrink wrap plastic before placement of concrete.

3.13. Cut and Restore Pavement. Where sewers must be installed in streets or other paved areas that are going to remain, the work is required to be in accordance with Item 400, "Excavation and Backfill for Structures."

When allowed by the construction sequence shown on the plans or as directed, a "Temporary Concrete Cap" of the depth and class of concrete as shown on the plans or as directed may be used instead of a permanent repair.

3.14. Concrete Sidewalks, Driveways, Curbs, Medians and Islands Replacement. Existing concrete sidewalks, driveways, curbs, medians and islands required to be removed and replaced solely for sewer installation are to be a part of sewer work. Removal is to be in accordance with Item 104, "Removing Concrete." Replacement is to be in accordance with the plans and with Item 529, "Concrete Curb, Gutter and Combined Curb and Gutter," Item 530, "Intersections, Driveways and Turnouts," Item 531, "Sidewalks," and Item 536, "Concrete Medians and Directional Islands."

Any work done due to damage to curbs, sidewalks, driveways, islands or medians outside the limits shown on the plans or approved in advance will not be measured for payment but is to be restored at the Contractor's expense.

3.15. Removing and Replacing Chain-Link and Wire Fence. Existing chain link or wire fences required to be removed solely for sewer installation is to be replaced as part of the sewer work to a condition comparable to that at removal. The existing fence materials may be reused if they are not damaged during removal. Any removal or damage to existing fences outside the limits shown on the plans or not approved in advance will not be measured for payment but is to be restored at the Contractor's expense.

3.16. Abandon Sewer Lines. Abandonment of existing sewer lines will be in accordance with the requirements under the "Grouting of Sewer Mains" section of this Special Specification.

3.17. Sewer Main Television Inspection.

3.17.1. Bypass Pumping. The Contractor must perform bypass pumping operations in accordance with "Bypass Pumping" sections of this Special Specification.

The Contractor must furnish all labor, supervision, tools, equipment, appliances, and materials to perform all operations in connection with bypass pumping of sewage flow for the purpose of preventing interference with the televising of the sanitary sewer manholes and mainlines as well as providing reliable sewer service to the occupants of the buildings being served.

3.17.2. Post Repair TV Inspection. Upon completion of any repairs required by the Engineer, the Contractor will re-televise the sewer and submit the DVDs to the Inspector. These DVDs are to be permanently labeled as described in this specification, and are to be used as a portion of the acceptance criteria. This post repair-TV inspection is to be done to the satisfaction of the Engineer and is subject to the same acceptance criteria as the post construction-TV inspection DVDs. Post repair-TV inspection is to be provided at the Contractor's expense.

3.17.3. Negotiability of Sewers. The Engineer makes no guarantee that all of the sanitary sewer mains proposed to be TV inspected are clear for the passage of a camera.

No separate or additional payment will be made for any excavation, man entry or any other method, which may be required to retrieve video equipment that has been hung up, destroyed or lost during the televising operation.

3.18. Reconstruct Manholes. The reconstruction of existing manholes, all types and sizes, will include the replacement of manhole ring and covers, the replacing of existing cone, manhole section or sections required, regardless of the type shown on the plans, and as specified herein.

Manholes must be raised or lowered by replacing the existing cone and manhole section or sections as required for installation to the finished surface course. All openings must be protected by hatch covers or the necessary steel plates. The Contractor will be required to backfill all manholes with an approved flowable fill (in accordance with all requirements of the right of way owner with jurisdiction over the project scope) up to 1 ft. above the cone section. All excess materials (of any type) must be disposed of by the Contractor at his own expense, and in an approved location. All openings will be protected by hatch covers or steel plates, as needed.

Reconstructed manholes will be cleaned of any debris as accepted by the San Antonio Water System's Inspector. If a new manhole cover, ring, or reconstructed manhole is damaged by the Contractor, it will be replaced, as directed by the San Antonio Water System Inspector, by the Contractor, at his expense. All installed concrete throat rings must be used in conjunction with a UV stabilized polyethylene liner and I/I barrier. Coat all interior concrete surfaces with a SAWS approved coating system as specified.

Voids between exterior pipe walls and manhole walls at all pipe connections in manholes must be filled with a non-shrink grout, as specified above, or as approved by the Engineer, or as shown in the contract documents and inspected before backfilling.

Joints between cones, risers, adjustment rings, flat tops, and between the ductile cast iron ring and the uppermost adjustment ring or flat top, as ductile cast iron ring and the uppermost adjustment ring or flat top, as applicable, must be thoroughly sealed in accordance with manufacturer's recommendations with strongly adhesive bitumastic products as specified above. Where precast concrete risers are used, any gaps in the outer joint surfaces must be additionally coated with non-shrink grout to a minimum thickness of 1/4 in.

3.19. Air Release Assembly. Air release valves and appurtenant items will be installed at the locations shown on the plans unless otherwise directed.

3.20. Anchorage and Blocking. Suitable reaction blocking or anchorage will be provided at all locations specified on the plans. Anchor blocks will be constructed solidly behind the fitting and symmetrical with the axis of

resultant thrust except where this is not possible as in the case of gravity anchorage for vertical bends. Special ties and anchor fittings may be used in conjunction with blocking when shown on the plans or as directed.

Concrete blocking for mains will be a minimum of 3,000 psi placed between solid ground and the fitting except as otherwise shown on the plans. The area of bearing in contact with solid ground will be that shown on the plans or as directed.

All thrust blocking placed in conjunction with mains and appurtenances constructed in Pressure Zones (formally known as Service Levels) 9 through 15 must be in accordance with the plans. In all cases, the design of thrust blocking must be of enough size to withstand a soil pressure of 3,000 psf, unless specified otherwise in the job plans or specifications. The maximum soil pressure value that will be allowed for the design of thrust blocking must be 5,000 psf. When soil pressure bearing values of 4,000 psf or 5,000 psf are recorded for design of thrust blocks, copies of soil tests made for determining the bearing value of the soil in question must be submitted to the Engineering for verification.

The blocking must be placed so that pipe and fitting joints will be accessible. Pipe polywrap must be placed between the pipe or fitting and the concrete.

The reaction block on the unused branch of a fitting must be poured separately from the block across the back of the fitting. If they are poured simultaneously, a rigid partition must be placed between the blocks.

Valves 12 in. or larger in size must be supported on a concrete pad extending vertically from 12 in. below the bottom of the valve to the lower quarter point of the hub and laterally from face to face of hubs and transversely form wall to wall of the trench.

3.21. Rehabilitation of Sanitary Sewer by Cured-In-Place Pipe (Hot Water or Steam Cured).

3.21.1. Installer Qualification Requirements. Installation of the CIPP products must be performed by a work force that is experienced and certified in installation of the products. The installer must be certified by the CIPP product manufacturer to have been trained and approved in the installation of their CIPP products and have a minimum of 3 years total experience with the product. The Contractor must submit such certification of hot water or steam cured CIPP Installer to Owner. Contractor must also submit to Owner at least five (5) recent references of the CIPP installer, indicating successful installation of proposed hot water or steam cured CIPP on projects of similar size and scope. Installer's project manager must have a minimum of 3 years of CIPP installation experience and must be onsite during the installation of the CIPP products.

3.21.2. Installer Equipment Requirements. Installer must only use hot water or steam curing equipment that has been certified and approved for use by the CIPP product manufacturer.

3.21.3. Public Notification. The Contractor must maintain service usage throughout the duration of the project. If a service will be out of service, the maximum quantity of time of no service will be 8 hr. for any property served by the sewer. A public notification program must be implemented, and must at a minimum, require the Contractor to be responsible for contacting each home or business connected to the sanitary sewer informing them of the work to be conducted, when the sewer will be offline, and any alternative method of service that may be provided.

Written notice to be delivered to each home or business two business days before the beginning of work being conducted on the section, and a local telephone number of the Contractor they can call to discuss the project or any problems which could arise.

Personal contact with any home or business which cannot be reconnected within the time stated in the written notice.

Inform SAWS Inspection Department 48 hr. before starting the work.

3.21.4. Protection. The Contractor must provide for the general safety of workers, pedestrians and traveling public throughout the project. Existing surface improvements and underground facilities and utilities must also be protected. Damage caused by the Contractor must be repaired at his own expense. Protection to be provided must include but not be limited to:

Provide barricades, warning lights and signs for excavations created by point repairs and excavation pits. Conform to requirements of The Department, City of San Antonio, Bexar County, or any other governing entity, and of contract documents.

Protection of Manholes and Structures: Install all pulleys, rollers, bumpers, alignment control devices and other equipment required to protect existing manholes and structures, and to protect the pipe from damage during installation. Lubrication may be used as recommended by the manufacturer. Under no circumstances will the liners be stressed beyond their elastic limit.

Do not allow sand, debris, or runoff to enter sewer system.

Verify location of all underground utilities and facilities potentially impacted by rehabilitation or other related project activities and take necessary precautions to provide protection from damage. Damage caused by the Contractor will be his responsibility and repaired at no additional cost to SAWS.

Protect the liner and components during all phases of work including, but not limited to hauling, installation, entry into the entry pit, and prevention of scarring or gouging of the liner, pipe or components.

Contractor will be responsible for monitoring weather before planning a CIPP tube insertion to account for a enough duration of tube wet out and insertion and curing to ensure that wet weather that will prevent access to the project site is accounted for. Contractor's failure to account for oncoming weather will be Contractor's responsibility which may extend to removal of damaged or improperly cured CIPP resulting from interrupted CIPP construction process.

Contractor must notify owner 72 hr. before liner wet out process for approval. Weather conditions and on-site conditions need to be considered.

One (1) hour before liner being installed, Contractor must televise host pipe with Inspector present to ensure no pipe condition changes have occurred.

3.21.5. Access Pit Location. Location and number of insertion or launching pits will be chosen by the Contractor and approved by SAWS, and will typically be located at or near existing or proposed manholes or junction boxes, Points of Intersection (P.I.) in the line, at logical breaks in the construction phasing, or at locations to comply with access or maintenance requirements. The ends of the insertion excavation pit must be sloped 2:1 or flatter, or proper shoring devices must be used. Pits must be placed and located to minimize the total number of pulls and maximize the length of CIPP, within the constraints of maintaining service and access and other requirements. When excess ground water is encountered, it must be removed by the Contractor, and will be considered incidental to the project.

3.21.6. Sewage Bypass. A detailed bypass plan must be submitted by Contractor and approved before starting work. The bypass plan must be developed in accordance with the Bypass Pumping sections of this specification.

3.21.7. Cleaning and Television Inspection. Before installing the new pipe, the existing sewer must be cleaned and television inspected per the requirements of this specification. Notify SAWS Inspection Department of any conditions which may prevent proper installation of the liner. All CCTV work will confirm active laterals and location.

3.21.8. Point Repairs and Obstruction Removal. SAWS must be notified and must approve any point repair or obstruction removal before it is constructed. Point Repairs and Obstruction Removals must conform the requirements of this specification.

3.21.9. Pipe Leakage Control. Contractor must stop infiltration or leakage into the existing pipeline to prevent contamination of resin in liner.

3.21.10. Operation. CIPP installation must be in accordance with ASTM F1216, Section 7, or ASTM F1743, Section 6, and manufacturer's recommendations with the following modifications:

Resin Impregnation – The quantity of resin used for tube impregnation must be enough to fill the volume of air voids in the tube with additional allowances for polymerization shrinkage and the loss of resin through cracks and irregularities in the original pipe wall. A vacuum impregnation process must be used. To ensure thorough resin saturation throughout the length of the felt tube, the point of vacuum must be no further than 25 ft. from the point of initial resin introduction.

After vacuum in the tube is established, a vacuum point must be no further than 75 ft. from the leading edge of the resin. The leading edge of the resin slug must be as near to perpendicular as possible. A roller system must be used to uniformly distribute the resin throughout the tube. If the installer uses an alternate method of resin impregnation, the method must produce the same results. Any alternate resin impregnation method must be proven.

Tube Insertion – The wetout tube must be positioned in the pipeline using either inversion or a pull-in method. Under the inversion method, care must be taken during the inversion process so as not to overstress the tube. If pulled into place, a power winch should be used and care should be exercised not to damage the tube as a result of pull-in friction. The tube should be pulled-in or inverted through an existing manhole or approved access point and fully extended to the next designated manhole or termination point. The Contractor must install a gauge to monitor the pulling force of the pulled in tube. A written log must be kept noting the pulling force and any fluctuations in the pulling force. The force must not exceed the manufacturer's recommendations. Any occurrences exceeding the manufacturer's recommendations will be cause for rejection of work.

The manufacturer must provide the minimum pressure required to hold the tube tight against the existing conduit, and the maximum allowable pressure so the tube is not damaged. These pressure ranges must be maintained until the inversion has been completed. A temporary water meter must be installed on the fire hydrant, if used for inversion process. The cost to coordinate and install the meter for construction purposes will be at the Contractor's expense.

Temperature gauges must be placed between the impregnated tube and the existing pipe at the invert level of each end to monitor the temperatures during the cure cycle. A written log must be kept and submitted to the owner. Any invalid temperature readings not recommended from the manufacturer will be cause for rejection.

The curing must be accomplished by utilizing hot water or steam under hydrostatic pressure in accordance with the manufacturer's recommended cure schedule. After the tube is cured, the new pipe must be cooled to a temperature below 100° F (38° C) before relieving the internal pressure within the section. In addition, care must be taken during cool down so that a vacuum will not develop that may damage the newly installed pipe.

The finished pipe must be continuous over the entire length of an inversion run and be free of dry spots, lifts, and delaminations. If these conditions are present, the Contractor must remove and replace the CIPP in these areas at no cost.

Branch connections or service reconnections must be reopened without excavation, utilizing a remote controlled cutting device, monitored by a video TV camera. The Contractor must certify he has a minimum of 2 complete working cutters plus spare key components on the site before each inversion. Unless otherwise directed by the owner or his authorized representative, all laterals will be reinstated. Open cut excavation for service reconnections will only be allowed if it has been approved in writing from a SAWS Inspector. Service reconnections must be in accordance with this specification. Contractor must provide all coupons removed as part of the reinstatement of service process to confirm that a) the appropriate number of service connections has been made and b) no coupons were left in the pipe to create an obstruction.

3.21.11. Clean Up. Upon acceptance of the installation work and testing, the Contractor must restore the project area affected by the operations to a condition at least equal to that existing before the work.

3.22. Point Repairs.

3.22.1. General. Locate and replace small lengths of one or more pipe sections where isolated line failure has occurred due to settlement, corrosion, crushing, or separation of joints.

The Inspector may identify potential locations for point repair, but the Contractor is responsible for verifying locations.

Determine the location of service line repairs by smoke testing the manhole section in which the failed pipe is located. The Saws Engineer will authorize the Contractor to make point repairs based on results of smoke testing.

Smoke testing must not be performed within 24 hr. of a rainfall event or if ponded or standing water is present on the ground or in the drainage channels in the area planned for smoke testing.

Smoke testing must be accomplished utilizing two minimum 1,750 CFM blowers designed specifically for smoke testing of sewers. Place blower on the upstream and downstream manhole of the line section to be tested. Place sandbags in the upstream and downstream manholes to isolate the section being tested and prevent the migration of smoke into sections not being tested. Use smoke bombs as necessary to ensure a continuous supply of smoke is provided for the entire duration of the test period.

Determine the location of point repairs by smoke testing or video inspection of the manhole section in which the failed pipe is located. The Inspector will authorize the Contractor to make additional point repairs. Replace all identified damaged pipe for point repairs unless otherwise directed by the Inspector.

The Inspector will authorize each point repair after failure points are located. Do not make point repairs without prior authorization of the Inspector. Perform point repairs only on those portions of service lines which are located in an easement or right of way; perform no repairs to service lines on private property.

3.22.2. Typical Sequence of Point Repair. Perform pre-installation video inspection, if required, to verify location of sewer main point repair locations. Perform service testing between manholes to verify location of service lateral point repair locations.

After the location of a point repair is determined, excavate the required length for the point repair.

Before replacing a damaged sections of pipe, determine condition of the existing line on both sides of the point repair by lamping the main at least 10 ft. in each direction. Determine whether additional lengths of main (beyond “minimum length” criteria) need replacement. Report need for additional replacement to Inspector and obtain authorization before proceeding.

Remove the damaged sections pipe and replace with new pipe, shaping the bottom of the trench and placing the required pipe bedding so that the grade of the replaced pipe matches the grade of the existing main. Establish proper grade for the sections of pipe being replaced using methods acceptable to the Inspector.

Connect the new pipe to existing main using flexible adapters. If joints cannot be made watertight using flexible adapters, place waterstop gaskets on each joint and encase in a reinforced concrete collar. Reconnect affected service connections or stacks using full-bodied fittings. No field fabrication of fittings is allowed.

After completion of point repair, and before backfill, perform a smoke test to demonstrate satisfactory integrity of the repair, in the presence of the Inspector. Test as specified in this specification. Repair and retest sections that fail until repaired sections pass the test.

Encase exposed pipe in cement stabilized sand. Backfill the excavation as specified in this specification.

Perform a post-installation video inspection as specified in these specifications. Point repairs that show offset joints, non-uniform grade, incorrect alignment, excessive deflection or similar conditions are considered defective work. Contractor must replace pipe and bedding, as required, to correct defective work.

3.22.3. Abandonment of Point Repair. Notify the Inspector if a pipe is exposed by excavation and is found to be in good condition, not requiring a point repair. That point repair must not be performed.

Notify the Inspector if the pre-installation video inspection reveals that no point repair is required. The point repair must not be performed.

Backfill the excavation, replace pavement or sidewalk, and repair and seed or sod unpaved areas. No separate pay item.

3.22.4. Obstruction Removal. Remote Device: Remove obstructions identified on video of a sanitary sewer line segment which could cause a non-uniform liner pipe installation or obstruction of the liner during installation. Obtain authorization from the Saws Construction Inspector for obstruction removal with a remote device before proceeding.

Use a power-driven cutting device (robotic cutter) to remove protruding taps. Cut protruding taps so that protrusions are no greater than 3/4 in. If a protruding tap cannot be removed by the cutting device, then a point repair may be performed. Obtain authorization from the Saws Construction Inspector before proceeding.

To remove other obstructions, use a remote device. Pull or drive the device from manhole to manhole up to a continuous length of 500 ft. using a solid steel mandrel, porcupine, root saw, bucket, robotic cutter or similar device to remove the obstruction. Select a device that is adequately sized to remove the obstruction.

Use excavation as the method of obstruction removal when installation of the liner in the sanitary sewer is in progress. If during the liner insertion operation, a collapsed sewer, offset joint, or other obstruction is encountered which prevents or blocks the passage or insertion of the liner, notify the Inspector for authorization to excavate.

Excavate at the point where there is an obstruction. Use a trench safety system as required.

Break out the existing sanitary sewer pipe (carrier pipe) as directed by the Saws Construction Inspector. Remove only that quantity of material which is causing the obstruction. Remove the minimum quantity of carrier pipe.

Under such conditions, replacement of the carrier pipe is not required. Do not disturb the existing sewer bedding during excavation. However, if embedment is disturbed during the obstruction removal procedure, place cement stabilized sand or crushed stone beneath the liner. No Separate pay item.

When the liner is completely in place, encase it with crushed stone or cement stabilized sand.

3.22.5. Bypass Pumping. Install and operate bypass pumping equipment as required to maintain sewage flow and to prevent backup or overflow. Comply with “Bypass Pumping” sections of this specification.

3.23. Reconstruction of Sanitary Sewer by Pipe Bursting Replacement Process.

3.23.1. Pit Location. Location and number of insertion or launching pits will be chosen by the Contractor, and will typically be located near existing or proposed manholes, P.I.'s in the line, at logical breaks in the construction phasing, or at locations to comply with access or maintenance requirements.

Pits must be placed and located to minimize the total number of pulls and maximize the length of pipe replaced per pull, within the constraints of maintaining service and access and other requirements. Use excavations at point repair locations for insertion pits where possible.

3.23.2. Operations. The Contractor must provide equipment, planning, and job execution necessary to accomplish the work in an efficient manner and consistent with the objectives of this specification, including preventing damage to existing infrastructure, maintaining pedestrian and vehicle access, and providing continual sewer service to customers.

Pipe must be assembled and fused on the ground in sections equivalent to the length of the anticipated pull. During installation, all bending and loading the pipe will be in conformance with manufacturer's recommendations and must not damage the pipe.

Manholes must be prepared so as to provide pipe installation at the lines and grades indicated in the contract documents. The invert in the manholes must be removed as required to allow for pipe installation activities and to accommodate invert replacement. Manhole inverts must be restored upon completion with 3,000 psi grout so as to establish a minimum 4 in. thick bottom on the manhole after shaping per the contract documents.

3.23.3. Equipment. The Contractor must use pipe bursting or crushing equipment with adequate pulling and pushing force to complete pulls in timely manner. The Contractor must provide equipment on the pulling mechanism to verify the pulling or pushing force exerted on the pipe does not exceed the manufacturer's recommendation for allowable pulling force to prevent damage to the pipe. The pulling force may not exceed the following: 6 tons for 8.625 in. O.D.; 10 tons for 10.75 in. O.D.; 17 tons for 14 in. O.D.; 23 tons for 16 in. O.D.; 28 tons for 18 in. O.D. Allowable pulling force for all diameters must be determined by the Contractor depending on the pipe size, wall thickness, manufacturer, field conditions, pull distance, manhole integrity, bearing capacity of soils, adjacent infrastructure, related equipment and cable strength, and related considerations.

3.23.4. Equipment Configuration. Equipment must be configured with adequate knives or other appropriate devices to minimize interruptions in the installation process due to obstruction removal and other problems. Pipe must be secured to the pulling or pushing device in accordance with standard practice. The diameter of the pulling or pushing head must be equal or slightly greater than the pipe O.D.

3.23.5. Minimize Noise Impact. Equipment used to perform the work will be located away from buildings so as not to create noise impact. Provide silencers or other devices to reduce machine noise as required to meet requirements.

3.23.6. Protection. The Contractor must provide for the general safety of workers, pedestrians and traveling public throughout this project. Existing surface improvements and underground facilities and utilities must also be protected. Damage caused by the Contractor must be repaired at his own expense. Protection to be provided includes:

Provide barricades, warning lights and signs for excavations created by point repairs. Conform to requirements of The Department, City of San Antonio, and of contract documents.

Protection of Manholes. The Contractor will install all pulleys, rollers, bumpers, alignment control devices and other equipment required to protect existing manholes, and to protect the pipe from damage during installation. Lubrication may be used as recommended by the manufacturer. Under no circumstances will the pipes be stressed beyond their elastic limit.

Do not allow sand, debris, or runoff to enter the sewer system.

Verify location of all underground utilities and facilities potentially impacted by rehabilitation related or other project activities and take necessary precautions to provide protection from damage. Damage caused by the Contractor will be at his cost and responsibility.

Protect the new pipe and components during all phases of work, including hauling, installation, entry into the entry pit and prevention of scarring or gouging of the pipe or components.

3.23.7. Sealing Liner in Manhole. Allow liner pipe to normalize to ambient temperatures as well as recover from imposed stretch before cutting to fit between manholes, sealing at manholes, and manhole invert shaping. Normalization usually takes at least 12 hr. for polyethylene.

Cut liner so that it extends four in. into manhole. Make a smooth, vertical cut and slope area over top of exposed liner using non-shrink grout.

Seal the annular space between liner and sanitary sewer main at each manhole with a chemical seal and non-shrink grout. Place strips of oakum soaked in sealer (Scotchseal 5600 as manufactured by 3M Corporation, or approved equal) in a band to form an effective watertight gasket in the annular space between liner and existing opening in manhole. Make width of the sealing band a minimum of eight in. or the thickness of the manhole wall, whichever is greater.

Finish seal with a non-shrink grout placed around annular space from inside manhole. Apply grout in a band not less than six in. wide.

Reshape and smooth the manhole invert. Form a smooth transition with a reshaped invert and a raised manhole bench to eliminate sharp edges of liner pipe, concrete bench, and channeled invert. Build up and smooth invert of manhole to match flow line of new liner.

3.24. Slip-lining Sanitary Sewers.

3.24.1. Obstruction Removal and Point Repair. Make point repairs and remove obstructions, such as roots, rocks and other debris, before installing liner pipe. Inspector is to first validate the need for either an obstruction removal or point repair. Refer to “Obstruction Removal” under “Point Repair” section of this specification.

3.24.2. Bypass Pumping. Install and operate bypass pumping equipment as required to maintain sewage flow and to prevent backup or overflow. Comply with “Bypass Pumping” section of this specification.

3.24.3. Insertion or Access Pits. Locate pits so that the total number is minimized and footage of liner pipe installed in a single pull is maximized. Where possible, use excavations at point repair locations for insertion pits.

Before excavating, check with various utility providers (e.g., CPS Energy, AT&T, Time Warner, etc.), and determine locations of utilities in or near the work area. Costs of utility repairs, temporary service and other costs arising out of damage to, or interruption of, utilities, resulting from operations under this Contract, will be borne by Contractor at no additional cost to SAWS.

Perform excavation and backfill in accordance with this specification. Perform excavation requiring trench safety in accordance with OSHA standards and this specification. Install and operate necessary dewatering and surface water control measures.

3.24.4. FRP Liner Pipe Installation. FRP Liner pipe may be pushed or pulled into existing sewers. Insert pipes, spigot end first, with bell end trailing. Apply pushing force to pipe wall end inside bell in accordance with manufacturer’s instruction. Do not apply jacking loads to end of bell. Maximum allowable joint angular deflection one degree.

3.24.5. Clamp Installation. Where excavations for liner pipe insertion are made between two manholes, cut ends of liner pipe smooth, square to pipe axis. Join liner pipes with appropriately sized stainless steel universal clamp couplings. Butt together gap between ends of liner pipe with space between ends not exceeding 2 in.

Install bedding in accordance with this specification.

3.24.6. FRP Collar Closure. Install FRP collar closure pieces in accordance with manufacturer's recommendations.

3.24.7. Field Quality Control. After liner installation, perform the following tests:

Service lateral connection test: After all service laterals have been completed for a particular sewer section, verify integrity of re-connections at points where they join liners and existing service lines by performing smoke test.

3.24.8. Sealing Liner in Manhole. Allow liner pipe to normalize to ambient temperatures and recover from imposed stretch before cutting to fit between manholes, sealing at manholes and shaping manhole invert. Allow at least 12 hr. for normalization of polyethylene.

Cut liner so it extends 4 in. into manhole. Make smooth, vertical cuts and slope areas over top of exposed liner using non-shrink grout.

Seal annular spaces between liner and sanitary sewer main at each manhole with chemical seal and non-shrink grout. Place strips of oakum soaked in sealer in a band to form effective water-tight gasket in annular space between liner and existing pipes in manhole. Make width of the sealing band at least 12 in., or one-half pipe diameter, whichever is greater.

Finish seal liner pipe to host pipe with non-shrink grout placed around annular space from inside manhole. Apply grout in a band at least 6 in. wide. Obtain the SAWS Engineer's approval of sealing methods, including seal chemicals and materials.

Use cementitious grout to form smooth transitions with reshaped inverts and raised manhole benches to eliminate sharp edges of liner pipe, concrete benches, and channeled inverts. Build up and smooth manhole invert to match flow line of new liner.

3.24.9. Grouting Annular Space. Provide grouting plan and obtain approval of grouting plan from SAWS Engineer before proceeding with the Work.

Grout annular space between the outside of liner and inside of existing pipe for sewer pipe 18 in. in diameter and larger.

3.24.10. Post Installation Videotape Recording. Provide the SAWS Engineer with DVD showing completed work including condition of restored connections. Comply with requirements of "Television Inspection" of this specification.

3.24.11. Final Clean-up. Upon completion of installation and testing, clean and restore project area affected by work of this Section. No separate pay item.

3.25. Sanitary Sewer System Cleaning. The Contractor will be required to have all materials, equipment, and labor necessary to complete the cleaning of the sanitary sewer system on the jobsite before isolating it for the cleaning process. The Contractor must only use the type of cleaning identified below to perform the necessary removal of all material which will not create hazards to health, property, affect downstream treatment plant processes, or damage to the sanitary sewer system.

The sanitary sewer mains, manholes, and structures must be cleaned using mechanical, hydraulically propelled, and high velocity sewer cleaning equipment. The cleaning process must remove all debris, grease, sand, silts, solids, rags, rock, etc. from each sewer segment, including the manholes or structures.

Selection of cleaning equipment and the method for cleaning will be based on the condition of the sanitary sewer lines at the time work commences and will be subject to SAWS' pre-approval. All cleaning equipment and devices must be operated by experienced personnel. Satisfactory precautions must be taken to protect the sanitary sewer lines, manholes, or structures from damage that might be inflicted by the improper use of the cleaning process or equipment. Any damages done to a sewer line manhole, or structure by the Contractor must be repaired by the Contractor at no additional cost and to the satisfaction of SAWS. Cleaning must also include the manhole or structure wall washing by a high pressure water jet.

3.25.1. Hydraulic Cleaning. Hydraulic-propelled devices which require a head of water to operate must use a collapsible dam. The dam must be easily collapsible to prevent damage to the sewer line, property, etc. When using hydraulically propelled devices, precautions should be taken to ensure that the water pressure created does not cause damage or flood public or private property. The Contractor must not increase the hydraulic gradient of the sanitary sewers beyond the elevation that could cause overflow of sewage into area waterways or laterals. The flow of wastewater present in the sanitary sewer line must be used to provide necessary fluid for hydraulic cleaning devices whenever possible.

3.25.2. High Velocity Cleaning. Cleaning equipment that uses a high velocity water jet for removing all debris must be capable of producing a minimum volume of 50 gpm, with a pressure of 1,500 psi, for the sanitary sewer main and 3,500 psi for the (manhole) structure at the pump. Any variations to this pumping rate must be pre-approved by the Inspector. To prevent damage to older sewer lines and property, a pressure less than 1,500 psi can be used. A working pressure gauge must be used on the discharge of all high pressure water pumps. The Contractor must use, in addition to conventional nozzles, a nozzle which directs the cleaning force to the bottom of the pipe for sewers 18 in. and larger in diameter. The Contractor must operate the equipment so that the pressurized nozzle continues to move at all times. The pressurized nozzle must be turned off or reduced anytime the hose is on hold or delayed to prevent damage to the line.

3.25.3. Mechanical Cleaning. Mechanical cleaning, in addition to normal cleaning when required, must be with approved equipment and accessories driven by power winching devices. The Contractor must submit the equipment manufacturer's operational manual and guidelines to the Inspector, which must be followed strictly unless modified by the Inspector. All equipment and devices must be operated by experienced operators so that they do not damage the pipe in the process of cleaning. Buckets, scrapers, scooters, porcupines, kites, heavy duty brushes, and other debris-removing equipment and accessories must be used as appropriate and necessary in the field, in conjunction with the approved power machines. The use of cleaning devices such as rods, metal pigs, porcupines, root saws, snakes, scooters, sewer balls, kites, and other approved equipment, in conjunction with hand winching device, and gas, electric rod propelled devices, must be considered normal cleaning equipment.

3.25.4. General Requirements. In addition to the requirements specified herein, the Contractor must maintain a clean work area and surrounding premises within the work limits so as to comply with Federal, State, and local environmental and anti-pollution laws, ordinances, codes, and regulations when cleaning and disposing of waste materials, debris, and rubbish. The Contractor must also keep the work and surrounding premises within work limits free of accumulations of dirt, dust, waste materials, debris, and rubbish. Suitable containers for storage of waste materials, debris, and rubbish must be provided until time of disposal. It is the responsibility of the Contractor to secure a licensed legal dump site for the disposal of this material. Under no circumstances must sewage or solids removed from the main or manhole be dumped on the ground, streets, ditches, catch basins, storm drains, or sanitary sewers. Cost for this item will be included in the price bid for sanitary sewer system cleaning.

The Contractor may be required to demonstrate the performance capabilities of the cleaning equipment proposed for use on the project. If the results obtained by the proposed sanitary sewer system cleaning equipment are not satisfactory to the Inspector, the Contractor must use different equipment and attachments, as required, to meet the requirements of the contract documents. More than one type of equipment or attachments may be required at any given location within the project scope. When hydraulic or high velocity cleaning equipment is used, a suitable sand trap, weir, dam, or suction must be constructed in the downstream manhole in such a manner that all the solids and debris are trapped for removal.

Whenever hydraulically propelled cleaning tools which depend upon water pressure to provide their cleaning force, or any tool which retard the flow of water in the sanitary sewer mains are used, precautions must be taken to ensure that the water pressure created does not cause any damage or flooding to public or private property being served by the manhole section involved. Any damage of property, as a result of flooding, will be the liability and responsibility of the Contractor. The flow of wastewater present in the sanitary sewer system must be used to provide necessary fluid for hydraulic cleaning devices whenever possible. When additional quantities of water from fire hydrants are necessary to avoid delay in normal working procedures, the water must be conserved and not used unnecessarily. No fire hydrant must be obstructed or used when there is a fire in the area. The Contractor will be responsible for obtaining the water meter and all related charges for the set-up, including the water usage bills from respective water purveyor agency. All expenses will be considered incidental to the cleaning of the existing sanitary sewer system.

3.26. Grouting of Sewer Mains. Abandoning and grouting of sewer lines must not occur until all existing sewer mains and services have been transferred to a relocated sewer line or another line as designated in the Contract Documents. The Contractor will be responsible for the satisfactory coordination of the pipe abandonments with other construction and activities in the area. Delays in work resulting from lack of coordination must not be cause for additional compensation. Any work involving or impacting asbestos concrete pipe must be in accordance with the specifications.

Remove or pump out any free standing wastewater in compliance with TCEQ and EARZ requirements before starting grout placement.

Place grout or flowable fill using concrete or grout pumps capable of continuous delivery at planned placement rate to fill volume between placement points not to exceed 500 ft. at a time. Pump grout/flowable fill through bulkheads constructed for placement of PVC pipes or other methods to contain grout in line to be abandoned. These pipes will be used for injection points or vents during placement. Place grout or flowable fill under pressure into properly vented open system until grout emerges from vent pipes indicating pipe is completely filled. Pumping must be completed under enough pressure to overcome friction and to fill sewer main from downstream to upstream end. Remediate areas where grout or flowable fill did not fill voids in sewer main by pressure grouting from inside sewer main or from surface if necessary. Plug each end of the sewer main being abandoned. Ensure that concrete is placed around plug or bulkhead and around pipe including bedding area, such that it is not penetrable by groundwater and that bedding at this location is not a conduit for groundwater. The method of installation must meet the requirement of completely filling the existing sewer main and any voids adjacent to it.

Backfill to grade above pipe left in place. Place and compact backfill in compliance with the Special Specifications.

Remove, transport, and dispose of spoils. Spoils including pipe, unused grout or flowable fill and other unsuitable materials must be hauled to a facility permitted to accept the material. The abandonment method must provide for the release of air. When intermediate points are required to be constructed for the abandonment of the system, they must be a part of the abandonment project process. The method must provide for the isolation of sewer mains to be grouted from sewer mains that are abandoned in place without grouting as shown on the plans.

Sewer mains that are not under proposed pavement are generally not required to be grouted unless it is specified in the contract documents. Mains to be abandoned must be grouted only if required by the contract documents and payment as per these specifications is provided.

4. TESTING

4.1. Manhole Testing. The Contractor must perform the testing for all sanitary sewer manholes in accordance with the following.

4.1.1. Leakage Testing. All manholes must pass a leakage test. The Contractor must test each manhole (after assembly and backfilling) for leakage, separate and independent of all other sanitary sewer piping, by means

of either a hydrostatic test, vacuum test, or other methods approved. The Contractor is hereby instructed to conduct either of the two identified tests in the following manner:

4.1.1.1. Hydrostatic Testing. Hydrostatic testing must be conducted by utilizing approved plugs to seal all influent and effluent pipes in the manhole and filling the manhole to the top of the cone with water. Additional water may be added over a 24 hr. period to compensate for absorption and evaporation losses. At the conclusion of the 24 hr. saturation period, the manhole must be filled to the top and observed. Any measureable loss within a 30-min. period will be considered an unsuccessful test and thus require the Contractor to assess the needed repairs, perform such repairs (subject to the approval), and notify the Inspector when the retest will be performed. All effort, materials, or other costs will be solely at the Contractor's expense.

4.1.1.2. Vacuum Testing. General: Manholes must be tested after construction/installation and backfilling, with all connections (existing or proposed) in place. Drop connections and gas sealing connections must be installed before testing.

Test Procedure: The lines entering the manhole must be temporarily plugged, with the plugs braced to prevent them from being drawn into the manhole. The plugs must be installed in the lines beyond drop connections, gas sealing connections, etc. Before performing the test, the Contractor must plug all lift holes and exterior joints with a non-shrink grout and plug all pipes entering the manhole. No grout must be placed in horizontal joints before testing. Contractor must use a minimum 60-in./lb. torque wrench to tighten the external clamps that secure the test cover to the top of the manhole. The test head must be inflated in accordance with the manufacturer's recommendations. A vacuum of 10 in. of mercury must be drawn and the vacuum pump will be turned off. With the valve closed, the level vacuum must be read after the required test time. If the drop in the level is less than 1 in. of mercury (final vacuum greater than 9 in. of mercury), the manhole will have passed the vacuum test. The required test time is 2 min.

Acceptance: Manholes will be accepted with relation to vacuum test requirements if they meet the criteria above. Any manhole which fails the initial test must be repaired with a non-shrink grout or other suitable material based on the material of which the manhole is constructed. The manhole must be retested as described above until a successful test is attained. After a successful test, the temporary plugs will be removed. To ensure that the plugs have been removed, Contractor will only do so in the presence of the Inspector.

Repairs to Existing Manholes: Any existing manhole which fails to pass the vacuum test will be closely examined by the Inspector and the Contractor to determine if the manhole can be repaired. Thereafter, the Contractor must either repair or remove and replace the manhole as directed. The manhole must then be retested and coated with a SAWS-approved sewer coating as stated above. The Owner may elect to simply remove and replace the existing manhole with a new one. Any manhole excavated for repairs or excavated for tie in must be backfilled with flowable fill up to 1 ft. below the top of the cone.

Measurement and Payment: Vacuum testing of new structures will not be a pay item. The cost of this work will be included in the bid price for the new manhole. Each vacuum test of an existing manhole will be a separate pay item. Repairs to existing manholes will be a separate pay item when authorized.

4.1.2. Holiday Testing. Inspect each sanitary sewer manhole using high-voltage holiday detection equipment. All detected holidays must be marked and repaired by abrading the coating surface with grit disk paper or other hand tooling method. After abrading and cleaning, additional protective coating material must be applied to the repair area. All touch-up repair procedures must follow the protective coating manufacturer's recommendations.

If a sanitary sewer manhole fails to pass one of the above tests, it must be repaired in accordance with the manufacturer's recommendations and re-tested. It will not be accepted until it passes all tests. All repairs and re-testing will be at no additional cost to SAWS.

4.2. Sanitary Sewer Pipe Low Pressure Air Testing. The Contractor must perform a low pressure air test, or an infiltration/exfiltration test, and a mandrel test before the installed work will be considered accepted. If a gravity collection main is composed of flexible pipe, a deflection test will also be required. Flexible pipe is

defined as pipe that will deflect at least 2% without structural distress. Contractor must insure that all testing is performed in the presence of the Inspector, with copies of all written test results made available to the Inspector.

Materials for Air Testing. The Contractor must furnish all materials and equipment for air testing including the air compressor.

Compressor Air Supply. Any source which will provide at least 300 cu. ft./min. at 100 lb./sq. in.

The equipment for air testing will consist of valves, plugs, and pressure gauges used to control the rate at which air flows to the test section and to monitor the air pressure inside the plugs and, for large diameter pipe, joint testers as manufactured by Cherne Industrial, Inc., of Edina, Minn., or an approved equal. Test equipment is to be assembled as follows and as shown in Figure 1 below:

- Hose connection,
- Shut off valve,
- Throttle valve,
- Pressure reduction valve,
- Gage cock, and
- Monitoring pressure gage.

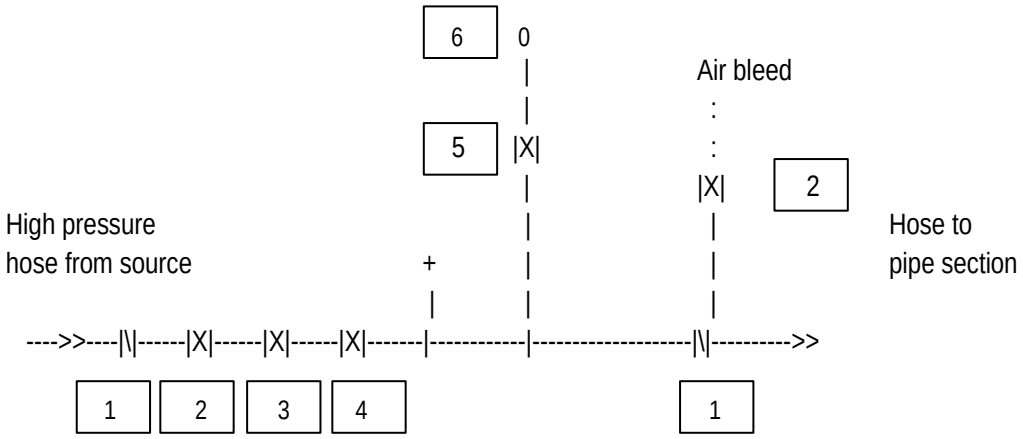

Figure 1

Air Testing Equipment Assembly Order

Test Procedures.

The procedure for the low pressure air test must conform to the procedures described in ASTM C-828, ASTM C-924, ASTM F-1417 or other appropriate procedures, except for testing times. The test times will be as outlined in this section. For sections of pipe less than 36 in. average inside diameter, the following procedure will apply unless the pipe is to be joint tested. The pipe must be pressurized to 3.5 psi greater than the pressure exerted by groundwater above the pipe. Once the pressure is stabilized, the minimum time allowable for the pressure to drop from 3.5 psi gauge to 2.5 psi gauge must be computed from the following equation:

$$T = (0.085 \times D \times K) / Q$$

T = Time for pressure to drop 1 lb./sq. in. gauge in seconds

K = 0.000419 x D x L, but not less than 1

D = Average inside pipe diameter in inches

L = Length of line of same pipe size being tested, in feet

Q = Rate of loss, 0.0015 cu. ft./min./sq. ft. internal surface will be used since a K value of less than 1 will not be used.

There are minimum testing times for each pipe diameter as shown in Table 8.

Table 8
Minimum Testing Times

Pipe Diameter	Minimum Time	Length for Minimum Time	Time for Longer Length
In.	Sec./Ft.	Ft.	Sec./Ft.
6	340	398	0.855
8	454	298	1.52
10	567	239	2.374
12	680	199	3.419
15	850	159	5.342
18	1,020	133	7.693
21	1,190	114	10.471
24	1,360	100	13.676
27	1,530	88	17.309
30	1,700	80	21.369
33	1,870	72	25.856

Note: Test time starts after the required 60 sec. of stabilization time.

The test may be stopped if no pressure loss has occurred during the first 25% of the calculated testing time. If any pressure loss or leakage has occurred during the first 25% of the testing period, then the test will continue for the entire test duration as outlined above or until failure.

Mains with a 27 in. average inside diameter and larger must be air tested at each joint. If the joint test is used, a visual inspection of the joint must be performed immediately after testing. The pipe is to be pressurized to 3.5 psi greater than the pressure exerted by groundwater above the pipe. Once the pressure has stabilized, the minimum time allowable for the pressure to drop from 3.5 psi gauge to 2.5 psi gauge will be 10 sec.

Mains that are greater than 33 in. diameter must be tested for leakage at each joint, or as approved.

4.3. Sanitary Sewer Pipe Infiltration/Exfiltration Test. The Contractor must perform a low pressure air test, or an infiltration/exfiltration test, and a mandrel test before the installed work will be considered accepted. The total exfiltration, as determined by a hydrostatic head test, must not exceed 50 gal. per inch of diameter per mile of main per 24 hr., at a minimum test head of 2 ft. above the crown of the main at an upstream manhole. The Contractor must use an infiltration test in lieu of an exfiltration test when mains are installed below the ground water level. In such cases, the total exfiltration, as determined by a hydrostatic head test, must not exceed 50 gal. per inch of diameter per mile of main per 24 hr., at a minimum test head of 2 ft. above the crown of the main at an upstream manhole, or at least 2 ft. above the existing groundwater level, whichever is greater. For construction work occurring within a 25-yr. floodplain, the infiltration or exfiltration must not exceed 10 gal. per inch of diameter per mile of main per 24 hr., at the same minimum test head as stated in the previous sentence. If the quantity of infiltration or exfiltration exceeds the maximum quantity specified, the Contractor must propose to the Engineer, and receive approval therefrom, all necessary remedial action, solely at the Contractor's own cost, in order to reduce the infiltration or exfiltration to an amount within the limits specified herein.

4.4. Sanitary Sewer Pipe Deflection Testing. The Contractor must perform a low pressure air test, or an infiltration/exfiltration test, and a mandrel test before the installed work will be considered accepted. As stated in the 30 TAC § 217, deflection test must be performed on all flexible pipe installed.

- For mains with inside diameters less than 27 in., a rigid mandrel must be used to measure deflection.
- For mains with an inside diameter 27 in. and greater, an approved method will be used to test for vertical deflections.

The deflection test must be accurate to within +0.2% deflection. The test must be conducted after the final backfill has been in place at least 30 days. No pipe will exceed a deflection of 5%. If a pipe should fail to pass the deflection test, the problem must be corrected and a second test must be conducted after the failed area's final backfill has been in place an additional 30 days. The tests must be performed without mechanical pulling devices. The Engineer should recognize that this is a maximum deflection criterion for all pipes and a deflection test less than 5% may be more appropriate for specific types and sizes of pipe. Upon completion of construction, the Engineer, or other Texas Licensed Professional Engineer appointed by the Owner, will certify to the Inspector that the entire installation has passed the deflection test. This certification may be made in conjunction with the notice of completion required in 30 TAC § 217.14. (1) of this title (relating to General Provisions). This certification must be provided for the Owner to consider the requirements of the approval have been met.

Mandrel Sizing:

The rigid mandrel must have an outside diameter (O.D.) not less than 95% of the inside diameter (I.D.) of the pipe. The inside diameter of the pipe, for the purpose of determining the outside diameter of the mandrel, will be the average outside diameter minus 2 minimum wall thicknesses for O.D. controlled pipe, and the average inside diameter for I.D. controlled pipe. All dimensions will be per appropriate standard. Statistical or other "tolerance packages" will not be considered in mandrel sizing.

Mandrel Design:

The rigid mandrel must be constructed of a metal or a rigid plastic material that can withstand 200 psi without being deformed. The mandrel must have 9 or more "runners" or "legs" as long as the total number of legs is an odd number. The barrel section of the mandrel must have a length of at least 75% of the inside diameter of the pipe. A proving ring must be provided and used for each size mandrel in use.

Method Options:

Adjustable or flexible mandrels are prohibited. A television inspection is not a substitute for the deflection test.

4.5. Testing for Reconstruction of Existing Manholes. The Contractor must perform the testing for all sanitary sewer manholes in accordance with the following. All manholes must pass a leakage test. The Contractor

must test each manhole (after reconstruction and backfilling) for leakage, separate and independent of all other sanitary sewer piping, by means of either a hydrostatic test, vacuum test, or other methods approved. The Contractor is hereby instructed to conduct either of the 2 identified tests in the following manner.

4.5.1. Hydrostatic Testing. Hydrostatic testing must be conducted by utilizing approved plugs to seal all influent and effluent pipes in the manhole and filling the manhole to the top of the cone with water. Additional water may be added over a 24 hr. period to compensate for absorption and evaporation losses. At the conclusion of the 24 hr. saturation period, the manhole must be filled to the top and observed. Any measureable loss within a 30 min. period will be considered an unsuccessful test and thus require the Contractor to assess the needed repairs, perform such repairs (subject to approval), and notify the Inspector when the retest will be performed. All effort, materials, or other costs will be solely at the Contractor's expense.

4.5.2. Vacuum Testing. Manholes must be tested after construction/installation and backfilling with all connections (existing and proposed) in place. Drop connections and gas sealing connections must be installed before testing.

Test Procedure: The lines entering the manhole must be temporarily plugged, with the plugs braced to prevent them from being drawn into the manhole. The plugs must be installed in the lines beyond drop connections, gas sealing connections, etc. Before performing the test, the Contractor must plug all lift holes and exterior joints with a non-shrink grout and plug all pipes entering the manhole. No grout must be placed in horizontal joints before testing. Contractor must use a minimum 60-in./lb. torque wrench to tighten the external clamps that secure the test cover to the top of the manhole. The test head must be inflated in accordance with the manufacturer's recommendations. A vacuum of 10 in. of mercury must be drawn, and the vacuum pump will be turned off. With the valve closed, the level vacuum must be read after the required test time. If the drop in the level is less than 1 in. of mercury (final vacuum greater than 9 in. of mercury), the manhole will have passed the vacuum test. The required test time is 2 min.

Acceptance: Manholes will be accepted with relation to hydrostatic/vacuum test requirements, if they meet the criteria above. Any manhole which fails the initial test must be repaired with non-shrink grout or other suitable material based on the material of which the manhole is constructed. The manhole must be retested as described above until a successful test is attained. After a successful test, the temporary plugs will be removed. To ensure that the plugs have been removed, Contractor must only do so in the presence of the Inspector.

Repairs to Existing Manholes: Any existing manhole which fails to pass the hydrostatic or vacuum test must be closely examined by the Inspector and the Contractor to determine if the manhole can be repaired. Thereafter, the Contractor must either repair or remove and replace the manhole as directed. The manhole must then be retested and coated with a SAWS approved sewer coating as stated above. The Owner may elect to simply remove and replace the existing manhole with a new one. Any manhole excavated for repairs or excavated for tie in must be backfilled with flowable fill up to 1 ft. below the top of the cone. The Contractor also has the option of backfilling with approved secondary materials, subject to the provisions of this specification.

Measurement and Payment: Hydrostatic/Vacuum testing of new structures will not be a pay item. The cost of this work will be included in the bid price for the new manhole. Each hydrostatic/vacuum test of an existing manhole will be a separate pay item. Repairs to existing manholes will be a separate pay item when authorized.

4.5.3. Holiday Testing. Inspect each sanitary sewer manhole using high-voltage holiday detection equipment. All detected holidays must be marked and repaired by abrading the coating surface with grit disk paper or other hand tooling method. After abrading and cleaning, additional protective coating material must be applied to the repair area. All touch-up repair procedures must follow the protective coating manufacturer's recommendations.

4.5.4. Test Failure. If a sanitary sewer manhole fails to pass one of the above tests, it must be repaired in accordance with the manufacturer's recommendations and retested. It will not be accepted until it passes all tests. All repairs and re-testing will be at no additional cost to SAWS.

4.6. Bypass Pumping. Testing and quality control will be required for all bypass pumping systems, stationary pumping, and flow diversion systems, as indicated below. Contractor must obtain and keep copies of all required permits on site before beginning testing and throughout performance of the work.

Contractor must prove to the Owner that the equipment, materials, and all operational aspects & appurtenances related to the BPP are in good condition before commencing the bypass pumping operation. Failure to do so will result in the Contractor not being permitted to continue with any construction work requiring bypass pumping operations. Contractor must notify the SAWS Inspections Department 48 hr. before commencing any testing. Any flows excessively surcharging the sanitary sewer system during the test or during actual bypass periods will deem the BPP to be unacceptable and it must be revised and resubmitted for approval. There will be no separate pay item if this condition occurs during the timeframe in which bypass pumping testing or operations are underway during the project. No testing of the bypass pumping operation will be conducted between Thursday and Sunday, unless approved by SAWS. If bypass pumping will take place outside normal work hours which are between 8 am to 5 pm Mondays through Fridays (except for SAWS observed holidays), Contractor must reimburse SAWS for the overtime costs required by his bypass pumping testing outside of SAWS normal work hours.

Discharge piping, joints, and all accessories will be required to be hydrostatic tested. All piping, joints, and accessories must be able to withstand at least twice the maximum system pressure or a minimum of 50 psi, whichever is greater.

For any bypass operations proposed a 24 hr. test run must be satisfactorily performed before commencing any construction work. The Inspector must provide acknowledgment first. Contractor must provide both a strobe light type high level alarm and alarm notification to Contractor cell phones, as well as other appointed personnel to be identified by SAWS, and insure adequate alarm notification is attained before actual startup of the test period.

During the testing period, the Contractor must install a Float Monitoring System in the upstream manhole or pipe to confirm that the bypass pumping flow data shown in their BPP remains applicable. The float monitoring system must remain in the manhole or pipe for the duration of the bypass operation. The data collected during the test and duration of the bypass operation must be provided to SAWS for evaluation and recording. It will be required of the Contractor to have personnel remain onsite at the flow monitoring system in order to continuously record (every 30 min.) the flows during both the test and actual bypass pumping periods. Contractor must submit a copy of Testing Float Monitoring System Data log to SAWS upon successful completion of test. Data log must be in column format with each line entry indicating the time, elapsed time of test, level of flow indicated in manholes, total flow being pumped by the BPP system, and any comments pertaining to the test.

Contractor must perform a full scale demonstration test of his proposed pump and haul bypass system to prove that his system can be successfully used for bypass pumping at the proposed locations. Contractor's test must use all of the equipment and staff that will operate the bypass pumping system during performance of the work. Traffic control systems required during the work must be used during the test. Withdrawals and discharges of flow must be from or into the manhole locations identified in the Contractor's BPP except for pump and haul system. This requirement is intended to demonstrate that the Contractor's proposed BPP is capable of providing satisfactory bypass pumping before Contractor beginning the work, including the size and number of trucks and cycles times. Pump and haul system flow must be disposed of in a TCEQ licensed facility and all manifests must be kept and submitted. Disposal of pump and haul flow in a nearby manhole is not acceptable.

Any failure of equipment or activities associated with the bypass pumping operations contributing to either an excessive surcharge or SSO will be deemed a failed test. The test will then be stopped and any necessary cleanup or reporting efforts performed. The BPP will need to be revised, resubmitted, and acknowledged before the test initiating again. Any effort by SAWS or other third parties to mitigate damages resulting from any surcharging or SSOs will be the direct and sole responsibility of the Contractor. This includes any related fines, penalties, or damages.

Plugs must be tested before use. The inflatable plug must be placed inside of a structurally sound pipe or conduit and inflated to its operating pressure, then monitored for 24 hr. to observe that it holds the required pressure. This testing must be performed in accordance with the manufacturer's recommendations. Inflating a plug when it is not constrained or overinflating the plug creates a risk of being injured by pieces of the plug exploding if it fails.

4.7. Sewer Force Main Flushing and Testing.

4.7.1. Flushing. Immediately upon completion of pipe laying, the Contractor will flush all mains which are scheduled to be tested. This flushing will be at the direction of the Engineer and will consist of completely filling sections of main between valves and then displacing such initial volumes of water by introducing clear water from existing facilities into and through the main to the point of discharge from the main being flushed. The flow-through will continue until the Engineer determines all dust, debris, or foreign matter that may have entered during pipe laying operations have been flushed out. The new line will then be left under system pressure for testing.

To avoid damage to pavement and inconvenience to the public, fire hoses will be used to direct flushing water from the main into suitable sewers.

4.7.2. Operation of Valves. No valve in the sanitary sewer force main system will be operated by the Contractor without prior permission. The Contractor will notify the Engineer when a valve is to be operated and will only operate the valve in the presence of the Engineer's representative.

4.7.3. Hydrostatic Tests. All new pressure mains will be hydrostatically field tested at a maximum test pressure of 200 psi before acceptance. It is the intent of these Specifications that all joints be watertight and that all joints which are found to leak by observation during any test must be made watertight by the Contractor.

All joints which are found to leak either by observation or during any test will be made watertight by the Contractor. In case repairs are required, the hydrostatic field test will be repeated until the pipe installation conforms to the specified requirements and is acceptable. The expense for tests which meet specified requirements will be made in accordance with the unit price for the hydrostatic pressure test. No payment will be made for tests which fail to meet specified test leakage requirements.

After the new main has been laid and backfilled as specified, but before replacement of pavement, it will be filled with water for a minimum of 24 hr. and then subjected to a hydrostatic pressure test.

The specified test pressure will be supplied by means of a pump connected to the main in a satisfactory manner. The pump, pipe connection, and all necessary apparatus including gauges and meters will be furnished by the Contractor. Unless otherwise specified, the San Antonio Water System will furnish potable water for filling lines and making tests through existing mains. Before applying the specified test pressure, all air will be expelled from the main. To accomplish this, taps will be made, if necessary, at the points of highest elevation and afterwards tightly plugged. At intervals during the test, the entire route of the new main will be inspected to locate any leaks or breaks. If any are found, they will be stopped or repaired. The test will be repeated until satisfactory results are obtained.

The hydrostatic test will be made so that the maximum pressure at the lowest point does not exceed the specified test pressure. The duration of each pressure test will be a minimum of 4 hr. for new mains in excess of 1,000 ft. after the main has been brought up to test pressure. The test pressure will be measured by means of a tested and properly calibrated pressure gauge. All pressure tests will be continued until the Engineer is satisfied that the new main meets the requirements of these specifications. Should any test of pipe in place disclose leakage greater than listed in Table 9, "Hydrostatic Test Leakage Allowances," the Contractor will, at his expense, locate and repair the defective joints until the leakage is within the specified allowance. Leakage is defined as the quantity of water supplied into the newly laid main, or any valved section of it, necessary to maintain the specified leakage test pressure after the main has been filled with water and the air expelled. The Contractor will notify the Engineer before beginning the test, and the San Antonio Water System's Inspector will be present during the pressure test.

Table 9

Hydrostatic Test Leakage Allowances (Max) @ 200 psi

Nominal Diameter and Pipe Material	Allowable Leakage in Gallons Per Hour (gph) [2]									
	100 Ft.	200 Ft.	300 Ft.	400 Ft.	500 Ft.	600 Ft.	700 Ft.	800 Ft.	900 Ft.	1000 Ft.
6 in. DI[1]	0.13	0.25	0.38	0.51	0.64	0.76	0.89	1.02	1.14	1.27
8 in. DI[1]	0.17	0.34	0.51	0.68	0.85	1.02	1.19	1.36	1.53	1.70
12 in. DI[1]	0.26	0.51	0.77	1.02	1.28	1.53	1.79	2.04	2.30	2.55
16 in. DI[1]	0.34	0.68	1.02	1.36	1.70	2.04	2.38	2.72	3.06	3.40
20 in. DI[1]	0.43	0.85	1.28	1.70	2.13	2.55	2.98	3.40	3.83	4.25
24 in. DI[1]	0.51	1.02	1.53	2.04	2.55	3.06	3.57	4.08	3.59	5.10
30 in. DI[1]	0.64	1.27	1.91	2.55	3.19	3.82	4.46	5.10	5.73	6.37
36 in. DI[1]	0.76	1.53	2.29	3.06	3.82	4.58	5.35	6.11	6.88	7.64
42 in. DI[1]	0.89	1.78	2.68	3.57	4.46	5.35	6.24	7.14	8.03	8.92
48 in. DI[1]	1.02	2.04	3.06	4.08	5.10	6.11	7.13	8.15	9.17	10.19

[1] PVC pipe must be tested to DI pressures. DI Pipe includes mechanical and push-on joints.

[2] Note: Leakage allowances may be determined for footages not specifically listed by interpolation or by the combination of various tabular data.

4.7.4. Contractor's Personnel and Equipment. The Contractor will supply labor and equipment necessary to make all excavations required for flushing, equipment connections, and placing the mains in service.

4.7.5. Safeguarding and Backfilling Open Holes. The Contractor will be responsible for safeguarding any open holes excavated or left open for flushing and testing purposes. Following completion of testing, the Contractor will backfill such holes in accordance with appropriate provisions of these specifications.

4.8. Rehabilitation of Sanitary Sewer by Cured-In-Place Pipe Testing.

4.8.1. Chemical Resistance. Chemical Resistance - The CIPP must meet the chemical resistance requirements of ASTM F1216, Appendix X2 except as modified herein. Table X2.1 of ASTM F1216 must be modified as follows. It is required that CIPP samples with and without plastic coating meet these chemical testing requirements. Proof of chemical resistance test must be provided to the Engineer at least 15 days before commencement of work.

Chemical Solution	Concentration %
Tap water	pH of 5 to 11
Acids	pH not less than 5
Gasoline	Total BETX limit of 100 mg/L
Oil & Grease	50 mg/L
Total Phosphorous	40 mg/L
Sodium Hydroxide and other Strong bases	pH not higher than 11
Ferric Chloride	3 mg/L
Sodium Hypochlorite	3 mg/L

4.8.2. Hydraulic Capacity. The Contractor must submit design calculations verifying that the CIPP will have flow capacity equal to at least 100% of the existing pipe. Flow capacity calculation must be based on Manning's formula using n (Manning's roughness coefficient) of 0.013 for existing sewer. The “n” value for CIPP used must have been verified by an independent testing laboratory (third party testing) which the Contractor must provide.

4.8.3. Samples. For each CIPP liner section installed, the Contractor must obtain CIPP samples large enough to provide a minimum of 3 specimens and a recommended 5 specimens for flexural testing. CIPP samples must be prepared and physical properties tested in accordance with ASTM F1216 or ASTM F1743, Section 8, using either method proposed. The properties must meet or exceed the values listed in this specification. If test results do not meet the properties, Contractor must remove and replace CIPP at no additional cost.

4.8.4. Television Inspection. Visual inspection of the CIPP must be in accordance with ASTM F1743, Section 8.6 and these specifications.

4.9. Reconstruction of Sanitary Sewer by Pipe Bursting Replacement Process Testing. After the existing sewer is completely replaced, internally inspect with television camera and DVD as required. The finished tape will be continuous over the entire length of the sewer between 2 manholes and to be free from visual defects.

Defects which may affect the integrity or strength of the pipe in the opinion of the Engineer will be repaired or the pipe replaced at the Contractor’s Expense.

The Contractor must smoke test to verify all sewer service connections.

The following items are excerpted from 30 TAC § 217 requirements for gravity sewer construction testing. Compliance with these requirements is required unless the Contractor obtains and provides written authorization from the TCEQ authorizing alternative testing and compliance procedures:

Testing of Installed Pipe. An infiltration, exfiltration, or low-pressure air test will be specified. Copies of all test results will be made available to the executive director (TCEQ) upon request. Test must conform to the following requirements:

Infiltration or Exfiltration Tests. The total exfiltration as determined by a hydrostatic head test must not exceed 50 gal./in. diameter per mile of pipe per 24 hr. at a minimum test head of 2 ft. above the crown of the pipe at the upstream manhole. When pipes are installed below the groundwater level an infiltration test must be used in lieu of the exfiltration test. The total infiltration, as determined by a hydrostatic head test, must not exceed 50 gal./in. diameter per mile of pipe per 24 hr. at a minimum test head of 2 ft. above the crown of the pipe at the upstream manhole, or at least 2 ft. above existing groundwater level, whichever is greater. For construction within the 25 yr. flood plain, the infiltration or exfiltration must not exceed 10 gal./in. diameter per mile of pipe per 24 hr. at the same minimum test head. If the quantity of infiltration or exfiltration exceeds the maximum quantity specified, remedial action must be undertaken in order to reduce the infiltration or exfiltration to an amount within the limits specified.

Low Pressure Air Test. Perform in accordance with requirements of this specification.

Deflection Testing. Perform in accordance with requirements of this specification.

Clean-up and Restoration. Any damage to existing utilities, structures, storm drain systems, curbs, sprinkler systems, mail boxes, driveway, etc., must be repaired as directed. All repairs and replacements will be made at the Contractor's expense. Upon acceptance of the installation work and testing, the Contractor must clean-up and restores the project area affected by operations. Daily clean-up of the project site to the satisfaction of the Engineer will also be required.

5. MEASUREMENT

5.1 Sewer Excavation and Non-stabilized Backfill

Sewer excavation and non-stabilized backfill will not be measured for payment and will be considered subsidiary to the sewer line installation.

5.2 Trench Excavation Protection

Trench Excavation Safety Protection will be measured by the foot along the centerline of any OSHA defined trench that may be entered by personnel and is not greater than 15 ft. wide, including manholes and other structures.

5.3 Sanitary Sewers

Longitudinal measurement of sanitary sewers will be made along the centerline of the sewer from center of manhole to center of manhole or end of main by the foot of the various sizes and types (when a specific type is required) of sewers shown on the plans, in accordance with this specification, complete and accepted.

One way cleanouts to be installed in all laterals at the customers property line and will be measured for payment by each installed.

Plugging existing sewer lines will be considered subsidiary to the pipe installation.

Casing installed in open trenches, where required by the plans, of the size and material required will be measured by the foot actually installed in accordance with plans.

5.4 Sanitary Sewer Laterals

Sanitary sewer laterals will be measured by the foot installed at the various diameter sizes. The measured dimension will be taken from the centerline of the main to the connection at – or just inside – the customer's property line. Measurement will be continuous through any fittings in the main. Wyes, tees, and bends of any kind will not be paid for separately for laterals but will be measured for payment by the foot of lateral to be installed.

5.5 Force Mains

Longitudinal measurement of force mains will be made along the centerline of the sewer from fitting to fitting or end of main by the foot of the various sizes and types (when a specific type is required) of force mains shown on the plans, in accordance with this specification, complete and accepted. Hydrostatic pressure test will not be measured separately, but will be inclusive of the force main installation and will be considered subsidiary to the force main bid item.

Tie-In (Complete) will be measured as each of the various sizes and types completed.

Restraint anchor will not be measured separately and will be inclusive of the force main installation and will be subsidiary to the force main bid item.

5.6 Jacking, Boring, or Tunneling

Jacking, Boring, or Tunneling will be measured by the foot of bore or tunnel as measured from face to face of jacking pits.

Carrier pipe used in bores and tunnels or backed into place will be measured by the foot of pipe installed from end to end of pipe to the limits shown on the plans.

Casing or liners of the size and material required will be measured by the foot actually installed in accordance with plans.

5.7 Steel Casing Installed in Open Cut

"Pipe Sewer Main (Steel Casing) (Open Cut)" for sewer pipe of the various sizes shown on the plans will be measured by the foot.

5.8 Vertical Stacks

Vertical Stacks will be measured by the foot. Footage will be computed as follows: Dimension from the top of the lateral (where it appears in the trench wall) to the invert of the sewer main.

5.9 Sanitary Sewer Cleanouts

"Sanitary Sewer Cleanout" will be measured by each cleanout of the size and type (when a specific type is required) specified on the plans.

5.10 Sanitary Sewer Structures

Manhole structures will be measured by each manhole structure complete in place. Manhole structures will be installed where any pipe intercepted is larger than 24 in. in diameter. Rings and Watertight Covers, concrete ring encasement, and I&I Barriers will not be measured for payment, but will be considered subsidiary to the manhole.

5.11 Pre-Cast Manholes

Manholes to 6 ft. deep and designated on plans will be measured by each type manhole complete in place including those exceeding 6 ft. in depth from the lowest invert elevation to the top of the ring. Rings and Watertight Covers, concrete ring encasement, and I&I Barriers will not be measured for payment, but will be considered subsidiary to the manhole.

Manholes deeper than 6 ft. will be measured by the number of feet in excess of 6 ft. as measured vertically.

5.12 FRP Manholes

FRP manholes to 6 ft. deep and designated on plans will be measured by each type manhole complete in place including those exceeding 6 ft. in depth from the lowest invert elevation to the top of the ring. Rings and Watertight Covers, concrete ring encasement, and I&I Barriers will not be measured for payment, but will be considered subsidiary to the FRP manhole.

Manholes deeper than 6 ft. will be measured by the number of feet in excess of 6 ft. as measured vertically.

5.13 Doghouse Manholes

Manholes up to 6 ft. deep and designated on plans will be measured by each type manhole complete in place including those exceeding 6 ft. in depth from the lowest invert elevation to the top of the ring. Rings and Watertight Covers, concrete ring encasement, and I&I Barriers will not be measured for payment, but will be considered subsidiary to the manhole.

Manholes deeper than 6 ft. will be measured by the number of feet in excess of 6-ft. as measured vertically.

5.14 Abandoned Manholes

Manholes abandoned and excavation & backfill required will not be measured for payment, but will be considered subsidiary to other items.

5.15 Sanitary Sewer Bypass Pumping

Measurement for the work specified herein will be by lump sum for either “Small Diameter Sanitary Sewers” or “Large Diameter Sanitary Sewers” as defined herein. Any effort required for multiple set-ups and operations will be included in the lump sum price. Measurement of the work for pipe plugs will be incidental to the work and will not have a separate pay item. Any damages, repairs, etc. to private or public property will not be considered for any additional payment.

5.16 Select Backfill

Cement Stabilized Backfill will be measured by the cubic yard in accordance with the backfill diagram shown on the plans or as directed.

5.17 Flowable Fill

Flowable Backfill will be measured by the cubic yard based on the dimensions and depths shown on the plans or as directed.

5.18 Select Bedding Material

Where directed to be used for rigid pipe installations, Select Bedding Material will be measured by the cubic yard as dimensioned on the plans. Select Bedding Material is always required for Flexible Pipe installation; therefore, it will not be measured for payment.

5.19 Concrete Encasement, Cradles, Saddles, and Collars

Concrete encasement, cradles, saddles, and collars for pipe will be measured by the cubic yard as dimensioned on the plans or as directed, complete in place. Reinforcing if required will not be measured.

5.20 Concrete Curb, Sidewalks, Driveways, Islands, and Medians

For concrete curbs, sidewalks, driveways, islands, and medians required to be removed and replaced due to placement of sewer lines, removal of the existing concrete will be measured by the foot or by the square yard as dimensioned and detailed on the plans.

5.21 Cut and Restore Pavement

The work to be done in the cutting and restoring of pavement will be measured by the square yard in accordance with the dimensions and details shown on the plans.

5.22 Television Inspection

Measurement and payment will be made for the work to be done on the basis of the unit bid price per foot of pipe diameters 8 in. through 15 in., 18 in. through 27 in., and 30 in. & larger, and will be considered full compensation for all labor, materials, equipment, tools, logging, cleaning, bypass pumping and incidentals necessary to complete the work.

5.23 Automatic Air Release Valve

Automatic Air Release Valve will be measured as each assembly of the size installed.

5.24 Ductile-Iron Fittings

Ductile-Iron and Grey-Iron Fittings will be measured by their weight as listed in Table 10 of this specification of the various sizes of fittings installed.

Table 10

WEIGHTS OF GRAY IRON AND DUCTILE IRON FITTINGS (LB.)

BENDS							
Size (In.)	MJ Compact (C153)	MJ (C110)	FLG SB	Size (In.)	MJ Compact (C153)	MJ (C110)	FLG SB
1/4 Bend (90°)				1/8 Bend (45°)			
4	25	55	44	4	21	51	36
6	43	86	67	6	35	75	57
8	61	125	115	8	50	110	105
12	119	258	236	12	96	216	196
16	264	454	478	16	200	345	315
20	447	716	878	20	337	555	485
24	602	1,105	1,085	24	441	777	730
30	979	1,740	1,755	30	775	1,393	1,355
36	1,501	2,507	2,135	36	1,140	2,163	1,755
42	2,277	3,410	3,055	42	1,652	2,955	2,600
48	3,016	4,595	4,095	48	2,157	4,080	3,580
BENDS							
Size (In.)	MJ Compact (C153)	MJ (C110)	FLG SB	Size (In.)	MJ Compact (C153)	MJ (C110)	FLG SB
1/16 Bend (22-1/2°)				1/32 Bend (11-1/4°)			
4	18	50	35	4	17	50	40
6	32	75	64	6	30	73	56
8	46	110	90	8	42	109	90
12	85	220	194	12	74	220	193
16	175	354	315	16	153	354	315
20	314	550	505	20	265	553	505
24	414	809	528	24	339	815	760
30	668	1,500	1,385	30	603	1,410	1,395
36	963	2,182	1,790	36	830	2,195	1,805
42	1,354	3,020	2,665	42	1,210	3,035	2,680
48	1,790	4,170	3,665	48	1,523	4,190	3,695

TABLE 10 CONTINUATION - WEIGHTS OF GRAY IRON AND DUCTILE IRON FITTINGS (LB.)				
TEES				
Size (In.)		Weight		
Run	Branch	MJ Compact (C153)	MJ (C110)	FLG Short Body
3	3	26	56	53
4	3	31	76	54
	4	33	80	60
6	4	49	114	90
	6	60	124	98
8	4	65	163	155
	6	76	175	148
	8	89	188	179
12	4	99	316	322
	6	115	325	297
	8	127	339	346
	12	162	407	369
16	6	226	563	573
	8	240	565	555
	12	283	615	590
	16	326	676	635
20	6	344	750	773
	8	371	766	720
	12	427	799	816
	16	503	975	950
	20	566	1,068	1,005

TABLE 10 CONTINUATION - WEIGHTS OF GRAY IRON AND DUCTILE IRON FITTINGS (LB.)				
TEES				
Size (In.)		Weight		
Run	Branch	MJ Compact (C153)	MJ (C110)	FLG Short Body
24	6	466	1,035	1,089
	8	487	1,047	1,060
	12	539	1,075	1,125
	16	625	1,109	1,070
	20	729	1,504	1,510
	24	785	1,617	1,685
30	8	739	1,808	-
	12	800	1,842	1,801
	16	959	1,885	-
	20	1,026	1,941	-
	24	1,228	2,496	2,475
	30	1,373	2,531	2,615
36	24	1,548	2,710	2,255
	30	1,901	3,545	3,000
	36	2,012	3,686	3,160
42	24	2,272	3,690	3,245
	30	2,512	4,650	4,125
	36	3,048	5,119	5,360
	42	3,225	6,320	5,580
48	24	2,934	4,995	4,385
	30	3,147	5,140	4,455
	36	4,046	6,280	5,555
	42	4,249	8,130	7,195
	48	4,469	8,420	7,385

TABLE 10 CONTINUATION - WEIGHTS OF GRAY IRON AND DUCTILE IRON FITTINGS (LB.)				
CROSSES				
Size (In.)		Weight		
Run	Branch	MJ Compact (C153)	MJ (C110)	FLG Short Body
3	3	34	70	-
4	3	42	90	-
	4	46	105	-
6	4	63	140	-
	6	74	160	160
8	4	88	185	185
	6	97	205	205
	8	105	239	234
12	4	114	340	-
	6	135	360	360
	8	151	382	385
	12	199	493	495
16	6	250	590	575
	8	270	619	605
	12	332	685	-
	16	409	811	790
20	6	358	760	-
	8	379	822	790
	12	413	883	860
	16	550	1,117	1,085
	20	598	1,274	1,230

TABLE 10 CONTINUATION - WEIGHTS OF GRAY IRON AND DUCTILE IRON FITTINGS (LB.)				
CROSSES				
Size (In.)		Weight		
Run	Branch	MJ Compact (C153)	MJ (C110)	FLG Short Body
24	6	566	1,025	-
	8	578	1,085	1,045
	12	610	1,153	1,110
	16	663	1,256	1,200
	20	975	1,733	1,675
	24	907	1,906	1,835
30	8	650	1,795	-
	12	870	1,925	1,865
	16	900	1,950	-
	20	1,220	2,060	-
	24	1,497	2,776	2,675
	30	1,808	3,188	3,075
36	24	1,853	2,928	2,980
	30	2,580	3,965	-
	36	2,698	4,370	4,370
42	24	2,415	3,910	-
	30	2,920	5,040	-
	36	3,788	5,835	-
	42	3,908	6,493	7,145
48	24	3,435	5,210	-
	30	4,145	5,495	-
	36	4,873	6,790	-
	42	5,465	8,815	-
	48	5,588	9,380	-

TABLE 10 CONTINUATION - WEIGHTS OF GRAY IRON AND DUCTILE IRON FITTINGS (LB.)				
	CAPS		PLUGS	
Size (In.)	MJ Compact (C153)	MJ (C110)	MJ Compact (C153)	MJ (C110)
4	10	17	12	16
6	16	29	19	28
8	24	45	30	46
12	45	82	54	85
16	95	160	97	146
20	141	235	146	218
24	193	346	197	350
30	362	644	381	626
36	627	912	688	884
42	893	1,322	1,200	1,222
48	1,076	1,737	1,550	1,597

TABLE 10 CONTINUATION - WEIGHTS OF GRAY IRON AND DUCTILE IRON FITTINGS (LB.)				
SOLID SLEEVES				
Size (In.)	Weight			
	MJ Short Compact (C153)	MJ Long Compact (C153)	MJ Short (C110)	MJ Long (C110)
4	17	21	35	46
6	28	35	45	65
8	38	48	65	86
12	57	77	113	143
16	127	172	192	257
20	201	258	258	359
24	264	337	340	474
30	500	651	690	1,005
36	725	960	947	1,374
42	877	1,209	1,187	1,628
48	1,406	1,516	1,472	2,033

TABLE 10 CONTINUATION - WEIGHTS OF GRAY IRON AND DUCTILE IRON FITTINGS (LB.)			
CONCENTRIC REDUCERS			
Size (In.)			Weight
Large End	Small End	MJ Compact (C153)	MJ (C110)
6	4	27	59
8	4	38	81
8	6	41	95
12	4	70	136
12	6	69	150
12	8	70	167
16	6	134	234
16	8	136	258
16	12	126	310
20	12	213	427
20	16	221	492
24	12	304	562
24	16	315	633
24	20	315	727
30	16	596	1,027
30	20	599	1,085
30	24	492	1,204
36	20	1,042	1,459
36	24	785	1,580
36	30	655	1,868
42	24	1,356	2,060
42	30	1,112	2,370
42	36	1,116	2,695
48	30	1,722	3,005
48	36	1,650	3,370
48	42	1,429	3,750

TABLE 10 CONTINUATION - WEIGHTS OF GRAY IRON AND DUCTILE IRON FITTINGS (LB.)		
2 In. Tapped Tees and Crosses		
Size (In.)	Weight	
	MJ Compact (C153)	MJ (C110)
4	24	47
6	36	71
8	54	97
10	69	130
12	87	169
20	-	259
24	-	320

TABLE 10 CONTINUATION - WEIGHTS OF GRAY IRON AND DUCTILE IRON FITTINGS (LB.)		
OFFSETS		
Size (In.)	Weight	
	MJ Compact (C153)	MJ (C110)
4 x 6	35	75
4 x 12	55	83
6 x 6	35	110
6 x 12	67	138
6 x 24	96	189
8 x 6	82	164
8 x 12	98	209
8 x 24	141	280
12 x 6	121	320
12 x 12	178	420
12 x 24	240	645
20 x 12	-	1,025
20 x 24	-	1,245

5.25 Hydrostatic Pressure Test

Hydrostatic Pressure Test will be measured as each successful test conducted on sanitary sewer force mains only. Hydrostatic testing of manholes will not be measured for payment.

5.26 Rehabilitation of Sanitary Sewer by Cured-In-Place Pipe

This Item will be measured by the foot, based on the measured distance of existing sanitary sewer line to be rehabilitated from centerline of manhole to centerline of manhole.

5.27 Point Repair

Measurement for sewer line point repair is on a unit price basis for each repair performed. Minimum length of pipe to be replaced for each repair, determined by depth of sewer line measured from natural ground to flow line at point of repair. 9 ft. minimum length. Measurement for sewer line extra length point repair is on a foot basis in excess of minimum replacement length specified above.

5.28 Obstruction Removal

Obstruction removal by excavation will be paid per each obstruction removal performed. Obstruction removal can be submitted for payment when the obstruction has been cleared from the sewer line to be lined. Liner work must proceed at least 6 ft. before payment for removal of another obstruction will be considered (i.e., all obstruction within a distance of 6 ft. is considered to be part of the same obstruction).

5.29 Reconstruction of Existing Manholes

All reconstructed manholes will be measured by the unit of each manhole (any type or size) regardless of the type shown in the contract documents.

5.30 Existing Manhole Adjustments

Manholes completely adjusted, as prescribed above, will be measured by the unit of each manhole adjusted. The excavation and the amount of flowable fill, reinforced concrete, or any other material as necessary to fill the area excavated, will not be measured for payment.

5.31 Cleaning Manhole and Mains

Sanitary sewer manhole and mainline cleaning will not be measured for payment and will be subsidiary to rehabilitation of manholes and lines.

5.32 Reconstruction of Sanitary Sewer by Pipe Bursting Replacement Process

All pipe bursting installations will be measured from center of manhole to center of manhole or end of main. Measurement will be continuous through any fittings in the main.

5.33 Sliplining Sanitary Sewers.

Measurement for sliplining is on a by foot basis for installed liner pipe, measured from centerline of upstream manhole to centerline of downstream manhole. Depth range for payment is based on depth measured at sewer main from natural ground level to flow line of sanitary sewer for each pipeline segment.

5.34 Grouting of Sewer Mains

All type of pipe abandonment with grout, including asbestos-concrete pipe, will be measured per foot for each size diameter of pipe, irrespective of the depth of the main, which will include the cost of removing the content within the pipe, cleaning, grouting, plugging, capping and abandoning all pipe, pipe bend section, and all other appurtenances, and for dewatering, trenching, excavation and backfill, removal, transportation and disposal, and all material or work necessary to properly abandon the pipe.

6. PAYMENT

6.1. Sewer Excavation. Payment for sewer excavation and non-stabilized backfilling in accordance with these specifications will not be paid for directly but will be included in the unit price bid for the sanitary sewer pipe installation. Select bedding and stabilized backfill will be paid for under their own items of work.

6.2. Trench Excavation Protection. Payment will be made at the unit price bid per foot for “Sanitary Sewer Trench Excavation Protection” in place. This price will be full compensation for all labor, equipment, materials, tools, all components of the trench protection system which can include but not limited to sloping, sheeting, trench boxes or trench shields, sheet piling, cribbing, bracing, shoring, dewatering/diversion of water to provide adequate/acceptable drainage, any additional excavation or backfill required, jacking, jack removal, removal of the trench support after completion, and all other labor, materials, tools, equipment, and incidentals necessary to complete the work.

6.3. Sanitary Sewers. Payment will be made at the unit price bid per foot, and will be full compensation for all labor, equipment, materials, tools, and incidentals for “Sanitary Sewers” of the size, and type (when a specific type is required) specified on the plans, complete in place.

Sanitary sewer service connections will be paid for at the unit price bid which will be full compensation for all labor, equipment, materials, tools, and incidentals for “Sanitary Sewers (Lateral Pipe)” of the size specified per foot, complete in place.

Casings installed in open cut trenches will be paid for at the contract unit price bid for "Sanitary Sewer Casing Open Cut" per foot which will be full compensation of casing installed and measured as prescribed above.

6.4. Sanitary Sewer Laterals. Payment will be made at the unit price bid which will be full compensation for all labor, equipment, materials, tools, and incidentals for “Sanitary Sewer Lateral” of the size and type (when a specific type is required) specified on the plans per foot, complete in place.

6.5. Force Mains. Force mains will be paid for at the unit price bid which will be full compensation for all labor, equipment, materials, tools, and incidentals for “Force Mains” of the size and type specified on the plans per foot, complete in place.

6.6. Jacking, Boring, or Tunneling. “Sanitary Sewer (Jack, Bore, or Tunnel)” will be paid for at the contract unit price bid per foot of jacking, boring or tunneling, which will be full compensation for furnishing all materials (except carrier pipe, casings, or liners), labor, tools, equipment, and incidentals necessary to complete the work, including excavation, grouting, backfilling, restoration to original ground conditions, and disposal of surplus materials.

Carrier pipe will be paid for at the contract unit price bid which will be full compensation for "Sanitary Sewer Carrier Pipe in Casing" per foot of pipe installed and measured as prescribed above.

Steel casings or liners will be paid for at the contract unit price bid which will be full compensation for "Sanitary Sewer Jack, Bore, Tunnel Pipe (STEEL)” or “Liner" per foot of steel casing or liner installed and measured as prescribed above.

6.7. Steel Casing Installed in Open Cut. Steel casings installed via open cut will be paid for at the contract unit price bid which will be full compensation for “Pipe Sewer Main (Steel Casing) (Open Cut)” per foot for the various sizes shown on the plans and measured as prescribed above.

6.8. Vertical Stacks. Payment will be made at the unit price bid per foot which will be full compensation for all labor, equipment, materials, tools, and incidentals, complete in place.

6.9. Sanitary Sewer Cleanouts. Payment will be made at the unit bid price for “Sanitary Sewer Cleanout” of the size and type (when a specific type is required) specified on the plans per each which will be full compensation for all labor, equipment, materials, tools, and incidentals complete in place.

6.10. Sanitary Sewer Structures. Payment for Manholes structures, including the stack, rings, watertight covers, steps, concrete ring encasement, and I&I Barriers will be made at the unit price bid for “Sanitary Sewer Structures” of the type specified per each which will be full compensation for all labor, equipment, materials, tools, and incidentals.

Payment for Extra Depth structures will be made at the unit price bid per foot as measured vertically.

6.11. Pre-Cast Manholes. Payment for Pre-Cast manholes, including the stack, rings, watertight covers, steps, concrete ring encasement, and I&I Barriers will be made at the unit price bid for “Sanitary Sewer Precast Manholes” of the type specified per each which will be full compensation for all labor, equipment, materials, tools, and incidentals.

Payment for Extra Depth manholes will be made at the unit price bid per foot as measured vertically.

6.12. FRP Manholes. Payment for FRP manholes, including the stack, rings, watertight covers, concrete ring encasement, and I&I Barriers will be made at the unit price bid for “Sanitary Sewer FRP Manholes” of the

type specified per each which will be full compensation for all labor, equipment, materials, tools, and incidentals.

Payment for Extra Depth FRP manholes will be made at the unit price bid per foot as measured vertically.

6.13. Doghouse Manholes. Payment for doghouse manholes, including the stack, rings, watertight covers, steps, concrete ring encasement, and I&I Barriers will be made at the unit price bid for "Sanitary Sewer Manhole (Doghouse)" of the type specified per each which will be full compensation for all labor, equipment, materials, tools, and incidentals.

Payment for Extra Depth manholes will be made at the unit price bid per foot as measured vertically.

6.14. Abandoned Manholes. Manholes abandoned will not be paid for separately.

6.15. Sanitary Sewer Bypass Pumping. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Bypass Pumping for Small Diameter Sanitary Sewers" or "Bypass Pumping for Large Diameter Sanitary Sewers." Payment of the "Lump Sum" bid for Bypass Pumping will be in accordance with the following: Any effort required for multiple set-ups and operations will be included in the lump sum price.

- When initial set-up and operation of the bypass pumping system begins (including a successful test), 20% of the "Lump Sum" cost will be paid as applicable to stationary bypass pumping to include flow diversion if used.
- 60% of the "Lump Sum" cost will be paid over equal monthly payments (estimated from the BPP or other documentation approved by the Inspector) during the course of the bypass pumping operation as applicable to stationary bypass pumping to include flow diversion if used.
- 20% of the remaining "Lump Sum" cost will be paid upon an acceptable removal or disassembly of all components of the BPP, including site cleanup as applicable to stationary bypass pumping to include flow diversion if used.

For multi-bypass pumping setups, payment will be proportional to the overall amount of the established bid line item.

6.16. Select Backfill. Payment will be made for "Cement Stabilized Backfill" at the unit price bid for "Sanitary Sewer (Cement Stabilized Backfill)" per cubic yard which will be full compensation for all labor, equipment, materials, tools, and incidentals to complete the work.

6.17. Flowable Fill. Payment for flowable backfill will be made at the unit price bid for "Sanitary Sewer Flowable Fill" per cubic yard which will be full compensation for all labor, equipment, materials, tools, and incidentals to complete the work.

6.18. Select Bedding Material. Payment for "Select Bedding Material" for rigid pipe installations will be made at the unit price bid for "Sanitary Sewer (Select Bedding)" per cubic yard. The select bedding for flexible pipes will not be paid for directly but will be subsidiary to the flexible pipe.

6.19. Concrete Encasement, Cradles, Saddles, and Collars. Payment will be made at the unit price bid for "Concrete Encasement," "Concrete Cradles," "Concrete Saddles," and "Concrete Collars" per cubic yard which will be full compensation for all labor, equipment, materials, tools, and incidentals to complete the work.

6.20. Concrete Curbs, Driveways, Sidewalks, Islands, and Medians. Payment for replacement of curbs, driveways, sidewalks, islands, and medians will be made at the unit price bid for "Sanitary Sewer (Concrete Sidewalk)," "Sanitary Sewer (Concrete Driveway)," "Sanitary Sewer (Concrete Islands)," "Sanitary Sewer (Concrete Medians)," and "Sanitary Sewer (Concrete Curb)" per square yard which will be full compensation for all labor, equipment, materials, tools, and incidentals to complete the work.

6.21. Cut and Restore Pavement. Payment will be made at the unit price bid for "Sanitary Sewer (Cut and Restore Pavement)" per square yard which will be full compensation for all labor, equipment, materials, tools, and incidentals to complete the work.

6.22. Television Inspection. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Sanitary Sewer Pre Television Inspection" or "Sanitary Sewer Post Television Inspection" per foot of the pipe sizes shown on the plans. This price will be full compensation all labor, materials, equipment, tools, logging, and all incidentals necessary to complete the work.

6.23. Automatic Air Release Valve. Payment for "Automatic Air Release Valve" will be made at the unit price bid for "Sanitary Sewer (Automatic Air Release Valve) (Complete)" and will be full compensation for each assembly of the various sizes installed in accordance with the details shown on the plans. This payment will also include selected embedment material, anti-corrosion embedment when specified, blocking, and various sizes and types of meter boxes.

6.24. Ductile-Iron Fittings. Payment for "Ductile-Iron Fittings" will be made at the unit price bid for "Sanitary Sewer (Ductile-Iron Fittings)" and will be full compensation for each ton of fittings of all sizes and types installed and will be based upon the weights of fittings shown in Table 10 "Weights of Gray Iron and Ductile Iron Fittings."

6.25. Hydrostatic Pressure Test. Payment for "Hydrostatic Pressure Test" will be made at the unit price bid for "Sanitary Sewer (Hydrostatic Pressure Test)" and will be full compensation for each successful test conducted on sanitary sewer force mains only. No direct payment will be made for hydrostatic testing manholes.

No direct payment will be made for concrete blocking of sanitary sewer force mains; furnishing and installing the joint restraint system; coating and wrapping pipe joints; polyethylene wrapping; trench excavation below specified limits; excavation and removal of unsuitable material at bottom of trench grade and restoration with approved material; supporting pipe or conduits of public utilities; and flushing sanitary sewer force mains. This work will be considered subsidiary to the various bid items.

6.26. Rehabilitation of Sanitary Sewer by Cured-in-Place Pipe. The work performed and materials furnished in accordance with this Item and measured as provided under 'Measurement" will be paid for at the unit price bid for "Rehabilitation of Sanitary Sewer by Cured-in-Place Pipe" per foot. This price will be full compensation for all labor, equipment, materials, tools, pre-rehabilitation line cleaning, water, clean-up, dump sites and hauling of debris, labor, materials and equipment used in replacing bases and pavements, access to right of ways and easements as necessary, removal of equipment due to bad ground or poor pipe conditions, and other incidentals necessary to complete the work for either method of sanitary sewer line rehabilitation.

6.27. Point Repair. The work performed and materials furnished in accordance with this Item and measured under "Measurement" will be paid for at the unit price bid for "Sanitary Sewer Point Repair," per each for sizes and types constructed (when a specific type is required), regardless of depth. This price will include all materials, including pipe, trenching, pumping, shoring and bracing, sand cushion, concrete plugs, laying and jointing, backfilling, tapping, water, labor, tools, equipment, pavement work, and all incidentals necessary to complete the work.

Payment for sewer line extra length will be in accordance with this Item and measured under "Measurement" and will be paid for at the unit price bid for "Sanitary Sewer (Point Repair sewer line extra length)," per foot for sizes and types constructed (when a specific type is required), regardless of depth. This price will include all materials, including pipe, trenching, pumping, shoring and bracing, sand cushion, concrete plugs, laying and jointing, backfilling, tapping, water, labor, tools, equipment, pavement work, and all incidentals necessary to complete the work.

6.28. Obstruction Removal. The work performed and materials furnished in accordance with this Item and measured under "Measurement" will be paid for at the unit price bid for "Sanitary Sewer Obstruction Removal," for sizes and types constructed (when a specific type is required), regardless of depth. This price

will include all materials, labor, tools, equipment, pavement work and all incidentals necessary to remove obstructions.

6.29. Reconstruction of Existing Manholes. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Reconstruction of Existing Manholes." This price will be full compensation for materials, labor, equipment, tools, testing, and all incidentals necessary to complete the work.

6.30. Existing Manhole Adjustments. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Existing Manhole Adjustments." This price will be full compensation for materials, labor, equipment, tools, testing, and all incidentals necessary to complete the work.

6.31. Cleaning Manholes and Mains. All work described by this Item will be subsidiary to rehabilitation of manholes and lines.

6.32. Reconstruction of Sanitary Sewer by Pipe Bursting Replacement Process. The inserted pipe will be paid for per foot of pipe installed using pipe-bursting/crushing method for the pipe diameter, type, quantity, and depth specified and will be full compensation for all labor, equipment, materials, tools, incidentals, all pipe installation materials, all submittals, sealing materials at manholes and annulus (if required), launching pits, receiving pits, post testing, shoring, bedding, backfill, and all necessary, corresponding, and related work specified herein.

6.33. Sliplining. Payment will be made at the unit price bid which will be full compensation for all labor, equipment, materials, tools, and incidentals for "Sliplining" of the size and type (when a specific type is required) specified on the plans per foot, complete in place.

Insertion pits, access pits, clamp installation, embedment (bedding, haunching, and initial backfill), field quality control (testing), sealing liner at manholes, grouting annular space, building up, shaping and reworking manhole inverts and benches, and pre-installation & post-installation cleaning and television inspection of completed work are included in the sliplining unit price and not paid for separately.

Excavations initially begun as obstruction removals or point repairs which the Contractor later decides to use as insertion pits are considered as insertion pits and not paid for separately.

Trench safety systems, well pointing, and other applicable bid items associated with insertion pits will be paid for at their respective contract unit prices.

6.34. Grouting of Sewer Mains. Payment for "Grout Abandonment Sewer Main" will be made on the contract unit price per foot per each size diameter of pipe complete in place at locations shown on the plans. Said price will be full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the work.

Special Specification 7196
Water Mains and Service Lines

1. DESCRIPTION

Provide and install a complete water main system in accordance with the plans and specifications and in compliance with the Department's Utility Accommodation Policy (UAP) (Title 43, T.A.C., Sections 21.31–21.55). The water mains will be of the sizes, materials and dimensions shown on the plans and must include all pipe, all joints and connections to new and existing pipes, all valves, fittings, fire hydrants, pipe joint restraint systems, blocking, and other items required to complete the work.

The abbreviations AWWA, ASA, ASTM, and ANSI, as used in this Specification, refer to the following organizations or technical societies:

- AWWA – American Water Works Association
- ASA – American Standards Association
- ASTM – American Society for Testing and Materials
- ANSI – American National Standards Institute
- NSF – National Science Foundation

Where reference is made to Specifications of the above organizations, it is to be construed to mean the latest standard in effect on the date of the proposal.

2. MATERIALS

All materials used in this project are to be new and unused unless otherwise specified on the plans, Specifications, or the proposal. The Contractor must submit descriptive information and evidence that the materials and equipment the Contractor proposed for incorporation into the Work are of the kind and quality that meet the material requirements listed herein. The SAWS Material Specifications are part of this Specification and are available on the SAWS website at http://www.saws.org/business_center/specs/matspecs/. Contractors may, when appropriate, use products that are specified in these Specifications; however, a Submittal is still required that clearly indicates the applicable SAWS Material Specification. The products listed in the SAWS Material Specifications must not be considered as a pre-approved list and cannot be substituted for items called out on the Drawings or on bid form.

2.1. Ductile-Iron Pipe and Fittings

2.1.1. **Ductile-Iron Pipe: 3 in. through 64 in.** All ductile-iron pipes are to be manufactured by process of centrifugal casting and are to conform to ANSI/AWWA C151/A21.51.91, “American Standard for Ductile-Iron Pipe Centrifugally Cast with push-on or mechanical joints for Water or Other Liquids,” or latest revision thereof, unless otherwise modified or supplemented herein.

Pipe is to conform to the following Table 1 pressure classes based on Type 3 bedding conditions, a bury depth of 6 ft., and a working pressure of 150 psi:

Table 1
Pipe Pressure Classes

Pipe Inside Diameter	Pressure
3"–2"	350 psi
16"–20"	250 psi
24"	200 psi
30"–64"	150 psi

Dimensions and tolerances for each nominal pipe size must be in accordance with Table 51.5 (push-on) or Table 51.5 (mechanical joint) of AWWA C-151 for pipe with a nominal laying length of 20 ft.

All pipes are to have standard water works interior cement mortar lining applied in accordance with ANSI/AWWA C-104/A21.4, latest revision. No asphaltic coating will be required on the interior cement mortar lining.

Exterior coating is to consist of a nominal 1-mil thick asphaltic material applied to the outside of the pipe as described in Section 51.8 of AWWA C-151.

Rubber joint gaskets used on ductile-iron pipe are to conform to ANSI/AWWA C-111/A21.11, latest revision.

Each length of pipe must bear identification markings in accordance with Section 51.10 of AWWA C-151.

Manufacturer is to take adequate measures during pipe production to assure compliance with AWWA C-151 by performing quality-control tests and maintaining results of those test as outlined in Section 51.14 of that standard.

The San Antonio Water System may, at no cost to the manufacturer, subject random lengths of pipe for testing by an independent laboratory for compliance with this Specification. Any visible defects or failure to meet quality standards herein will be grounds for rejecting the entire order.

Approved Manufacturers for Ductile Iron Pipe: Please see SAWS website for a list of approved manufacturers - http://www.saws.org/business_center/specs/product_submittal/

2.1.2. Fittings for Ductile-Iron Pipe, PVC C-900, or PVC C-905. This Section covers ductile-iron fittings 3 in. through 48 in. in size designed and manufactured for use with gray-iron, ductile-iron, PVC C-900 or PVC C905 pipe. Standard, compact and anchor fittings included herein are of the following types of joints: Flanged and Mechanical Joint

Unless otherwise modified or supplemented herein, the latest revision of AWWA C-110 for Gray-Iron and Ductile-Iron Fittings, 3 in. through 48 in. for Water and Other Liquids and AWWA C-153 for Ductile-Iron Compact Fittings, will govern the design, manufacture, and testing of all fittings under this Specification.

For 3 in. through 24 in. size range, the pressure rating of all fittings is to be a minimum of 250 psi. The working pressure for all fittings of size greater than 24 in. is to be a minimum of 150 psi, unless a change in pressure rating is directed by purchase documents.

Fittings are to be furnished with the types of end combination specified. Flanged fittings are to be faced and drilled in accordance with ANSI Specification B 16.1, Class 125. Anchor fittings are to be furnished in size and type or length as specified.

The exterior of all fittings must be provided with a petroleum asphaltic coating in accordance with the latest revision of AWWA C110. The interior of flanged fittings supplied under this Specification must be either cement-mortar lined in accordance with the latest revision of AWWA C104 or lined with a petroleum asphaltic material in accordance with the latest revision of AWWA Standard as specified. The interior of all other fittings supplied under this Specification must be cement-mortar lined in accordance with the latest revision of AWWA C104.

Two inch fittings are to be manufacturer's standard design in accordance with applicable design standards of AWWA C-110.

2.2. Concrete Steel Cylinder Pipe and Fittings: 20 in. and larger. This Section covers prestressed reinforced concrete water pipe with a steel cylinder and wire reinforcement in sizes 20 in. and larger.

Except as otherwise modified or supplemented herein, AWWA C301, "Prestressed Concrete Pressure Pipe—Steel Cylinder Type, for Water and Other Liquids" will govern the design, component materials, manufacture, and testing of all concrete-steel cylinder pipe furnished under this Specification.

Unless otherwise specified, all pipes must be AWWA Class 150 and must be designed for an internal working pressure of 150 psi and a minimum external load equivalent to 6 ft. of earth cover. Where the bury depth of the pipe is indicated to be greater than 6 ft. in the contract Specifications or on the drawings the design of the pipe must be suitable for the earth loads indicated.

All data submitted by the Contractor must include a tabulated layout schedule referencing the stationing and grade lines shown on the job plans. A design summary for each size of pipe furnished must be provided for each pressure and bury depth.

Each special and length of straight pipe must have plainly marked on the inside of the bell end the class of pipe and identification marks enough to show the proper location of the pipe by reference to layout drawings.

Pipe 20 in. through 42 in. in size must be furnished in nominal lengths of 20 ft. to 32 ft.; pipe 48 in. through 72 in. in size must be furnished in nominal lengths of 16 ft. except where modified by plan design requirements.

Each joint of pipe must be furnished with a rubber gasket and a 12 in. diaper.

2.3. Steel Pipe, Fittings and Flanges. This Section covers steel pipe 4 in. and larger in size and manufactured for the purpose of conveying water.

2.3.1. Steel Pipe. Steel pipe with nominal diameters from 4 in. through 20 in. must conform to ASTM A 106, A 53 Grade B or A 139 Grade B standard weight class as the minimum

Steel Pipe greater than 20 in. must conform to AWWA C-200 and AWWA M-11 or as required by the Engineer for special circumstances.

Pipe must be designed for a minimum of 150 psi working pressure with an additional 50% of the working pressure allowance for surge pressure unless otherwise specified. Pipe design must be in accordance with AWWA M-11.

Pipe must be designed to cover conditions as shown on the plans. The design for deflection must be in accordance with AWWA M-11.

Use of an enhanced /better soil backfill to limit deflection will be allowed with approval by the Engineer. (Criteria will be based on AWWA M-11)

Pipe for use with sleeve-type couplings must have plain ends at right angles to the axis.

Pipe joint length is to be up to 50 ft. net laying lengths except for special lengths, field trim pieces, and closure pieces as otherwise specified on the plans for location of elbows, tees, reducers, and other inline fittings. Manufacturer is to prepare a lay schedule showing the location of each piece by a mark number with station and invert elevation at each bell end.

2.3.2. Fittings for Steel Pipe. Unless otherwise shown on the plans, all specials and fittings must conform to the dimensions of AWWA C-208. Pipe material used in fittings must be of the same material and thickness as the pipe. The minimum radius of elbows must be 2.5 times the pipe diameter and the maximum miter angle on each section of the elbow must not exceed 11-1/4° (One cut elbow up to 22-1/2°). If elbow radius is less than 2.5 times pipe diameter, stresses must be checked per AWWA M-11 and wall thickness or yield strength increased if necessary. Fittings must be equal in pressure design strength. Specials and fittings, unless otherwise shown on the Plans, must be made of segmentally welded sections from hydrostatically tested pipe, with ends compatible with the type of joint or coupling specified for the pipe. All welds made after hydrostatic testing of the straight sections of pipe must be checked per the requirements of AWWA C-200 Section 5.2.2.1.

2.3.3. Joints.

2.3.3.1. Rolled-Groove Rubber Gasket Joint. The standard joint must be rolled-groove rubber gasket joint unless otherwise noted on the plans. Rolled-grooved rubber gasket joints must conform to AWWA C-200 and as shown in Chapter 8 of AWWA M-11.

The O-ring rubber gasket must have enough volume to approximately fill the area of the groove and must conform to AWWA C-200.

The joint must be suitable for a safe working pressure equal to the class of pipe furnished and must operate satisfactorily with a deflection angle, the tangent of which is not to exceed 1.00/D where D is the outside diameter of the pipe in in. with a pull-out of 1 in.

Rolled-Groove Rubber Gasket Joints may be furnished only by a manufacturer who has furnished pipe with joints of similar design for comparable working pressure, pipe diameter, pipe length, and wall thickness that have been in successful service for a period of at least 5 yr.

2.3.3.2. Lap Weld. Lap field welded joints must be used where tied joints are indicated on the plans. The standard bell must provide for a 2-1/2 in. lap. The minimum lap must be 1 in. The design maximum joint deflection or offset must be a 1 in. joint pull.

2.3.3.3. Mechanical Couplings. Mechanical couplings, where indicated on the plans, must be Smith Blair Style 411, Baker Style 200, Brico Depend-O-Loc or equal. Insulating mechanical couplings, where indicated on the plans, must be double insulated Smith Blair Style 416, Baker Style 216, or equal. Mechanical couplings must be rated to meet or exceed the working pressures and surge pressure of the pipe.

Couplings for buried service must have all metal parts painted with Epoxy paint and conform to AWWA C-219.

Pipe ends for mechanical couplings must conform to AWWA C-200 and M-11. The shop applied outside coating must be held back as required for field assembly of the mechanical coupling or to the harness lugs or rings.

Harness lugs or rings and pipe ends must be painted with one shop coat of epoxy conforming to AWWA C-210. The inside lining must be continuous to the end of the pipe.

2.3.4. Flanges, Gaskets, Bolts and Nuts

2.3.4.1. Flanges. Flanges must be in accordance with AWWA C207 Class D for operating pressures to 175 psi on 4 in. through 12 in. diameter, and operating pressures to 150 psi on diameters over 12 in.; or Flanges must

be AWWA C207 Class E for operating pressures up to 275 psi; or Flanges must be AWWA C207 Class F for pressures to 300 psi. (drilling matches ANSI B 016.5 Class 250) Shop lining and coating must be continuous to the end of the pipe or back of the flange. Flange faces must be shop coated with a soluble rust preventive compound.

2.3.4.2. Gaskets: Full face, 1/8 in. thick, cloth inserted rubber, Garlock 3000, John Crane Co. Style 777 or equal.

2.3.4.3. Bolts and Nuts for Flanges: Bolts for flanges located indoors and in enclosed vaults and structures must be carbon steel, ASTM A-307, Grade B for class B and D flanges and nuts must be ASTM A-563, Grade A heavy hex. Bolts for class E and F flanges must be ASTM A-193 grade B7 and nuts must be ASTM A-194, grade 2 H, heavy hex.

2.3.4.4. Bolts for buried and submerged flanges and flanges located outdoors above ground or in open vaults in structures must be Type 316 stainless steel conforming to ASTM A-193, Grade B8M, Class 1 for class B and D Flanges with ASTM A-194, Grade 8M nuts. For Class E and F flanges the bolts must be ASTM A-194 grade-2H nuts with bolt and nuts to be zinc plated in accordance with ASTM B-633

2.3.5. Linings and Coatings.

2.3.5.1. Polyethylene Tape Coating. Prefabricated Multi-layer Cold Applied Tape Coating - the coating system for straight-line pipe must be in accordance with AWWA C-214. The system must consist of 3 layers of polyethylene material with a nominal thickness of 80 mils when complete.

2.3.5.2. Coating Repair. Coating repair must be made using tape and primer conforming to AWWA C-209, Type II. The tape and primer must be compatible with the tape system used for straight-line pipe.

2.3.5.3. Coating of Fittings, Specials and Joints.

2.3.5.3.1. General. Fittings, specials and joints which cannot be machine coated in accordance with above, must be coated in accordance with AWWA C-209. Prefabricated tape must be Type II and must be compatible with the tape system used for straight-line pipe. The system must consist of 3 layers consisting of the following: Alternate coating methods for fittings specials and field joints would be Shrink sleeves per C-216, or paint per C-210, C-218, or C-222. The field coating must completely encapsulate the joint bonds on O-ring joints.

2.3.5.3.2. Coating Repair. Coating repair for fittings and specials must be in accordance with the procedure described above for straight-line pipe and as recommended by the manufacturer.

2.3.5.4. Other Coating Systems. If specified must be governed by the appropriate American Water Works Association standard.

2.3.5.5. Cement Mortar per AWWA C-205.

2.3.5.5.1. Cement Mortar Lining of Steel Pipe. Except as otherwise provided in AWWA C-205, interior surface of all steel pipes, fittings, and specials must be cleaned and lined in the shop with cement-mortar lining applied centrifugally in conformity with AWWA C-205.

The pipe ends must be left bare where field joints occur as shown on the Plans. Ends of the linings must be left square and uniform. Feathered or uneven edges will not be permitted.

Defective linings as identified in AWWA C-205 must be removed from the pipe wall and must be replaced to the full thickness required. Defective linings must be cut back to a square shoulder to avoid feather edged joints.

Cement mortar lining must be kept moist during storage and shipping.

2.3.5.5.2. Fittings.

Fittings must be lined and coated per AWWA C-205.

2.3.6. Steel Casing Pipe. Steel casing pipe must conform to ASTM A134 with a minimum thickness of 3/8 in.; actual thickness will be as indicated on the plans.

2.3.7. Quality Assurance. Commercial Standards (All manufacturing tolerances referenced in the below standards apply unless specifically excluded).

- ANSI/AWWA C-200 Standard for Steel Water Pipe 6 in. and Larger.
- ANSI/AWWA C-205 Standard for Cement-Mortar Protective Lining and Coating for Steel Water Pipe, 4 in. and Larger-Shop Applied.
- ANSI/AWWA C-206 Standard for Field Welding of Steel Water Pipe.
- ANSI/AWWA C-207 Standard for Steel Pipe Flanges for Water Works Service, 4 in.–144 in.
- ANSI/AWWA C-208 Standard for Dimensions for Fabricated Steel Water Pipe Fittings.
- ANSI/AWWA C-209 Standard for Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
- ANSI/AWWA C-210 Standard for Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
- ANSI/AWWA C-214 Standard for Tape Coating Systems for the Exterior of Steel Water Pipelines.
- ANSI/AWWA C-216 Standard for Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
- ANSI/AWWA C-218 Standard for Liquid Coating the Exterior of Aboveground Steel Water Pipelines and Fittings.
- ANSI/AWWA C-219 Standard for Bolted Sleeve-Type Couplings for Plain-End Pipe.
- ANSI/AWWA C-222 Standard for Polyurethane Coatings for the Interior and Exterior of Steel Water Pipelines and Fittings.
- AWWA M-11 Steel Pipe - A guide for Design and Installation.
- ASTM A-106 Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
- ASTM A-53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
- ASTM E-165 Method for Liquid Penetrant Examination.
- ASTM E-709 Guide for Magnetic Particle Examination.
- ASME Section V Nondestructive Testing Examination.
- ASME Section IX Welding and Brazing Qualification.
- AWS B2.1 Standard for Welding Procedure and Welding Qualifications.

2.3.8. Qualifications. Manufacturers who are fully experienced, reputable, and qualified in the manufacture of the products to be furnished must furnish all Steel pipe and fittings. The pipe and fittings must be designed, constructed and installed in accordance with the best practices and methods and must comply with these Specifications as applicable

Pipe must be the product of one manufacturer that has not less than 5 yr. successful experience manufacturing pipe in the United States of the particular type and size indicated. All pipe manufacturing including cylinder production, lining, coating and fittings must be produced by one manufacturer. The pipe manufacturer must have a certified quality assurance program. This certified program must be ISO 9001:2000 or other equivalent nationally recognized program.

2.4. Polyvinyl Chloride Pipe and Fittings.

2.4.1. Polyvinyl Chloride Pipe, 4 in. through 12 in. (C-900). This Section covers 4 in. through 12 in. diameter polyvinyl chloride (PVC) pressure pipe made from class 1245A or 1245B compounds as determined by

ASTM D1784 and providing for a hydrostatic test basis (HDB) of 4,000 psi. All pipe furnished must be in accordance with AWWA C900, or latest revision thereof.

Except as noted on the plans or procurement Specifications for specific jobs, all PVC C900 pipe must be Class 150 (DR 18) with a sustained pressure requirement of 500 psi (ASTM D2241) and a minimum burst pressure of 755 psi (ASTM D1599). PVC C900 pipe installed in the SAWS High Pressure Zone must be class 200 (DR 14) with a sustained pressure requirement of 650 psi (ASTM D1598) and a minimum burst pressure of 985 psi (ASTM D1599). Pipe pressure class must be written on the pipe and as per most current applicable AWWA standards.

Dimensions and tolerances for each nominal pipe sizes must be in accordance with Section 2.2, Table 1 of AWWA C900.

Pipe must be furnished in standard laying lengths of 20 ft. (±1 in.) unless otherwise noted. Each pipe must have an integral bell formed on the pipe end, and be designed to be at least as strong as the pipe wall (ASTM D2472).

An elastomeric gasket must be designed with a retainer ring, which "locks" the gasket into integral bell groove and must be installed at the point of manufacture. Gasket must be in accordance with ASTM F477.

Each length of pipe furnished must bear identification markings in accordance with Section 2.6 of AWWA C900.

Pipe must be bundled in pallets for ease of handling and storage. Pipe bundles (units) must be packaged to provide structural support to ensure that the weight of upper units must not cause deformation to pipe in lower units. No pipes bundles will be accepted which show evidence of ultraviolet radiation "sunburn" on exposed pipe as may be caused from extended unprotected storage conditions.

The manufacturer must take adequate measures during pipe production to assure compliance with AWWA C900 by performing quality-control tests and maintaining results of those tests as outlined in Section 3 of that standard. Submission of product will constitute certification of compliance with this standard.

The pipe is intended for use as an underground, direct bury pressure pipe for transport of potable water. The expected life of the pipe system, after installation, is 25 to 50 yr.

Inductive Tracer Detection Tape must be placed directly above the centerline of all non-metallic pipe a minimum of 12 in. below subgrade or, in areas outside the limits of pavement, a minimum of 18 in. below finished grade to aid locating pipe in the future. The tracer tape must be encased in a protective, inert, plastic jacket and color coded according to American Public Works Association Uniform Color Code. Except for minimum depth of cover, the tracer tape must be placed according to manufacturer’s recommendations.

A 1 yr. warranty must be provided for all materials sold and delivered for use and incorporated into the San Antonio water distribution system. Such warranty will take effect on the date that the pipe is received and accepted by an authorized representative of the San Antonio Water System.

User references and a claims history must be provided for further investigation, before rending a final decision on the acceptance of the product to be furnished.

The San Antonio Water System may, at no cost to the manufacturer, subject random lengths of pipe to testing by an independent laboratory for compliance with this Specification. Any visible defect of failure to meet the quality standards herein will be grounds for rejecting the entire order.

Approved Manufacturers for PVC C-900 Pipe: Please see SAWS website for a list of approved manufacturers- http://www.saws.org/business_center/specs/product_submittal/

2.4.2. Polyvinyl Chloride Pipe, 14 in. through 36 in. (C-905). This Section covers 14 in. nominal diameter through 36 in. nominal diameter polyvinyl chloride (PVC) potable water transmission pipe with integral bell and spigot joints. The pipe must be extruded from Class 1245-A or 1245-B PVC compound as defined in ASTM D-1784 and provide for a hydrostatic design basis (HDB) of 4,000 psi (27.58 MPa). The pipe outside diameters must conform to dimensions of cast iron pipe (CI). All pipe furnished must be in accordance with American Water Works Association (AWWA) C-905, or latest revision thereof.

Pipe must be homogenous throughout. It must be free from voids, cracks, inclusions, and other defects. It must be as uniform as commercially practical in color, density, and other physical properties. Pipe surfaces must be free from nicks and scratches. Joining surfaces of spigots and joints must be free from gouges and imperfections that could cause leakage.

Inductive Tracer Detection Tape must be placed directly above the centerline of all non-metallic pipe a minimum of 12 in. below subgrade or, in areas outside the limits of pavement, a minimum of 18 in. below finished grade to aid locating pipe in the future. The tracer tape must be encased in a protective, inert, plastic jacket and color coded according to American Public Works Association Uniform Color Code. Except for minimum depth of cover, the tracer tape must be placed according to manufacturer's recommendations.

2.4.2.1. Definitions. All definitions are defined according to AWWA C-905-97 Section 1.2, "Definitions."

2.4.2.1.1. Dimension Ratio (DR). The ratio of the pipe outside diameter to the minimum wall thickness. The quotient is rounded to the nearest 0.5 when necessary

2.4.2.1.2. Pressure Rating (PR). The nominal pressure rating of transmission pipe is determined from formulas in Section 5, "Transmission-Pipe Ratings" found in the AWWA C905-97 using a safety factor of 2.0. There is no allowance for surge pressure in the pressure rating.

2.4.2.2. General Requirements. Except as noted on the plans or procurement Specifications for specific jobs, all PVC C-905 pipe must have a pressure rating of 235 psi and a dimension ratio of 18 or have the highest pressure rating available for each size of pipe.

Dimensions and tolerances for each nominal pipe size must be in accordance with Table 2 Dimensions for PVC Transmission Pipe with CI outside Diameter of Section 3, "Pipe Requirements" in AWWA C-905-97. All pipes must be suitable for use as a pressure conduit.

Pipe must be gauged full length and furnished in standard laying lengths of 20 ft. ± 1 in. (6.1 m ± 25 mm), unless otherwise noted. Each pipe must have an integral bell formed on the pipe end, and be designed to be at least as strong as the pipe wall.

An elastomeric gasket must be designed with a retainer ring, which locks the gasket into integral bell groove and must be installed at the point of manufacture. The dimensions and design of the gasket joint provided for the PVC transmission pipe must meet requirements provided in ASTM D-3139 and ASTM D-2122. The gasket must be reinforced with a steel band and must conform to ASTM F-477.

Each length of pipe furnished must bear identification markings that will remain legible after normal handling, storage, and installation. Markings must be applied in a manner that will not weaken or damage the pipe. Markings must be applied at intervals of not more than 5 ft. (1.5 m) on the pipe. The minimum required markings are given in the list below. Marking requirements must be in accordance with Section 4.7, "Marking Requirements" found in the AWWA C-905-97.

- Nominal size and OD base (for example, 24 CI).
- PVC.
- Dimension Ratio (for example, DR 18).
- AWWA pressure rating (for example, PR 235).
- AWWA designation number for this standard (AWWA C-905).
- Manufacturer's name or trademark.

- Manufacturer's production code, including day, month, year, shift, plant, and extruder of manufacture.

Pipe must be bundled in pallets for ease of handling and storage. Pipe bundles (Units) must be packaged to provide structural support to ensure that the weight of upper units will not cause deformation to pipe in lower units. No pipes bundles will be accepted which show evidence of ultraviolet radiation "sunburn" on exposed pipe as may be caused from extended unprotected storage conditions.

The manufacturer must take adequate measures during pipe production to assure compliance with AWWA C905-97 by performing quality-control tests and maintaining results of those tests as outlined in Section 4, "Inspection and Testing" of that standard. Submission of product will constitute certification of compliance with AWWA C905-97 Section 4, "Inspection and Testing."

The pipe is intended for use as an underground, direct bury pressure pipe for transport of potable water. The expected life of the pipe system, after installation, is 25 to 50 yr.

A 1 yr. warranty must be provided for all materials sold and delivered for use and incorporated into the San Antonio Water System distribution system. Such warranty will take effect on the date that the pipe is received and accepted by an authorized representative of the San Antonio Water System.

User references and a claims history must be provided for further investigation, before rendering a final decision on the acceptance of the product to be furnished.

2.4.2.2.1. Test. The manufacturer must pressure test all pipe, including the joint, which is marked with the designation number of AWWA C-905-97 at 73.4ºF ± 3.6ºF (23ºC ± 2ºC). Each length of pipe must be proof tested at twice the pressure rating listed in Table 3 Transmission-Pipe Pressure Rating of AWWA C-905-97 Sec 4.6 Pressure Strength and Hydrostatic Proof Testing.

2.4.2.2.2. Random Tests. The San Antonio Water System may, at no cost to the manufacturer, subject random lengths of pipe to testing by an independent laboratory for compliance with this Specification. Any visible defect or failure to meet the quality standards herein will be grounds for rejecting the entire order.

2.4.2.2.3. References. The documents listed below are referenced in this Specification.

AWWA C-905-97; Polyvinyl Chloride (PVC) Water Transmission Pipe Nominal Diameters 14 in. through 36 in.

- ASTM D-1784; Standard Specification for Rigid Polyvinyl Chloride (PVC) Compounds and Chlorinated Polyvinyl Chloride (CPVC) Compounds.
- ASTM D-2122; Standard Method of Determining Dimensions of Thermoplastic Pipe and Fittings.
- ASTM D-3139; Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
- ASTM F-477; Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

Manufacturers. Approved Manufacturers for PVC C-905 Pipe: Please see SAWS website for a list of approved manufacturers- http://www.saws.org/business_center/specs/product_submittal/

2.4.3. Polyvinyl Chloride Pipe, 4 in. through 12 in. (C-909). This Section covers molecularly oriented 4 in. through 12 in. diameter Polyvinyl Chloride (PVC) pressure pipe manufactured from starting stock pipe made from class 12454A or 12454B compounds as determined by ASTM DI784. The starting stock materials are then oriented through circumferential expansion to provide a hydrostatic design basis of 7,100 psi. Pipe must be homogenous throughout. It must be free from voids, cracks, inclusions and other defects. It must be as uniform as commercially practical in color, density and other physical properties. Pipe surfaces must be free from nicks and scratches. Joining surfaces of spigots and joints must be free from gouges and imperfections that could cause leakage. All pipe furnished must be in accordance with AWWA C-909-02, or latest revision thereof and meet the ANSI/NSF 61 requirements. Inductive Tracer Detection Tape must be placed directly above the centerline of all non-metallic pipe a minimum of 12 in. below subgrade or, in areas outside the limits of pavement, a minimum of 18 in. below finished grade to aid locating pipe in the future. The tracer

tape must be encased in a protective, inert, plastic jacket and color coded according to American Public Works Association Uniform Color Code. Except for minimum depth of cover, the tracer tape must be placed according to manufacturer's recommendations

2.4.3.1. General Requirements. Except as noted on the plans or procurement Specifications for specific jobs, all PVC C-909 pipe must be Class 150 with a sustained pressure requirement of 500 psi (ASTM D2241) and a minimum burst pressure of 755 psi (ASTM D1599.)

Dimensions and tolerances for each nominal pipe size must be in accordance with Section 4.3 "Pipe Requirements," Table 1 of AWWA C-909.

Pipe must be furnished in standard lengths of 20 ft. (± 1 in.) unless otherwise noted. Each pipe must have an integral bell formed on the pipe end and be designed to be at least as strong as the pipe wall.

An elastomeric gasket that "locks" into the integral bell groove must be installed at the point of manufacture. The gasket must be in accordance with ASTM F477.

Each length of pipe furnished must bear identification markings in accordance with Section 6.1.2, "Pipe" of AWWA C-909.

Pipe must be bundled in pallets for ease of handling and storage. Pipe bundle units must be packaged to provide structural support to ensure that the weight of upper units will not cause deformation to pipe in the lower units.

No pipe bundles will be accepted which show evidence of ultraviolet radiation "sunburn" on exposed pipe as may be caused from extended unprotected storage conditions.

The manufacturer must take adequate measures during pipe production to assure compliance with AWWA C-909 by performing quality-control tests and maintaining results of those tests as outlined in Section 5.2 Quality- Control Records of that standard. Submission of product will constitute certification of compliance with this standard.

The pipe is intended for use as an underground, direct bury pressure pipe for transport of potable water. The expected life of the pipe is received and accepted by an authorized representative of the San Antonio Water System.

A 1 yr. warranty must be provided for all materials sold and delivered or use and incorporated into the San Antonio water system. Such warranty will take effect on the date that the pipe is received and accepted by an authorized representative of the San Antonio Water System.

User references and a claims history must be provided for further investigation before rendering a final decision on the acceptance of the product to be furnished.

The San Antonio Water System may, at no cost to the manufacturer, subject random lengths of pipe testing by an independent laboratory for compliance with this Specification. Any visible defect of failure to meet the quality standards herein will be grounds for rejecting the entire order.

2.4.3.2. References.

- ANSI/AWWA C-909; AWWA Standard for Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 4 In. through 12 In. for Water Distribution.
- ASTM D 1598; Test Method for Time-to-Failure of Plastic Pipe under Constant Internal Pressure.
- ASTM D 1599; Test Method for Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing and Fittings.
- ASTM D 1784; Specification for Rigid Polyvinyl Chloride (PVC) Compounds and Chlorinated Polyvinyl Chloride (CPVC) Compounds.

- ASTM D 2122; Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings.
- ASTM D 2152; Test Method for Degree of Fusion of Extruded Poly Vinyl Chloride (PVC) Pipe and Molded Fittings by Acetone Immersion.
- ASTM D 2241; Specification for Polyvinyl Chloride (PVC) Pressure Rated Pipe (SDR Series.)
- ASTM D 2412; Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
- ASTM D 2837; Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
- ASTM D 3139; Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
- ASTM F 477; Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
- ANSI/NSF 61; Drinking Water System Components – Health Effects.
- PPI TR3; Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials.

2.4.3.3. Manufacturers. Approved Manufacturer for PVC C-909 Pipe: Please see SAWS website for a list of approved manufacturers- http://www.saws.org/business_center/specs/product_submittal/

2.5. Joint Restraint System. This Section covers pipe joint restraint systems to be used on domestic water mains for PVC C-900 pipe sizes 4 in. through 12 in. diameter and PVC C-905 pipe sizes 16 in. through 24 in. diameter, and for Ductile Iron pipe sizes from 4 in. through 24 in. diameter. Joint restraint systems are classified as “compression,” “mechanical joint,” or “non-metallic restrained joint” for the specific type of pipe joint to be restrained.

2.5.1. General Requirements. Underwriter Laboratories (U.L) and Factory Mutual (FM) certifications are required on all restraint systems.

Unless otherwise noted, restraint systems to be used on PVC C-900 and C-905 pipe must meet or exceed A.S.T.M. F1674-96, “Standard Test Methods for Joint Restraint Products for Use with PVC Pipe,” or the latest revision thereof. Restraint systems used on ductile pipe must meet or exceed U.L. 194.

Non-metallic restrained joint pipe and couplings must be used specifically for PVC C-900 pipe and fittings in sizes 4 in. through 12 in.

Each restraint system must be packaged individually and include installation instructions.

2.5.2. Specific Requirements.

2.5.2.1. Restrainer for PVC C-900/C-905 & Ductile Iron Push-on Type Connections. Pipe restraints must be used to prevent movement for push-on D.I. or PVC (C-900 & C-905) (compression type) bell and spigot pipe connections or where a transition or flexible coupling has been used to join two sections of plain-end pipe D.I. or PVC (C-900 & C-905). The restrainer may be adapted to connect a plain end D.I. or PVC pipe to a ductile iron mechanical joint (MJ) bell fitting. The restrainer must not be directionally sensitive.

The pipe must be restrained by a split retainer band. The band must be cast ductile iron, meeting or exceeding ASTM A-536-80, Grade 65-45-12. The inside face or contact surface of the band must be of enough width to incorporate cast or machined non-directionally sensitive serration to grip the outside circumference of the pipe. The serration must provide full (360°) contact and maintain pipe roundness and avoid any localized points of stress. The split band casting must be designed to “bottom-out” before clamping bolt forces (110-ft. lb. minimum torque) can over-stress the pipe, but will provide full non-directionally sensitive restraint at the rated pressures.

Bolts and nuts used to attach the split retainer ring must comply with ANSI B-18.2/18.2.2, SAE Grade 5. Tee-bolts, nuts and restraining rods must be fabricated from high-strength, low-alloy steel per AWWA C-111-90.

The split ring type non-directionally sensitive restrainer system must be capable of a test pressure twice the maximum sustained working pressure listed in Table 2 and be for both D.I. and PVC C-900.

Restraint systems sizes 6 in. through 12 in. must be capable of use for both ductile iron and PVC C-900.

The restraint system may consist of two types: the two split retainer rings and for new construction use only the one split and one solid cast backup ring.

2.5.2.2. Compression Ring Fitting Restrainer for Ductile Iron Pipe & PVC C-900. Compression ring with follower gland type of restrainer may be used in conjunction with Mechanical Joint (MJ) bell end ductile iron pipe fittings for restraining PVC C-900 and ductile iron pipe.

The system must use a Standard MJ gasket with a color-coded compression ring and replacement gland conforming to ASTM A-536-80, Grade 65-45-12.

Standard MJ fitting Tee-bolts and nuts must be fabricated from high strength steel conforming to ANSI AWWA C-111/A-21.11 and AWWA C-153/A-21.53-88.

Standard MJ gasket must be virgin SBR meeting ASTM D-2000 3 BA 715 or 3 BA 515.

The restraint system must be capable of a test pressure twice the maximum sustained working pressure listed in Table 2.

2.5.2.3. Non-metallic restrained joint pipe and couplings for PVC C-900 Type Connections. Gasketed restrained coupling connections must join two sections of factory grooved PVC C-900 pipe. The restrainer coupling must not be directionally sensitive.

The coupling must incorporate twin elastomeric sealing gaskets meeting the requirements of ASTM F-477 and must be DR-14 Class 200 PVC C-900 in all applications, meeting or exceeding the performance requirements of AWWA C-900, latest revision. The inside face or contact surface of the coupling connection must be of enough width to incorporate a factory machined non-directionally sensitive groove in both pipe and coupling to grip the outside circumference of the pipe. The couplings must provide full (360°) contact and maintain pipe roundness and avoid and localized points of stress. The coupling must be designed with an internal stop to align the precision-machined grooves in the coupling and pipe before installation of a non-metallic thermoplastic restraint spleen, and will provide full non-directionally sensitive restraint at the rated pressures.

High-strength flexible thermoplastic spleens must be inserted into mating precision–machined grooves in the pipe and coupling to provide full non-directional restraint with evenly distributed loading.

The non-metallic restrained joint pipe and couplings for PVC C-900 type non-directionally sensitive restrainer system must be capable of a test pressure twice the maximum sustained working pressure listed in Table 2 and be for PVC C-900 pipe sizes 4 in. through 12 in.

Non-metallic restrained joint pipe and couplings for PVC C-900 restrained systems sizes 4 in. through 12 in. must be capable of use for both Class 150 (DR 18) and 4 in. through 8 in. for Class 200 (DR 14) PVC C-900 pipe.

The non-metallic restrained joint pipe and couplings for PVC C-900 restraint system must consist of a pipe and couplings system produced by the same manufacturer meeting the performance qualifications of Factory Mutual (FM) and Underwriters Lab (UL).

2.5.2.4. Fitting Restraint for Ductile Iron Pipe (only). Radial bolt type restrainer systems must be limited to ductile iron pipe in conjunction with Mechanical Joint (MJ) bell end pipe of fittings. The system must use a Standard MJ gasket with a ductile iron replacement gland conforming to ASTM A-536-80. The gland dimensions must conform to Standard MJ bolt circle criteria.

Individual wedge restrainers must be ductile iron heat treated to a minimum hardness of 370 BHN. The wedge screws must be compressed to the outside wall of the pipe using a shoulder bolt and twist-off nuts to insure proper actuating of the restraining system.

Standard MJ fitting Tee-bolts and nuts must be high strength steel conforming to AWWA C111/A21.11 and C153/A21.53-88.

Standard MJ gasket must be virgin SBR meeting ASTM D-2000 3 BA 715 or 3 BA 515.

2.5.3. Maximum Sustained Working Pressure Requirement

Table 2
Max Sustained Working Pressure Requirement

Nominal Diameter	PVC C-900 / C-905	Ductile Iron
4 in. & 6 in.	200 psi	350 psi
8 in.	200 psi	250 psi
10 in. & 12 in.	200 psi	200 psi
14 in. & 16 in.	200 psi (C-900) / 235 psi (C-905)	200 psi
20 in. & 24 in.	200 psi (C-900) / 235 psi (C-905)	200 psi

2.5.3.1. Tests. The San Antonio Water System may, at no cost to the Contractor, subject random joint restraint system products to testing by an independent laboratory for compliance with these standards. Any visible defect of failure to meet the quality standards herein will be ground for rejecting the entire order.

2.5.3.2. Manufacturers. Please see SAWS website for a list of approved manufacturers- http://www.saws.org/business_center/specs/product_submittal/

2.6. Stainless Steel Casing Spacer/Insulators. This Section covers casing spacers for use in water supply service. Casing spacers are used to facilitate installing a water pipe inside a casing pipe or tunnel. Casing spacers must consist of two or more segments of circular steel that bolt together forming a shell around the carrier pipes. Casing spacers should protect the carrier pipe and any protective coating or wrapping from damage during the installation, and properly support and electrically isolate the carrier pipes within the casing or tunnel. On occasion multiple carrier pipes may be installed in one casing or tunnel.

2.6.1. General Requirements. The San Antonio Water System (SAWS) reserves the right to limit the purchase of casing spacers from the manufacturers and to the models specified as shown on the SAWS website - http://www.saws.org/business_center/specs/product_submittal/, providing such casing spacers conform to the provisions contained herein.

Casing spacers must be 8 in. long for carrier pipes up to 16 in. diameters and 12 in. long for larger carrier pipe sizes. Manufacturer's approval in writing will be required for installations exceeding 300 ft. in length, carrier pipes in excess of 48 in. diameter or multiple carrier pipes in one casing or tunnel.

Casing spacers must have a minimum 14-gauge steel band and 10-gauge steel riser when required. The band, risers and connecting studs must be welded and cleaned at the factory before the application of a fluidized bed fusion bonded PVC coating. Stainless steel (type 304) casing spacer is an acceptable alternative.

The fluidized bed fusion bonded PVC coating must be between 10-16 mils thickness. The PVC coating must provide good resistance to acids and alkalize and excellent resistance under ASTM B117 salt spray tests. The coating must have a minimum 1380 volts/mil per ASTM D149-61 short time 0.010 in. test and a Durometer-shore A @ (10 sec) of 80 per ASTM D1706-61T. Epoxy coatings are not an acceptable alternative.

The spacers must have a flexible PVC liner of 0.09 in. thickness with Durometer “A” 85-90 hardness and a minimum 58,000- volt dielectric strength (60,000-volt minimum Surge Test.) Moisture absorption must not exceed 1%.

The runners must be of high pressure molded glass reinforced polyester with a minimum compressive strength of 18,000 psi per ASTM D695, flexural strength of 25, 300 psi per ASTM D790, tensile strength of 17,600 psi per ASTM D638 and Rockwell hardness (M) of 90 per ASTM D785. The riser must be designed and fabricated to place the runner (skid) in full contact with the inside surface of the casing pipe. This evenly distributes the load force to all support members. The ends of all runners must be shaped to resist hanging or sticking inside casing during installation of the carrier pipe. Polyethylene runners are not acceptable.

Runners must be a minimum of 1 in. in width and a minimum of 7 in. long for carrier pipes up to 16 in., and a minimum of 2 in. in width and 11 in. long for larger carrier pipes. Bolts on runners are not acceptable. The runners must be attached to the band or riser by 3/8 the wearing surface on the runner. The recess must be filled with a corrosion inhibiting filler. There must be 4 runners per casing spacer for carrier pipes up to 12 in. diameter, 6 runners for 14 in. through 36 in. and 8 or more runners for carrier pipes over 36 in. diameter. Number of bottom runners must be multiples of two. Number of top runners must be multiples of two.

The band section must be bolted together with 5/16 in. cadmium-plated studs, nuts and washers. There must be 6 sets per 8 in. long casing spacer and 8 sets per 12 in. long spacer. Stainless steel casing spacers must be furnished with stainless steel studs, nuts and washers.

Casing spacers must have ample riser height to limit vertical movement of the carrier pipe in the casing. A minimum of 1 in. to 2 in. clearance must be provided between the top runner and the ID of the casing or tunnel.

Continuous operating temperatures for the PVC Coated Casing Spacers should not exceed 150°F. Stainless steel casing must be used in applications where continuous operating temperatures exceed 150°F.

Unless noted otherwise, casing spacers and end seals will be required on all carrier pipes installed in casing or tunnel applications.

2.6.2. Quality Assurance. All casing spacers are to be manufactured in accordance to NACE International Recommend Practice RP 0286-97 (Isolation Spacers.) Each casing spacer must be manufactured in the USA at a facility that has a Registered ISO 9002 Quality Management System or be in the process of achieving this certification by March 2005. Non-compliance to this registered commercial quality system requirement by March 2005 will result in removal of the manufacturer’s product from the approved manufacturers.

If on receipt of casing spacers they are found to be non-compliant, the manufacturer must replace the defective casing spacer with a casing spacer that meets the San Antonio Water System’s Specifications, at no charge to San Antonio Water System.

If San Antonio Water System audits, product inspection and performance data review in accordance to these Specifications determine excessive casing spacer Non-compliance, the manufacturer will be subject to removal by the Products Standard Committee. Copy of the current ISO 9002 registration (or written documentation of being “in the process of achieving ISO registration,” before March 2005) must be provided with material submittal.

2.7. Copper Tubing and Brass Fittings for Copper Service Lines.

2.7.1. Copper Tubing. This Section covers copper tubing in nominal sizes of 3/4 in., 1 in., 1-1/2 in. and 2 in.

2.7.1.1. General Requirements. Copper tubing must be of the type commercially known as Type “K” soft and conforms to NSF 61, ASTM Specifications B-88, or latest revision thereof.

3/4 in. and 1 in. copper tubing must be furnished in 60 ft. coils or 100 ft. coils as specified; 1-1/2 in. must be furnished in 20 ft. lengths, 40 ft. coils or 60 ft. coils as specified, and 2 in. must be furnished in 20 ft. lengths or 40 ft. coils as specified.

Copper tubing is the only allowable material for small service lines.

2.7.2. Brass Fittings. This Section covers waterworks brass goods, such as corporation stops, curb stops, couplings, connectors, nipples, etc.

2.7.2.1. General Requirements. The brass composition must conform to ASTM Specifications B-62, or latest revision thereof, fittings must conform to ANSI/AWWA Specifications C-800, or latest revision thereof.

All brass components in contact with potable water must be "lead free" and marked by stamping, etching or casting "NL" in the main body made from either CDA/UNS Brass Alloys C89520 in accordance with ASTM B584; or C89833. Brass saddles must be made from CDA/UNS C83600.

Any brass component not in contact with potable water must be made of 85-5-5-5 brass as defined per ASTM B62, ASTM B584 and AWWA C-800.

All service fittings must be certified as suitable for contact with drinking water by an ANSI accredited organization in accordance with ANSI/NSF 61, Drinking Water Systems Components-Health affects Section 8. Proof of certification is required. The lead content of the wetted components in contact with potable water must also be verified by an ANSI accredited testing facility.

All brass fittings and valves must have the manufacturers name or trademark integrally stamped, or cast into it indicating that the product is manufactured from the low-lead alloy as specified. Another marking such as "NL," "EBII," "FD" or other commonly accepted identifier, indicating the alloy as "No-lead"; must also be cast or stamped into the fitting or valve.

Painting, printing, sticker, or decals attesting to the components "no-lead" certification will not be permitted.

All casting must have a natural, clean uniform and smooth surface, and be free from internal porosity.

All machining must be done in a workmanlike manner and within the acceptable tolerances.

2.7.2.2. Design Criteria for Ball Type Curb Stops/Angle Valves. All Curb Stop, Corporation and Angle valves must be ball valves. "Inverted/Ground Key," type angle valves will not be accepted.

Ball type valves will not have a stop.

All ball valves, couplings and adapters will be pressure rated to 300 psi, and will be supplied with blowout proof stainless steel stems with double SBR, NBR or EPDM O-ring steam seal.

Stem and cap assembly will be two-piece design and will withstand minimum 200-ft. lb. of torque.

Ball seats will be made with unfilled Teflon or EPDM for resilience and minimal friction.

Ball will be lead free cast brass or stainless design. Coated ball is not permitted.

All fittings must have a lifetime guarantee against lead leachate from the casting.

The reduced port design not will be acceptable.

Pack Joints will not be accepted.

2.8. Gate Valves, Tapping Valves and Tapping Sleeves.

2.8.1. Resilient-Seated Gate and Tapping Valves ANSI/AWWA C509-01. This product Specification covers resilient seated gate valves, with nominal diameters of 3 in., 4 in., 6 in., 8 in., 10 in., 12 in., 16 in., and 20 in. Sizes refer to the nominal diameter, in in., of the waterway through the inlet and outlet connections and the closure area. All products furnished must conform to the ANSI/AWWA C-509-01, or latest revision thereof.

2.8.1.1. Definitions. All definitions are defined according to ANSI/AWWA C509-01.

2.8.1.1.1. Cosmetic Defect. A blemish, which has no effect on the ability of the component to meet the structural design and production test requirements of this standard. Should the blemish or the activity of plugging, welding, grinding, or repairing of such blemish cause the component to fail these requirements, then the blemish will be considered a structural defect.

2.8.1.1.2. Flanged Joint. The flanged and bolted joint as described in ANSI/AWWA C110/A21.10.

2.8.1.1.3. Mechanical Joint. The gasket and bolted joint as described in ANSI/AWWA C111/A21.11.

2.8.1.1.4. Push-on Joint. The single rubber gasket joint as described in ANSI/AWWA C111/A21.11.

2.8.1.1.5. Structural Defect. A flaw that causes the component to fail the structural design or test requirement of this standard. This includes, but is not limited to imperfections that result in leakage through the walls of a casting, failure to meet the minimum wall-thickness requirement, or failure to meet production tests.

2.8.1.1.6. Tapping Valve. A special gate valve designed with end connections and an unobstructed waterway to provide proper alignment and positioning of a tapping sleeve, valve, and machine for tapping pipe dry or under pressure as described in AWWA C-509 Section 1.2, “Definitions” and MSS SP-60.

2.8.1.2. General Requirements. Except as otherwise modified or supplemented herein, AWWA C-509-01 or the latest revision thereof, will govern the design, component materials, construction; manufacture and testing of all resilient seated gate valves. Valves must be suitable for frequent operation as well as service involving long periods of inactivity. Valves must be NSF-61 certified.

The San Antonio Water System reserves the right to limit the purchase of resilient seat gate valves from manufacturers and to the models specified, provided such resilient seat gate valves conform to the provision contained herein. Please see SAWS website for a list of approved manufacturers- http://www.saws.org/business_center/specs/product_submittal/

The minimum design working water pressure for gate valves with nominal diameters of 3 in., 4 in., 6 in., 8 in., 10 in., and 12 in. must be 200 psig unless otherwise specified.

The minimum design working water pressure for gate valves with nominal diameters of 16 in., 20 in., and 24 in. must be 150 psig unless otherwise specified.

Valves must be resilient-seated types, bronze mounted with non-rising stems. The closure member must be fully encapsulated by an elastomer without thin spots or voids. When open the valve must have a clear, full-port, unobstructed waterway.

Gray iron, ductile iron, steel, brass and bronze materials must meet or exceed the material requirements of Section 2, “Materials” of AWWA C-509-01.

Gaskets, O-rings, Coatings, and elastomers must meet or exceed the material requirements of Section 2, “Materials” of AWWA C-509-01.

The gate valves must be designed and constructed for installation in either a horizontal or vertical position. Valves must be designed for buried installation with stem in the vertical position and must be furnished for mounting in a horizontal pipeline, unless otherwise specified.

Valve components of brass or bronze must be manufactured to ASTM recognized alloy Specifications of low zinc content bronze, as shown in Table 1 of Section 2.2.4. of ANSI/AWWA C-509-01, or the latest revision thereof. Materials for the stem have minimum yield strength of 40,000 psi. A minimum elongation in 2 in. of 12% and must be made of bronze per ASTM B763, alloy number UNS C99500. A maximum zinc content of 2% as shown in Table 2 Chemical Requirements of ASTM B763-96 or the latest revision thereof. Stem nut material must be ASTM B-62 UNS C83600 or ASTM B-584 UNS C84400. The stem must have a visible external marking at the top to indicate low-zinc, high strength material. The marking must include a red plastic or neoprene washer placed around the top of the stem under the operating nut.

Valve ends must be either flanged, tapping valve, mechanical joint, push-on joint or any combination thereof, as specified. All mechanical joint valves must be supplied with glands, bolts, and gaskets. Valve body bolts and nuts must meet the strength requirements of ASTM A-307 with dimensions conforming to ANSI B18.2.1. The size of the bolt head must be equal to the size of the nut and must be stainless steel in accordance with ASTM 276.

All gate valves must open right (clockwise), unless otherwise specified.

The following parts of the valve must be made of either gray or ductile iron: bonnet, body, yoke, wrench nut, O-ring packing plate or seal plate, and gland follower. The gate may be made of gray or ductile iron.

If glands and bushings are used for NRS valves they must be made of ASTM B-763 bronze UNS C99500. The stem must be made of cast, forged, or rolled ASTM B-763 bronze UNS C99500. The stem nut material must be ASTM B-62 bronze UNS C83600 or ASTM B-584 bronze UNS C84400. The gate may be made of bronze ASTM B-763 bronze UNS C99500. Stem seals must be “O” ring type. The seals must be designed for dynamic applications.

The design must be such that the seal above the stem collar can be replaced with the valve under full pressure in the fully open position. Materials for the “O” ring packing plate must be in accordance with Section 4.8.3 of ANSI/AWWA C509-01 or the latest revision thereof.

Enclosed and buried valves must be coated inside and outside with a fusion bonded epoxy with a nominal 8 mils dry film thickness, which meets or exceeds AWWA C-550-01 and to the maximum extent possible must be free of holidays. All coatings in contact with the potable water must be approved for potable water immersion service per ANSI/NSF 61.

The bidder must submit with his proposal 3 sets of certified drawings showing the principal dimensions, general construction and material Specification of the valve proposed. The number of turns to open (close) must be clearly noted in the valve information submitted with the proposal documents. The number of turns to open or close the valve must be consistent for each valve size for each approved manufacturer.

Valves furnished under this Specification must be supplied from the San Antonio Water System approved manufacturer list shown on the SAWS website - http://www.saws.org/business_center/specs/product_submittal/. To be included on the qualified product list, the manufacturer must provide an Affidavit of Compliance in accordance with the Section 1.5 of ANSI/AWWA C-509-01 or latest revision thereof, to include compliance with San Antonio Water System Specification No. 21-02. Records of all tests performed in accordance with Section 6.1 and Section 6.2 of ANSI/AWWA C-509-01 or latest revision thereof will be made available or provided. These records will be representative test results for Section 6.1 and certificate of testing for Section 6.2. An affidavit of testing for the valve assembly as outlined in Section 6.2.2 of ANSI/AWWA C-509-01, (350-ft. lb.) will also be provided. A copy of the manufacturer’s Quality Assurance Program will be submitted. Blueprints and parts list for the valve must also be provided.

All gate valve parts must be designed to withstand the following two pressure requirements, without being structurally damaged. (1) An internal test pressure of twice the rated design working pressure of the valve. (2) The full rated internal working pressure when the closure member is cycled once from a fully open to a fully closed position against the full rated unbalanced working water pressure. In addition to these pressure requirements, the valve assembly and mechanism must be capable of withstanding an input torque as

follows: 200-ft. lb. for a 3 in. and 4 in. nominal diameters, and 300-ft. lb. for a 6 in. 8 in., 10 in., and 12 in. nominal diameters. For sizes larger than a 12 in. nominal diameter, refer to the manufacturer's Specifications.

Resilient seats must be applied to the gate and must seat against a corrosion resistant surface. The non-metallic seating surface must be applied in a manner to withstand the action of line fluids and the operation of the sealing gate under long-term service. A metallic surface must have a corrosion resistance equivalent to or better than bronze. A non-metallic surface must be in compliance with ANSI/AWWA C-550. The gate must be fully encapsulated by an elastomer without thin spots or voids. Resilient seats must be bonded. ASTM D-429 either method A or method B must prove the method used for bonding or vulcanizing. For method A, the minimum strength must not be less than 250 psi. For method B, the peel strength must be 75 lb./in.

The end flanges of flanged valves must conform to dimensions and drillings of ANSI/AWWA C-110/A21.10 or ANSI B-16.1, Class 125.

Mechanical joint bell dimensions must conform to ANSI/AWWA C-111/A21.11.

Push-on joints must conform to the requirements of ANSI/AWWA C-111/A21.11.

The tapping valves must be mechanical joints with tapping flange on the other end. The tapping valves must be furnished complete with glands, bolts, and gaskets. The tapping valve must have a clear unobstructed waterway.

The seat rings must be of a large diameter to the permit entry of the full diameter tapping machine cutters. The valve end which mates with the tapping sleeve must have an alignment lip to fit the recess in the tapping sleeve flange for proper alignment. The lip will be dimensioned in accordance with MSS SP-60 for valves 20-in. nominal pipe size and smaller.

All interchangeable parts must conform to their required dimensions and must be free from defects that could prevent proper functioning of the valve. When assembled, valves manufactured in accordance with this standard must be well fitted and operate smoothly. All like parts of valves of the same model and size produced by the same manufacturer must be interchangeable.

All castings must be clean and sound, without defects that will weaken their structure or impair their service. Plugging, welding, or repairing of cosmetic defects is allowed. Repairing of structural defects is not allowed. Repaired valves must comply with the testing requirements of this Specification after repairs have been made. Repairs within the bolt circle of any flange face are not allowed.

All gate valves must be hydrostatically tested with twice the specified rated pressure applied to one side of the gate and zero pressure applied to the other side. The test is to be made in each direction across the gate. All tests are to be performed at the manufacturer's plant.

All gate valves must be operated through a complete cycle in the position for which it was designed to ensure free and proper functioning of all parts in the intended manner. Any defects in workmanship must be corrected and the test repeated until satisfactory performance is demonstrated. All tests are to be performed at the manufacturer's plant.

A hydrostatic test pressure equal to twice the rated working pressure of the valve must be applied to all assembled valves with the gates in the open position. The test must show no leakage through the metal, pressure containing joints, or stem seals. All tests are to be performed at the manufacturer's plant.

A test must be made from each direction at rated working pressure to prove the sealing ability of each valve from both directions of flow. The test must show no leakage through the metal, pressure containing joints, or past the seat. All tests are to be performed at the manufacturer's plant.

Markings must be cast on the bonnet or body of each valve and must show the manufacturer's name or mark, the year the valve casting was made, the size of the valve, and the designation of working water pressure, for example "200 W."

The San Antonio Water System may, at no cost to the Contractor, subject random valves to testing by an independent laboratory for compliance with these standards. Any visible defect or failure to meet the quality standards herein will be grounds for rejecting the entire order and removal from the approval list.

2.8.1.3. Workmanship. All parts of the resilient seat gate valve must be designed and manufactured to the tolerances specified in ANSI/AWWA C-509-01 or latest revision thereof and this Specification.

All parts of the resilient seat gate valve manufactured by a given manufacturer must be interchangeable with like parts from another resilient seat gate valve of the same model and size and by the same manufacturer.

All interchangeable parts must conform to their required dimensions and must be free from defects that could prevent proper functioning of the valve.

All castings must be clean and sound, without defects that will weaken their structure or impair their service. Plugging, welding, or repairing of cosmetic defects is allowed. Repairing of structural defects is not allowed. Repaired valves must comply with the testing requirements of this Specification after repairs have been made. Repairs within the bolt circle of any flange face are not allowed.

The resilient seat gate valves must be well fitted. Operation of the resilient seat gate valve must be smooth. All parts must be free of structural defects. The resilient seat gate valve must be watertight.

2.8.1.4. Painting. All exterior and interior surfaces of the valve must be coated with epoxy, NSF 61 certified. The epoxy must have a nominal dry film thickness of 8 mils, and must be in accordance with AWWA C-550, latest revision.

Coating must be as close to holiday free as is technologically possible.

2.8.1.5. Testing.

Hydrostatic Test: Hydrostatic Test must be performed on the valve in accordance with Section 6.1, "Proof of Design Testing" of ANSI/AWWA C-509-01 or latest revision thereof.

Torque Test: Torque Test for prototype valves must be performed on the valve in accordance with Section 6.1, "Proof of Design Testing" of ANSI/AWWA C-509-01 or latest revision thereof.

Leakage Test: Leakage Test must be performed on the valve in accordance with Section 6.1, " Proof of Design Testing" of ANSI/AWWA C-509-01 or latest revision thereof.

Pressure Test: Pressure Test must be performed on the valve in accordance with Section 6.1, "Proof of Design Testing" of ANSI/AWWA C-509-01 or latest revision thereof.

Operation Test: Operation Test must be performed on the valve in accordance with Section 6.2, "Production Testing" of ANSI/AWWA C-509-01 or latest revision thereof.

Shell Test: Shell Test must be performed on the valve in accordance with Section 6.2, "Production Testing" of ANSI/AWWA C-509-01 or latest revision thereof.

Seat Test: Seat Test must be performed on the valve in accordance with Section 6.2, "Production Testing" of ANSI/AWWA C-509-01 or latest revision thereof.

An Affidavit of Compliance certifying that all required tests have been performed must be provided in accordance with Section 6.3, "Affidavit of Compliance" of ANSI/AWWA C-509-01.

The Affidavit of Compliance, the results of ASTM testing procedures and requirements for materials, Manufacturer's Quality Assurance Program, and the records of all tests performed on the valve must be kept and provided by the supplier/manufacturer in a single hard cover bound notebook with the bid or with the shipping documents and must be approved by the San Antonio Water System.

2.8.1.6. Quality Assurance. Manufacturers must have an ASME or I.S.O. 9001 registered commercial quality system or is in the process of achieving this certification by June 2001. Non-compliance to this registered commercial quality system requirement by June 2001 will result in removal of the manufacturer's product from the approved manufacturers list. If on receipt of resilient seat gate valves they are found to be non-compliant the manufacturer must replace the defective resilient seat gate valves according to resilient seat gate valve size with a resilient seat gate valve that meets the San Antonio Water System's Specifications. The defective resilient seat gate valve will be returned to the manufacturer, freight collect, and the manufacturer must replace the resilient seat gate valve, freight prepaid. If San Antonio Water System audits, product inspection and performance data review in accordance with these Specifications determine excessive resilient seat gate valve non-compliance, the manufacturer will be subject to removal by the Products Standards Committee. If the resilient seat gate valve becomes defective during the manufacturer's specified warranty period a San Antonio Water System quality assurance and manufacturer review will ensue. If the review determines manufacturing non-conformance the manufacturer must replace the resilient seat gate valve according to size with a resilient seat gate valve that meets the San Antonio Water System's Specifications. The defective resilient seat gate valve removed from the field will be returned to the manufacturer, freight collect, and the manufacturer must replace the resilient seat gate valve, freight prepaid. If the non-conformance product amounts are excessive and result in increased product replacement by San Antonio Water System field staff the manufacturer may be subject to time and material charges.

2.8.1.7. References.

American National Standards Institute and American Water Works Association Standard C-509-01 (ANSI/AWWA C-509-01).

Manufacturers Standardization Society MSS SP-60.

2.8.2. Reduced Wall, Resilient Seated Gate and Tapping Valves AWWA C515-01. This product Specification covers reduced wall resilient seated gate valves, with nominal diameters of 4 in. through 48 in. Sizes refer to the nominal diameter, in in., of the waterway through the inlet and outlet connections and the closure area. All products furnished must conform to ANSI/AWWA C515-01) or latest revision thereof and Manufacturers Standardization Society Standard Practice for Connecting Flange Joint Between Tapping Sleeves and Tapping Valves MSS SP-60 or latest revision thereof.

2.8.2.1. Definitions. All definitions are defined according to ANSI/AWWA C515-01.

2.8.2.1.1. Cosmetic Defect. A blemish, which has no effect on the ability of the component to meet the structural design and production test requirements of this standard. Should the activity of plugging, welding, grinding, or repairing of such blemish cause the component to fail these requirements, and then the blemish will be considered a structural defect.

2.8.2.1.2. Flanged Joint. The flanged and bolted joint as described in ANSI/AWWA C110/A21.10 or ANSI B16.1, Class 125.

2.8.2.1.3. Mechanical Joint. The gasketed and bolted joint as described in ANSI/AWWA C110/A21.10, ANSI/AWWA C111/A21.11, or ANSI/AWWA C153/21.53.

2.8.2.1.4. Push-on Joint. The single rubber gasket joint as described in ANSI/AWWA C111/A21.11.

2.8.2.1.5. Structural Defect. Flaws that cause the component to fail the structural design or test requirements of this standard. This includes, but is not limited to imperfections that result in leakage through the walls of a casting, failure to meet the minimum wall- thickness requirement, or failure to meet production tests.

2.8.2.1.6. Tapping Valve. A special gate valve designed with end connections and an unobstructed waterway to provide proper alignment and positioning of a tapping sleeve, valve, and machine for tapping pipe dry or under pressure.

2.8.2.2. General Requirements. Except as otherwise modified or supplemented herein, ANSI/AWWA C515-01 or the latest revision thereof, will govern the design, component materials, construction; manufacture and testing of all reduced wall resilient seated gate valves. Valves must be suitable for frequent operation as well as service involving long periods of inactivity. Valves must be NSF-61 certified.

The San Antonio Water System reserves the right to limit the purchase of reduced wall resilient seat gate valves from manufacturers and to the models specified, as shown on the SAWS website - http://www.saws.org/business_center/specs/product_submittal/, provided such reduced wall resilient seat gate valves conform to the provision contained herein.

The minimum design working water pressure for gate valves with nominal diameters of 4 in., 6 in., 8 in., 10 in., 12 in., 14 in. and 16 in. must be 200 psig unless otherwise specified.

The maximum fluid velocity for flow through the valve in full open position must be 16 ft. per sec.

Valves must be reduced wall, resilient-seated types, bronze mounted with non-rising stems. The closure member must be fully encapsulated by an elastomer without thin spots or voids. When open the valve must have a clear, full-port, unobstructed waterway.

Gray iron, ductile iron, steel, brass, and bronze materials must meet or exceed the material requirements of Section 4.2, “Materials” of AWWA C515-01 and Table 3 below.

Table 3
Reduced Wall, Resilient Seated Gate and Tapping Valves

Material	Standard
Gray Iron	ASTM A 126, Class B
Ductile Iron	ASTM A 536 no more than 0.08% phosphorous
Steel	SAE Grade 2, ASTM A 307, and zinc plated
Bronze	ASTM B 763 UNS C 99500
Bronze Stem Nuts Only	ASTM B 62 UNS C 836000 ASTM B 584 UNS C 84400

Gaskets, O-rings, Coatings, and elastomers must meet or exceed the material requirements of Section 4.2, “Materials” of AWWA C515-01.

The gate valves must be designed and constructed for installation in either a horizontal or vertical position. Valves designed for buried installation must have a stem in the vertical position and must be furnished for mounting in a horizontal pipeline, unless otherwise specified.

Valve components of brass or bronze must be manufactured to ASTM recognized alloy Specifications of low zinc content bronze, as shown in Section 4.2, “Materials” of ANSI/AWWA C515-01 or the latest revision thereof. Material for the stem must have minimum yield strength of 40,000 psi. A minimum elongation in 2 in. of 12% and must be made of bronze per ASTM B763, alloy number UNS C99500. A maximum zinc content of 2% as shown in Table 2 Chemical Requirements of ASTM B763-96 or the latest revision thereof. Stem nut material must comply with the requirements shown above. The stem must have a visible external marking at the top to indicate low-zinc, high strength material. The marking must include a red plastic or neoprene washer placed around the top of the stem under the operating nut.

Valve ends must be either flanged, tapping valve, mechanical joint, push-on joint or any combination thereof, as specified. All mechanical joint valves must be supplied with glands, bolts, and gaskets. Valve body bolts and nuts must meet the strength requirements of ASTM A307 with dimensions conforming to ANSI B18.2.1. The size of the bolt head must be equal to the size of the nut and must be stainless steel in accordance with ASTM 276.

All gate valves must open right (clockwise), unless otherwise specified.

The following parts of the valve must be made of ductile iron: bonnet and body. Shell thickness must meet the minimum thickness requirements of Table 1 Minimum Thickness of Body and Bonnet of Section 4.4, “Detailed Design” of ANSI/AWWA C515-01. Valves larger than 16 in. must meet the performance requirements of the San Antonio Water System resilient seat reduced gate valve Specification.

If glands and bushings are used for the valves must be made of ASTM B763 bronze UNS C99500. The stem must be made of cast, forged, or rolled ASTM B763 bronze UNS C99500. The gate may be made of bronze ASTM B763 UNS C99500. Stem seals must be “O” ring type. The seals must be designed for dynamic applications. The design must be such that the seal above the stem collar can be replaced with the valve under full pressure in the fully open position. Materials for the “O” ring packing plate must be in accordance with Section 4.4.6, “Stem Sealing” of ANSI/AWWA C515-01 or the latest revision thereof.

Enclosed and buried valves must be coated inside and outside with a fusion bonded epoxy with a nominal 8 mils dry film thickness, which meets or exceeds AWWA C550-01 and to the maximum extent possible must be free of holidays. All coatings in contact with the potable water must be approved for potable water immersion service per ANSI/NSF 61.

The bidder must submit with his proposal 3 sets of certified drawings showing the principal dimensions, general construction and material Specification of the valve proposed. The number of turns to open (close)

must be clearly noted in the valve information submitted with the proposal documents. The number of turns to open or close the valve must be consistent for each valve size for each approved manufacturer.

Valves furnished under this Specification must be supplied from the San Antonio Water System approved manufacturer list on the SAWS website - http://www.saws.org/business_center/specs/product_submittal/.

All gate valve parts must be designed to withstand the following two pressure requirements, without being structurally damaged. (1) An internal test pressure of twice the rated design working pressure of the valve. In no case must the pressure be less than 500 psi without any visual deformation. (2) The full rated internal working pressure when the closure member is cycled once from a fully open to a fully closed position against the full rated unbalanced working water pressure. In addition to these pressure requirements, the valve assembly and mechanism must be capable of withstanding an input torque as follows: 200-ft. lb. for a 4 in. nominal diameter, 300-ft. lb. for a 6 in., 8 in., 10 in., and 12 in. nominal diameters, 400-ft. lb. for a 14 in. through 20 in. nominal diameters, and 600-ft. lb. for a 24 in. nominal diameter.

Resilient seats must be applied to the gate and must seat against a corrosion resistant surface. The non-metallic seating surface must be applied in a manner to withstand the action of line fluids and the operation of the sealing gate under long-term service. A metallic surface must have a corrosion resistance equivalent to or better than bronze. A non-metallic surface must be in compliance with ANSI/AWWA C550. The gate must be fully encapsulated by an elastomer without thin spots or voids. Resilient seats must be bonded. ASTM D429 either method A or method B must prove the method used for bonding or vulcanizing. For method A, the minimum strength must not be less than 250 psi. For method B, the peel strength must be 75 lb. per in.

The end flanges of flanged valves must conform to dimensions and drillings of ANSI/AWWA C110/A21.10 or ANSI B16.1, Class 125.

Mechanical joint bell dimensions must conform to ANSI/AWWA C111/A21.11.

Push-on joints must conform to the requirements of ANSI/AWWA C111/A21.11.

Markings must be cast on the bonnet or body of each valve and must show the manufacturer's name or mark, the year the valve casting was made, the size of the valve, the letters "C515," and the designation of working water pressure, for example "200 W." Markings must conform to Section 6.1, "Marking" of ANSI/AWWA C515-01 or latest revision thereof.

The San Antonio Water System may, at no cost to the manufacturer, subject random valves to testing by an independent laboratory for compliance with these standards. Any visible defect or failure to meet the quality standards herein will be grounds for rejecting the entire order and removal of the manufacturer from the attached approval list.

The tapping valves must be configured with a mechanical joint on one end and a tapping flange on the other end. The tapping valves must be furnished complete with glands, bolts, and gaskets. The tapping valve must have a clear unobstructed waterway. The seat rings must be of a large diameter to permit the entry of the full diameter tapping machine cutters. The valve end which mates with the tapping sleeve must have an alignment lip to fit the recess in the tapping sleeve flange for proper alignment. The lip will be dimensioned in accordance with MSS SP-60 for valves 20 in. nominal pipe size and smaller.

2.8.2.3. Workmanship. All parts of the reduced wall resilient seat gate valve must be designed and manufactured to the tolerances specified in ANSI/AWWA C515-01 or latest revision thereof and this Specification.

All parts of the reduced wall resilient seat gate valve manufactured by a given manufacturer must be interchangeable with like parts from another reduced wall resilient seat gate valve of the same model and size and by the same manufacturer.

All interchangeable parts must conform to their required dimensions and must be free from defects that could prevent proper functioning of the valve.

All castings must be clean and sound, without defects that will weaken their structure or impair their service. Plugging, welding, or repairing of cosmetic defects is allowed. Repairing of structural defects is not allowed. Repaired valves must comply with the testing requirements of this Specification after repairs have been made. Repairs within the bolt circle of any flange face are not allowed.

The reduced wall resilient seat gate valve must be well fitted. Operation of the reduced wall resilient seat gate valve must be smooth. All parts must be free of structural defects. The reduced wall resilient seat gate valve must be watertight.

2.8.2.4. Painting. All exterior and interior surfaces of the valve must be coated with epoxy, NSF 61 certified. The epoxy must have a nominal dry film thickness of 8 mils, and must be in accordance with AWWA C550, latest revision.

Coating must be as close to holiday free as is technologically possible.

2.8.2.5. Testing.

Hydrostatic Gate Test: Hydrostatic Gate Test must be performed on the valve in accordance with Section 5.1, “Testing” of ANSI/AWWA C515-01 or latest revision thereof.

Torque Test: Torque Test for prototype valves must be performed on the valve in accordance with Section 5.1, “Testing” of ANSI/AWWA C515-01 or latest revision thereof. Prototype valves larger than 16 in. must meet the torque requirements of Section 2.7.2.2, “Design Criteria for Ball Type Curb Stops/Angle Valves” above.

Leakage Test: Leakage Test must be performed on the valve in accordance with Section 5.1, “Testing” of ANSI/AWWA C515-01 or latest revision thereof.

Hydrostatic Shell Test: Hydrostatic Shell Test must be performed on the valve in accordance with Section 5.1, “Testing” of ANSI/AWWA C515-01 or latest revision thereof. Valves larger than 16 in. must be shell tested at twice the rated working pressure but at least 500 psi.

Production Test: Production Test must be performed on the valve in accordance with Section 5.1, “Testing” of ANSI/AWWA C515-01 or latest revision thereof. This same test must apply to valves larger than 16 in.

Operation Test: Operation Test must be performed on the valve in accordance with Section 5.1, “Testing” of ANSI/AWWA C515-01 or latest revision thereof.

Seat Test. Seat Test must be performed on the valve in accordance with Section 5.1, “Testing” of ANSI/AWWA C515-01 or latest revision thereof.

An Affidavit of Compliance certifying that all required tests have been performed must be provided in accordance with Section 6.3, “Affidavit of Compliance” of ANSI/AWWA C515-01.

The Affidavit of Compliance, the results of ASTM testing procedures and requirements for materials, Manufacturer's Quality Assurance Program, and the records of all tests performed on the valve must be kept and provided by the supplier/manufacturer in a single hard cover bound notebook with the bid or with the shipping documents and must be approved by the San Antonio Water System.

2.8.2.6. Quality Assurance. Manufacturers must have an ASME or I.S.O. 9001 registered commercial quality system. If on receipt of reduced wall resilient seated gate valves they are found to be non-compliant the manufacturer must replace the defective reduced wall resilient seated gate valves according to reduced wall resilient seated gate valve size with a reduced wall resilient seated gate valve that meets the San Antonio Water System's Specifications. The defective reduced wall resilient seated gate valve will be returned to the manufacturer, freight collect, and the manufacturer must replace the reduced wall resilient seated gate valve, freight prepaid. If San Antonio Water System audits, product inspection and data review in accordance with these Specifications determine excessive reduced wall resilient seated gate valve non-compliance, the

manufacturer will be subject to removal by the Products Standards Committee. If the reduced wall resilient seated gate valve becomes defective during the manufacturer's specified warranty period a San Antonio Water System quality assurance and manufacturer review will ensue. If the review determines manufacturing non-conformance the manufacturer must replace the reduced wall resilient seated gate valve according to size with a reduced wall resilient seated gate valve that meets the San Antonio Water System's Specifications. The defective reduced wall resilient seated gate valve removed from the field will be returned to the manufacturer, freight collect, and the manufacturer must replace the reduced wall resilient seated gate valve, freight prepaid. If the non-conformance product amounts are excessive and result in increased product replacement by San Antonio Water System field staff the manufacturer may be subject to time and material charges.

2.8.2.7. References.

American National Standards Institute and American Water Works Association C509-01 (ANSI/AWWA C509-01).

Manufacturers Standardization Society MSS SP-60.

2.8.3. Tapping Valves and Tapping Sleeves. This Section covers tapping sleeves installed on pipe from 4 in. and larger nominal pipe diameter.

2.8.3.1. General Requirements. Band must conform to the minimum OD size ranges and lengths specified in Table 8. The flange must be manufactured in compliance with AWWA C-223-07, Class D ANSI B.16.1 drilling, recessed for tapping valves MSS-SP60. Mechanical Joint tapping sleeve outlet must meet or exceed all material Specifications as listed below and be suitable for use with standard mechanical joint x mechanical joint resilient wedge gate valves per ANSI/AWWA C-509-94.

2.8.3.2. Tapping sleeves from 4 in. through 12 in. nominal pipe diameter.

Entire fitting to be stainless steel type 304 (18-8). The body, lug and gasket armor plate to be in compliance with ASTM A-240. The flange must be cast stainless steel in compliance with ASTM A-743. The MJ outlet must be one-piece casting made of stainless steel. The test plug must be 3/4 in. NTP in compliance with ANSI B2.1 and must be lubricated or coated to prevent galling. All metal surfaces must be passivated after fabrication in compliance with ASTM A-380.

The gasket is to provide a 360-sealing surface of such size and shape to provide an adequate compressive force against the pipe after assembly, to affect a positive seal under combinations of joint and gasket tolerances. The materials used must be vulcanized natural or synthetic rubber with antioxidants and antioziant ingredients to resist set after installation. No reclaimed rubber should be used. A heavy-gauge-type 304-stainless armor plate must be vulcanized into the gasket to span the lug area.

The lugs are to be heliarc welded (GMAW) to the shell. Lug must have a pass-through-bolt design to avoid alignment problems and allow tightening from either side of the main. Bolts must not be integrally welded to the sleeve. Finger Lug designs are not approved; it is the intent of these Specifications to allow tapping sleeve that has a lug design similar to the approved models.

Bolts and nuts must be type 304 (18-8) stainless steel and lubricated or Teflon coated to prevent galling or seizing. Bent or damaged unit will be rejected.

Quality control procedures must be employed to ensure that the shell, Lug, (4 in. and larger nominal pipe diameter) armor plate, gasket and related hardware are manufactured to be free of any visible defects. Each unit, after proper installation, must have a working pressure rating up to 200 psi, and a test pressure of 250 psi.

The sleeve construction must provide a positive means of preventing gasket cold flow and extrusion.

Each sleeve must be stenciled, coded or marked in a satisfactory manner to identify the size range. The markings must be permanent type, water resistant that will not smear or become illegible.

2.8.3.3. Tapping Sleeves 16 in. and larger nominal pipe diameter.

The body must be in compliance with ASTM A285 Grade C or ASTM A36. Test plug must be 3/4 in. NPT conforming to ANSI B2.1.

The gasket is to provide a watertight sealing surface of such size and shape to provide an adequate compressive force against the pipe. After assembly, the gasket will insure a positive seal under all combinations of joint and gasket tolerances. Gasket will be formed from vulcanized natural or synthetic rubber with antioxidants ingredients to resist set after installation. No reclaimed rubber will be used.

Bolts and nuts must be type high strength, corrosion resistant, low alloy per AWWA C-111, ANSA A21.11

Quality control procedures must be employed to ensure that the shell, gasket and related hardware are manufactured to be free of any visible defects. Each unit, after proper installation, must have a working pressure rating up to 150 psi, and a test pressure of 200 psi.

Unless otherwise noted, unit must be protected by fusion Epoxy 8-10 mil line and coat per AWWA C-213.

Units for concrete steel cylinder pipe must be furnished with load bearing set screws on the gland flange to transfer loads on the outlet away from the steel cylinder and onto the sleeve. Epoxy-coated tapping sleeves do not require grout seal cavity. (AWWA Manual of Practice M-9)

Each sleeve must be stenciled, coded or marked in a satisfactory manner to identify the size range. The markings must be permanent type, water resistant that will not smear or become illegible.

See Table 4 for Standard Dimension Ranges:

Table 4
Standard Ranges: (4 in.–30 in. Nominal Pipe Diameter)

Nominal Dia. (in.) x Min Length (in.)	Flange Outlet (in.)	Range	Min OD Range (in.)[2]
4 x 16	4	A	4.75–4.95
		B	4.90–5.10
6 x 16	4	A	6.70–7.10
		B	7.00–7.40
		C	7.35–7.75
6 x 16	6	A	6.80–7.15
		B	7.05–7.40
		C	7.40–7.75
8 x 16	4 & 6	A	9.00–9.45
		B	9.35–9.70
		C	9.70–10.10
8 x 20	8	A	9.00–9.35
		B	9.35–9.70
		C	9.70–10.00
10 x 16	4 & 6	A	11.03–11.47
10 x 20	8	B	11.60–12.00
10 x 24	10[1]		
12 x 16	4 & 6	A	13.00–13.40
12 x 20	8	B	13.40–13.80
12 x 24	10	C	14.10–14.50
12 x 32	12[1]		

16 x 12	4 & 6		17.33–17.87
16 x 16	8		18.62–19.19
16 x 20	10[1]		
16 x 24	12[1]		
16 x 36	16[1]		
20 x 12	4 & 6	A	21.51–22.15
20 x 16	8	B	23.46–24.16
20 x 20	10[1]		
20 x 24	12[1]		
20 x 36	16[1]		
20 x 40	20[1]		
24 x 12	4 & 6	A	25.71–26.41
24 x 16	8	B	28.14–28.84
24 x 20	10[1]		
24 x 24	12[1]		
24 x 36	16[1]		
24 x 40	20[1]		
24 x 48	24[1]		
30 x 12	4 & 6	A	29.78–30.48
30 x 16	8	B	31.52–32.22
30 x 20	10[1]		
30 x 24	12[1]		
30 x 36	16[1]		
30 x 40	20[1]		
30 x 48	24 x 30[1]		

1. Range to be specified when ordered
2. Ranges may be broadened by not narrowed. For concrete steel cylinder pipe the OD of the pipe and cylinder must be supplied with the order.

For pipe larger than 30 in. nominal diameter, tapping sleeves must be custom fabricated to fit nonstandard ranges, in conformance with the intent of these Specifications.

The San Antonio Water System may, at no cost to the manufacturer, subject random units to testing by an independent laboratory for compliance with these standards. Any visible defect of failure to meet the quality standards herein will be ground for rejecting the entire order.

Please see SAWS website for a list of approved manufacturers.
http://www.saws.org/business_center/specs/product_submittal/.

2.9. **Butterfly Valves.** This Section covers class 150/250 rubber-seated butterfly valves, 4 in. through 54 in. All products furnished must be in accordance with ANSI/AWWA C504 or latest revision thereof; however, the body construction of the valve must exceed the ANSI/AWWA C504 by the values specified herein. All coatings in contact with potable water must be certified to NSF 61. A proof of design certification must be provided upon request.

2.9.1. **Definitions.** All definitions are defined according to ANSI/AWWA C-504.

Actuator: A device attached to the valve for the purpose of rotating the valve disc to an open, closed, or intermediate position; preventing disc over travel; and maintaining the disc in any position.

Butterfly Valve: A valve that uses a disc rotatable through an angle of approximately 90° as a closure member. The valve is closed when the disc is perpendicular to the flow way, open when parallel to the flow way, or used for throttling when positioned between open and closed.

Disc: The closure member that is positioned in the flow stream to permit flow or to obstruct flow (depending on closure position) and that rotates through an angle of 90° from full open to full shutoff.

Rubber Seat: A rubber ring around the inside of the valve body to affect a seal against the metal seating surface when the disc is closed or resilient seats must be located on the valve disc and must provide a 360° continuous, uninterrupted seating surface. Seats must be mechanically retained with a stainless-steel retaining ring and stainless steel Nylok cap screws, which must pass through both the resilient seat and the retaining ring.

The resilient seat's mating surface must be to a 360° continuous, uninterrupted stainless steel body seat ring. The retaining ring must be continuous or investment cast with overlapping sections serrated grooves, and shoulders.

2.9.2. General Requirements. Except as otherwise modified or supplemented herein, AWWA C504 or the latest revision thereof, will govern the design, component material construction, manufacture and testing of all butterfly valves.

The San Antonio Water System reserves the right to limit the purchase of butterfly valves from manufacturers and to the models specified on the SAWS website - http://www.saws.org/business_center/specs/product_submittal/, , provided such butterfly valves conform to the provisions contained herein.

Valves must be Class 150/250 of the short-body type with a 150/250 psig bi-directional shut-off rating, a 500 psig hydrostatic body shell test and a maximum upstream line velocity rating according to Table 5 listed below unless specified otherwise.

Table 5
Butterfly Valves Max Velocity

Diameter	Velocity
3 in. through 20 in.	16 ft./sec.
24 in. through 72 in.	8 ft./sec.

Valve must be in the same alignment as a horizontal pipe and must be for buried service, unless otherwise specified. Valve must be configured with a horizontal valve shaft and a vertical actuator shaft with standard 2 in. AWWA operating nut. The actuator must be side mounted.

Valve body must be of cast iron conforming to ASTM Specification A-26, Class B, or Ductile Iron ASTM A536, grade 65-45-12.

Valve body ends must be flat-faced flanged in accordance with ANSI B16.1, Class 150/250. All cast iron valves must exceed minimum body shell thickness AWWA C504 Class 150B/250B, Table 2 of Section 3.1, "Valve Bodies."

Laying lengths for flanged and wafer valves and minimum body shell thickness for all body types by the following: Sizes 3 in. through 10 in. - 15% or greater, Sizes 12 in. through 24 in. - 20% or greater, and Sizes 30 in. through 54 in. - 50% or greater. Ductile iron valve body thicknesses must conform to the table below. Ductile iron and cast iron laying lengths must be as specified in tables 6a and 6b below unless otherwise specified.

Table 6a
Ductile Iron Valves Laying Length

Valve Diameter (in.)	Thickness (in.)	Laying Lengths (in.)
3	0.37	5
4	0.40	5
6	0.43	5
8	0.46	6
10	0.54	8
12	0.58	8
14	0.63	8
16	0.68	8
18	0.79	8
20	0.83	8
24	0.93	8
30	1.10	12
36	1.22	12
42	1.35	12
48	1.48	15
54	1.63	15
60	1.89	15
66	2.00	18
72	2.375	18

Table 6b
Cast Iron Valves Laying Length

Valve Diameter	Thickness	Laying Length (In.)
6	Per Specification	6
8–12	Per Specification	8
14–30	Per Specification	12
36–54	Per Specification	15

Valve must be of such design that the disc will seat at 90° with the pipe axis.

Valve must be of such design that the disc will not flutter or vibrate when operated in a throttled position.

Valves disc must be of Cast Iron A-48, Cast Iron A-126, class B or Ductile Iron ASTM A-536, grade 65-45-12 and must be of disc design to provide 360° uninterrupted seating.

The valve seat must be natural or synthetic rubber and may be applied to the disc or body. For valves 24-in. or larger, the rubber seat must be capable of mechanical adjustment in the field and must be field replaceable. Special tools required for seat adjustment must be provided with the valve. Special tools required for seat replacement must be furnished with the replacement seat. Mechanical adjustment or attachment of the seat and seat ring does not include welding. The mating seat surface must be type 304 or type 316 stainless steel, ni-chrome or monel. Sprayed or plate mating seat surfaces are not acceptable.

Valve shafts must be type 630 stainless steel conforming to ASTM A-564 condition H-1100 and must have a diameter equal to or greater than that shown for Class 150B in Table 3 of AWWA C504. Shafts must conform to the requirements of Section 3.3, “Valves Shaft” of AWWA C504 for one-piece or stub shaft types. Connection between the shaft and disc must be dowel, taper pins, or torque plugs, which are mechanically secured.

The valve assembly must be furnished with a factory-set, non-adjustable disc shaft thrust bearing that insures the valve disc is centered within the valve body seat at all times.

Valve shaft bearings must be permanent, self-lubricated bearings which provide continuous, low-friction maintenance-free operation. Shaft bearing must be contained in integral hubs of the valve body.

Valve shaft seal must consist of O-ring, V-type, or U-cup type packing where the shaft projects through the valve body for the actuator connection.

The valve must be provided with a fully enclosed, permanently lubricated actuator of the traveling nut or worm gear design. The actuator must be connected to the valve shaft by means of a key and keyway connection.

All actuators must have adjustable, mechanical stop limits in accordance with AWWA C504, Section 3.8.2. All 4 in.–54 in. valve actuators must be capable of withstanding 450-ft. lb. of input torque against the open or closed stops without damage.

Valves for below ground applications must be provided with an AWWA wrench nut. The wrench nut must have an arrow cast thereon, indicating the direction on of opening. The wrench nut must be suitably fastened to the actuator input shaft. If the shaft is smooth, the wrench nut must be fastened to the input shaft by means of a minimum 5/16 in. diameter steel pin passing entirely through the shaft and the wrench nut. Key with keyway will be acceptable. If the shaft is splined, the wrench nut must be formed to fit the splined shaft. The actuator must be designed to produce the specified torque with a maximum input of 150-ft. lb. applied to the wrench nut.

Valves for aboveground applications must be provided with a handwheel. The handwheel must have an arrow thereon, indicating the direction of the opening. The handwheel must be suitably fastened to the actuator input shaft. Actuators equipped with handwheels must be designed to produce the specified torque with a maximum pull of 80 lbs. of the handwheel rim.

The requirement for either wrench nut or handwheel and the direction of opening will be specified on each purchase order.

The bidder must submit with his proposal 3 sets of certified drawings showing the principal dimensions, general construction and material Specification of the valve proposed. The number of turns to open (close) must be clearly noted in the valve information submitted with the proposal documents.

The supplier/manufacturer must provide Affidavit of Compliance with applicable sections of AWWA C504 to include the following: Results of ASTM testing procedures and requirements for materials will be provided to the Owner upon request, Manufacturer's Quality Assurance Program, leak-tightness testing and proof of design testing of representative actuators in accordance with AWWA C504, Section 3.8.5.2 as modified herein (450-ft. lb.). Compliance assurance will be required in accordance with AWWA C504, Section 5.1.2, “Affidavits.” Results of performance tests, proof of design test, AWWA C504, Section 5.2.4, “Hydrostatic test,

leakage test, and Affidavit of Compliance" must be provided with the bid or with the shipping documents and must be approved by the San Antonio Water System.

2.9.3. Workmanship. All parts of the butterfly valve must be designed and manufactured to the tolerances specified in ANSI/AWWA C509 or latest revision thereof and this Specification.

All parts of the butterfly valve manufactured by a given manufacturer must be interchangeable with like parts from another butterfly valve of the same model and size and by the same manufacturer.

2.9.4. Painting. All interior and exterior ferrous surfaces of the valve, including the disc, must be coated with epoxy, NSF 61 certified or fusion bonded epoxy, NSF 61 certified. The epoxy (or fusion bonded epoxy) must have a nominal thickness of 8 mils, and must be in accordance with AWWA C550, latest revision.

Coating must be as close to holiday free as is technologically possible.

2.9.5. Testing and Inspection.

Performance Tests: Performance tests must be performed on each valve in accordance with Section 5.2.1, "Testing" of ANSI/AWWA C504 or latest revision thereof.

Leakage Tests: Leakage tests must be performed on each valve in accordance with Section 5.2.2, "Testing" of ANSI/AWWA C504 or latest revision thereof.

Hydrostatic Tests: Hydrostatic tests must be performed on each valve in accordance with Section 5.2.3, "Testing" of ANSI/AWWA C504 or latest revision thereof.

Proof-of-Design Tests: Proof-of-Design tests must be performed on each valve in accordance with Section 5.2.4, "Testing" of ANSI/AWWA C504 or latest revision thereof.

An Affidavit of Compliance certifying that all required tests have been performed must be provided.

The Affidavit of Compliance and the records of all tests performed on the valves must be kept and provided in a single hard cover bound notebook.

2.9.6. Quality Assurance. Manufacturers must have an ASME or I.S.O. 9001 registered commercial quality system. If on receipt of butterfly valves they are found to be non-compliant the manufacturer must replace the defective butterfly valves according to butterfly valve size with a butterfly valve that meets the San Antonio Water System's Specifications. The defective butterfly valves will be returned to the manufacturer, freight collect, and the manufacturer must replace the butterfly valve, freight prepaid.

If San Antonio Water System audits, product inspection and performance data review in accordance with these Specifications determine excessive butterfly valve non-compliance, the manufacturer will be subject to removal by the Products Standards Committee. If the butterfly valve becomes defective during the Manufacturer's specified warranty period a San Antonio Water System quality assurance and manufacturer review will ensue. If the review determines manufacturing non-conformance the manufacturer must replace the butterfly valve according to size with a butterfly valve that meets the San Antonio Water System's Specifications. The defective butterfly valve removed from the field will be returned to the manufacturer, freight collect, and the manufacturer must replace the butterfly valve, freight prepaid. If the non-conformance product amounts are excessive and result in increased product replacement by San Antonio Water System field staff the manufacturer may be subject to time and material charges.

2.9.7. References.

American National Standards Institute and American Water Works Association C504 (ANSI/AWWA C504).

2.10. Valve Boxes. This Section covers cast-iron valve box assemblies.

2.10.1. General Requirements. Each valve box assembly must be of cast-iron and must consist of a base, top section, and lid as shown on the plans.

Valve boxes must be of a single size with a nominal diameter of 6 in.

The valve box lid must be labeled "water" and must be so designed so that it will remain firmly seated in place when subjected to vehicular traffic.

The valve box assembly must have enough toughness and strength to withstand impact loads and shock resulting from vehicular traffic.

The valve box assembly must be coated with a standard bituminous coating of either coal tar or asphalt basic applied to all inside and outside surfaces.

2.11. Meter Boxes. This Section covers meter boxes for 5/8 in., 3/4 in., 1 in., 1-1/2 in., and 2 in. meters.

2.11.1. General Requirements. For non-traffic bearing locations, the meter box assembly for 5/8 in. through 1 in. meters must be made from 100% high-quality recycling plastic. The meter box and lid must be black and constructed out of modified polyethylene material for maximum durability and corrosion resistance. The black material is for maximum UV protection. The black material must be uniform throughout the meter box and lid for maximum longevity and not have a foaming agent that creates air pockets within the plastic wall. The body and lid must withstand 20,500 lbs. loading in a non-deliberate and incidental traffic.

For traffic bearing locations, the meter box assembly for 5/8 in. through 2 in. meters must consist of a cast-iron rectangular box and a steel checkered plate rectangular cover with raised lug pattern as shown on the plans.

2.11.2. Specific Requirements.

2.11.2.1. Plastic Lid. Must have the following:

"Water Meter" and "SAWS" molded into the lid

Seat securely and evenly inside the meter box and must not overlap the top edge of the meter box

"Overlap" and securely and evenly on the existing SAWS cast iron meter box with like dimensions.

A diamond pattern for skid resistance and an AMR Slide Mount molded into the lid on the underneath side and off center for placement for an AMR transponder to help in the protection of the radio antenna.

A brass worn gear lock that will secure the existing SAWS cast iron meter box of like dimensions and secure the plastic meter box. See detail on plans.

A molded receptacle for placement of SAWS key.

One (1) piece of 1/2 in. rebar secured in lid. See detail.

2.11.2.2. Plastic body. Must have the following:

A crush resistant ribbing along the outside of box.

A flange around the top opening to help prevent setting and aide in adjustment to grade.

Designed to accommodate all plastic lids.

2.11.2.3. Cast Iron Rectangular box for Traffic Bearing Locations. Must have the following:

Ultimate tensile strength of 25,000 psi and must not be brittle.

"As cast" clean smooth surface and be free from internal porosity, castings that are made smooth by grinding will not be considered.

Be dipped in a coal tar at a temperature of 350°F and the metal must be at a temperature of 300°F before dipping. The casting should be dipped and cured independently and the coating must have ceased to be "tacky" within 72 hr. after dipping.

The steel checkered plate rectangular cover is to be hot dip galvanized after fabrication.

2.11.3. Quality Assurance. If on receipt of meter boxes or lids they are found to be non-compliant, the manufacturer must replace the defective boxes or lids with a replacement that meets the San Antonio Water System's Specifications, at no charge to San Antonio Water System. Any visible defect or failure to meet the quality standards herein will be ground for rejecting the entire order.

Product that is non-compliant will be returned to the manufacturer, freight collect and the manufacturer will replace the defective product, freight prepaid within thirty (30) days from receipt of the defective product.

2.12. Fire Hydrants. This Section covers post-type, dry-barrel fire hydrants with compression shut off (opening against pressure) or gate shutoff for use in water supply service in all climates, including those where freezing occurs. All products furnished must conform ANSI/AWWA C502-05 or latest revision thereof and must be UL approved.

2.12.1. Definitions. All definitions are defined according to ANSI/AWWA C502-05.

Cosmetic Defect. A blemish that has no effect on the ability of a component to meet the structural design and production test requirements of this standard. Should the blemish or the activity of plugging, welding, grinding, or repairing such blemishes cause the component to fail these requirements, and then the blemish must be considered a structural defect.

Structural Defect. A flaw that causes a component to fail the structural design or test requirements of this standard. This includes but is not limited to imperfections that result in leakage through the walls of a casting, failure to meet minimum wall thickness requirements, or failure to meet production tests.

Bury. The length of bury is the distance measured to the nearest ½ ft. from the bottom of the connecting pipe to the ground line of the hydrant.

2.12.2. General Requirements. The San Antonio Water System reserves the right to limit the purchase of fire hydrants from manufacturers and to the models specified, as shown on the SAWS website - http://www.saws.org/business_center/specs/product_submittal/, provided such fire hydrants conform to the provision contained herein.

Each hydrant must be designed for a minimum working pressure of 200 psig.

All parts of the hydrant must be designed to withstand, without being functionally impaired or structurally damaged, a hydrostatic test of not less than 400 psig or twice the rated working pressure, whichever is greater, with the hydrant completely assembled and pressurized as follows:

With the nozzle caps in place, the main valve open, the hydrant inlet capped, and the test pressure applied to the interior of the hydrant.

With the main valve closed, the hydrant inlet capped, and the test pressure applied at the hydrant inlet.

The design safety factor of the operating mechanism must not be less than 5 and must be based on the ft. lbs. of torque required for the closing and opening of the hydrant at a working pressure of 200-psig. Hydrants must be functional and capable of being opened or closed without difficulty following an application of an operating torque of 200-lbf. ft. at the operating nut in the opening direction with the

hydrant fully opened and the closing direction with the hydrant fully closed. The torque requirements apply only to hydrants of 5 ft. bury or less.

The length of bury must be as specified but not less than 4 ft. The fire hydrant must have 2 hose nozzles and 1 pumper nozzle. The nominal inside diameter of the hose nozzle must be 2.5 in. The nominal inside diameter for the pumper nozzle must be 4 in. The outlet-nozzle threads are to conform to the National Fire Protection Association (NFPA) 2003, Standard for Fire Hose Connections. The nominal diameter of the main valve opening must be 5.25 in. The hydrant shoe must be provided with a 6 in. mechanical joint connection to fit the connecting pipe. The fire hydrant must open right (clockwise). The color of the finish paint above the ground line must be aluminum; however, fire hydrants for private use must be painted red. The fire hydrant must have a non-rising stem. No more than one 6 in. stem extension must be provided if required to make the base of the fire hydrant grade level.

The bonnet section must be designed so all bearing surfaces and stem threads are sealed in a lubricant reservoir. If oil is used as a lubricant, the reservoir must be designed to allow for easy filling through a fitting or plug. Where grease is used as a lubricant, the reservoir will be sealed. The reservoir will be adequately sealed with “O” rings or other suitable sealing system approved by the San Antonio Water System.

The fire hydrant must have a safety flange or breakaway flange at the ground line as stipulated in Section 3.1, “General Design” of ANSI/AWWA C-502-05 or latest revision thereof.

Fire hydrant nozzle cap chains will be required and must be attached permanently to the fire hydrant as stipulated in Section 3.2, “Detailed Design” of ANSI/AWWA C-502-05 or latest revision thereof.

Parts that require lubrication and come into contact with water must be lubricated with a non-toxic food grade lubricant that does not pose a health hazard to the public if consumed.

2.12.3. Workmanship. All foundry and machine work must be performed in accordance with good standard practice for the class of work involved and in conformance with accepted drawings, if required. When assembled, hydrants manufactured in accordance with this Specification must be well fitted and must operate smoothly. The body and shaft must be watertight.

All parts must conform to the required dimensions and must be free from defects that could prevent proper functioning of the hydrant.

All castings must be clean and sound without defects that will weaken their structure or impair their service.

2.12.4. Paint. The exterior surface of the hydrant must be coated with a coating that must meet or exceed the requirements of Federal Specification TT-C-494b. A second coat of water based or oil-based enamel paint aluminum in color will then be applied from the top of the hydrant to a point 18 in. to 20 in. below the centerline of the pumper nozzle or down to the traffic safety flange connection at the ground line.

All interior surfaces, machined surfaces, such as the threaded portion of the stem or stem nut, which must fit closely with the adjacent parts, must be coated with a coating that must meet or exceed Federal Specification TT-C-494b. Stem surfaces contained within a lubricant reservoir and not in contact with potable water may be free of coating.

The interior and exterior of the hydrant shoe must be coated with a fusion-bonded epoxy with a nominal dry film thickness of 8-mils, conforming to ANSI/AWWA C-550-05, and certified to NSF 61.

Coating must be as close to holiday free as is technologically possible.

2.12.5. Testing and Inspection. Each assembled hydrant must be subjected to two shop tests under a hydrostatic pressure of 400 psig or twice the rated working pressure, whichever is greater. One test must be made with the entire interior of the hydrant under pressure and another test made with the main valve closed and the base under pressure from the inlet side. Under the test procedure, there should be no leakage through the

main valve or seals or through the castings or the joints of the assembled hydrant. Under the test conditions, the leakage through the drain valves must not exceed 5 fl oz./min. Other leakage or other imperfections found in either test must be corrected or the hydrant retested. The tests must be conducted for enough time to allow a check of all points of possible leakage and for a minimum of 30 sec. after all air has been exhausted.

Each assembled hydrant must be operated through a full open-close cycle when not under pressure. The torque required for performing this operation must not exceed 20-lb. ft.

All fire hydrant tests and inspections must conform to ANSI/AWWA C-502 Section 5.1, "Production Testing," ANSI/AWWA C-502 Section 5.2, "Prototype Testing," and ANSI/AWWA C-502-05 Section 5.3, "Inspection and Rejection."

The manufacturer must provide an Affidavit of Compliance conforming to Section 1.7, "Affidavit of Compliance" of ANSI/AWWA C-502-05 or latest revision thereof.

2.12.6. Quality Assurance. Manufacturers must have an ASME or I.S.O. 9001 registered commercial quality system or is in the process of achieving this certification by June 2001. Noncompliance to this registered commercial quality system requirement by June 2001 will result in removal of the manufacturer's product from the approved manufacturers list. If on receipt of fire hydrants they are found to be noncompliant the manufacturer must replace the defective fire hydrants according to fire hydrant size with a fire hydrant that meets the San Antonio Water System's Specifications. The defective fire hydrants will be returned to the manufacturer, freight collect, and the manufacturer must replace the fire hydrant, freight prepaid. If San Antonio Water System audits, product inspection and performance data review in accordance with these Specifications determine excessive fire hydrant non-compliance, the manufacturer will be subject to removal by the Products Standards Committee. If the fire hydrant becomes defective during the manufacturer's specified warranty period a San Antonio Water System quality assurance and manufacturer review will ensue. If the review determines manufacturing non-conformance the manufacturer must replace the fire hydrant according to size with a fire hydrant that meets the San Antonio Water System's Specifications. The defective fire hydrant removed from the field will be returned to the manufacturer, freight collect, and the manufacturer must replace the fire hydrant, freight prepaid. If the non-conformance product amounts are excessive and result in increased product replacement by San Antonio Water System field staff the manufacturer may be subject to time and material charges.

2.12.7. Maintenance Kits. The San Antonio Water System will attempt to use fire hydrant maintenance kits in the repair of the approved hydrants. Please see SAWS website for a list of approved manufacturers- http://www.saws.org/business_center/specs/product_submittal/

2.12.8. References.

American National Standards Institute and American Water Works Association C-502-05 (ANSI/AWWA C-502-05).

American National Standards Institute and American Water Works Association C-550-05 (ANSI/AWWA C-550-05).

2.13. Polyethylene Wrapping Material. This Section covers polyethylene-wrapping material for use in encapsulating ductile and cast iron pipe.

General Requirements. Polyethylene wrapping for ductile and cast iron water mains is to consist of a 4 mil tubular section of cross-laminated high-density polyethylene, which has a high dielectric and tensile strength, for use in insulating cast-iron and ductile-iron pipe from the electrolytic action encountered in highly active soils. Polyethylene wrapping is to consist of opaque cross-laminated high-density polyethylene sheet continuously thermally bonded to form a tubular section. The tubes may be supplied in bulk length on rolls or in individual pre-cut lengths. See Table 7 below for size and length chart, in accordance with AWWA C-105 (Table 1) for minimum requirements. When supplied in specific pipe lengths, the tubes are to contain a minimum of 4 ft. over the actual pipe length to allow for overlap.

The polyvinyl sheet of film for the tubular wrapping is to be of virgin resins meeting raw and physical properties of ASTM D-1248 and AWWA C-105, latest edition. The material is to be 4 mil cross-laminated high-density polyethylene of uniform film thickness and be free of imperfections such as pin holes, etc., after being thermally seamed into tubular form. The finished product will have a nominal thickness of 4 mils, with tolerances of minus 10%.

The polyethylene wrapping material is to have no volatile constituents, the loss of which may affect ductility. The material is also to have the following properties:

- Mechanical: The polyethylene film is to have a tensile strength per latest ASTM D-882 test, of 6300 psi min. The film is to have an elongation of not less than 100% of the test strip per latest ASTM D-882 test. The film is to have an impact resistance 800 gram min per (ASTM D-1709 Method B). The film is to have a propagation tear resistance of 250 gf minimum in machine and transverse direction (ASTM D1922).
- Dielectric: The film is to have a dielectric strength of 800 volts per mil thickness per latest ASTM D-149.
- Inspection and Certification by Manufacturer:
- *Quality control and inspection*. The manufacturer must establish the necessary quality control and inspection practice to ensure compliance with this standard.
- *Manufacturer's statement*. The manufacturer must, provide a sworn statement on each lot purchased that the inspection and all applicable material requirements of Section 2.13, "Polyethylene Wrapping Material" below have been met and that all results comply with the requirements of this standard.
- *Freedom from defects*. All polyethylene film must be clean, sound, and without defects that could impair service.

2.13.1. Marking Requirements. The polyethylene film supplied must be clearly marked, at a minimum of every 2 ft. along its length, containing the following information:

- Manufacturer's name or trademark
- Year of manufacture
- ANSI/AWWA C-105/A21.5
- Minimum film thickness and material type.
- Applicable range of nominal pipe diameter sizes.
- Warning-Corrosion Protection-Repair any Damage.

The San Antonio Water System may at no cost to the Contractor, subject random testing by an independent laboratory for compliance with this Specification. Any visible defect of failure to meet the quality standards herein will be grounds for rejecting the entire order.

Table 7
4 Mil Polyethylene Wrapping Materials
Size & Length (All sizes lay flat size)

Pipe Size (in.)	Product Size Width (in.) x Length
4, 6 & 8	20 x 200/500
8, 10 &12	27 x 200/500
16 & 18	37 x 200/500
20	41 x 200/500
24	54 x 200/500
30	67 x 140/500
36	81 x 120/500
48	95 x 100/500
54	108 x 100/500

2.14. Standard/Wide Range Ductile Iron Couplings. This Section covers ductile iron couplings for use in connection of smooth end joints of cast iron, ductile iron, asbestos cement, steel, PVC or other types of pipe. The couplings must be capable of fitting this variety of pipes with one set of follower flanges or end rings.

2.14.1. General Requirements. Sleeve or center ring must be nominal O.D. size range and length specified. Sleeve must be of Ductile Iron ASTM A536. Ends must have a smooth inside taper to provide uniform gasket seal. Sleeve must be given a shop coat of oil–modified urethanes, corrosion-resistant paint, or epoxy coating.

Follower flanges or end rings must be of the thickness determined by the coupling size, and must be ductile iron, ASTM-536. Flanges must be identified by a color-coded shop coat finish as described in Section 2.13.1, "Marking Requirements."

Gaskets must be compression – type, formed with Virgin Styrene Butadiene Rubber (SBR,) ASTM D2000 3 BA715, and compounded with ingredients to produce permanence and resistance to set after installation. O.D. range must be imprinted/molded on the gasket in permanent ink (Minimum.)

Bolts and Nuts must be of high-strength, low-alloy steel, with nominal coarse thread, and hex nuts with black finish. Dimensions and minimum stress values must be in accordance with AWWA/ANSI C111/A21.11.

Where Specification states a cast transition or reducing coupling in place of a straight coupling, the sleeve and follower flange must be of the same manufacturer and compatible for the specific use intended.

Quality control procedures must be employed to ensure that the sleeve, follower flanges and gaskets are properly fabricated and free of any visible defects. Each coupling must have a working-pressure rating not less than the following:

Table 8
Ductile Iron Couplings

Pipe Size (in.)	Minimum Working Pressure Rating (psi)
16 and smaller	175
20	150
24	150

2.14.2. Straight Coupling Ranges.

Table 9
Ductile Iron Straight Coupling Ranges

Nominal Diameter (in.) x Minimum Length (in.)	O.D. Range[1](in.)
4 x 6	4.80–5.10
6 x 6	6.90–7.22
8 x 6	9.05–9.45
10 x 6	11.10–11.60
12 x 6	13.20–13.50 13.78–14.38
16 x 6	17.40–17.80 18.46–19.00
20 x 7	21.35–21.75 21.75–22.25
24 x 10	25.00–25.80 26.10–26.32

1. Ranges may be broadened, but not narrowed.

Table 10
Ductile Iron Wide Range Coupling

Coupling Size (in.)	O.D. Range[1](in.)
3	3.40–4.20
4	4.20–5.33
6	6.25–7.45
8	8.40–9.79
10	10.70–12.12
12	12.75–14.38

1. Ranges may be broadened, but not narrowed.

The San Antonio Water System may, at no cost to the manufacturer, subject random couplings to testing by an independent laboratory for compliance with these standards. Any visible defect or failure to meet the quality standards herein will be grounds for rejecting the entire order.

2.14.3. Approved Manufacturers. Please see SAWS website for a list of approved manufacturers- http://www.saws.org/business_center/specs/product_submittal/

2.15. Air Release, Vacuum, and Combination Air Valves. This Specification covers automatic valves installed on water mains to vent accumulated air under system pressure, and to provide air exhaust during initial fill or to prevent a vacuum during draining or water column separation of the system.

2.15.1. General Requirements. Valves furnished under this Specification must conform to ANSI/NSF 60 for direct additives and ANSI/NSF 61 for indirect additives. Cast Iron Valve Body and cover must be in accordance with ASTM A48-35 or ASTM A126 class B. Non-Metallic Valve Body must be fabricated from fiberglass reinforced nylon. Inlet sizes through 2 in. must be screwed (NPT). Pipe sizes 3 in. and above must have flanged inlets (125# ASNSI B 16.1). A protective hood or cowl must be installed on the outlet of flange-bodied valves.

Metallic Internal seat trim float arm and pivot pin must be stainless steel type 303, 304 or 316. Metallic Floats must be stainless steel ASTM A 240. Other stainless steel metal internal parts must be stainless steel ASTM A240 or ASTM A276.

Non-metallic floats must be foamed polyethylene with stainless steel type 316 fasteners.

Valves requiring Internal seats or orifice buttons must be Buna-N rubber compounded for water service. For valves requiring cover gaskets, the cover gasket must be composition type, equal to Armstrong CS-231, Garlock 3000, or Lexide NK-511. If an O-Ring is used to seal the cover, it must be on NSF 61 certified rubber. Cover bolts must be alloy steel. Rolling seals must be furnished for non-metallic valves 2 in. and below.

Valve body must have a test pressure rating of 300 psi and working pressure rating of 150 psi.

All components in contact with potable water must be “lead free” and marked by stamping, etching, or casting “NL” in the main body.

2.15.2. General Operation Requirements. The air release valve must be designed to vent accumulated air automatically. The outlet orifice must be properly sized to facilitate valve operation at pressures up to 150 psi. The air release valve must be simple-lever, compound-lever, ball and orifice or rolling seal depending upon volume requirements and the design of the valve.

The air and vacuum valve must be designed with the inlet and outlet of equal cross-sectional area where applicable. The valve must be capable or automatically allowing large quantities of air to be exhausted during the filling cycle an also capable of automatically allowing air to re-enter the system to prevent a negative pressure at water column separation or during the draining cycle. The float must be guided to minimize premature closure by air and to provide proper alignment for normal closure by floating on the water surface.

Combination air and vacuum relief valves must provide for both automatic air release under system pressure and to allow air movement during filling or draining operations or water column separation. The combination valve may be housed in a single casting. The housing must be designed to incorporate conventional or kinetic flow principles to properly vent the air without premature closure. Flanged sized (4 in. and larger) may be furnished in a dual housing. When dual casings are used a bronze manual isolation valve must be installed if indicated by the manufacturer. This will allow the air release valve to be serviced when the system is under pressure. Field service of the valve may also be performed by closing the isolation valve between the air valve and the pipe connection.

2.15.3. Tests. The San Antonio Water System may, at no cost to the manufacturer, subject random valves to testing by an independent laboratory for compliance with these standards. Any visible defect or failures to meet the quality standards herein will be grounds for rejecting the entire order.

2.15.4. Quality Assurance. The manufacturers must provide certification that products furnished under this Specification are manufactured in an ISO 9001 certified facility or documentation from an accredited facility that ISO 9001 certification is in process.

Please see SAWS website for a list of approved manufacturers - http://www.saws.org/business_center/specs/product_submittal/

2.16. Reinforced Concrete Vaults.

2.16.1. General Requirements. Concrete used should be transit mix and must have a 28-day compressive strength of 3,000 psi with a maximum slump of 6 in. and a minimum slump of 3 in. The use of admixtures will not be permitted unless approved by the Engineer. Cement should be Type I or Type III and must conform to the requirements of the latest provision of ASTM C-150 and C-156, or most applicable approved equal provision.

2.17. Blow-off Assemblies. The materials required for both permanent and temporary 2 in. and 4 in. blow-off assemblies must conform to the Specifications contained herein and as shown on the plans.

2.18. Backfill.

2.18.1. Bedding/Initial Backfilling. The bedding and initial backfill materials for concrete steel cylinder pipe (CSC), ductile iron pipe (DI), HDPE Pipe, Wrapped Steel Pipe, and Polyvinyl Chloride Pipe (PVC) in all nominal diameters must be composed or well graded crushed stone or gravel conforming to the following Table 11 requirements unless modified by the Engineer.

Table 11
Modified Grade 5 Gravel

Retained on 1/2" sieve	0%
Retained on 3/8" sieve	0–5%
Retained on No. 4 sieve	20–80%
Retained on No. 10 sieve	75–100%
Retained on No. 20 sieve	98–100%

The quantity and thickness of lifts and compaction of initial backfill materials is to be in accordance with Section 3.3, "Backfill" of this Specification.

Where copper services (3/4 in. – 2 in.) are installed, initial backfill must be sand conforming to the following requirements: Natural sand or sand produced from crushed gravel or crushed rock maximum 1/4 in.; 95% must pass No. 4 sieve, free from clay and organic material, with a maximum 8% passing the No. 200 sieve. Larger services usinguctile iron pipe or PVC C-900 pipe must be backfilled the same as mains.

2.18.2. Secondary Backfill for Water Mains. Secondary backfill is defined as backfill from 1 ft. above the top of the pipe to the top of the trench or bottom of pavement section. Secondary backfill must be constructed in accordance with details shown in the construction documents.

Secondary backfill must generally consist of materials removed from the trench and should be free of brush, debris and trash. Rock or stones with a dimension larger than 6 in. at the largest dimension must be sifted out and removed before the material is used in the secondary backfilling zone. Secondary backfill material should be primarily composed of compactible soil materials. The secondary backfill material must be placed in maximum 12 in. loose lifts or as directed.

2.19. Asphalt. All asphaltic concrete used in the replacement of pavement over the trench line is to conform to Item 341, "Dense-Graded Hot-Mix Asphalt (QC/QA), Type "C," except when the use of 6 in. of asphalt treated base is directed, unless otherwise specified on the plans.

2.20. Concrete. All concrete used as the trench cap and in sidewalks and blocking mains is to conform to Item 421, "Hydraulic Cement Concrete." Class "A" concrete is to be used in sidewalks and for blocking concrete steel cylinder mains; Class "D" concrete is to be used for the trench cap and for blocking all other types, unless otherwise specified on the plans.

2.21. Reinforcing Steel. All bar reinforcement is to be Grade 60, conforming to the requirements of Item 440, "Reinforcement for Concrete."

2.22. Affidavit of Compliance. Unless otherwise directed, the Contractor is to furnish a manufacturer's affidavit of compliance for each of the materials used in this project. The affidavit is to certify that factory inspection and all specified tests have been made and that the material furnished complies with the requirements outlined herein.

2.23. Recycled Water System. All material used in the improvement, adjustment, removal or construction of the recycled water system must meet these standards (i.e., uses of CSC pipe, trenching and excavation, etc.), except as otherwise noted, and must be wrapped or painted with pantone 512 color.

2.24. Grouting of Water Mains. This Section will govern the grouting of existing water mains with diameter of larger than 4 in. for the purposes of abandonment underneath roadways, paved areas, and at other designated locations. The location of this Work is as shown on the Contract Document plans or as encountered in the field during construction. The Contractor must, unless otherwise specified, furnish all labor, materials, equipment, tools and all other appurtenances necessary to abandon water lines segments in place by filling them with flowable cementitious low strength grout including plugs, bulkheads, excavation and backfill at locations as required to completely fill the line to be abandoned in place to protect against future collapse of the line.

Submittals for Grouting Water Mains:

- Proposed Mix Design Report for grout
- Submit manufacturers data for proposed plugs and detail of bulkhead
- Technical information for equipment and operations procedures including projected injection rate, grout pressure, method of controlling grout pressure, bulkhead and vent design and number of stages of grout application.
- Submit project specific plan for abandonment at least 15 days before commencing grouting activities, describe proposed sequence, access points and other appropriate information for completion of Work.

Materials for Grouting Water Mains:

- Cement-based grout/flowable fill with self-leveling and non-shrink characteristics.
- Unconfined compressive strength: Minimum 100 psi at 56 days as determined based on average of 3 tests for same placement. Present at least 3 acceptable strength tests for proposed mix design in mix design report.

3. CONSTRUCTION

3.1. **Excavation.** Excavation (trenching) as required to complete the water main installation is to be performed in accordance with Item 400, "Excavation and Backfill for Structures," as outlined herein, as shown on the plans and as directed.

3.1.1. **Trenches.** Trench walls must be vertical. The practice of undercutting at the bottom or flaring at the top will not be permitted except where it is justified for safety or at the Engineer's or Inspector's direction. In special cases, where trench flaring is required, the trench walls must remain vertical to a depth of at least 1 ft. above the top of the pipe.

The trench bottom must be square or slightly curved to the shape of the trenching machine cutters. The trench must be accurately graded along its entire length to provide uniform bearing and support for each section of pipe installed upon the bedding material. Bell holes and depressions for joints should be dug after the trench bottom has been graded and bedding installed. The pipe should rest upon the new bedding material for its full length

Where over-excavation occurs, the under-cut trench must be restored to grade at no cost to the Department by replacement with a material conforming to the requirements of the bedding material or a material approved by the Engineer.

3.1.2. **Width of Trench.**

3.1.2.1. **Minimum Width of Trench.** The minimum width of pipe trenches, measured at the crown of the pipe, must be not less than 12 in. greater than the exterior diameter of the pipe, exclusive of bells. The minimum base width of such trench must be not less than 12 in. greater than the exterior diameter of the pipe, exclusive of special structures or connections. Such minimum width must be exclusive of trench supports and not greater than the width at the top of the trench.

3.1.2.2. **Maximum Width of Trench.** The maximum allowable width of trench for pipelines measured at the top of the pipe must be the outside diameter of the pipe (exclusive of bells or collars) plus 24 in. A trench wider than the outside diameter plus 24 in. may be used without special bedding if the Contractor, at his sole expense, furnishes pipe of the required strength to carry additional trench load. Such modifications must be submitted to the Engineer and approved in writing. Whenever such maximum allowable width of trench is exceeded, except as provided for on the drawings, or in the Specifications, or by the written approval of the Engineer, the Contractor, at his sole expense, must encase the pipe in concrete from trench wall to trench wall, or other pipe bedding material approved by the Engineer. Any excavation wider than this maximum width or subsequent Surface or Paving work, will be done at the Contractor's sole expense.

3.1.3. **Classification of Excavated Materials.** No classification of excavated materials will be made. Excavation and trench work is to include the removal and subsequent handling of all materials excavated in accordance with Item 400, "Excavation and Backfill for Structures."

3.1.4. **Grade of Trench Bottom.** The trench is to be over-excavated to a depth of 6 in. below the grade line established for the bottom of the pipe, regardless of the type of pipe. The grade line of the pipe is to then be met by the addition of a layer of approved bedding material as directed.

3.1.5. **Excavation Below Grade.** Any part of the bottom of the trench excavated below the limits specified in Section 3.1.4., "Grade of Trench Bottom," is to be corrected with approved material and compacted by mechanical tamping or other means which must provide a stable foundation for the pipe. Should excessive over-excavation occur, except at bell holes, the grade is to be restored in accordance with the methods described in Section 3.1.6, "Unstable Conditions at Grade," at no cost to SAWS.

3.1.6. **Unstable Conditions at Grade.** Where the bottom of the trench at grade is found to be unstable or to include ashes, cinders, any type of refuse, vegetable or other organic material, or large pieces of fragments or inorganic materials which in the judgment of the Engineer should be removed, the Contractor is to

excavate and remove such unsuitable material to a depth at least 6 in. below pipe. Before the pipe is laid the grade is to be restored by backfilling with an approved material in layers of 3 in. before mechanical compaction to provide stable foundation. The layers are to be slightly moistened and thoroughly compacted so as to provide a uniform and continuous bearing and support for the pipe at every point between bell or collar holes. The finished grade is to be accurately graded to provide uniform bearing and support for each section of pipe at every point along its entire length except for the portions of the pipe sections where it is necessary to excavate for bell holes and for the proper seating of pipe joints.

3.1.7. Trench Excavation Protection. All trench excavation required on this project is to be accomplished as required by the provisions of Item 402, "Trench Excavation Protection."

3.1.8. Caution in Excavation. The Contractor is to proceed with caution in the excavation and preparation of the trench so that the exact location of underground structures and utilities may be determined whether shown on the plans or not. Machine excavation is not permitted closer than 12 in. on either side of other existing underground utilities. The Contractor is to be responsible for the repair of such structures and utilities when broken or damaged. He is also to be responsible for adjusting alignment and trench grades with reference to such structures to obtain specified clearance for the water main construction.

Whenever the Engineer determines that it is necessary to explore and excavate to determine the location of existing underground structures and utilities, the Contractor is to make explorations and excavations for such purposes at his expense.

3.1.9. Protection and Restoration of Underground Structures and Facilities. The Contractor is to furnish temporary support, adequate protection, and maintenance of all underground and surface structures, drains, sewers, and other obstructions encountered in the progress of the work. All underground structures and utilities which are disturbed are to be restored by the Contractor at his expense. Materials and methods used for restoration are to be in accordance with current building codes with local amendments, the Department's Utility Accommodation Policy (UAP) (Title 43, T.A.C., Sections 21.31—21.55), and the requirements of the utility agency involved.

If a sanitary sewer is broken by the Contractor's operations the release of sewage into the trench is to be immediately intercepted by the insertion of a section of sheet metal tubing known as a "tin-horn" between the broken ends of the sewer. All leakage at the ends of the "tin-horn" is to be effectively stopped. The "tin-horn" is to remain in place until permanent repairs can be made. It is to be the responsibility of the Contractor to determine in advance of his trenching operations the size of all sanitary sewer lines and services which will require this treatment.

All sanitary sewer lines crossing the excavation, whether bridged or replaced, are to have proper support consisting of sound timber supports with a minimum 2 in. nominal thickness and a minimum 6 in. nominal width placed with the width horizontal and extending a minimum of 12 in. into the trench wall on either side.

In all cases where a sewer pipe is replaced or bridged, the backfill material is to be thoroughly compacted to the bottom of the pipe and compacted by hand from this point to a distance of 6 in. above the top of the sewer line being replaced.

The locations of all sewer lines crossing excavations, whether replaced or bridged are to be properly marked, and care is to be taken to avoid damage to the pipe by a hydra tamping machine or other mechanical equipment. The Contractor is to be liable for the failure of such lines due to negligence or poor workmanship.

3.1.10. Backfill Material Derived from Excavation. Any excess excavated material, not used after all fill requirements have been met, must become the responsibility of the Contractor. The Contractor must transport and dispose of it outside the limits of the rights-of-way or easements of this project and of public thoroughfares and water courses, to a permitted fill site in conformity with all applicable City, County, State and Federal codes and ordinances and without liability to SAWS or any individual.

3.1.11. Trench Restoration. The surface of the backfilled trench must be restored to match the previous existing conditions. This will include final grading, placement of topsoil and seeding, placement of sod (such as at homes or businesses that had maintained grass), or other unprepared and prepared surfaces.

Trenches in alleys actively being used by vehicles (such as trash pickup, vehicle parking, etc.) must be restored by grading and compacting to 98% or higher with a minimum of 4 in. of flex base materials for the entire width of the alley. Asphaltic materials must have a compaction density of 95%. Alleys not actively used by vehicles must be graded and compacted to 98% or higher from the top of the initial backfill to the bottom of the pavement section, then spread grass seed for entire width of the alley.

Trenches in paved streets must be covered with a temporary all weather surface to allow for vehicular traffic until the final asphalt/concrete paving is complete. This surface must be a minimum of 4 in. compacted and rolled asphaltic black base, either hot-mix or cold-mix applied. It is the Contractor's responsibility to maintain this surface until the final street restoration is complete. Temporary street striping may also be required. This surface must be removed before final asphalting.

All street work must be done in accordance with the latest DEPARTMENT construction specifications. Included in this requirement is replacement of any curbs or sidewalks damaged or removed during the construction.

No separate payment for the surface restoration is permitted. The cost for this work must be included in the appropriate bid item.

3.1.12. Pavement. The Contractor is to remove pavement and surfaces as a part of the trench excavation. The removal of pavement and surfaces and their restoration is to be based on the minimum trench widths as specified, plus 6 in. either side or as otherwise provided herein. The Contractor is to use such methods as sawing, drilling, or chipping to assure the breaking of the pavement along straight lines.

If the Contractor removes or damages pavement or surfaces beyond the limits specified above, such pavement and surfaces are to be restored at the expense of the Contractor.

Where water line construction necessitates cutting through existing streets outside the limits of new street construction, said streets are to be replaced in kind as directed.

Where, in the opinion of the Engineer, it is necessary to maintain traffic across a trench, the Contractor is to install temporary metal bridges as necessary to facilitate the movement of traffic.

The street surface adjacent to the trench is to be kept free of surplus spoil. Construction materials are to be placed at locations that will minimize interference with the traveling public.

3.1.13. Concrete Sidewalks, Driveways, Etc. All concrete sidewalks, driveways, etc., are to be cut with a concrete saw. When transverse expansion or "dummy" joints are encountered, the concrete is to be removed to the nearest transverse joint on each side of the trench and restored. The depth of cut is to be such that upon removal of the concrete, the sides of the cut are to be straight and square.

Existing reinforcing wire fabric or bars are to be cut and removed to permit completion of trench excavation, pipe laying, and backfill operations. When the backfill operations have been completed, the existing reinforcement is to be replaced in its original position and satisfactorily spliced before the replacement of concrete over the new trench alignment.

Transverse "dummy" joints are to be made by a jointing tool or other means acceptable, and are to match in depth and thickness in the existing transverse joints.

Expansion joint material is to be provided where new construction abuts the existing curb or driveway if the Engineer deems it necessary.

Concrete is to be spaded, tamped, and thoroughly compacted until mortar entirely covers the surface and has a monolithic finish. The top surface is to be floated, troweled, and finished to match the existing concrete surface.

Immediately after finishing, the concrete surface is to be protected by a membrane compound curing agent, or by wetted cotton or burlap mats. Either method is to be subject to approval.

3.1.14. Dewatering. Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding areas.

The Contractor must not allow water to accumulate in excavations or at subgrade level. Remove water to prevent softening of foundation bottoms and soil changes detrimental to stability of subgrades and foundations. Provide and maintain dewatering system components necessary to convey water from excavations.

Convey water removed from excavation and rainwater to collecting or runoff areas away from buildings and other structures. Establish and maintain temporary drainage ditches and other diversion outside excavation limits. Do not use trench excavations as temporary drainage ditches.

Dewatering devices must be provided by the Contractor with filters to prevent the removal of fines from the soil. Should the pumping system draw fines from the soil, the Engineer must order immediate shutdown, and remedial measures will be responsibility of the Contractor.

Upon completion of the dewatering work, the Contractor must remove all equipment and leave the construction area in a neat, clean, condition that is acceptable to the Owner.

The Contractor must maintain ground water table at least 12 in. below the finished excavation subgrade.

Performances of the dewatering system for lowering ground water must be measured by observation wells on piezometers installed in conjunction with the dewatering system, and these must be documented at least daily. The Contractor must maintain a log of these readings and submit them to the Owner.

No direct payment will be made for costs associated with dewatering. All costs in connection therewith will be included in the applicable contract price for the item to which the work pertains.

3.2. Pipe Laying.

3.2.1. General Requirements. The Contractor is to start his work at a tie in point, unless otherwise indicated on the plans. Pipe is to be laid with bell ends facing the direction of lying, unless otherwise authorized or directed by the Owner. Under no circumstances is pipe to be laid in water and no pipe is to be laid under unsuitable weather or trench conditions. All valves and fire hydrants must be installed as soon as pipe laying reaches their established location. Pipe is to be installed to the required lines and grades with fittings, valves, and hydrants placed at the required locations.

Spigots are to be centered in bells or collars, all valves and hydrant stems are to be set plumb, and fire hydrant nozzles are to face as shown on the plans or as directed by the Owner. No valve or other control on the existing system is to be operated for any purpose by the Contractor unless a representative of SAWS is present.

The Contractor is to maintain a neat and orderly work area. Complete cleanup is to be maintained at all times as closely behind the pipe laying operations as possible, but in no case is such cleanup be permitted to lag more than 1,000 ft. behind the pipe laying, unless otherwise directed.

The Contractor is to maintain service to water connections, whether connected to the existing or proposed water lines, at all times for the duration of the construction, unless directed otherwise by the Engineer.

3.2.2. Crossing other Underground Lines. New water mains crossing other utilities are to have a minimum of 30 in. of cover over the top of the pipe, unless otherwise waived or modified by the Engineer. Excavation around other utilities is to be done by hand for at least 12 in. all around. Any damage to the protective wrap on gas lines or electrodes is to be reported immediately to CPS Energy, phone (210) 353-4357. Any damage to other utilities must be reported to their proper governing entity. In any case of utility damage, Contractor must also promptly notify the Inspector.

3.2.3. Pipe Separation – Parallel Lines. Where a new potable waterline parallels an existing, non-pressure or pressure-rated wastewater main or lateral and the licensed Professional Engineer licensed in the State of Texas is able to determine that the existing wastewater main or lateral is not leaking, the new potable waterline must be located at least 2 ft. above the existing wastewater main or lateral, measured vertically, and at least 4 ft. away, measured horizontally, from the existing wastewater main or lateral. Every effort must be exerted not to disturb the bedding and backfill of the existing wastewater main or lateral.

Where a new potable waterline parallels an existing pressure-rated wastewater main or lateral and it cannot be determined by the licensed Professional Engineer if the existing line is leaking, the existing wastewater main or lateral must be replaced with at least 150 psi pressure-rated pipe. The new potable waterline must be located at least 2 ft. above the new wastewater line, measured vertically, and at least 4 ft. away, measured horizontally, from the replaced wastewater main or lateral.

Where a new potable waterline parallels a new wastewater main, the wastewater main or lateral must be constructed of at least 150 psi pressure-rated pipe. The new potable waterline must be located at least 2 ft. above the wastewater main or lateral, measured vertically, and at least 4 ft. away, measured horizontally, from the wastewater main or lateral.

3.2.4. Pipe Separation – Crossing Lines. Where a new potable waterline crosses an existing, non-pressure rated wastewater main or lateral, one segment of the waterline pipe must be centered over the wastewater main or lateral such that the joints of the waterline pipe are equidistant and at least 9 ft. horizontally from the centerline of the wastewater main or lateral. The potable waterline must be at least 2 ft. above the wastewater main or lateral. Whenever possible, the crossing must be centered between the joints of the wastewater main or lateral. If the existing wastewater main or lateral is disturbed or shows signs of leaking, it must be replaced for at least 9 ft. in both directions (18 ft. total) with at least 150 psi pressure-rated pipe.

Where a new potable waterline crosses an existing, pressure-rated wastewater main or lateral, one segment of the waterline pipe must be centered over the wastewater main or lateral such that the joints of the waterline pipe are equidistant and at least 9 ft. horizontally from the centerline of the wastewater main or lateral. The potable waterline must be at least 6 in. above the wastewater main or lateral. Whenever possible, the crossing must be centered between the joints of the wastewater main or lateral. If the existing wastewater main or lateral shows signs of leaking, it must be replaced for at least 9 ft. in both directions (18 ft. total) with at least 150 psi pressure-rated pipe.

Where a new potable waterline crosses a new, non-pressure-rated wastewater main or lateral and the standard pipe segment length of the wastewater main or lateral is at least 18 ft., one segment of the waterline pipe must be centered over the wastewater main or lateral such that the joints of the waterline pipe are equidistant and at least 9 ft. horizontally from the centerline of the wastewater main or lateral. The potable waterline must be at least 2 ft. above the wastewater main or lateral. Whenever possible, the crossing must be centered between the joints of the wastewater main or lateral. The wastewater pipe must have a minimum pipe stiffness of 115 psi at 5.0% deflection. The wastewater main or lateral must be embedded in cement stabilized sand for the total length of one pipe segment plus 12 in. beyond the joint on each end.

Where a new potable waterline crosses a new, non-pressure-rated wastewater main or lateral and a standard length of the wastewater pipe is less than 18 ft. in length, the potable water pipe segment must be centered over the wastewater line. The materials and method of installation must conform with one of the following options:

- Within 9 ft. horizontally of either side of the waterline, the wastewater pipe and joints must be constructed with pipe material with a minimum pressure-rating of at least 150 psi. An absolute minimum vertical separation distance of 2 ft. must be provided. The wastewater main or lateral must be located below the waterline.
- All sections of wastewater main or lateral within 9 ft. horizontally of the waterline must be encased in an 18 ft. (or longer) section of pipe. Flexible encasing pipe must have a minimum pipe stiffness of 115 psi at 5.0% deflection. The encasing pipe must be centered on the waterline and must be at least two nominal pipe diameters larger than the wastewater main or lateral. The space around the carrier pipe must be supported at 5 ft. (or less) intervals with spacers or be filled to the springline with washed sand. Each end of the casing must be sealed with watertight non-shrink cement grout or a manufactured watertight seal. An absolute minimum separation distance of 6 in. between the encasement pipe and the waterline must be provided. The wastewater line must be located below the waterline.

3.2.5. Pipe Grade. Water mains 16 in. or smaller must have a minimum of 60 in. of cover from the proposed final finish ground/street elevation and 60 in. of cover when the main is installed in a parkway or under the pavement where there are no existing/proposed curb or existing drainage facilities. Water mains 20 in. and above must have a minimum of 60 in. of cover over the top of the pipe from the proposed final finish ground/street elevation unless otherwise waived or modified by the Engineer.

Contractor is responsible for maintaining line grade with an electronic grade maintaining laser device. Pipe grades are to be as required on the plans, or as directed in writing. Grades are to be met as specified by Sub Article 3.1, “Excavation.” If Contractor fails to maintain grade all cost to reestablish grade must be borne by the Contractor. Care is to be taken to ensure that the pipe barrel has uniform contact with the bedding material for its full length except at couplings. The coupling is not to be in contact with the original trench bottom before backfill. Bedding material is to be placed under the coupling and compacted by hand before backfilling so as to provide an even bearing surface under the coupling and pipe. Change in grade is to be made only at joints.

3.2.6. Bedding and Bedding Materials. Before placing pipe in a trench, the trench is to have been excavated to the proper depth as required in Section 3.1, “Excavation.” Approved imported materials or Engineer-approved materials selected from suitable fines derived from the excavation must be smoothly worked across the entire width of the trench bottom to provide a supporting cushion.

3.2.7. Structures to Support Pipe. When either the Inspector or Engineer note that the material at the bottom of a trench at subgrade consists of material that is notably unstable and conditions are such that the existing material cannot be reworked to make it stable then the trench subgrade must be over excavated, filled with approved material and properly compacted in place to provide a suitable base to support the pipe. If it is determined by the Engineer that this method cannot be used to stabilize the trench subgrade the Contractor must then construct a foundation for the pipe consisting of piling, concrete beams, or other supports in accordance with plans prepared by the Engineer. Extra compensation will be allowed for the Contractor for the additional work done. Coordinate with Engineer for approval of extra compensation before beginning work.

3.2.8. Lowering Materials into Trench. Proper implements, tools and facilities satisfactory to the Engineer are to be approved and used by the Contractor for the safe and convenient execution of work. All pipe, fittings, valves, and hydrants are to be carefully lowered into the trench piece by piece by means of a derrick, ropes, or other suitable tools or equipment in such a manner as to prevent damage to water main materials and protective coatings and lining. Under no circumstances are water main materials to be dropped or dumped into the trench. Take care to avoid damaging polywrap films. Use of chains or slings is not allowed unless entire sling is wrapped with a protective nylon web sock.

3.2.9. Installing Pipe. Take precautions to prevent foreign material from entering the pipe while it is being placed in the line. Under adverse trench conditions, extended period of time or otherwise required by the Engineer, a manufactured cap/plug is to be used to prevent any foreign type material entering. Leave the cap/plug in

place until a connection is made to the adjacent pipe. Inspect the interior of each pipe for defects and reject if defects are found.

After placing a length of pipe in the trench, the jointed end is to be centered on the pipe already in place, forced into place, brought to correct line and grade, completed in accordance with the requirements specified herein. Pipe must be installed in a continuous bedding envelope which should extend the full trench width to a depth of at least 6 in. below the pipe and to a depth at least 12 in. above water pipe. The pipe is to be secured in place with approved bedding placed in lifts not exceeding 8 in. loose thickness and compacted thoroughly to provide uniform support for the pipe barrel and to fill all voids around the pipe. Pipe and fittings which do not allow an enough and uniform space for joints will be rejected and are to be replaced with pipe and fittings of proper dimensions. Precautions are to be taken to prevent dirt or other foreign matter from entering the joint space.

At times when pipe laying is not in progress close the open end of pipe in the trench by a watertight plug or other means approved. Pipe in the trench which cannot temporarily be jointed is to be capped or plugged at each end to make it watertight. This provision is to apply during all periods when pipe laying is not in progress. Should water enter the trench, the seal is to remain in place until the trench is completely dry. The Contractor must provide plug and caps of the various sizes required.

3.2.9.1. Steel Pipe. The Contractor must furnish all steel piping including fittings, couplings, specials, pipe supports, eyebolts, nuts, and accessories which are shown on the plans and as required for proper connection to existing piping. The Contractor must pay close attention to the fact that the exact location and elevation of existing piping must be determined in the field before fabrication of connecting piping.

All steel pipe and specials may be either mill pipe or fabricated pipe and, in either case, must be fabricated to the sizes, dimensions and shapes as indicated on the plans and as shown on the plans. Unless otherwise indicated on the plans, all steel pipe, bends, or specials must have an outside diameter minimum wall thickness and unit weights as shown on plans.

Any pipe section, fitting, or special which shows dents, kinks, abrupt changes of curvature other than specified, or any other damage will be rejected. Any pipe section, fittings, or special section that has been dropped from a truck or crane will be rejected. The Contractor must, at his own expense, replace or recondition each rejected section. All reconditioning procedures must first be presented to the Engineer for review and approval.

3.2.9.1.1. Ends of Sections. Ends of pipe sections, bends, and specials must be beveled for field welding, unless shown otherwise on the plans.

3.2.9.1.2. Seams. All piping must be made from steel plate rolled into cylinders or sections thereof, with not more than two longitudinal butt welds, or must be spirally formed and butt welded. Girth seams must be butt welded and not be closer than 6 ft. apart except in specials and bends.

3.2.9.1.3. Length tolerance. Standard and special section must be within 1/16 in. (±) of the specified or theoretical lengths.

3.2.9.1.4. Welded Joints. Except where ends are shown on the plans to be joined by mechanical couplings, all joints for steel pipe installed on a bridge structure and in open trench must be welded.

Welders appointed to do welding on steel pipe must be certified with 4F and 5G certification. All welds must be sound, free from embedded scale and slag, must have a tensile strength across the weld not less than that of the thinner of the connective sections, and be water tight. Use butt welds for all welded joints in line-pipe assemblies and in the fabrication of bends and other specials. All welds must be subject to pre-manufacturing inspection and available to the Inspector and Engineer upon request.

Welding for field joints must conform to the applicable requirements of the AWWA “Standard Specification for Field Welding of Steel Water Pipe Joints, C 206.” Parties involved in the construction of mains must pay special attention to the AWWA “Standard Specification for Field Welding of Steel Water Pipe Joints, C-206,

Control of Temperature Stresses." After welding, the joints must be prepared, primed and painted, or wrapped in accordance with this specification.

Repair leaks in welds by chipping our defective material and re-welding. Hammering is not permitted.

3.2.9.2. PVC (C-900 and C-905). Lay PVC mains to the depths and grades shown on plans. Lay pipe by inserting spigot end into bell flush with insertion line or as recommended by manufacturer. At no time is bell end allowed to go past "insertion line." A gap between end of spigot and adjoining pipe is necessary to allow for expansion and contraction.

3.2.10. Defective or Damaged Material. Pipe and accessories are to be inspected for defects before being lowered into the trench. Any pipe section, fitting, or special which shows dents, kinks, abrupt changes of curvature other than specified, or any other damage will be rejected. Any pipe section, fittings, or special section that has been dropped from a truck or crane will be rejected. The Contractor must, at his expense, replace or recondition each rejected section. Reconditioning procedures must be acceptable to the Engineer. Any defective, damaged, or unsound material is to be repaired or replaced as directed.

Should a damaged piece of pipe furnished by the Contractor be placed in the water main, the Contractor is to furnish, at his expense, all labor and materials required for removing and replacing the defective pipe and restoring the street to its condition just before the failure of the pipe. Should the Contractor damage the pipe after installation, the Engineer may permit the damaged section to be cut from the length unless it is the opinion of the Engineer that the entire length was damaged. The cost and replacement of broken pipe is to be at the expense of the Contractor.

3.2.11. Holes at Bells and Collars. Bell holes of enough size are to be provided at each joint to permit the joints to be made properly. For mechanical type joints the minimum clearance between the bell and natural ground is to be 6 in. in all directions. Bell holes for concrete steel cylinder pipe are to be of enough size to properly joint the pipe and place the required grout. Subject to the above provisions the length of excavation for bell holes below grade of the trench bottom is to be kept to a minimum.

3.2.12. Deviations in Line or Grade. Wherever obstructions, not shown on the plans, are encountered during the progress of the work and such obstructions interfere to such an extent that an alteration on the plan is required, the Engineer is to have the authority to change the plans and direct a deviation from the line and grade or to arrange with the owners of the structures for the removal, relocation, or reconstruction of the obstruction. Any deviation from the line is to be accomplished by the use of appropriate bends unless such requirements are specifically waived by the Engineer. These deviations must clearly and accurately be reflected in the Contractor's submittal of their redline drawings for permanent recording purposes.

Whenever it is necessary to deflect pipe from a straight line the deflection is to be as directed. In no case are the amounts shown in Table 12, "Maximum Deflections of Ductile-Iron Pipe" and Table 13, "Maximum Defections of Concrete-Steel Cylinder Pipe," to be exceeded.

Table 12
Max Deflections of Ductile-Iron Pipe

Nominal Pipe Diameter	Max Joint Open	Max Deflection Angle	Max Deflection in In. with Pipe Length of:		Approximate Radius of Curve in Ft. Produced by Succession of Joints with Pipe Length of:	
(In.)	(In.)	°/min.	18 ft.	20 ft.	18 ft.	20 ft.
6	0.58	4/25	16.7	18.5	234	260
8	0.65	3/51	14.6	16.2	268	297
10	0.75	3/42	14.0	15.5	279	310
12	0.75	3/08	11.9	13.2	327	363
16	0.75	2/21	8.8	9.7	440	488
20	0.75	1/55	7.2	8.0	540	600
24	0.75	1/35	6.0	6.7	648	720

Table 13
Max Deflections of Concrete-Steel Cylinder Pipe

Nominal Pipe Diameter	Max Deflection Angle	Max Deflection in In. with Pipe Length of:		Approximate Radius of Curve in Ft. Produced by Succession of Joints with Pipe Length of:	
(in.)	°/min	16 ft.	20 ft.	16 ft.	20 ft.
16	2/20	-	9.8	-	500
20	1/52	-	7.8	-	600
24	1/34	-	6.6	-	750
30	1/16	-	5.3	-	900
36	1/02	-	4.3	-	1,100
42	0/54	-	3.8	-	1,300
48	0/47	2.6	-	1,170	-
54	0/44	2.5	-	1,237	-
60	0/54	3.0	-	1,024	-

3.2.13. Cutting Pipe. The cutting of pipe for inserting valves, fittings or closure pieces is to be accomplished so as to produce a smooth end at right angles to the axis of the pipe. Strictly follow the recommendations of the pipe manufacturer. Under no circumstances is a workman not equipped with proper safety goggles and helmet and other required safety attire permitted to engage in this work.

3.2.13.1. Asbestos-Cement (AC). No field cutting will be allowed on asbestos-cement pipe. Repairs to AC pipe must be accomplished by removing one full joint of AC pipe and replacing with appropriate PVC or Ductile Iron pipe and fittings. Information about handling AC pipe can found in Section 3.2.19, "Tie-in to Existing Mains" and Section 3.2.20, "Asbestos Cement (AC) Pipe Removal" of this Special Specification.

All cuts made on ductile-iron pipe are to be done with a torch or power saw. The cuts are to be made at right angles to the pipe axis and are to be smooth. The edges of the cut are to be finished smoothly with a hand or machine tool to remove all rough edges. The outside edge of pipe should be finished with a small taper at an angle of about 30°.

Field Cut PVC (C-900 and C-905 and C-909) using a power saw with a steel blade or abrasive disc depending on the size of pipe. If a bevel is needed after field cutting, it should be in accordance with the latest Uni-Bell recommendations.

To facilitate future repair work on water mains, no sections less than 3 ft. in length between fittings is allowed.

3.2.14. Coating and Wrapping Underground Pipe.

3.2.14.1. Steel Pipe. Steel pipe, bends and special are to be prepared, primed, painted or wrapped in the field as follows.

Exterior Surface Above Ground: Exterior surfaces of new pipe and appurtenances installed are to be thoroughly cleaned to bare metal by high speed wire brushing, scraping or other suitable methods approved by Engineer, given a single coat of industrial grade rust inhibitive primer and two finish coats of aluminum paint.

Exterior Surfaces Underground: Exterior surface of steel pipe, bends and specials installed in open trench are to be thoroughly cleaned to bare metal by high speed wire brushing, scraping or other suitable methods approved by Engineer, given a single coat rust inhibitive primer and wrapped with polyvinyl tape in accordance with AWWA C-203-91 "Protective Coatings for Steel Water Pipelines," (Appendix C), or most applicable approved equal provision.

The procedure for coating flanged joints and mechanical coupling joints when used with steel pipe is to be as specified.

Field Welded Joints: After installation of pipe, bends, and specials, all ends of pipe adjacent to welded field joints, including the weld proper, must be cleaned, primed, painted or wrapped as specified for the pipe adjacent to the weld.

Interior Surfaces: The interior surfaces of all steel pipe, fittings and specials must be cleaned by sandblasting and then primed and coated with a cement mortar lining. Cement mortar-lined and coated steel pipe must be used for transmission mains 4 in. and larger.

All cement-lined steel pipes must be prepared with the following processes:

Steel pipe must not be tested until the factory-applied mortar lining and coatings on all piping and specials have been in place for a minimum of 14 days. Steel piping with cement mortar field applied to the interior of the pipe must not be filled with water until a minimum of 8 hr. has elapsed after the final placement of cement mortar, unless otherwise approved by the Engineer.

- Contractor to submit details of all specials, and of the lining and coating.

- Use lining conforming to the latest provision of AWWA C205 or most applicable approved equal provision, except as is noted otherwise in the contract documents.
- Cement used in mortar lining must be Portland Cement, per the latest provision of ASTM C150 or most applicable approved equal provision, Type II or V for lining.
- Pipe must be cement mortar lined in the shop by the centrifugal process, in accordance with the latest provision of AWWA C205 or most applicable approved equal provision.

Cement mortar-lined pipe must be braced as required to maintain roundness during the shipping and handling activities and must have ends capped before shipment. For pipes with 14 in. nominal diameter and larger, the finished ID after lining must be the nominal size. For pipes with 12 in. nominal diameter and smaller, standard OD pipe sizes must be furnished.

3.2.14.2. Ductile-Iron Pipe.

3.2.14.2.1. Open Trench. Ductile-iron pipe to be installed in a trench is to be protected in the following manner. Each pipe joint is to be covered with a 4 mil thick polyethylene sleeve that is 2 ft. longer than the pipe joint. The sleeve is to cover the full length of the pipe joint, lap over 1 ft. on each end of the adjoining pipe joints and be secured with a minimum of two circumferential turns of pressure sensitive polyvinyl tape. Excess material should be neatly drawn up around the pipe barrel, folded into an overlap on top of the pipe and held in place by means of pieces of pressure sensitive tape at approximately 5 ft. intervals. After assembling the joint, the polywrap tube from the previously installed pipe is to be pulled over the joint and secured by the Contractor. The polywrap tube from the new joint is to be pulled over the first tube and secured to provide a double seal.

Cast iron and ductile-iron fittings are to be completely wrapped in 8 mil thick polyethylene films with a minimum of 1 ft. overlap on each end and appropriately taped. Laps are to cover joints with adjoining pipe joints or fittings when installed. Fire hydrant barrel from the surface to the valve is to be wrapped as specified herein.

Any damaged areas in the polyethylene film are to be repaired by covering the area with a sheet of polyethylene film large enough to lap over the damaged area 1 ft. minimum in any direction and appropriately taped. Take care at service to locations to ensure that tape extends beyond corporation and onto service line pipe 1 ft.

Before placing pipe in the trench, a cushion of approved materials is to be placed in the trench as required by Section 3.3. “Backfill” material is to be carefully placed on the pipe so as to avoid any damage to the polyethylene sleeve.

The Contractor must use care to protect and preserve the polyethylene wrap around ductile iron water mains when installing service corporations. The required method is to wrap pipe tape around the pipe over the polywrap in the area to be tapped. The tap is to be made through the tape and polywrap. It is not necessary to remove and replace poly wrap. All exposed pipe, the corporation, and the first 3 ft. of the service must be wrapped and taped to achieve a complete seal. In addition, a sand envelope must extend over and around the connection to a depth of 8 in. above the main.

3.2.14.2.2. In Casing. Where ductile-iron pipe is installed in a bore, the pipe is to be to thoroughly clean down to the coal-tar enamel pipe coating by approved methods. Where damaged, a prime coat compatible to the polyvinyl tape to be used is to then be applied to the pipe. Following application of prime coat, wrap pipe with Scotchrap, Trantex V-10 polyvinyl tape, or approved equal. Tape must not be applied until prime coat is completely dry.

The tape must be spirally and tightly wrapped on each section of the pipe with a 50% lap. The wrap must be made to the bell on the bell end and to a point 6 in. from the spigot end. The joint must be protected with tape 6 in. in width on pipe 12 in. or less in size and with tape 8 in. in width on pipe greater than 12 in. in size.

3.2.15. Protective Coating and Wrapping on Joints. All bolts and nuts installed for underground service on valves, fire hydrants, cast-iron mechanical joint fittings, pipe joints, and other ferrous metal appurtenances are to be

packed in an approved protective coating material after installation. After the joint has been made and bolts drawn to proper tension, the joint including glands, flanges, bolt heads, and nuts are to be covered with an approved coating. Such protective coating is supplemental to anti-corrosive sand embedment. Asphaltic coatings such as Talcote are not allowed. Coating and wrapping of joints will not be paid for directly.

Steel Pipe Field Welded Joints: After installation of pipe, bends and specials, all end of pipe adjacent to welded field joints, including the weld proper, must be cleaned, primed, painted or wrapped as specified for the pipe adjacent to the weld.

3.2.16. Joint Assembly.

3.2.16.1. Rubber Ring Joints. The installation of pipe and the assembly of rubber ring joints for ductile-iron pipe, concrete-steel cylinder pipe and asbestos cement pipe, is to conform to the pipe manufacturer's assembly instructions. The method of inserting spigot ends of pipe in bells or collars known as “stabbing” is not permitted with pipe larger than 6 in.in size. Spigot ends of pipe larger than 6 in. in size must be properly inserted in the joint by means of suitable pushing or pulling devices, or an approved manufacturer’s method.

3.2.16.2. Mechanical Couplings. The installation of mechanical couplings is to be assembled and installed according to the standards recommended by the manufacturer. Before the installation of the mechanical coupling, the pipe ends are to be cleaned by wire brush or other acceptable method to provide a smooth bearing surface for the rubber compression gasket. The pipe is to be marked to align the end of the coupling which will center it over the joint. After positioning, the nuts are to be drawn up finger tight. Uniform pressure on the gaskets is to be applied by tightening alternate bolts on the opposite side of the circle in incremental amounts. Final tensioning is to be accomplished with a torque wrench and in a manner similar to the tightening procedure. The coupling is to then be left undisturbed for 24 hr. to allow the gaskets to “pack in.” Final torque check is to then be made before coating and wrapping the joint. Table 14, Torque for Mechanical Couplings, sets forth the proper torque for various sized mechanical couplings and is included for the convenience of the Contractor.

3.2.16.3. Restrained Joints. Install restraint joints as shown on plans or as directed by Engineer. Install in accordance with manufacturer’s recommendations.

Table 14
Torque for Mechanical Couplings

Coupling Size	Bolt Diameter	Torque
2” to 24”	5/8”	75-ft. lb.
2” to 24”	3/4”	90-ft. lb.
30” and 36” (1/4” x 7” Middle Rings)	5/8”	65-ft. lb.
30” thru 36” (3/8” & heavier Middle Rings)	5/8”	70-ft. lb.
30” to 48”	3/4”	80-ft. lb.
48” to 72”	3/4”	70-ft. lb..

3.2.17. Gray Iron and Ductile Iron Fittings. Fittings 6 in. through 12 in. in size are to be either mechanical joint, push-on joint short body, or push-on joint compact body unless otherwise stated on the plans. Fittings must be installed with the thrust blocking or joint restraint shown on the plans. Fittings 16 in. through 24 in. in size are to be mechanical joint type unless otherwise specified on the plans. Adaptors are to be used where necessary to provide a transition between asbestos-cement pipe and the fittings. Restraint or thrust blocking is to be provided as specified on the plans or as directed. Anti-corrosion embedment incidental to all installed cast-iron fittings must be provided as specified in and no separate payment will be made for this embedment.

3.2.17.1. Cleaning Ductile Iron. All lumps, blisters, and excess coal-tar coating is to be removed from the ends of ductile-iron pipe fittings. The outside of the spigot and the inside of the bell is to be wire-brushed and wiped clean, dry, and free from oil and grease before the pipe is laid. The interior of the pipe is to be blown clean with compressed air or swabbed out clean and dry as directed. Immediately before placing any pipe in the

trench the interior is to be cleaned by an approved brush or swab or with compressed air to remove all dirt and foreign materials. All pipe and fittings are to be inspected by the Contractor for defects while suspended above ground.

3.2.18. Corrosion Protection for Ferrous Pipe, Fittings, and Valves. Except as otherwise shown on plans or as direct, anticorrosion embedment is to be provided for all ductile-iron pipe, fittings, and valves and at all valve fittings or outlets for nonferrous or reinforced concrete steel cylinder pipe. The embedding material is to be Modified Grade 5 gravel washed sand which conforms to the requirements set forth in Section 2.18, "Backfill."

Prepare the trench in accordance with applicable provisions of Section 3.1, "Excavation." After subgrade has been prepared, lay pipe to grade in accordance with plans and specification. Pipe, fitting or valve are to be firmly embedded in and surrounded by an insulating blanket of embedding material. The minimum thickness of this blanket is to be 6 in. in every direction

3.2.19. Tie-in to Existing Mains. The Contractor must make tie ins from new water mains to existing water mains as shown in the contract documents or as directed. The Contractor must be responsible for all shutdowns and isolation of the existing mains; cutting pipe for the connection; dewatering the excavation; customer notification of the shutdown; and all other requirements as directed by the Inspector to provide completion of this effort in a safe and secure manner. Work performed by the Contractor on mains 16 in. and larger, will require operation of any valves by SAWS forces. Therefore ample coordination beforehand (2 work days) must be provided by the Contractor for this interaction to occur. All tie ins must be done after normal work hours, (8 A.M.—5 P.M.). During construction, the planned shutdown and tie in work must be coordinated through and approved by the Inspector with a minimum of two weeks prior notice of such activity and accomplished at a time which will be at the least inconvenience to the customers. No additional compensation will be provided for tie ins accomplished after normal working hours.

Tying in to existing mains of asbestos cement (AC) pipe, the Contractor will comply with the requirements of Item 6 of the Department Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges. At each location shown on the plans or identified by the Contractor to involve AC pipe, the Contractor will comply with the requirements of Item 6 of the Department Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges for the removal of the necessary amount of AC pipe required to make the connection without creating any friable material. Excavate to the top of the AC water line to allow a separate contractor hired by the State to remove the AC water line. The excavation for the AC water line removal is subsidiary to the work that created the need for the removal (excavation for structures, roadway, a new line, tie ins, etc.). The third party contractor will remove whole sections of AC pipe so that the Contractor can make the tie in at the nearest joint.

3.2.20. Asbestos Cement (AC) Pipe Removal. AC pipe removal quantities shown within plans are estimated and are to be field verified. Estimated quantities for removal are based on removal required to perform tie ins to existing AC mains (as described in Section 3.2.19, "Tie-in to Existing Mains") and locations where existing AC pipe is in conflict with proposed Department's storm drains, culverts, streets, grading, retaining walls, and traffic signal foundations. The Contractor will comply with the requirements of Item 6 of the Department Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges. Excavate to the top of the AC water line to allow a separate contractor hired by the State to remove the AC water line. The excavation for the AC water line removal is subsidiary to the work that created the need for the removal (excavation for structures, roadway, a new line, tie ins, etc.). The third party contractor will remove whole sections of AC pipe.

3.2.21. Abandonment of Old Mains and Valves. Regarding planned main abandonment, the Contractor must accomplish all cutting, capping, plugging, and blocking necessary to isolate those existing mains retained in service from those abandoned. The open ends of abandoned mains and all other openings or holes in such mains occasioned by cutting or removal of outlets must be blocked off by manually forcing cement grout or concrete into and around the openings in enough quantity to provide a permanent substantially watertight seal. Abandonment of old, existing water mains will be included in the work required, and no direct payment will be made.

When specified or shown otherwise in the contract documents, Contractor must remove the main and all related appurtenances that are to replaced, or will no longer be in service, and all effort to accomplish this requirement will be included in the work required, and no direct payment will be made.

Abandoned Valves: Valves abandoned in the execution of the work must have the valve box and extension packed with sand to within 8 in. of the street surface. The remaining 8 in. must be filled with 2,500 psi concrete or an equivalent sand-cement mix and finished flush with the adjacent pavement or ground surface. The valve covers must be salvaged and returned to the Owner.

New/Existing Valves: At no time during the project work must any valves be covered or rendered inaccessible for operation due to any activities by the Contractor. Any work during construction activities will be suspended until this requirement is met. No claims for cost or schedule delays will be accepted.

3.2.22. Jacking, Boring, or Tunneling Pipe.

3.2.22.1. Jacking. Suitable pits or trenches must be excavated for the purpose of jacking operations for placing end joints of the pipe. When trenches are cut in the side of embankment, such work must be securely sheeted and braced. Jacking operations must in no way interfere with the operation of railroads, streets, highways or other facilities and must not weaken or damage such facilities. Barricades and lights must be furnished as directed to safeguard traffic and pedestrians.

The pipe to be jacked must be set on guides to support the section of pipe being jacked and to direct it in the proper line and grade. Embankment material must be excavated just ahead of the pipe and material removed through the pipe, and the pipe forced through the opening thus provided.

The excavation for the underside of the pipe, for at least ⅓ of the circumference of the pipe, must conform to the contour and grade of the pipe. A clearance of not more than 2 in. may be provided for the upper half of the pipe.

The distance that the excavation must extend beyond the end of the pipe will depend on the character of the material, but it should not exceed 2 ft. in any case.

The pipe should be jacked from downstream end. Permissible lateral or vertical variation in the final position of the pipe from line and grade will be as shown on the plans or as determined by the Engineer.

Any pipe that cannot be repaired to its original condition or is damaged in jacking operations must be removed and replaced at the Contractor's expense. Jacking pits must be backfilled immediately upon completion of jacking operations.

3.2.22.2. Excavation. Excavation for "Boring" pits and installation of shoring will be as outlined under "Jacking." Boring operations may include a pilot hole which should be bored the entire length of crossing and must be used as a guide for the larger hole to be bored. Water or drilling fluid may be used to lubricate cuttings. Variation in line and grade must apply as specified under "Jacking."

3.2.22.3. Tunneling. Tunneling may be used when the size of the proposed pipe would make the use of tunneling more satisfactory than "Jacking" or "Boring." The excavation for pits and the installation of shoring must be as specified under "Jacking." The lining of the tunnel must be of the material shown on the plans.

Access holes for grouting annular space should be spaced a maximum of 10 ft.

3.2.22.4. Joints. Joints for pipe for "Jacking," "Boring," or "Tunneling," must be as specified in these specifications, or as shown on the project plans or shop drawings as per pipe manufacturer's recommendation.

3.2.22.5. Grouting of Bores or Tunnels. Annular Space between casing pipe and limits of excavation (borehole) must be pressure grouted, unless otherwise specified on the plans.

3.2.23. Cutting in Valves. The work involved in cutting a valve into an existing main is to consist of excavation and backfilling with approved selected material; hauling and disposition of surplus excavation and other materials; installation of the valve, valve box assembly, all pipe cut used to complete cut in; reaction blocking; polyethylene wrapping where required.

3.2.24. Tapping Sleeves and Valves. Size on size taps are not permitted.

The work involved in the installation of a tapping sleeve and valve is to consist of excavation, backfilling the excavation with approved selected material, installing the tapping sleeve, reaction blocking, tapping valve, valve box assembly, concrete collar (where subjected to street traffic), and a cast iron lid. New taps will not be permitted closer than 2 ft. of a joint or existing tap. The use of a shell type cutter will be required with tapping sleeves and valves. Whenever working on potable or recycled water system, disinfect the shell cutter with bleach before start of work. The cutting edge is to be sharp and round. Inspector will reject defective cutters.

Air test tapping sleeves to 50 psi before tapping main line.

The valve box must be placed in such a manner to prevent shock or stress from being transmitted to the valve. Valve boxes must be centered over the valve's operating nut with the box cover flush with the finished pavement surface or located at another level as directed by the Inspector. Valve boxes located in streets or other areas subject to vehicular traffic must be provided with concrete collars as shown in the accompanying standard drawings. Collars around such valve boxes must be formed and finished off neatly and in a sound workmanlike manner.

3.2.25. Cutting in Tees. The work involved in cutting in a tee is to consist of excavation, shut-down and isolation of existing main to which the new main is to be connected, cutting pipe for connection, dewatering the excavation, customer notification of service interruption where required, installation of all pipe used to complete the connection, all necessary tie ins (connection to existing or new main), fittings, approved reaction blocking required and backfilling the excavation with approved selected materials or flowable backfill if required. Where the installation of a valve is required, payment will be for valve accordance with this specification.

The processes associated with disturbing and restoring pavements (any type), curbs, sidewalks, backfilling to final grade, flowable backfill (if required) and sodding for the installation of a cut in tee will be included in the work and must comply with the applicable Department Specification, any other governing entity's specifications, and applicable street cut policies, ordinances, or permits.

3.2.26. Pipe Joint Restraint System. Pipe joint restraints must be used to prevent movement for PVC push-on bell and spigot pipe connections. The restrainer may be adapted to connect a plain end PVC pipe to a ductile iron mechanical joint (MJ) bell fitting. Joint restraint is to be non-directional and installed to fully restrain system. All pipe and fitting systems with restrained joints must be identified by applying an adhesive-backed warning tape to the top of the pipe and for the full length of the pipe, regardless of the type of pipe. For plastic pipes the warning tape must be applied directly to the top of the pipe. For metal pipes and fittings the warning tape must be applied to the top of the polyethylene film wrap.

3.2.27. Concrete Encasement, Cradles, Saddles and Collars.

3.2.27.1. Concrete Encasement. When concrete encasement is shown on the plans or when directed, the trench is to be excavated and fine graded to a depth conforming to the details and sections shown on the plans. The pipe is to be supported by pre-cast concrete blocks of the same strength as the concrete for encasement and securely tied down to prevent floatation. Encasement concrete is to be placed to a depth and width conforming to details and sections shown on the plans.

3.2.27.2. Concrete Cradles. When concrete cradles are shown on the plans or when directed, the trench is to be prepared and the pipe supported in the same manner as described above. The cradle must be constructed in accordance with details and sections shown on the plans. Strap/Tie Downs must be No. 4 rebar diameter minimum or better as determined by the Water System Inspector.

3.2.27.3. Concrete Saddles. When shown on the plans or when directed, pipe to receive concrete saddle is to be backfilled in accordance with Section 3.3, "Backfill" of this specification to the spring line and concrete placed for a depth and width conforming to details and sections shown on the plans.

3.2.27.4. Concrete Collars. When shown on the plans or when directed, concrete collars are to be constructed in accordance with details and sections shown on the plans.

3.2.28. Fire Hydrants. Hydrants are to be connected to the main as shown on the plans or as directed. They are to be installed in a manner which will provide complete accessibility and in a safe location where there is a minimum possibility of damage from vehicles or injury to pedestrians.

When the hydrant is placed directly behind the curb the hydrant barrel is to be set so that no portion of the hydrant will be less than 12 in. no more than 7 ft. from the back of the curb.

When the hydrant is set in the lawn space between the curb and the sidewalk or between the sidewalk and the property line no portion of the hydrant or nozzle cap is to be within 6 in. of the sidewalk. Setting final grade of fire hydrants to match proposed or existing field conditions is the responsibility of the Contractor.

Hydrants are to be set in accordance with plans and details are to be set plumb and are to have their nozzles parallel with or at right angles to the curb with the pumper nozzle facing the curb. Drainage and concrete pad are to be provided at the base of the hydrant as shown on the plans. No fire hydrant drainage system or pit is to be connected to a storm sewer or to a sanitary sewer.

Restrained Joints: Restrained mechanical joints that require field welding or groove cuts into the pipe barrel for restrain will not be accepted. Restrained joints must be furnished for pipe at all changes in direction at indicated on plans, details, or as directed. Restrained mechanical joints must be locked mechanical joints. Joints must be capable of test pressure twice the maximum sustained working pressure of 350 psi for ductile iron pipe and PVC.

Replacing and Relocating Existing Fire Hydrants: When existing fire hydrants are to be replaced or relocated, the work is to be accomplished by either of the following:

- Cutting or installing a tee of the size and type indicated on plans or as directed.
- Using a tapping sleeve and valve of the size and type indicated on plans to install a new fire hydrant to an existing or new water main. Size on size taps is not permitted.
- Relocating the existing fire hydrant by closing the existing fire hydrant, extending the fire hydrant branch and installing the existing fire hydrant as specified herein.

Salvage the existing fire hydrant and other materials as designated in the field by the Construction Inspector and deliver to Water System material storage yard located at 3930 East Houston Street, San Antonio, Texas. Fire hydrant branches are to be abandoned by cutting and capping fire hydrant cast iron tee at the service main and surface restored to its original condition.

After the fire hydrant has been set, paint hydrant with suitable primer and finish with oil-based aluminum paint from top of hydrant to a point 18 in. to 20 in. below centerline of the pumper nozzle and apply to all exposed metal surfaces above the hydrant base flange. The payment for fire hydrant painting is to be included in the unit cost for installing the fire hydrant.

Installation on Water Mains: Ductile iron pipe, cast iron and ductile iron fittings, and valves used in the placement of fire hydrants and connections to the main will be considered part of the fire hydrant installation and not a part of the main construction. No separate payment will be made for this pipe. Hydrants should be connected to the mains as shown in the contract documents or as directed. Hydrants must also be installed in a location where there is accessibility and in a safe location where there is a minimum possibility of damage from vehicles or injury to pedestrians.

3.2.29. Gate Valves, Valve Boxes, Adjustments. Gate valve installation should include valve, reaction blocking, cast iron boot, valve box extension (with ductile iron riser pipe), valve box, concrete collar (where subjected to vehicular traffic), and valve box lid. Gate valves constructed in the terrace must be constructed with No. 3 bars all around.

The valve box must be placed in such a manner to prevent shock or stress being transmitted to the valve. All valves located 6 ft. and deeper must include valve key extensions inside the valve box. The Contractor has the option to install fully adjustable valve box and valve key extension systems, on all valves located between 6 ft. and 13 ft. Adjustable valve box and valve key extension systems must be centered over the valve's operating nut with the box cover flush with the finished pavement surface or located at another level as directed. Valve boxes located in streets or other area subject to vehicular traffic must be provided with concrete collars as shown in these standard drawings. Collars around such valve boxes must be formed and finished off neatly and in a sound workmanlike manner.

Valve pits must be located so that the valve operating nut is readily accessible for operation through the opening in the valve box. The valve box must be set flush with the finished pavement surface or at other finish elevations as may be specified. Pits should be constructed in such a manner to permit minor valve repairs and provide protection to the valve and pipe from impact (where penetrating through pit walls).

In Pressure Zones 9—16, all valves 6 in. and larger must be supported on a concrete pad in accordance with details shown on the plans.

Existing valve boxes located within the limits of new street construction which are in conflict are to be adjusted to match proposed finish grades.

3.2.30. Air Release Assembly. Air release valves and appurtenant items are to be installed at the locations shown on the plans unless otherwise directed.

Install air release assemblies in open trench in accordance with plans and details. Assemblies include the valve, valve box, tapping saddle, pipe fittings, accessories and appurtenances. It also includes service line and tap to main. Air release assemblies installed in parkways or easements and outside of street pavement must be installed in accordance with plans.

Air release assemblies installed on steel pipe attached to bridge structure includes the outlet on the steel pipe, valve, valve box, pipe fittings, security enclosure, accessories and appurtenances.

3.2.31. Blow-offs. Permanent and temporary blow-off assemblies should be installed where shown on the plans or at locations designated by the Engineer/Owner and at the end of all dead end mains in accordance with the Texas Administrative Code (TAC) rules to include 30 TAC § 290.44 (d)(5), (6).

The permanent blow-off will consist of the following: all galvanized iron pipe, valve, and fittings of the various sizes shown on the plans, 6 in. valve box assembly and concrete collar around the valve box. The temporary blow-off will consist of the following; all galvanized iron pipe, valve and fittings of the various sizes shown on the plans. Valve box must be raised or installed to finished grade and installed in accordance with the details.

3.2.32. Anchorage and Blocking. Suitable reaction blocking or anchorage is to be provided at all dead ends, plugs, caps, tees, crosses, valves and bends as shown on the plans. All mechanical (joint) restraints are to be bidirectional. Anchor blocks are to be constructed solidly behind the fitting and symmetrical with the axis of resultant thrust except where this is not possible as in the case of gravity anchorage for vertical bends. Special ties and anchor fittings may be used in conjunction with blocking when shown on the plans or as directed.

Thrust blocking is to be a minimum of Class "A" (3,000 psi), concrete placed between solid ground and the fitting except as otherwise shown on the plans. The area of bearing in contact with solid ground is to be that shown on the plans or as directed.

All thrust blocking placed in conjunction with mains and appurtenances constructed in Pressure Zones 9 through 15 should be as shown on the plans. In all cases, the design of thrust blocking must be of enough size to withstand a soil pressure of 3,000 psf, unless specified otherwise in the job plans or specifications. The maximum soil lateral load bearing capacity that will be allowed for the design of thrust blocking must be 5,000 psf. When soil lateral load bearing capacities of 4,000 psf or 5,000 psf are recorded for design of thrust blocks, copies of soil tests made for determining the bearing value of the soil is question should be submitted to the Engineer for verification.

The blocking is to be placed so that pipe and fitting joints will be accessible. Pipe polywrap is to be placed between the pipe or fitting and the concrete.

The reaction block on the unused branch of a tee is to be poured separately from the block across the back of the tee. If they are poured simultaneously, a rigid partition is to be placed between the blocks.

Valves 12 in. and larger in size are to be supported on a concrete pad extending vertically from 12 in. below the bottom of the valve to the lower quarter point of the hub and laterally from face to face of hubs and transversely from wall to wall of the trench.

3.2.33. Butterfly Valves. Butterfly valve installation will include: butterfly valve, coated and wrapped steel pipe nipple with reaction stop ring, concrete reaction blocking, cast-iron boot, valve box extension (ductile iron riser pipe), valve box and lid, concrete collar where subjected to vehicular traffic, all couplings and all coupling adapters required to complete the connection. The entire valve, except for the operating nut, must be coated with an approved SAWS sewer structural coating, and wrapped with Polywrap. Butterfly Valves constructed in a terrace must be constructed with No. 3 bars all around.

The valve box must be placed in such a manner to prevent shock or stress being transmitted to the valve. All valves located 6 ft. and deeper must include valve key extensions inside the valve box. The Contractor has the option to install fully adjustable valve box and valve key extension systems on all valves located between 6 ft. and 13 ft. Adjustable valve box and valve key extension systems must be centered over the valve's operating nut with the box cover flush with the finished pavement surface or located at another level as directed. Valve boxes located in streets or other areas subject to vehicular traffic must be provided with concrete collars as shown on the plans. Collars around such valve boxes must be formed and finished off neatly and in a workmanlike manner.

3.2.34. Reinforced Concrete Vaults.

3.2.34.1. Forms. Forms should be designed to produce hardened concrete with the shape, lines, and dimensions shown on the plans.

Surfaces which will be exposed to view when construction is completed should be prefabricated plywood panel forms, job-built plywood forms, or forms that are lined with plywood or fiberboard. The forms must produce finished surfaces that are free from off-sets, ridges, waves, and concave or convex areas.

Plywood or lined forms will not be required for surfaces which are normally submerged or not ordinarily exposed to view. Other types of forms, such as steel or unlined wooden forms, may be used for surfaces which are not restricted to plywood or lined forms and may be used as backing for form linings.

Before concrete is placed, a film of light form oil must be applied to the forms.

Forms should be substantial and tight to prevent leakage of mortar. Form must be thoroughly cleaned, braced, or tied to maintain the desired position, shape, and alignment during and after concrete placement.

Form ties must be corrosion resistant and must have enough strength and rigidity to support and maintain the form in proper position and alignment.

3.2.34.2. Form Removal. Form must be removed after 24 hrs., provided that the exposed surfaces can be immediately and effectively sealed to prevent loss of moisture. Otherwise, the forms should remain in place for 48-hrs. Precautions should be taken in form removal to avoid surface gouging, corner or edge breaking, and other damage to the concrete.

3.2.34.3. Reinforcing Steel. Reinforcing steel should be accurately formed and must be free from loose rust, scale, and contaminants which reduce bond. Unless otherwise shown on the plans, bar reinforcement must be deformed and conform to the general requirements of Item 440, “Reinforcement for Concrete.”

3.2.34.4. Reinforcing Steel Placement. Reinforcing steel should be accurately positioned on supports, spaces, hangers, or other reinforcements and must be secured in place with wire ties or suitable clips. All bars must be shop fabricated and bent cold.

3.2.34.5. Concrete Placement. Concrete should be placed as nearly as practicable in its final position to avoid segregation due to re-handling. When the concrete pour has commenced, it should be carried on as a continuous operation until the placing of the panel or section is completed as a whole. All concrete must be thoroughly compacted by suitable means during pouring operations and must be thoroughly worked around reinforcement bars and into the corners of the forms. Mechanical vibration or other acceptable means should be used to completely embed the reinforcement and eliminate honeycomb. Finished surfaces should be brought to proper grade, struck off, and completed in a workmanlike manner. No honeycombing, rough spots, or protruding stones should be left exposed.

3.2.34.6. Curing. Concrete must be protected from loss of moisture for at least 7 days after placement. Curing of concrete should be by methods which will keep the concrete surfaces adequately wet during the specified curing period.

3.2.34.7. Water Curing. Water saturation of concrete surfaces should begin as quickly as possible after the initial set of the concrete. The rate of water application should be regulated to provide complete surface coverage with a minimum of runoff.

3.2.34.8. Membrane Curing. Chlorinated, rubber-type, membrane curing compound may be used instead of water curing on concrete which will not be covered later with mortar or additional concrete. Membrane curing compound should be spray applied at coverage of not more than 300-sq. ft. per gal. If forms are removed before the end of the specified curing period, curing compound must be immediately applied to the formed surfaces before they dry out.

Curing compound should be suitably protected against abrasion during the curing period.

3.2.34.9. Finishing Surfaces. Fins and other surface projections should be removed from all formed surfaces. All exposed exterior surfaces should have a rubbed finish. The floor surface should be brush finished, unless otherwise specified.

3.2.34.10. Repairing Defective Concrete. Defects in formed concrete surfaces must be repaired to the satisfaction of the Engineer within 24 hr., and defective concrete must be replaced within 48 hr. after the forms have been removed. All concrete which is honeycombed or otherwise defective should be cut out and removed to sound concrete with edges square cut to avoid feathering.

Concrete repair work should be performed in a manner that will not interfere with thorough curing of surrounding concrete. Repair work must be adequately cured.

3.2.34.11. Painting. All exposed metallic surfaces such as the cover plate, hinges, handles, and other exposed hardware, must be primed and painted with one coat of primer and one coat of aluminum paint of approved and compatible quality.

3.2.34.12. Backfill. The Contractor should cover the openings at each end of the vault with 1/4 in. plywood placed outside the vault. Selected backfill (consisting of job excavated materials, finely divided and free from debris, organic material and stones larger than 2 in. in greatest dimension) must be placed in uniform layers not

exceeding 8 in. in uncompacted thickness and must be carefully compacted around the sides of the vault until level with the surrounding ground.

3.3. Backfill.

3.3.1. Initial Backfill. Initial backfill is defined as backfill with a thickness in its compacted state from the surface of the bedding to a point 1 ft. above the top of pipe. The first lift of initial backfill is to be inspected and approved before placement of the second lift. The second lift of initial backfill material is to extend from the spring line of the pipe with a minimum of 1 ft. above the top of the pipe. The second lift is to be evenly spread in a similar manner as the first lift.

For diameters 24 in. and larger, simultaneously spread initial backfill material alongside, under the lower quadrant of pipe and over the pipe in 12 in. lifts to a minimum of 1 ft. above the top of pipe.

Consolidate initial backfill material to assure it is incorporated. A handheld vibrator, commonly used for concrete work, can be used for this purpose. The vibrator must be inserted every 3 ft. on each side of pipe.

3.3.2. Secondary Backfill. Secondary backfill is defined as backfill from 1 ft. above the top of pipe to the top of the trench or bottom of pavement section. Secondary back fill is to be constructed in accordance with details shown on plans and these specifications.

Secondary backfill material should be placed in maximum 12 in. loose lifts or as directed.

3.3.3. Sand Backfilling of Cross Trenches and Open Holes. Blow-offs, tie ins, air release valves, and service lines, meter boxes, or other specials are to be backfilled with sand and thoroughly consolidated by saturating with water, unless otherwise directed. The use of mechanical tamping equipment for compaction of backfill will not be permitted at such locations. Disposal of surplus excavated material and placement of sand is to be included in the trenching and backfilling and will not be paid for directly.

3.3.4. Trench Backfill Across Traffic Arteries. Any trench in or across traffic arteries is to be backfilled immediately after the pipe is installed unless the Engineer determines unusual conditions exist that render immediate backfilling unfeasible.

3.3.5. Flowable Backfill. Instead of normal backfill materials, the Contractor is to backfill the trench with flowable backfill with fly ash material at the locations shown on the plans or at locations directed. The flowable backfill material and operation is to be in accordance with Item 401, “Flowable Backfill.”

3.4. Flushing and Testing Mains.

3.4.1. Flushing. Immediately upon completion of water main work, the Contractor must flush all mains affected by the scope of the work. This flushing will consist of completely filling sections of main between valves and then displacing such initial volumes of water by introducing clear water from existing facilities into and through the main to the point of discharge from the main being flushed. The flow-through should continue until it is determined all dust, debris, or foreign matter that may have entered during pipe laying operations has been flushed out. All new mains must then be left under system pressure for testing.

To avoid damage to pavement and inconvenience to the public, fire hoses should be used to direct flushing water from the main into suitable drainage channels or sewers. The Contractor is to coordinate with the Inspector before flushing.

3.4.2. Operation of Valves. No valve in the distribution system is to be operated by the Contractor without prior permission of the Inspector. The Contractor must notify the Inspector when a valve is to be operated and must only operate the valve in the presence of the Inspector.

3.4.3. Hydrostatic Tests. After the pipe has been installed and backfilled and all service laterals, fire hydrants and other appurtenances installed and connected, a hydrostatic pressure followed by a leakage test will be

performed. Except in the high pressure sections of the water distribution system (Pressure Zones 9-16) where test pressures will exceed 150 psi, all new mains must be hydrostatically field tested at a maximum test pressure of 150 psi before acceptance by the Engineer or Inspector. Where designated as "High Pressure Area," all new mains must be hydrostatically field tested at a maximum test pressure of 200 psi before acceptance by the Engineer or Inspector. It is the intent of these Specifications that all joints be watertight and that all joints which are found to leak by observation during any test must be made watertight by the Contractor. When repairs are required, the hydrostatic field test must be repeated until the pipe installation conforms to the specified requirements and is acceptable to the Engineer/Inspector. The Contractor must insure that the Engineer/Inspector be present for the duration of the pressure test.

3.4.4. Test Procedures. After the new main has been laid and backfilled as specified, but before chlorination and replacement of pavement, it is to be filled with water for a minimum of 24 hr. and then subjected to a hydrostatic pressure test.

The specified test pressure is to be supplied by means of a pump connected to the main in a satisfactory manner. The pump, pipe connection, and all necessary apparatus including gauges and meters are to be furnished by the Contractor. Unless otherwise specified, the Water System Company will furnish water for filling lines and making tests through existing mains. Before applying the specified test pressure, all air is to be expelled from the main. To accomplish this, taps are to be made, if necessary, at the points of highest elevation and afterwards tightly plugged at no cost to the Department. At intervals during the test, the entire route of the new main is to be inspected to locate any leaks or breaks. If any are found, they are to be stopped or repaired. The test is to be repeated until satisfactory results are obtained. The hydrostatic test is to be made so that the maximum pressure at the lowest point does not exceed the specified test pressure.

The duration of each pressure test is to be a minimum of 4 hr. for new mains in excess of 1,000 ft. and a minimum of 1 hr. for new mains less than 1,000 ft. after the main has been brought up to test pressure. The test pressure is to be measured by means of a tested and properly calibrated pressure gauge acceptable to Engineer. All pressure tests are to be continued until the Engineer is satisfied that the new main meets the requirements of these specifications.

Should any test of pipe in place disclose leakage greater than listed in Table 15 and 16, Hydrostatic Test Leakage Allowances, the Contractor is to, at his expense, locate and repair the defective joints until the leakage is within the specified allowance. Leakage is defined as the quantity of water supplied into the newly laid main, or any valve section of it, necessary to maintain the specified leakage test pressure after the main has been filled with water and the air expelled. The Contractor is to notify the Engineer before beginning the test, and the Water System Company's Inspector is to be present during the pressure test.

PVC pipe leakage allowances must conform to DI leakage allowances listed on Tables 27 and 28, Hydrostatic Test Leakage Allowances.

Table 15
Hydrostatic Test Leakage Allowance (Max) @ 150 psi

Nominal Diameter and Pipe Material	Allowable Leakage in Gallons per Hr. (gph) [2]													
	100 Ft.	200 Ft.	300 Ft.	400 Ft.	500 Ft.	600 Ft.	700 Ft.	800 Ft.	900 Ft.	1000 Ft.	2000 Ft.	3000 Ft.	4000 Ft.	5000 Ft.
6" DI[1]	0.11	0.22	0.33	0.44	0.55	0.66	0.77	0.88	0.99	1.10	2.20	3.30	4.40	5.50
8" DI[1]	0.15	0.29	0.44	0.59	0.74	0.88	1.03	1.18	1.32	1.47	2.94	4.41	5.88	7.35
12" DI[1]	0.22	0.44	0.66	0.88	1.10	1.32	1.54	1.76	1.98	2.20	4.40	6.60	8.80	11.00
16" DI[1]	0.29	0.59	0.88	1.18	1.47	1.76	2.06	2.35	2.65	2.94	5.88	8.82	11.76	14.70
20" DI[1]	0.39	0.74	1.10	1.47	1.84	2.21	2.55	2.94	3.31	3.68	7.63	11.04	14.72	18.40
20" CSC	0.08	0.16	0.24	0.32	0.40	0.47	0.55	0.63	0.71	0.79	1.58	2.37	3.16	3.95
24" DI[1]	0.44	0.88	1.32	1.76	2.21	2.65	3.09	3.53	3.97	4.41	8.82	13.23	17.64	22.05
24" CSC	0.10	0.19	0.29	0.38	0.48	0.57	0.67	0.76	0.86	0.95	1.90	2.85	3.80	4.75
30" DI[1]	0.55	1.10	1.66	2.21	2.76	3.31	3.86	4.42	4.97	5.52	11.04	16.56	22.08	27.60
30" CSC	0.12	0.24	0.35	0.47	0.59	0.71	0.83	0.94	1.06	1.18	2.36	3.54	4.72	5.90
36" DI[1]	0.66	1.32	1.99	2.65	3.31	3.97	4.63	5.30	5.96	6.62	13.24	19.86	26.48	33.10
36" CSC	0.14	0.28	0.43	0.57	0.71	0.85	0.99	1.14	1.28	1.42	2.84	4.26	5.68	7.10
42" DI[1]	0.77	1.54	2.32	3.09	3.86	4.63	5.40	6.18	6.95	7.72	15.44	22.16	30.88	38.60
42" CSC	0.17	0.33	0.50	0.66	0.83	1.00	1.16	1.33	1.49	1.66	3.32	4.98	6.64	8.30
48" DI[1]	0.88	1.77	2.65	3.53	4.42	5.30	6.18	7.06	7.95	8.83	17.66	26.16	35.32	44.15
48" CSC	0.19	0.38	0.57	0.76	0.95	1.13	1.32	1.51	1.70	1.89	3.78	4.98	6.64	8.30
54" CSC	0.21	0.42	0.63	0.84	1.05	1.26	1.47	1.68	1.89					
60" CSC	0.24	0.48	0.72	0.96	1.20	1.44	1.68	1.92	2.16					

1. PVC pipe must be tested to DI pressures. DI Pipe includes mechanical and push-on joints.

2. GPH for CSC Pipe are manufacturer's maximum.

Note: Leakage allowances may be determined for footages not specifically listed by interpolation or by the combination of various tabular data.

Table 16
Hydrostatic Test Leakage Allowance (Max) @ 200 psi

Nominal Diameter and Pipe Material	Allowable Leakage in Gallons Per Hr. (gph) [2]									
	100 FT.	200 FT.	300 FT.	400 FT.	500 FT.	600 FT.	700 FT.	800 FT.	900 FT.	1000 FT.
6" DI[1]	0.13	0.25	0.38	0.51	0.64	0.76	0.89	1.02	1.14	1.27
8" DI[1]	0.17	0.34	0.51	0.68	0.85	1.02	1.19	1.36	1.53	1.70
12" DI[1]	0.26	0.51	0.77	1.02	1.28	1.53	1.79	2.04	2.30	2.55
16" DI[1]	0.34	0.68	1.02	1.36	1.70	2.04	2.38	2.72	3.06	3.40
20" DI[1]	0.43	0.85	1.28	1.70	2.13	2.55	2.98	3.40	3.83	4.25
20" CSC	0.08	0.16	0.24	0.32	0.40	0.47	0.55	0.63	0.71	0.79
24" DI[1]	0.51	1.02	1.53	2.04	2.55	3.06	3.57	4.08	3.59	5.10
24" CSC	0.10	0.19	0.29	0.38	0.48	0.57	0.67	0.76	0.86	0.95
30" DI[1]	0.64	1.27	1.91	2.55	3.19	3.82	4.46	5.10	5.73	6.37
30" CSC	0.12	0.24	0.35	0.47	0.59	0.71	0.83	0.94	1.06	1.18
36" DI[1]	0.76	1.53	2.29	3.06	3.82	4.58	5.35	6.11	6.88	7.64
36" CSC	0.14	0.28	0.43	0.57	0.71	0.85	0.99	1.14	1.28	1.42
42" DI[1]	0.89	1.78	2.68	3.57	4.46	5.35	6.24	7.14	8.03	8.92
42" CSC	0.17	0.33	0.50	0.66	0.83	1.00	1.16	1.33	1.49	1.66
48" DI[1]	1.02	2.04	3.06	4.08	5.10	6.11	7.13	8.15	9.17	10.19
48" CSC	0.19	0.38	0.70	0.76	0.95	1.13	1.32	1.51	1.70	1.89
54" CSC	0.21	0.42	0.63	0.84	1.05	1.26	1.47	1.68	1.89	2.10
60" CSC	0.23	0.46	0.69	0.92	1.15	1.38	1.61	1.84	2.07	2.30

1. PVC pipe must be tested to DI pressures. DI Pipe includes mechanical and push-on joints.

2. GPH for CSC Pipe are manufacturer's maximum.

Note: Leakage allowances may be determined for footages not specifically listed by interpolation or by the combination of various tabular data.

3.5. Disinfection of New Mains Utilizing Machine Chlorination. After the new mains have successfully passed the pressure test specified in Section 3.4.3, "Hydrostatic Tests," the San Antonio Water System will disinfect those mains shown on the plans or otherwise indicated as "Machine Chlorination." This disinfection is to include chlorination, flushing, and placing the mains in service. All other disinfection requirements must be accomplished by the Contractor. Disinfection by the Contractor is limited to sections of pipe less than 800 ft. in length between sections.

3.5.1. Operation of Valves. During and after disinfection of mains less than or equal to 16 in. in diameter, the Contractor must be notified by the Inspector sufficiently in advance (2 work days) to enable the Contractor to have a competent representative present whenever valves are to be operated that will affect the pressure in any part of the work for which the Contractor is responsible.

3.5.2. Contractor's Personnel and Equipment. The Contractor is to supply labor and equipment necessary to make all excavations required for chlorination, equipment connections, subsequent flushing, and placing the mains in service.

3.5.3. Safeguarding and Backfilling Open Holes. The Contractor is to be responsible for safeguarding any open holes excavated or left open for flushing and disinfection purposes. Following completion of disinfection, the Contractor is to backfill such holes in accordance with appropriate provisions of Section 3.3, "Backfill."

3.5.4. Disinfection of Mains Utilizing Dry Calcium Hypochlorite. Mains are to be disinfected with dry Calcium Hypochlorite (HTH) where shown on the plans or as directed and must not exceed a total length of 800 ft. This method will also be followed for main repairs. Contractor must use appropriate safety measures to protect personnel during disinfection operation.

3.5.5. Dosage. The Contractor is to disinfect the new or replaced mains with Calcium Hypochlorite (HTH) of 70% available chlorine. Calcium Hypochlorite (HTH) is to be used to obtain a minimum chlorine concentration of 50 ppm. The following Table 17, Chlorine Dosage, is included for the convenience of the Contractor:

Table 17
Chlorine Dosage

Diameter of Pipe In.	oz./ft. To Obtain 50 ppm Chlorine Dosage
6	0.0138
8	0.0233
10	0.0364
12	0.0523
14	0.0708
16	0.0934
18	0.1175
20	0.1455
24	0.2080
30	0.3270
36	0.4690
42	0.6370
48	0.8330
54	1.0575
60	1.308

A heaping tablespoon holds approximately 1/2 oz., and a standard measuring cup holds approximately 8 oz.

3.5.6. Filling the Main. Those sections of main to which dry Calcium Hypochlorite (HTH) has been applied is to be filled slowly to allow for the even distribution of the disinfecting material. The manipulation of valves is to be under the direction of the Engineer in accordance with Section 3.5.1, “Operation of Valves.”

3.5.7. Holding Time. The length of time that sections of main disinfected with Calcium Hypochlorite (HTH) is to be allowed to stand undisturbed will depend upon the particular job and Texas Commission on Environmental Quality (TCEQ) criteria.

- When circumstances permit a shutdown with no customers out of service, the required minimum detention time will be 24 hr. with a 50 ppm chlorine dosage.
- When customers are out of service during a shutdown with no leakage past valves, the required minimum detention time will be 3 hr. and the chlorine dosage will be 300 ppm.
- When customers are out of service during a shutdown with some leakage past valves, the required minimum detention time will be 30 min. with a 500 ppm chlorine dosage.

3.5.8. Flushing. Following the expiration of the specified holding time, the treated section of main is to be flushed thoroughly by the Contractor in accordance with the applicable provisions of Section 3.4, “Flushing and Testing Mains.” Flushing is to continue until no chlorine remains detectable by taste or odor or until the chlorine residual is less than 0.3 ppm. The Contractor must make provisions for the disposal and runoff of the flushing operations to minimize erosion or impact to residents.

3.5.9. Preventing Reverse Flow. Valves are to be manipulated so that the strong chlorine solution in the line being treated will be flushed out of the main and will not flow back into the line supplying the water.

3.5.10. Supervision. All disinfection is to be done as is done under the general supervision of the San Antonio Water System.

3.5.11. Additional Treatment. Should the new main fail to meet minimum public health standards for bacteriological quality after flushing, further treatment is to be as directed. If further disinfection is required, chlorination is to be done in accordance with Section 3.5, “Disinfection of New Mains Utilizing Machine Chlorination.” In no case, however, is the new line to be acceptable as complete and satisfactory until the bacteriological quality of the water taken from the main meets the Standards of the TCEQ.

If an open hole is unsafe and does not have proper trench protection, owner’s chlorination crew will not chlorinate project until acceptable trench protection is provided.

3.6. Service Supply Lines. Service supply lines and fittings, meter boxes and appurtenances must conform to material specifications and must be installed by the Contractor as specified herein, or as directed and in accordance with plans. Service supply lines in High Pressure Zones should be installed with two strap service saddle clamps.

3.6.1. Designation of Service Supply Lines. A service supply line located between the Water main and the inlet side of the water meter is designated as a “water service line.” A service supply line located between the outlet side of the water meter to the point of connection within the limits of the Customers lot or property is designated as “Customer’s yard piping.” Services 2 in. and smaller are designated “small services”; services 4in. and larger are designated “large services.”

3.6.1.1. Service Relays. New transfer mains to which services are to be relayed and are on the same side of the streets as the Customer’s meter are defined as “short relays.” New transfer mains to which services are to be relayed and are on the opposite side of the street from the Customer’s meter are defined as “long relays.”

3.6.1.2. Service Reconnects. New transfer mains to which services are to be reconnected and on the same side of the street as the old main are defined as “service reconnects.” Existing services on the opposite side of the street to the new main will be defined as a “long reconnects.”

3.6.1.3. Service Relocates. Service Relocates are defined as services that are relocated from an alley to a side or front street. New transfer mains to which services are to be relocated and are on the same side of the street as the Customer’s new meter box location, are designated as “short relocates.” New transfer mains to which services are to be relocated and are on the opposite side of the street from the Customer’s new meter box location, are designated as “long relocates.”

3.6.1.4. New Services. If a new main is required to be extended to provide water service for new Customers, the service lines laid to the new main will be designated as "new services." New laid mains to which new services are on the same side of the street as the Customer's new meter box location, are designated as "new short services." New laid mains to which new services on the opposite side of the street from the Customer's new meter box location, are designated as "new long services."

3.6.1.5. New Un-metered Services. New Un-metered services are defined as services that are installed on existing mains or new mains to provide service to Customers platted vacant lots. Where the new main or existing main to which new un-metered services are being installed is on the same side of the street as the Customer's new or existing meter box location, (Inspector to set location of new meter box if no existing

meter box is set), the services to be laid are designated "new un-metered short services." Where the new main or the existing water main to which new un-metered services are installed is on the opposite side of the street from the Customer's new or existing meter box location, (Inspector to set location of new meter box if no existing meter box is set), the services to be laid are designated "new un-metered long service." New un-metered long services and new un-metered short services will not include "Customer's yard piping" and no meter will be set.

3.6.1.6. Tap Holes. Tap holes are defined as excavations at existing mains, which are required in association with replacements of water service lines by pulling, boring or jacking operations.

All backfill material will be as specified for main and service line trench excavation.

For service lines and tap holes, payment for bedding, initial backfill and secondary backfill will be included in the various sizes of each service placed.

3.6.1.7. Service Line Installation. Unless otherwise notified, service relays, service reconnects, service relocates and new services will be installed as described herein, and in plans. Unless otherwise indicated, existing meter and meter box relocation will be included in the service line installation.

All service line installation will include a dielectric union to be installed within the meter box on the outlet side of the meter, as shown in plans.

Cutting, excavation, backfill and replacement of pavement will be done as specified herein and in accordance with applicable sections of this specification and the contract documents. The minimum trench width for small service lines will be 8 in., while the minimum trench width for large service Lines will be the nominal pipe diameter plus 16 in., except when specified otherwise by the Engineer. For 3/4 in. to 2 in. service lines, minimum bury depth will be 3 ft. For services greater than 2 in., minimum depth of bury will be 4 ft.

All service lines should be installed in accordance with plans, and specifications, except that two strap service saddle clamps must be installed for all tap connections made on water mains located within boundaries of Pressure Zones (formally known as Service Levels) 9 through 16.

The Contractor must use precaution to protect and preserve the polyethylene wrap around Ductile-Iron (DI) water mains when installing service corporations. The required method is, wrap pipe tape around the pipe, over the polywrap, in the area to be tapped. The tap should be made through the tape and polywrap. It is not necessary to remove and replace polywrap. All exposed pipe, corporation and the first 3 ft. of the service, must be wrapped and taped to achieve a complete seal. In addition, a sand envelope must extend over and around the connection to a depth of 8 in. above the main.

Small service lines must be embedded in sand in accordance with specification

When approved by the Construction Inspector, the Contractor may lay the new service line from the corporation stop to the curb stop or angle valve. Upon completion, the Contractor must isolate the new service line by closing the curb stop or angle valve until the meter box is set.

3.6.1.8. Splicing. A long service line single splice may be permitted by means of a 3 part compression or flared coupling only when approved in advance by the Engineer, provided the location of the splice is not under pavement or concrete. The segment added is required to be the same material as the existing service line, unless otherwise directed by the Engineer. Splicing short service lines will not be permitted.

3.6.1.9. Boring or Jacking Service Lines. Service lines which cross paved streets may be installed at the Contractor's option by boring or jacking operations. Where it becomes necessary to widen the main trench section to accommodate a bore pit, such widening must not extend more than 1 additional ft. into the traffic side of the street.

3.6.1.10. Tapping Asbestos Cement (AC) Water Mains. All necessary service line tapping of AC pipe must be completed during the period immediately before or after hydrostatic pressure testing operations so that subsequent flushing will maximize the elimination of contaminants associated with the tapping process. Direct tapping will not be allowed. Service saddles must be used when tapping AC pipe. Drill tools should be used for services less than 2 in. shell type drills should be used for all services 2 in. and greater.

Tapping of AC pipe must be done in accordance with manufacturers' recommendation and done only with tap machine with a built in flush valve and the flush valve must be open during the entire procedure.

3.6.1.11. Abandonment of Service Lines. The Contractor should accomplish all cutting, capping, and plugging necessary to isolate new service lines transferred to new and existing mains from those abandoned, including service lines designated on the plans as "tap plug" and "tap kill." The corporation stop for an abandoned service line tapped on a ferrous main must be removed, and the tap at the main must be plugged with an appropriately sized brass plug. For a non-ferrous main, the corporation stop must not be removed from the main. Instead, the corporation stop must be closed and the flared nut should be removed from the corporation stop. After the appropriately sized copper disc is inserted inside the flared nut, replace the flared nut on the corporation stop. The Contractor should salvage copper service line tubing, brass fittings, and other materials as directed by the Inspector and return them to the Owner.

3.6.1.12. Tapping PVC C 900. Tapping of PVC must be done in accordance with Uni-Bell procedures. Direct Tapping will not be allowed. All drill cutting tools must be the "shell type" with internal teeth or double slots which will retain the coupon. The shell cutters must be designed for C900 pipe, thus with enough root depth to handle the heavier walled pipe.

3.6.1.13. Small Service Lines. Copper tubing should be used for 3/4 in. through 2 in. service lines. Brass fittings for 3/4 in. and 1 in. service lines should be of the flared or compression type for the use with Type 'K' soft annealed copper tubing. Brass fittings for 1.5 in. and 2 in. lines should be of the flared or compression type for use with Type 'K' soft annealed copper tubing, except as modified by this specification.

Copper tubing must be cut squarely by using an approved cutting tool and by avoiding excessive pressure on the cutting wheels which might bend or flatten the pipe walls. Following the copper tubing cut, but before flaring, a reamer should be used to remove the inside rolled lip from the tubing. Flared ends should be expanded by the use of a flaring tool using care to avoid splitting, crimping, or overstressing the metal. Pipe adjacent to the fittings must be straight for at least 10 in. Bending of tubing should be accomplished by using an appropriate sized bending tool. No kinks, dents, flats, or crimps will be permitted, and should such occur, the damaged section should be cut out and replaced. When compression fittings are used, the copper tubing should be cut squarely before insertion into the fitting Final assembly must be in accordance with the manufacturers' recommendations.

3.6.1.14. Small Service Lines on New Mains. Installation of new copper service lines will consist of all excavation through miscellaneous material encountered; trench excavation protection; drilling and tapping the new main with an approved tapping machine; setting the curb stop or angle valve at the meter; laying the new copper service line at the specified depth between the main and the meter and its tie in at the corporation and the curb stop or the angle valve; relocating the existing meter and installing a new meter box where required in accordance with this specification, herein; backfilling the trench with approved selected material and disposal of surplus excavated material; capping the tap hole with asphalt treated base, including the outer limits of the main trench line with service line trench; cutting and replacing pavements, curbing and sidewalks of all types over the limits of the main line trench and the completed service line trench.

3.6.1.15. Reconnecting Service Lines. Both old and new water mains at existing service line connections as shown on the plans must be exposed. The old main must be exposed for the purpose of gaining access to the existing service corporation stop and the new main for the purpose of installing the new corporation stop. The new main must be exposed for the purpose of being drilled and tapped with an approved tapping machine, a new corporation stop installed under pressure, and the trench extended laterally to expose enough length of the existing service line to provide slack to bend it to position for tying to the new corporation stop. After suitable notification to the Customer, the Contractor should "kill" the existing service by closing the corporation stop, removing the existing flare nut, inserting the existing flared nut on the corporation stop if the

main is non-ferrous, or plugging the existing service line at the main if the main is ferrous. The Contractor must then immediately open the stop and restore water service to the Customer. Where it is not possible to obtain enough length in the existing service to tie directly to the new main, at the direction of the Engineer, the Contractor must splice the necessary length of new tubing and tie it to the existing service by means of a compression coupling at a point as close as practicable to the new main.

Cutting and bending of the tubing, introduction of slack to compensate for soil movement, and completion of the installation will be as specified herein.

Where old and new mains are on opposite sides of the street, service lines may be installed under the street pavement by boring rather than trenching.

3.6.1.16. Relaying Service Lines. The existing or new mains shown on plans must be exposed opposite location stakes placed on site at the direction of the Engineer. The existing or new main should be drilled and tapped with an approved tapping machine, a new corporation stop installed, and the trench extended laterally to the location specified for the meter box. The existing meter must be reset and the meter box and base must be installed at its staked location and perpendicular to the corporation stop in the water main. The meter box location should not vary more than 24 in. in any direction from its staked location. The service line must be installed with enough slack to compensate for soil movement. Where the location of the existing meter is not changed, the new service line should be extended from the main to the existing meter, a new curb stop installed at the end of the service line, and connected to the inlet side of the meter. If disturbed, the existing meter box must be reset to correct grade. Long service relays may be placed under the street pavement by boring or jacking rather than trenching.

3.6.1.17. Single Service Line - Dual Meters. The single service line - dual meter installation will consist of a 1 in. copper service line reducing to two 3/4 in. copper service lines at a tee which should be set in line with the front edge of meter boxes for 5/8 in. and 3/4 in. meters. A single service line with dual meters should be installed in those new residential developments where new 5/8 in. and 3/4 in. meters are required and in main replacement work where it is necessary to change the location of existing 5/8 in. and 3/4 in. meters. Single service line - dual meter materials and installation requirements must conform to requirements established herein.

3.6.1.18. Small Service Lines on Existing Mains. The work involved in the installation of new copper service lines on existing mains will consist of jacking, boring, tunneling, and, where authorized, open trench operations all excavation through whatever material encountered; trench excavation protection; using the existing corporation when approved by the Engineer; tapping the existing main and installing the new corporation and setting the curb stop or angle valve at the meter; relocating the existing meter and installing a new meter box where required in accordance with this specification; abandoning the existing corporation stop, removing the existing flared nut, inserting inside the existing flared nut an appropriately sized copper disc and replacing the existing flared nut on the corporation stop if the main is non-ferrous, or plugging the existing service line at the main if the main is ferrous; installing the new service line at the same grade as the existing service line or at the specified grade between the main and the existing meter and its tie in at the corporation and the curb stop; disposal of surplus excavated material; capping the tap hole with asphalt treated base including the outer limits of the main line trench and the service line trench; cutting and replacing all surfaces of whatever type encountered over the completed service line trench; restoration of the site.

3.6.1.19. Large Service Lines. DI pipe and cast-iron fittings used for metered service lines and non-metered fire service lines larger than 2 in. must be installed in accordance with the applicable provisions of this specification, except where otherwise approved by the Engineer.

3.6.1.20. Large Service Lines on New Mains. Work involved in the installation of a new metered service lines and non-metered fire service lines will consist of all excavation through whatever material encountered; trench excavation protection, installing tees, pipe and fittings of various sizes including main line and service line valves, valve boxes, DI pipe, fittings, in accordance with plans and reaction block required; backfilling with approved selected material; cutting and replacing pavements, curbing, and sidewalks of all types over the limits of the main line trench and the completed DI service line.

3.6.1.21. Large Service Lines on Existing Mains. The work involved in the installation of the new metered service lines and non-metered fire service lines will consist of all excavation through whatever material encountered, trench excavation protection, cutting in tees and installing tapping sleeves and valves, pipe and fittings of various sizes including main line and service valves; valves boxes, DI pipe, fittings and reaction block required; backfilling with approved selected material; cutting and replacing pavements, curbing, and sidewalks of all types over the limits of the main line trench and the completed DI service line.

3.6.2. Meter Boxes. Physical movement of existing meters and meter boxes to new locations may be required where service lines are transferred to new mains in conjunction with main replacement work. Unless specified otherwise, the Contractor should move existing meters and meter boxes and reconnect and adjust customer's yard piping as part of transferring service lines. A dielectric coupling PVC Schedule 80 must be installed within the meter box between the meter and the customer's yard piping.

Round and oval meter boxes with round covers should be salvaged and returned to the Owner by the Contractor. The Contractor must also replace the salvaged meter boxes with the new, appropriately styled oval plastic meter box with oval cover, or rectangular meter box. Unless otherwise specified, the old service line should be abandoned after the existing meter has been reset in the existing or new meter box.

Where meter boxes are installed in sidewalks or driveways, the Contractor should install a number one meter box (2 pieces) as shown on plans.

New meters will be set by the Owner where mains are extended and new services lines are installed for new or initial customer service. Instead of the new meter, the Contractor should furnish and install a meter template in accordance with plans.

Meter and meter box configuration should have the meter set horizontal, approximately 6 in. below the top of meter box, so that the meter is above the bottom of the meter box and in line with the meter box lid opening. The top of the meter box should be flush with the existing ground surface. All excess soil above the meter coupling, meter flange and meter nuts inside the meter box should be removed so that the meter register is clearly visible. The Contractor must exercise special precautions during excavation at the existing meter location to minimize the disturbance of the customer's yard piping. However, if the existing meter elevation is low, the Contractor must raise the existing meter to conform to the correct configuration indicated herein. Adjustment of meter to proper grade is incidental to the construction and will not be paid for separately.

Where required, pressure reducing valves should be installed by the customer in accordance with the Uniform Plumbing Code and must be placed beyond the outlet side of the meter, but not within the Owner's meter box. The pressure reducing valve will be the property of the water user who will be responsible for its installation, maintenance, and replacement as required.

The meter box adjustment must not exceed 10 ft. from the existing box.

3.6.3. Water Service for Fire Lines.

3.6.3.1. Start of Work. Three working days' notice will be given to the assigned Inspector before start of a project after permit has been issued. The Contractor must start his work at a tie in or point designated by the Engineer. Pipe must be laid with bell ends facing in the direction of laying, unless otherwise authorized or directed by the Engineer. All valves and fire hydrants must be installed as soon as pipe laying reaches their established location. Pipe must be installed to the required lines and grades with fittings, valves, and hydrants placed at the required locations. Spigots must be centered in bells or collars, all valves and hydrant stems must be set plumb, and fire hydrant nozzles must face as shown on the plans or as directed. No valve or other control on the existing system should be operated for any purpose by the Contractor unless a representative of the San Antonio Water System is present.

3.6.3.2. Crossing Other Underground Lines. New fire line services crossing any other utilities must have a minimum of 48 in. of cover over the top of the pipe unless otherwise waived or modified by the Engineer. Excavation around other utilities must be done by hand for at least 12 in. all around. Any damage to other utilities must be reported to the governing entity/owner of said utility as well as the Inspector.

3.6.3.3. Pipe Grade. Fire line services must have a minimum of 48 in. of cover for mains 16 in. and below, and 60 in. for mains 20" and above, over the top of the pipe unless otherwise waived or modified by the Engineer. Pipe grades must be as required by the plans or as directed. Grades must be met as specified. Precautions must be taken to ensure that the pipe barrel has uniform contact with the Modified Grade 5 for its full length except at couplings. Couplings should not be in contact with the original trench bottom before backfilling. Modified Grade 5 material should be placed under the coupling and compacted by hand before backfilling so as to provide an even bearing surface under the coupling and pipe. Changes in grade should be made only at joints.

3.6.4. Modified Grade 5 Materials. Before placing pipe in a trench, the trench should have been excavated to the proper depth as required herein. Approved imported materials or Engineer approved materials selected from suitable fines derived from the excavation should be smoothly worked across the entire width of the trench bottom to provide a supporting cushion.

3.6.5. Structures to Support Pipe. When either the Inspector or Engineer note that the material at the bottom of a trench is unstable or unsuitable, and conditions are such that the existing material cannot be reworked to make it stable then the trench subgrade should be over-excavated, with approved material, and properly compacted in place to provide a suitable base to support the pipe. If it is determined by the Engineer that this method cannot be used to stabilize the trench subgrade, the Contractor should then construct a foundation for the pipe consisting of piling, concrete beams, or other supports in accordance with plans prepared by the Engineer. Extra compensation will be allowed for the Contractor for the additional work done. Coordinate with Engineer for approval of extra compensation before beginning work.

3.6.6. Lowering Materials into Trench. Proper implements, tools, and facilities satisfactory to the Engineer must be provided and used by the Contractor for the safe and convenient completion of work. All pipe, fittings, valves, and hydrants must be carefully lowered into the trench piece by piece, by means of a derrick, ropes, or other suitable tools or equipment in such a manner as to prevent damage to water service materials and protective coatings and linings. Under no circumstances should water service materials, pipes, fittings, etc., be dropped or dumped into the trench. Extreme care must be taken to avoid damaging polywrap films. No chains or slings should be allowed unless the entire sling is wrapped with a protective nylon web sock.

3.6.7. Laying of Pipe. Every precaution must be taken to prevent foreign material from entering the pipe during its installation. Under adverse trench conditions, work stoppage for more than 24 hr. or as otherwise required by the Engineer, a manufactured cap/plug is to be used to prevent any foreign material from entering the pipe. The cap/plug must be left in place until a connection is made to the adjacent pipe. The interior of each pipe must be inspected for foreign material or defects, and the pipe must be cleaned or rejected if any foreign debris or defects are found, respectively.

After placing a length of pipe in the trench, the jointed end should be centered on the pipe already in place, forced into place, brought to correct line and grade, and completed in accordance with the requirements herein. The pipe should be secured in place with approved backfill material tamped around it. Pipe and fittings which do not allow enough and uniform space for joints will be rejected by the Engineer or Inspector and must be replaced with pipe and fittings of proper dimensions. Precautions must be taken to prevent dirt or other foreign matter from entering the joint space.

At times when pipe laying is halted, the open end of pipe in the trench must be closed by a watertight plug or other means approved by the Engineer. Pipe in the trench which cannot temporarily be joined must be capped or plugged at each end to make it watertight. This provision will apply during all periods when pipe laying is not in progress. Should water enter the trench, the seal must remain in place until the trench is pumped completely dry. The Contractor must provide all plugs and caps of the various sizes required.

3.6.8. Deviations in Line or Grade. Wherever obstructions not shown on the plans are encountered during the progress of the work and interfere to an extent that an alteration in the plan is required, the Construction Inspector will have the authority to change the plans and direct a deviation from the line and grade or to arrange with the owners of the structures for the removal, relocation, or reconstruction of the obstructions. Any deviation from the line should be accomplished by the use of appropriate bends unless such

requirement is specifically waived by the Construction Inspector. These deviations must be clearly and accurately reflected in the Contractor's submittal of redline drawings for permanent recording purposes.

Whenever it is necessary to deflect pipe from a straight line, the deflection must be as directed by the Construction Inspector and as described herein. In no case should the amounts exceed those shown in Table 18 "Maximum Deflections of Ductile-Iron Pipe" for ductile-iron pipe.

Table 18
Max Deflections of Ductile-Iron Pipe

Nominal Pipe Diameter	Max Deflection Angle	Max Deflection (in.)		Approximate Radius of Curve (ft.)	
		18 ft.	20 ft.	18 ft.	20 ft.
6"	4°25'	16.7	18.5	234	260
8"	3°51'	14.6	16.2	268	297
10"	3°42'	14.0	15.5	279	310
12"	3°08'	11.9	13.2	327	363
16"	2°21'	8.8	9.7	440	488
20"	1°55'	7.2	8.0	540	600
	1°35'	6.0	6.7	648	720

3.6.9. Cutting Pipe. The cutting of pipe for inserting valves, fittings, or closure pieces must be accomplished in a neat manner so as to produce a smooth end at right angles to the axis of the pipe. The recommendations of the pipe manufacturer should be strictly followed by the Contractor. Only qualified and experienced workmen must be used and, under no circumstances, should a workman not equipped with proper safety goggles, helmet and all other required safety attire be permitted to engage in this work.

3.6.9.1. Asbestos-Cement (AC). No field cutting, breaking, or crushing will be allowed on AC pipe. Installation of fire line services to AC pipe mains must be accomplished by removing one full joint of AC pipe and replacing with appropriate PVC or Ductile Iron pipe and fittings.

All cuts made on ductile-iron pipe must be done with a power saw. The cuts should be made at right angles to the pipe axis and must be smooth. The edges of the cut must be finished smoothly with a hand or machine tool to remove all rough edges. The outside edge of pipe should be finished with a small taper at an angle of about 30°. Solid sleeves or cast couplings must be allowed on precast/prefab vaults only. All other fire line services should be installed with full joints of pipe.

To facilitate future repair work on water mains, no sections less than 3 ft. in length between fittings will be allowed.

3.6.10. Joint Assembly.

3.6.10.1. Rubber Ring Joints. The installation of pipe and the assembly of rubber ring joints for Ductile-Iron pipe must conform to the pipe manufacturer's assembly instructions. The method of inserting spigot ends of pipe in bells or collars known as "stabbing" will not be permitted. Spigot ends of pipe must be properly inserted in the joint by means of suitable pushing/pulling devices or a manufacture approved method.

3.6.10.2. Mechanical Couplings. Mechanical couplings must be assembled and installed according to the standards recommended by the manufacturer.

Mechanical coupling consists of a cylindrical steel middle ring, two steel follower rings, two rubber compound gaskets, and a set of steel bolts. The middle ring is flared at each end to receive the wedge-shaped gasket which is compressed between the middle ring flare and the outer surface of the pipe by pressure exerted on the follower rings through the bolt circle.

Before the installation of the mechanical coupling, the pipe ends must be cleaned by wire brush or other acceptable method to provide a smooth bearing surface for the rubber compression gasket. The pipe must be marked to align the end of the coupling which will center it over the joint. After positioning, the nuts should be drawn up finger tight. Uniform pressure on the gaskets should be applied by tightening alternate bolts on the opposite side of the circle in incremental amounts. Soap and final tensioning should be accomplished with a torque wrench and in a matter similar to the tightening procedure after 15 min.

3.6.10.3. Restrained Joints. Restrained Joints should be installed as shown on the plans or as directed by the Construction Inspector. Installation must conform to the manufacture's recommendations

3.7. Installation of the Nonmetallic Pipe Detection System. The nonmetallic pipe detection system is to be installed concurrently with the proposed pipe placement. Tracer wire will be used for location purposes and taped directly to the pipe. The tracer wire must be solid core (14 gauge insulated) and should be taped to the main in 10 in. increments. Wire should also come up to the top of valve extensions and fire hydrant stems, as directed by the Inspector.

3.8. High Pressure Zone. Work performed for construction of a high pressure water distribution system, including water mains, services, fire hydrants, and all related appurtenances, is to be done in accordance with this specification. This Section applies solely to the construction of high pressure water systems and will govern when in conflict with of sections of this specification.

3.8.1. High Pressure Systems. Each water distribution system that furnishes water in Pressure Zone 9 through Pressure Zone 16 will be designated as a high pressure system. The static water pressure in each in each Service Level must be not less than 35 psi nor exceed 175 psi with no fire hydrants in use.

3.8.2. Locations of High Pressure Levels. Geographically, boundaries of Pressure Zones 9 through 16 conform to the surface contour tabulation shown in Table 19, High Pressure Levels. Most of the area within Pressure Zones 9 through 16 is located north of Loop 1604 between IH 35 North and Bandera Road.

Table 19
Pressure Zone Surface Contour Tabulation

Static Gradient Service Level	Max Ground Elevation (ft.)	Ground Elevation (ft.)	Ground Elevation 110 psi (ft.)	Ground Elevation 150 psi (ft.)	Ground Elevation 175 psi (ft.)
9	1,125	1,000	870	780	720
10	1,290	1,160	1,040	940	880
11	1,400	1,270	1,150	1,050	1,000
12	1,520	1,390	1,270	1,170	1,120
14	1,630	1,500	1,380	1,280	1,230
15	1,860	1,730	1,600	1,510	1,460
16	1,990	1,860	1,740	1,640	1,590

3.9. Recycled Water System. The installation of any recycle water system components will be done in accordance with these Specifications, except as otherwise noted. Recycled Water mains must also be installed at the TCEQ required separation distance between sewer and water mains as required by Texas Administrative Code (TAC) rules to include: The latest provision of 30 TAC § chapters 210, 290, and 217, or most applicable approved equal provision.

3.10. Grouting of Water Mains. Abandoning and grouting of water lines must not occur until all existing water mains and services have been transferred to a relocated water line or another line as designated in the Contract Documents. The Contractor will be responsible for the satisfactory coordination of the pipe abandonments with other construction and activities in the area. Delays in work resulting from lack of coordination will not be cause for additional compensation. Any work involving or impacting asbestos concrete pipe must be in accordance with the specifications.

Remove all water line appurtenances, such as hydrants, valves and valve casing and castings. Return these appurtenances to the designated utility representative or dispose of properly. Make cuts, install bulkheads, vents to allow for air release. Remove any free standing water before starting grout placement.

Place grout/flowable fill using concrete or grout pumps capable of continuous delivery at planned placement rate to fill volume between placement points not to exceed 500 ft. at a time. Pump grout/flowable fill through bulkheads constructed for placement of PVC pipes or other methods to contain grout in line to be abandoned. These pipes will be used for injection points or vents during placement. Place grout/flowable fill under pressure into properly vented open system until grout emerges from vent pipes indicating pipe is completely filled. Pumping must be completed under enough pressure to overcome friction and to fill water main from downstream to upstream end. Remediate areas where grout/flowable fill did not fill voids in water main by pressure grouting from inside water main or from surface if necessary. Plug each end of the water main being abandoned. Ensure that concrete is placed around plug/bulkhead and around pipe including bedding area, such that it is not penetrable by groundwater and that bedding at this location is not a conduit for groundwater. The method of installation must be able to meet the requirement of completely filling the existing water main and any voids adjacent to it.

Backfill to grade above pipe left in place. Place and compact backfill in compliance with Section 3.3 “Backfill.”

Remove, transport, and, dispose of spoils. Spoils including pipe, unused grout/flowable fill and other unsuitable materials must be hauled to a facility permitted to accept the material. The abandonment method should provide for the release of air. When intermediate points are required to be constructed for the abandonment of the system, they will be a part of the abandonment project process. The method should

provide for the isolation of water mains to be grouted from water mains that are abandoned in place without grouting as shown on the plans.

Water mains that are not under proposed pavement are generally not required to be grouted unless it is specified in the contract documents. Mains to be abandoned should be grouted only if required by the contract documents and payment as per these specifications is provided.

3.11. Cutting and Replacing Concrete Sidewalk, Driveway, etc. The Contractor will cut and replace concrete sidewalks, driveways, etc. per the plans.

3.12. Cutting and Replacing Concrete Sidewalk (Asphalt). The Contractor will cut and replace concrete asphalt sidewalks per the plans.

3.13. Cutting and Replacing Asphalt Pavement. The Contractor will cut and replace asphalt pavement per the plans.

3.14. Cutting and Replacing Concrete Curb. The Contractor will cut and replace concrete curb per the plans.

3.15. Cutting and Replacing Asphalt Pavement with 6 in. Asphalt Treated Base. The Contractor will cut and replace Asphalt Pavement with 6 in. Asphalt Treated Base, per the plans.

4. MEASUREMENT

4.1. Water main installed as "Pipe Water Main (DI)," "Pipe Water Main (PVC)," "Pipe Water Main (CSC)," "Pipe Water Main (PVC Casing) (Open Cut)," or "Pipe Water Main (Steel Casing) (Open Cut)" for water pipe of the various sizes shown on the plans, will be measured by the foot as follows:

- From the centerline intersection of runs and branches of tees to the end of the valve of a dead-end run,
- between the centerline intersections of runs and branches of tees, and where the branch is plugged for future connection,
- the measurement will include the entire laying length of the branch or branches of the fitting,
- the measurement of each line of pipe of each size will be continuous and is to include the full laying lengths of all fittings and valves installed between the ends of such line except that the laying lengths of reducers will be divided equally between the connected pipe sizes,
- lines leading to a tapping connection with an existing main will be measured to the center of the main tapped, and
- excavation and installation of the nonmetallic pipe detection system will not be measured for payment.

4.2. Fire Lines. "Fire Lines" will be measured by the foot for each size and type from the centerline intersection of the fire line with the main distribution line to the property line. The measurement will include the entire laying length of the branch or branches of the fitting and valves. Line leading to a tapping connection with an existing main will be measured to the center of the main tapped.

4.3. Water (Jacking, Boring or Tunneling). "Water (Jacking, Boring or Tunneling)" will be measured by the foot of bore or tunnel as measured from face to face of jacking pits.

4.4. Carrier Pipe used in Bores and Tunnels or Jacked into Place. Carrier pipe used in bores and tunnels or jacked into place will be measured by the foot of pipe installed from end to end of pipe to the limits shown on the plans.

4.5. Carrier Pipe Installed in Open Trenches. Carrier pipe installed in open trenches, where required by the plans, will be measured by the foot of pipe installed from end to end of pipe to the limits shown on the plans.

4.6. Casing or Liners Used in Bores and Tunnels. Casing or liners used in bores and tunnels, where required by the plans, of the size and material required will be measured by the foot actually installed in accordance with plans.

4.7. Casing Installed in Open Trenches. Casing installed in open trenches, where required by the plans, of the size and material required will be measured by the foot actually installed in accordance with plans.

4.8. Butterfly Valve and Box (Complete). "Butterfly Valve and Box (Complete)" will be measured as each assembly of the various sizes installed to finished grade.

4.9. Gate Valve and Box (Complete). "Gate Valve and Box (Complete)" will be measured as each assembly of the various sizes installed to finished grade.

4.10. Tapping Sleeve, Valve and Box (Complete). "Tapping Sleeve, Valve and Box (Complete)" will be measured as each assembly of the various sizes installed.

4.11. Cut in Tee (Complete). "Cut in Tee (Complete)" will be measured by the unit of each such assembly of the various sizes of tee installed.

4.12. Adjust Valve Box. "Adjust Valve Box" will be measured as each assembly adjusted to correspond to finish grade.

4.13. Removal Transport and Disposal of AC. "Removal Transport and Disposal of AC" will be measured by the unit linear foot of AC water main removed regardless of size, to the limits shown on the plans. The measurement shown on the plans is for contractor's information only and the work will be performed by a third party contractor as per Item 6 of the Department Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges.

4.14. Concrete Encasement, Concrete Cradles, Concrete Saddles and Concrete Collars. "Concrete Encasement, Concrete Cradles, Concrete Saddles and Concrete Collars" for pipe will be measured by the cubic yard of accepted work, complete in place. Reinforcing, if required, will not be measured for payment.

4.15. Fire Hydrant Assembly. "Fire Hydrant Assembly" will be measured as each fire hydrant assembly installed. Also included will be enough pipe, valve, box and fittings.

4.16. Tapped Fire Hydrant. "Tapped Fire Hydrant" will be measured as each fire hydrant including the various sizes of tapping sleeves, valves, and boxes installed.

4.17. Relocate Fire Hydrant. "Relocate Fire Hydrant" will be measured as each fire hydrant relocated.

4.18. Permanent Blow-off (Complete). "Permanent Blow-off (Complete)" will be measured as each assembly of the various sizes installed.

4.19. Temporary Blow-off (Complete). "Temporary Blow-off (Complete)" will be measured as each assembly of the various sizes installed.

4.20. Air Release Valve (Complete). "Air Release Valve (Complete)" will be measured as each assembly of the size installed.

4.21. Trench Excavation Protection. "Trench Excavation Protection" will be measured by the foot along the centerline of trench where the depth of trench exceeds 5 ft.

4.22. Tie in (Complete). "Tie in (Complete)" will be measured as each of the various sizes and types completed.

4.23. New Short Service. “New Short Service” will be measured as each of the various sizes and types of new service lines installed.

4.24. New Long Service. “New Long Service” will be measured as each of the various sizes and types of new service lines installed.

4.25. New Unmetered Short Service. “New Unmetered Short Service” will be measured as each of the various sizes and types of new unmetered service lines installed.

4.26. New Unmetered Long Service. “New Unmetered Long Service” will be measured as each of the various sizes and types of new unmetered service lines installed.

4.27. Reconnect Short Service. “Reconnect Short Service” will be measured as each of the various sizes of service lines reconnected.

4.28. Reconnect Long Service. “Reconnect Long Service” will be measured as each of the various sizes of service lines reconnected.

4.29. Relay Short Service. “Relay Short Service” will be measured as each of the various sizes of service lines re-laid.

4.30. Relay Long Service. “Relay Long Service” will be measured as each of the various sizes of service lines re-laid.

4.31. Relocate Short Service. “Relocate Short Service” will be measured as each of the various sizes of service lines relocated.

4.32. Relocate Long Service. “Relocate Long Service” will be measured as each of the various sizes of service lines relocated.

4.33. Relocate Existing Meter and Existing Meter Box. “Relocate Existing Meter and Existing Meter Box” will be measured as each assembly relocated and customer's service reconnected.

4.34. Relocate Existing Meter and New Meter Box. “Relocate Existing Meter and New Meter Box” will be measured as each assembly relocated and customer's service reconnected.

4.35. Cut and Replace Concrete Sidewalk, Driveway, Etc. ”Cut and Replace Concrete Sidewalk, Driveway, Etc.” will be measured by the square yard of surface area of the concrete sidewalk and driveway cut and replaced, but not to exceed the maximum trench width specified in Section 3.1.2, “Width of Trench” or as shown on plans.

4.36. Cut and Replace Concrete Sidewalk (Asphalt). “Cut and Replace Concrete Sidewalk (Asphalt)” will be measured by the square yard of surface area of concrete sidewalk to be cut and replaced with temporary asphalt (4 in. depth, Type C) pavement, but not to exceed the maximum trench width specified in Section 3.1.2, “Width of Trench” or as shown on the plans.

4.37. Cut and Replace Asphalt Pavement. “Cut and Replace Asphalt Pavement” will be measured by the square yard of surface area of the asphalt pavement cut and replaced, but not to exceed the maximum trench width specified in Section 3.1.2, “Width of Trench” or as shown on plans.

4.38. Cutting and Replacing Concrete Curb. “Concrete Curb” will be measured by the foot of the concrete curb cut and replaced, but not to exceed the maximum trench width specified in Section 3.1.2, “Width of Trench” or as shown on plans.

4.39. Cut and Replace Asphalt Pavement with 6 in. Asphalt Treated Base. “Cut and Replace Asphalt Pavement with 6 in. Asphalt Treated Base” will be measured by the square yard of surface area of the

asphalt pavement cut and replaced with 6 in. of asphalt treated base, but not to exceed the maximum trench width specified in Section 3.1.2, "Width of Trench" or as shown on plans.

4.40. Hydrostatic Pressure Test. "Hydrostatic Pressure Test" will be measured as each successful test conducted.

4.41. Flowable Fill Backfill. "Flowable Fill Backfill" will be measured by the cubic yard in accordance with Item 401, "Flowable Backfill," but not to exceed the maximum trench width specified in Section 3.1.2, "Width of Trench" or as shown on the plans.

4.42. Water Service Line Breaks Leak Repair. "Water Service Line Breaks Leak Repair" will be measured by the unit of each such assembly of all types and sizes of service lines, repair and tap clamps required to repair the service line break and or leak.

4.43. Water Main Breaks Leak Repair. "Water Main Breaks Leak Repair" will be measured by the unit of each such assembly of the various types and sizes of water mains, services, repair and tap clamps required to repair the water main break or leak.

4.44. Ductile Iron and Gray Iron Fittings. "Ductile Iron and Gray Iron Fittings" will be measured by the weight to the nearest 1/100 of a ton of the various sizes of fittings installed.

4.45. Reinforced Concrete Vault. "Reinforced Concrete Vault" will be measured by the each of the various sizes.

4.46. Grout Abandonment Water Main. "Grout Abandonment Water Main" will be measured by the unit foot of main grout abandoned of the various sizes to the limits shown on the plans.

4.47. Removal Transport and Disposal of AC. "Removal Transport and Disposal of AC" will be measured by the unit foot of AC water main removed regardless of size, to the limits shown on the plans. The measurement shown on the plans is for Contractor's information only and the work will be performed by a third party contractor as per Item 6 of the Department Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges.

4.48. New Meter Box. "New Meter Box" will be measured for payment as each new meter box is placed.

5. PAYMENT

The work performed and materials furnished in accordance with each item and measured as provided under "Measurement" will be paid for at the unit prices bid for the items of work hereinafter described. These prices are to be full compensation for furnishing and hauling all materials; for placing or installing the materials; for inspection and testing; and for all other items of material, labor, equipment, tools and incidentals necessary to complete the work in accordance with the plans and specifications.

5.1. Pipe Water Main (DI), Pipe Water Main (PVC), Pipe Water Main (CSC), Pipe Water Main (PVC Casing) (Open Cut), and Pipe Water Main (Steel Casing) (Open Cut). Payment for "Pipe Water Main (DI)," "Pipe Water Main (PVC)," "Pipe Water Main (CSC)," "Pipe Water Main (PVC Casing) (Open Cut)," and "Pipe Water Main (Steel Casing) (Open Cut)" will be made at the unit price bid per foot of pipe of the various sizes installed by the open cut method. This price will be full compensation for all labor, equipment, materials, tools, selected bedding, excavation, backfill materials, polyethylene sleeve, and hauling and disposition of surplus excavated materials.

5.2. Fire Lines. Payment for "Fire Lines" installed will be made at the unit price bid per linear foot of pipe of various sizes installed by the open cut method. This price will be full compensation for all labor, equipment, materials, tools, excavating selected embedment material, backfill, compaction of trench backfill, testing of compaction, tie in, polyethylene sleeve where required, hauling, disposing of surplus excavated material, and restoration of the surface, including asphalt, concrete, curbing, sidewalks, sod grass, landscaping, and any other surface type encountered. All replacement mains will include tie in costs for existing fire lines.

5.3. Water (Jacking, Boring or Tunneling). Payment for “Water (Jacking, Boring or Tunneling),” will be paid for at the contract unit price bid per foot of jacking, boring or tunneling, which price will be full compensation for furnishing all materials (except carrier pipe, casings or liners), casing spacers, grout, labor, tools, equipment and incidentals necessary to complete the work, including excavation, grouting, backfilling, restoration to original ground conditions, end caps, and disposal of surplus materials.

5.4. Carrier Pipe Used in Bores or Tunnels. Carrier pipe used in bores or tunnels will be paid for at the contract unit price bid for "Carrier Pipe (in Casing)" per foot which will be full compensation of pipe installed and measured as prescribed above.

5.5. Carrier Pipe Installed in Open Cut Trenches. Carrier pipe installed in open cut trenches will be paid for at the contract unit price bid for "Carrier Pipe for Open Cut Trench" per foot which will be full compensation of pipe installed and measured as prescribed above.

5.6. Casings or Liners Used in Bores or Tunnels. Casings or liners used in bores or tunnels will be paid for at the contract unit price bid for "Casing (Bore)" per foot which will be full compensation of casing or liner installed and measured as prescribed above.

5.7. Casings Installed in Open Cut Trenches. Casings installed in open cut trenches will be paid for at the contract unit price bid for "Casing (Open Cut)" per foot which will be full compensation of casing installed and measured as prescribed above.

5.8. Butterfly Valve and Box (Complete). Payment for “Butterfly Valve and Box (Complete),” will be made at the unit price bid for each such assembly of the various sizes installed. This price will be full compensation for all labor, equipment, materials, tools, selected embedment material, anti-corrosion embedment, concrete collar at the valve box where subjected to vehicular traffic, ductile iron riser pipe, cast-iron boot, packing, tarpaper, concrete grout, concrete reaction blocking, asphaltic material for bolts, nuts and ferrous surfaces, polyethylene sleeve, hauling and disposition of excavated surplus material and backfill where required. Such payment is also to include mechanical or transition couplings, and coated and wrapped steel pipe nipples required to complete the connection.

5.9. Gate Valve and Box (Complete). Payment for “Gate Valve and Box (Complete)” will be made at the unit price bid for each such assembly of the various sizes installed. This price will be full compensation for all labor, equipment, materials, tools, selected embedment material, anti-corrosion embedment, concrete collar at the valve box where subjected to vehicular traffic, ductile iron riser pipe, cast-iron boot, packing, tarpaper, concrete grout, concrete reaction blocking, asphaltic material for bolts, nuts and ferrous surfaces, polyethylene sleeve, hauling and disposition of excavated surplus material and backfill where required.

5.10. Tapping Sleeve and Valve. Payment for “Tapping Sleeve and Valve” will be made at the unit price bid for each such assembly of the various sizes installed. This price will be full compensation for all labor, equipment, materials, tools, selected embedment material, anti-corrosion embedment when specified, concrete collar at the valve box where subjected to vehicular traffic, ductile iron riser pipe, cast-iron boot, packing, tarpaper, concrete grout, concrete reaction blocking, asphaltic material for bolts, nuts and ferrous surfaces, polyethylene sleeve, hauling and disposition of excavated surplus material and backfill where required.

5.11. Cut in Tee (Complete). Payment for “Cut in Tee (Complete)” will be made at the unit price bid for each assembly of the various types and sizes of tees to be installed. This price will be full compensation for all labor, equipment, materials, tools, necessary tie ins, protective coating for bolts, nuts, ferrous surfaces, selected embedment material, anti-corrosion embedment when specified, backfill, fittings, polyethylene sleeve when required, site restoration, and any necessary hauling and disposition of surplus excavated materials.

5.12. Adjust Valve Box. Payment for “Adjust Valve Box” will be made at the unit price bid which will be full compensation for each valve box adjusted to finish grade including all labor, materials, and incidentals to complete the work.

5.13. Removal Transport and Disposal of AC. Payment for "Removal Transport and Disposal of AC" will be made to a third party contractor through force account for safely removing, transporting, and disposing of AC pipe.

5.14. Concrete Encasement, Concrete Cradles, Concrete Saddles and Concrete Collars. Payment will be made at the unit price bid for "Concrete Encasement, Concrete Cradles, Concrete Saddles and Concrete Collars" by the cubic yard of concrete placed, which price will be full compensation for furnishing and placing all materials, manipulation, labor, tools, equipment and incidentals necessary to complete the work. Reinforcing, if required, will not be measured separately for payment.

5.15. Fire Hydrant Assembly. Payment for "Fire Hydrant Assembly" will be made at the unit prices bid which will be full compensation for each such assemblies, including excavation, backfill, selected material, anti-corrosion embedment when specified, branch line pipe, fittings exclusive of the tee from the main line pipe, polyethylene sleeve, hauling and disposition of excavated surplus material where required, asphalted material for ferrous surfaces, joint restraints, concrete pad, restoration of existing fire hydrant sites, and removal of existing fire hydrant as specified.

5.16. Tapped Fire Hydrant. Payment for "Tapped Fire Hydrant" will be made at the unit prices bid which will be full compensation for each such assemblies installed, including excavation, backfill, selected material, anti-corrosion embedment when specified, branch line pipe, fittings exclusive of the tee from the main line pipe, polyethylene sleeve, hauling and disposition of excavated surplus material where required, asphalted material for ferrous surfaces, joint restraints, concrete pad, restoration of existing fire hydrant sites, and removal of existing fire hydrant as specified. Payment for "Fire Hydrant with Tapping Sleeve, 6 in. Valve and Box" will include tapping sleeve specified on plans and 6 in. valve and box.

5.17. Relocate Fire Hydrant. Payment for "Relocate Fire Hydrant" will be made at the unit prices bid which will be full compensation for each such assemblies installed, including excavation, backfill, selected material, anti-corrosion embedment when specified, branch line pipe, fittings exclusive of the tee from the main line pipe, polyethylene sleeve, hauling and disposition of excavated surplus material where required, asphalted material for ferrous surfaces, joint restraints, concrete pad, restoration of existing fire hydrant sites, and removal and relocation of existing fire hydrant as specified.

5.18. Permanent Blow-off (Complete). Payment for "Permanent Blow-off (Complete)" will be made at the unit price bid which will be full compensation for each such assembly installed in accordance with the details shown on the plans. Payment for the eccentric reducer will be made at the unit price bid for each ton of fittings of all types and sizes installed. Payment for the pipe nipple with reaction stop ring will be made at the unit price bid for each foot of pipe of the various sizes installed by the open cut method. These payments are also to include excavation, anti-corrosion when specified, the housing and disposition surplus excavated materials and approved selected backfill.

5.19. Temporary Blow-off (Complete). Payment for "Temporary Blow-off (Complete)" will be made at the unit price bid which will be full compensation for each such assembly installed in accordance with the details shown on the plans. Payment for the eccentric reducer will be made at the unit price bid for each ton of fittings of all types and sizes installed. Payment for the pipe nipple with reaction stop ring will be made at the unit price bid for each foot of pipe of the various sizes installed by the open cut method. These payments are also to include excavation, anti-corrosion when specified, the housing and disposition surplus excavated materials and approved selected backfill.

5.20. Air Release Valve (Complete). Payment for "Air Release Valve (Complete)" will be made at the unit price bid for each assembly of the various sizes installed in accordance with the details shown on the plans. This price will be full compensation for all labor, equipment, materials, tools, selected embedment material, anti-corrosion embedment when specified, excavation and hauling and disposition of surplus excavated materials, blocking, and various sizes and types of meter boxes.

5.21. Trench Excavation Protection. Payment for "Trench Excavation Protection" is to be made on the basis of the unit price bid which will be full compensation for each foot of "Trench Excavation Protection" in place. Payment is to include all components of the trench excavation safety protection system which can include,

but not limited to sloping, sheeting, trench boxes or trench shields, sheet piling, cribbing, bracing, shoring, dewatering or diversion of water to provide adequate drainage. Payment is also to include the additional excavation and backfill required, any jacking, jack removal, and removal of the trench support after completion and be full compensation for all other labor, materials, tools, equipment, and incidentals necessary to complete the work.

5.22. Tie in (Complete). Payment for "Tie in (Complete)" will be made at the unit price bid for each tie in of the various sizes and types completed. This price will be full compensation for all labor, equipment, materials, tools, shutdown, and isolation of the existing main to which the tie is to be made, cutting pipe for connection, de-watering the excavation, and customer notification of service interruption where required. Connections between new and existing mains which are made with tapping sleeves and valves by cutting in tees will be as a no separate pay item.

5.23. New Short Service. Payment for "New Short Service" will be made at the unit price bid for each new service line of the various sizes and types installed. This payment is to include reconnection of new service to the existing meter and the adjustment of the meter, meter box, and Customer valve. This price will be full compensation for all labor, equipment, materials, tools, excavation, trench excavation protection, hauling and disposition of surplus excavated materials, sand backfill, cutting pavement and surface structures of whatever type fittings of the various sizes used in the service line relay and copper tubing or ductile iron pipe (4 in. and larger).

5.24. New Long Service. Payment for "New Long Service" will be made at the unit price bid for each new service line of the various sizes and types installed. This payment is to include reconnection of new service to the existing meter and the adjustment of the meter, meter box, and Customer valve. This price will be full compensation for all labor, equipment, materials, tools, excavation, trench excavation protection, hauling and disposition of surplus excavated materials, sand backfill, cutting pavement and surface structures of whatever type fittings of the various sizes used in the service line relay and copper tubing or ductile iron pipe (4 in. and larger).

5.25. New Unmetered Short Service. Payment for "New Unmetered Short Service" will be made at the unit price bid for each new un-metered service line of the various sizes and types installed. This price will be full compensation for all labor, equipment, materials, tools, excavated materials, trench excavation protection, sand backfill, cutting in pavement and surface structures of whatever type encountered and replacement with whatever type specified, a new meter box where required, copper tubing or ductile iron pipe (4 in. and larger), valve and valve box assembly, and fittings of the various sizes used in the installation of new service lines.

5.26. New Unmetered Long Service. Payment for "New Unmetered Long Service" will be made at the unit price bid for each new un-metered service line of the various sizes and types installed. This price will be full compensation for all labor, equipment, materials, tools, excavated materials, trench excavation protection, sand backfill, cutting in pavement and surface structures of whatever type encountered and replacement with whatever type specified, a new meter box where required, copper tubing or ductile iron pipe (4 in. and larger), valve and valve box assembly, and fittings of the various sizes used in the installation of new service lines.

5.27. Reconnect Short Service. Payment for "Reconnect Short Service" will be made at the unit price bid for each service line of the various sizes and types reconnected. This price will be full compensation for all labor, equipment, materials, tools, excavation, trench excavation protection, hauling and disposition of surplus excavated materials, sand backfill, meter box relocation where required, cutting pavement and surface structures of whatever type encountered and replacement with whatever type specified, copper tubing or ductile iron pipe (4 in. and larger), valve and valve box assembly, and fittings of the various sizes used in the service line reconnection.

5.28. Reconnect Long Service. Payment for "Reconnect Long Service" will be made at the unit price bid for each service line of the various sizes and types reconnected. This price will be full compensation for all labor, equipment, materials, tools, excavation, trench excavation protection, hauling and disposition of surplus excavated materials, sand backfill, meter box relocation where required, cutting pavement, and surface

structures of whatever type encountered and replacement with whatever type specified, copper tubing or ductile iron pipe (4 in. and larger), valve and valve box assembly, and fittings of the various sizes used in the service line reconnection.

5.29. Relay Short Service. Payment for "Relay Short Service" will be made at the unit price bid for each service line of the various sizes and types re-laid. This price will be full compensation for all labor, equipment, materials, tools, reconnection of new service to existing meter, sand backfill, meter box relocation where required, copper tubing or ductile iron pipe (4 in. and larger), valve and valve box assembly, and fittings of the various sizes used in the service line relay.

5.30. Relay Long Service. Payment for "Relay Long Service" will be made at the unit price bid for each service line of the various sizes and types re-laid. This price will be full compensation for all labor, equipment, materials, tools, reconnection of new service to existing meter, sand backfill, meter box relocation where required, copper tubing or ductile iron pipe (4 in. and larger), valve and valve box assembly, and fittings of the various sizes used in the service line relay.

5.31. Relocate Short Service. Payment for "Relocate Short Service" will be made at the unit price bid for each service line of the various sizes relocated. This price will be full compensation for all labor, equipment, materials, tools, sand backfill, meter box relocation where required, copper tubing or ductile iron pipe (4 in. and larger) when required, valve and valve box assembly when required, and fittings of the various sizes used in the service line relocation.

5.32. Relocate Long Service. Payment for "Relocate Long Service" will be made at the unit price bid for each service line of the various sizes relocated. This price will be full compensation for all labor, equipment, materials, tools, sand backfill, meter box relocation where required, copper tubing or ductile iron pipe (4 in. and larger) when required, valve and valve box assembly when required, and fittings of the various sizes used in the service line relocation.

5.33. Relocate Existing Meter and Existing Meter Box. Payment for "Relocate Existing Meter and Existing Meter Box" will be made at the unit price bid for each assembly relocated. This price will be full compensation for all labor, equipment, materials, tools, sand backfill, removal and replacement of yard piping with piping of the various sizes, and types and in the quantities necessary to complete the connection between the relocated existing meter and the existing yard piping.

5.33.1. Payment for the number one meter box installation in sidewalks and driveways will be paid in the amount difference between the standard meter box and the number one meter box.

5.34. Relocate Existing Meter and New Meter Box. Payment for "Relocate Existing Meter and New Meter Box" will be made at the unit price bid for each assembly relocated. This price will be full compensation for all labor, equipment, materials, tools, sand backfill, removal and replacement of yard piping with piping of the various sizes and types and in the quantities necessary to complete the connection between the new meter box and the existing yard piping.

5.34.1. Payment for the number one meter box installation in sidewalks and driveways will be paid in the amount difference between the standard meter box and the number one meter box.

5.35. Cut and Replace Concrete Sidewalk, Driveway, Etc. Payment for "Cut and Replace Concrete Sidewalk, Driveway, Etc." will be made at the unit price bid which will be full compensation of concrete sidewalk, driveways, etc. to be removed and replaced.

5.36. Cut and Replace Concrete Sidewalk (Asphalt). Payment for "Cut and Replace Concrete Sidewalk (Asphalt)" will be made at the unit price bid which will be full compensation of concrete sidewalk removed and replaced with asphalt.

5.37. Cut and Replace Asphalt Pavement. Payment for "Cut and Replace Asphalt Pavement" will be made at the unit price bid which will be full compensation of asphalt pavement removed and placed.

5.38. Cutting and Replacing Concrete Curb. Payment for "Concrete Curb" will be made at the unit price bid which will be full compensation for concrete curb placed.

5.39. Cut and Replace Asphalt Pavement with 6 in. Asphalt Treated Base. Payment for "Cut and Replace Asphalt Pavement with 6 in. Asphalt Treated Base" will be made at the unit price bid which will be full compensation of asphalt and asphalt treated base removed and placed.

5.40. Hydrostatic Pressure Test. Payment for "Hydrostatic Pressure Test" will be made at the unit price bid which will be full compensation for each successful test. Such payment includes all materials and equipment required to conduct test.

5.41. Flowable Fill Backfill. Payment for "Flowable Fill Backfill" will be made at the unit price bid, which will be full compensation for each cubic yard of flowable fill placed, but not to exceed the maximum trench width specified in Section 3.1.2, "Width of Trench."

5.42. Water Service Line Breaks Leak Repair. Payment for "Water Service Line Breaks Leak Repair" will be made for if during construction, certain water service lines break or if leaks occur within or immediately adjacent to the Contractor's specified area of construction operations, the Inspector may authorize the replacement or repair to be performed. However, the Contractor is cautioned that no payment will be made by SAWS when particular breaks or leaks are direct results of the Contractor's construction operations. Where encountered, payment to the Contractor for cutting and replacing pavements (any type), curbs, trench protection, sidewalks, and sodding must be considered subsidiary to this item and no direct payment will be made. Such payment must include any necessary hauling and disposition of surplus excavated material, and pumping of water.

5.43. Water Main Breaks Leak Repair. Payment for "Water Main Breaks Leak Repair" will be made if during construction, certain water main breaks or if leaks occur within, or immediately adjacent to, the Contractor's specified area of construction operations, the Inspector may authorize the replacement or repair to be performed by the Contractor. The work involved must consist of excavation, hauling of disposition material, dewatering, shut-down and isolation of the existing main if required, installation of the necessary repair clamps and or new water main (length to be determined by the Inspector) to include all necessary tie ins, fittings, approved reaction blocking required, backfilling the excavation with approved materials; customer notification or service interruption where required. Cutting and replacing pavements (any type), curbs, sidewalks, trench protection, and sodding will be considered subsidiary to the work. However, the Contractor is cautioned that no payment will be made by SAWS when particular breaks or leaks are direct results of the Contractor's construction operations. Where encountered, payment to the Contractor for cutting and replacing pavements (any type), curbs, trench protection, sidewalks, and sodding must be considered subsidiary to this item and no direct payment will be made. Such payment must include any necessary hauling and disposition of surplus excavated material, and pumping of water.

5.44. Gray Iron Fittings and Ductile Iron Fittings. Payment for "Gray Iron Fittings" and "Ductile Iron Fittings" will be made at the unit price bid for each ton of fittings of all sizes and types installed and will be based upon the weights of fittings shown in Table 20, "Weights of Ductile-Iron and Gray Cast-Iron Fittings." This price will be full compensation for all labor, equipment, materials, tools, excavation, selected embedment material, anti-corrosion embedment when specified, hauling and disposition of surplus excavated materials, polyethylene sleeve, asphaltic material for ferrous surfaces, all glands, nuts, bolts, gaskets and concrete reaction and thrust blocking. If compact fittings are not manufactured and other fittings are installed, Contractor will provide quantities and unit weights with pay request.

Weigh tables are estimated quantities and can be verified by vender information. Payments will be made by the lesser of the two (weights versus supplier) at the inspector's discretion.

5.45. Reinforced Concrete Vault. Payment for "Reinforced Concrete Vault" will be made at the unit price for each size vault installed.

5.46. Grout Abandonment Water Main. Payment for "Grout Abandonment Water Main" will be made for all types of pipe abandonment with grout, including asbestos-concrete pipe, and will be paid for at the contract bid

price per foot for each size diameter of pipe, irrespective of the depth of the main, which will include the cost of removing content within the pipe, cleaning, grouting, plugging, capping and abandoning all pipe, pipe bend section and all other appurtenances, and for dewatering, trenching, excavation and backfill, removal, transportation and disposal and all material or work necessary to properly abandon the pipe. Payment for abandoning water lines will be made on the contract unit price per foot per each size diameter of pipe complete in place at locations shown on the plans. Said price will be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

5.47. Removal Transport and Disposal of AC. Payment for "Removal Transport and Disposal of AC" will be paid to a third party Contractor through force account for safely removing, transporting, and disposing of AC pipe.

5.48. New Meter Box. Payment for "New Meter Box" will be made at unit price bid which will be full compensation for all labor, equipment, materials, and tools required to set the new meter box.

No direct payment will be made for concrete blocking of water mains; coating and wrapping pipe joints; trench excavation below specified limits; excavation and removal of unsuitable material at bottom of trench grade and restoration with approved material; supporting pipe or conduits of public utilities; abandonment of water mains and valves; resetting existing meters and meter boxes in proper configuration; salvaging fire hydrants, valve boxes and meter boxes; flushing water mains; and disinfection of water mains. This work is to be considered subsidiary to the various bid items.

No direct payment will be made for furnishing and installing the nonmetallic pipe detection system. This work and materials are to be considered subsidiary to the various pay items. In addition, the Contractor is to ensure that the detection system is complete and operational to the satisfaction of the Engineer.

No direct payment will be made for furnishing and installing the pipe joint restraint system. This work and materials will be considered subsidiary to the various bid items.

No direct payment will be made for furnishing and installing the Joint Restraint System for PVC C-905. This work and materials will be considered subsidiary to the various pay items.

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the various unit prices. These prices are full compensation for furnishing materials and for equipment, labor, tools, and incidentals.

Table 20
Weights Of Gray Iron And Ductile Iron Fittings (Lbs.)

Bends							
Size (in.)	MJ Compact (C153)	MJ (C110)	FLG SB	Size (in.)	MJ Compact (C153)	MJ (C110)	FLG SB
1/4 Bend (90°)				1/8 Bend (45°)			
4	25	55	44	4	21	51	36
6	43	86	67	6	35	75	57
8	61	125	115	8	50	110	105
12	119	258	236	12	96	216	196
16	264	454	478	16	200	345	315
20	447	716	878	20	337	555	485
24	602	1,105	1,085	24	441	777	730
30	979	1,740	1,755	30	775	1,393	1,355
36	1,501	2,507	2,135	36	1,140	2,163	1,755
42	2,277	3,410	3,055	42	1,652	2,955	2,600
48	3,016	4,595	4,095	48	2,157	4,080	3,580
Bends							
Size (in.)	MJ Compact (C153)	MJ (C110)	FLG SB	Size (in.)	MJ Compact (C153)	MJ (C110)	FLG SB
1/16 Bend (22-1/2°)				1/32 Bend (11-1/4°)			
4	18	50	35	4	17	50	40
6	32	75	64	6	30	73	56
8	46	110	90	8	42	109	90
12	85	220	194	12	74	220	193
16	175	354	315	16	153	354	315
20	314	550	505	20	265	553	505
24	414	809	528	24	339	815	760
30	668	1,500	1,385	30	603	1,410	1,395
36	963	2,182	1,790	36	830	2,195	1,805
42	1,354	3,020	2,665	42	1,210	3,035	2,680
48	1,790	4,170	3,665	48	1,523	4,190	3,695

Table 20 Continuation

Weights Of Gray Iron And Ductile Iron Fittings (Lbs.)

Tees				
Size (in.)		Weight		
Run	Branch	MJ Compact (C153)	MJ (C110)	FLG Short Body
3	3	26	56	53
4	3	31	76	54
	4	33	80	60
6	4	49	114	90
	6	60	124	98
8	4	65	163	155
	6	76	175	148
	8	89	188	179
12	4	99	316	322
	6	115	325	297
	8	127	339	346
	12	162	407	369
16	6	226	563	573
	8	240	565	555
	12	283	615	590
	16	326	676	635
20	6	344	750	773
	8	371	766	720
	12	427	799	816
	16	503	975	950
	20	566	1,068	1,005

Table 20 Continuation

Weights Of Gray Iron And Ductile Iron Fittings (Lbs.)

Tees				
Size (In.)		Weight		
Run	Branch	MJ Compact (C153)	MJ (C110)	FLG Short Body
24	6	466	1,035	1,089
	8	487	1,047	1,060
	12	539	1,075	1,125
	16	625	1,109	1,070
	20	729	1,504	1,510
	24	785	1,617	1,685
30	8	739	1,808	-
	12	800	1,842	1,801
	16	959	1,885	-
	20	1,026	1,941	-
	24	1,228	2,496	2,475
	30	1,373	2,531	2,615
36	24	1,548	2,710	2,255
	30	1,901	3,545	3,000
	36	2,012	3,686	3,160
42	24	2,272	3,690	3,245
	30	2,512	4,650	4,125
	36	3,048	5,119	5,360
	42	3,225	6,320	5,580
48	24	2,934	4,995	4,385
	30	3,147	5,140	4,455
	36	4,046	6,280	5,555
	42	4,249	8,130	7,195
	48	4,469	8,420	7,385

Table 20 Continuation

Weights Of Gray Iron And Ductile Iron Fittings (Lbs.)

Crosses				
Size (In.)		Weight		
Run	Branch	MJ Compact (C153)	MJ (C110)	FLG Short Body
3	3	34	70	-
4	3	42	90	-
	4	46	105	-
6	4	63	140	-
	6	74	160	160
8	4	88	185	185
	6	97	205	205
	8	105	239	234
12	4	114	340	-
	6	135	360	360
	8	151	382	385
	12	199	493	495
16	6	250	590	575
	8	270	619	605
	12	332	685	-
	16	409	811	790
20	6	358	760	-
	8	379	822	790
	12	413	883	860
	16	550	1,117	1,085
	20	598	1,274	1,230

Table 20 Continuation

Weights Of Gray Iron And Ductile Iron Fittings (Lbs.)

Crosses				
Size (In.)		Weight		
Run	Branch	MJ Compact (C153)	MJ (C110)	FLG Short Body
24	6	566	1,025	-
	8	578	1,085	1,045
	12	610	1,153	1,110
	16	663	1,256	1,200
	20	975	1,733	1,675
	24	907	1,906	1,835
30	8	650	1,795	-
	12	870	1,925	1,865
	16	900	1,950	-
	20	1,220	2,060	-
	24	1,497	2,776	2,675
	30	1,808	3,188	3,075
36	24	1,853	2,928	2,980
	30	2,580	3,965	-
	36	2,698	4,370	4,370
42	24	2,415	3,910	-
	30	2,920	5,040	-
	36	3,788	5,835	-
	42	3,908	6,493	7,145
48	24	3,435	5,210	-
	30	4,145	5,495	-
	36	4,873	6,790	-
	42	5,465	8,815	-
	48	5,588	9,380	-

Table 20 Continuation

Weights Of Gray Iron And Ductile Iron Fittings (Lbs.)

Caps			Plugs	
Size (In.)	MJ Compact (C153)	MJ (C110)	MJ Compact (C153)	MJ (C110)
4	10	17	12	16
6	16	29	19	28
8	24	45	30	46
12	45	82	54	85
16	95	160	97	146
20	141	235	146	218
24	193	346	197	350
30	362	644	381	626
36	627	912	688	884
42	893	1,322	1,200	1,222
48	1,076	1,737	1,550	1,597

Table 20 Continuation

-Weights Of Gray Iron And Ductile Iron Fittings (Lbs.)

Solid Sleeves				
Size (In.)	Weight			
	MJ Short Compact (C153)	MJ Long Compact (C153)	MJ Short (C110)	MJ Long (C110)
4	17	21	35	46
6	28	35	45	65
8	38	48	65	86
12	57	77	113	143
16	127	172	192	257
20	201	258	258	359
24	264	337	340	474
30	500	651	690	1,005
36	725	960	947	1,374
42	877	1,209	1,187	1,628
48	1,406	1,516	1,472	2,033

Table 20 Continuation

Weights Of Gray Iron And Ductile Iron Fittings (Lbs.)

Concentric Reducers			
Size (In.)			Weight
Large End	Small End	MJ Compact (C153)	MJ (C110)
6	4	27	59
8	4	38	81
8	6	41	95
12	4	70	136
12	6	69	150
12	8	70	167
16	6	134	234
16	8	136	258
16	12	126	310
20	12	213	427
20	16	221	492
24	12	304	562
24	16	315	633
24	20	315	727
30	16	596	1,027
30	20	599	1,085
30	24	492	1,204
36	20	1042	1,459
36	24	785	1,580
36	30	655	1,868
42	24	1,356	2,060
42	30	1,112	2,370
42	36	1,116	2,695
48	30	1,722	3,005
48	36	1,650	3,370
48	42	1,429	3,750

Table 20 Continuation

Weights Of Gray Iron And Ductile Iron Fittings (Lbs.)

2" Tapped Tees and Crosses		
Size (In.)	Weight	
	MJ Compact (C153)	MJ (C110)
4	24	47
6	36	71
8	54	97
10	69	130
12	87	169
20	-	259
24	-	320

Table 20 Continuation

Weights Of Gray Iron And Ductile Iron Fittings (Lbs.)

Offsets		
Size (In.)	Weight	
	MJ Compact (C153)	MJ (C110)
4 x 6	35	75
4 x 12	55	83
6 x 6	35	110
6 x 12	67	138
6 x 24	96	189
8 x 6	82	164
8 x 12	98	209
8 x 24	141	280
12 x 6	121	320
12 x 12	178	420
12 x 24	240	645
20 x 12	-	1,025
20 x 24	-	1,245