GENERAL MEETING OF THE BOARD OF DIRECTORS
OF THE
CENTRAL TEXAS REGIONAL MOBILITY AUTHORITY

RESOLUTION NO. 25-002

APPROVING A CONTRACT WITH ELECNOR BELCO ELECTRIC, INC. FOR METAL BEAM GUARD FENCE REPLACEMENT AND INTELLIGENT TRANSPORTATION SYSTEM CABINET UPGRADES ON 290 TOLL

WHEREAS, the Central Texas Regional Mobility Authority (Mobility Authority) desires the replacement of metal beam guard fence and intelligent transportation system cabinet upgrades along the 290 Toll mainlanes and ramps from 183 Toll to East of SH 130 Toll (the "Project"); and

WHEREAS, the Mobility Authority staff advertised the Project on November 13, 2024, and received three (3) bids by the bid opening on January 15, 2025; and

WHEREAS, the bids were reviewed by engineering staff who determined the lowest responsive and responsible bidder to be Elecnor Belco Electric, Inc.; and

WHEREAS, after reviewing the engineering staff's evaluation, the Executive Director recommends that the Board approve a contract with Elecnor Belco Electric, Inc. for the Project in an amount not to exceed $2,449,888.00 and in the form published in the bid documents attached hereto as Exhibit A.

NOW, THEREFORE, BE IT RESOLVED, that the Board of Directors approves a contract with Elecnor Belco Electric, Inc. for the replacement of metal beam guard fence and intelligent transportation system cabinet upgrades along the 290 Toll from 183 Toll to East of SH 130 Toll in an amount not to exceed $ 2,449,888.00, and hereby authorizes the Executive Director to finalize and execute the contract in the form or substantially the same form published in the bid documents attached hereto as Exhibit A.

Adopted by the Board of Directors of the Central Texas Regional Mobility Authority on the 29th day of January 2025.

Submitted and reviewed by:

James M. Bass
Executive Director

Approved:

Robert W. Jenkins, Jr.
Chairman, Board of Directors

Exhibit A

CENTRAL TEXAS REGIONAL
MOBILITY AUTHORITY

290E Metal Beam Guard Fence & ITS Cabinet Upgrades Maintenance Project

CTRMA Contract No.: 25290E22701M

Bid Documents

Advertisement: November 13, 2024
Pre-Qualification Deadline: 12:00PM December 20, 2024
Bid Date: 2:00 PM January 15, 2025

Central Texas Regional Mobility Authority

290E METAL BEAM GUARD FENCE & ITS CABINET UPGRADES MAINTENANCE PROJECT

CTRMA CONTRACT NO. 25290E22701M

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BID DOCUMENTS
CONTRACT AND CONTRACT BOND
SPECIAL PROVISIONS
SPECIAL SPECIFICATIONS
PLANS

January 15, 2025

Central Texas Regional Mobility Authority

290E METAL BEAM GUARD FENCE & ITS CABINET UPGRADES MAINTENANCE PROJECT

CTRMA CONTRACT NO. 25290E22701M

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INVITATION TO BID

Electronic proposal forms for the above project shall be submitted via the project's CivCast https://www.civcastusa.com/project/66febaccb78f62c65ffa353e/summary to the Central Texas Regional Mobility Authority (Authority), by **2:00 PM local time, January 15, 2025**. The bids will be publicly posted via the project's CivCast website within 48 hours after the bids are opened.

The contractor will have one hundred twenty (120) working days after the date stated in the written Full Notice to Proceed to achieve full completion of all work. The Authority reserves the right to make changes in the work to complete the contract, as defined in the specifications.

A Full NTP will be issued no later than 180 calendar days after award for the Contractor to begin work. Time charges will begin accruing upon issuance of the Full NTP.

The complete list of quantities is located in the Bid Form. The principal items of work are as follows:

- Metal Beam Guard Fence End Treatment Install/Removal
- Metal Beam Guard Fence Install/Removal
- Mow Strip Install/Removal
- ITS Cabinets Standardization/Upgrading

The Official Bid Form for this Contract will be made available to prospective bidders who have met all prequalification requirements on or before 5:00 PM local time, on December 23, 2024 via the project's CivCastUSA website https://www.civcastusa.com/project/66febaccb78f62c65ffa353e/summary.

Prequalification requirements:

- Be registered with State of Texas,
- Be fully prequalified by Texas Department of Transportation (TxDOT),
- Have a bidding capacity per TxDOT prequalification system of $3,000,000
- Submit a valid Non-Collusion Affidavit, Debarment Affidavit, and Child Support Statement,

The deadline for meeting the prequalification requirements and still obtaining an Official Bid Form is December 20, 2024 at Noon.

The Authority cannot be held liable in the event a party is unable to submit a valid bid due to delay in the prequalification procedure. Securing prequalification through TxDOT and the timing thereof, shall at all times be the sole responsibility of the Prospective Bidder.

Complete Contract documents will be available on November 13, 2024 for potential bidders and others through the Authority's website (www.mobilityauthority.com) and CivCast's website https://www.civcastusa.com/project/66febaccb78f62c65ffa353e/summary.

Standard Specifications (Texas Department of Transportation "Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges", September 1, 2024) which form an integral part of this Contract, are available on line at the Texas Department of Transportation (TxDOT) website (https://www.txdot.gov/business/resources/txdot-specifications.html).

The contract will be awarded in accordance with the Authority's Procurement policy. A copy of the Procurement Policy is available online at the Authority website: (https://www.mobilityauthority.com/about/policy-disclaimers/code).

For more information, please submit a question to the project team through CivCast.com.

Each bid must be accompanied by a Bid Guaranty consisting of a Bid Bond (on the form provided) in the amount of at least five percent (5%) of the Total Bid Amount. The apparent low bidder shall deliver the original sealed Bid Bond to CTRMA within five (5) calendar days of such notification.

CENTRAL TEXAS REGIONAL MOBILITY AUTHORITY
James Bass, Executive Director
Austin, Texas

Central Texas Regional Mobility Authority

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290E METAL BEAM GUARD FENCE & ITS CABINET UPGRADES MAINTENANCE PROJECT

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BID DOCUMENT CHECKLIST

Prior to submitting a bid, prospective bidders should review the checklist below to ensure that the bid is accepted and not declared nonresponsive. No joint venture participants will be allowed.

Bid Document:

- Are you aware if your affiliates are bidding on the same project?
- Are you pre-qualified by TxDOT through the Confidential Questionnaire process and have a bidding capacity of $3,000,000?
- Have you submitted a valid Non-Collusion Affidavit, Debarment Affidavit, and Child Support Statement in order to receive an Official Bid Form?

Bid Document Preparation:

- Is the bid being submitted on the Official Bid Form via the CivCast website?
- Are you submitting only one bid for this project?
- Is the bid signed by your company representative or each joint venture participant?
- Have you entered prices for all bid items?
- Does the bid document contain all items included in the Official Bid Form?
- Does the bid document contain a total bid value?
- Is the bid free of any additional conditions not included in the bid document provided to you?
- Have you electronically submitted a complete and executed Bid Bond?
- Have you acknowledged each Addendum on CivCast?

Bid Bonds:

- Is the bid bond signed by the surety?
- Is the bid bond signed by the company representative?
- Is the exact name of the contractor(s) listed as the principal?
- Is the impressed surety seal affixed to the bid bond?
- Does the name on the surety seal match the name of the surety on the bond?
- Is the bond dated on or earlier than the letting date of the project?
- Is the signer for the surety listed on the power of attorney attached to the bond?
- Is the surety authorized to issue the bond?

Bid Document Submission:

- Are you aware of the time and date deadline for submission for the bid document?
- Are you submitting a complete bid document?

290E METAL BEAM GUARD FENCE & ITS CABINET UPGRADES MAINTENANCE PROJECT

Unofficial Bid Form

To receive Official Bid Form, request via the project's CivCast website.

ITEM NO.	DESC. CODE	DESCRIPTION	UNIT	QTY	UNIT PRICE
0104	7006	REMOV CONC (RIPRAP)	SY	464.9	
0132	7003	EMBANK (FNL)(OC)(TY B)	CY	197.0	
0164	7004	BROADCAST SEED (PERM_URBAN_CLAY)	SY	7,260.0	
0432	7001	RIPRAP (CONC)(4 IN)	CY	17.1	
0432	7013	RIPRAP (MOW STRIP)(4 IN)	CY	53.0	
0500	7001	MOBILIZATION	LS	1.0	
0502	7001	BARRICADES, SIGNS AND TRAFFIC HANDLING	MO	6.0	
0503	7002	PORTABLE CHANGEABLE MESSAGE SIGN	EA	4.0	
0505	7001	TMA (STATIONARY)	DAY	90	
0506	7044	BIODEG EROSN CONT LOGS (INSTL) (12")	LF	630.0	
0506	7046	BIODEG EROSN CONT LOGS (REMOVE)	LF	630.0	
0540	7001	MTL W-BEAM GD FEN (TIM POST)	LF	187.5	
0540	7002	MTL W-BEAM GD FEN (STEEL POST)	LF	425.0	
0540	7005	MTL BEAM GD FEN TRANS (THRIE-BEAM)	EA	1.0	
0540	7015	DOWNSTREAM ANCHOR TERMINAL SECTION	EA	3.0	
0542	7001	REMOVE METAL BEAM GUARD FENCE	LF	315.0	
0542	7003	REMOVE DOWNSTREAM ANCHOR TERMINAL	EA	3.0	
0542	7004	RM MTL BM GD FENCE TRANS (THRIE-BEAM)	EA	1.0	
0544	7001	GUARDRAIL END TREATMENT (INSTALL)	EA	63.0	
0544	7003	GUARDRAIL END TREATMENT (REMOVE)	EA	63.0	
0618	7021	CONDT (PVC) (SCH 40) (1")	LF	130.0	
0618	7030	CONDT (PVC) (SCH 40) (2")	LF	2,755.0	
0618	7031	CONDT (PVC) (SCH 40) (2") (BORE)	LF	1,500.0	
0618	7078	CONDT (RM) (2")	LF	25.0	
0620	7002	ELEC CONDR (NO.14) INSULATED	LF	1,665.0	
0620	7009	ELEC CONDR (NO.6) BARE	LF	205.0	
0620	7010	ELEC CONDR (NO.6) INSULATED	LF	670.0	
0620	7011	ELEC CONDR (NO.4) BARE	LF	780.0	
0620	7012	ELEC CONDR (NO.4) INSULATED	LF	1,560.0	
0620	7015	ELEC CONDR (NO.2) BARE	LF	6,040.0	
0620	7016	ELEC CONDR (NO.2) INSULATED	LF	12,080.0	
0620	7017	ELEC CONDR (NO.1) BARE	LF	2,200.0	
0620	7018	ELEC CONDR (NO.1) INSULATED	LF	4,400.0	
0620	9001	ELEC CONDR (REM)	LF	22,665.0	
0624	7002	GROUND BOX TY A (122311)W/APRON	EA	7.0	
0624	7008	GROUND BOX TY D (162922)W/APRON	EA	8.0	
0628	7160	ELC SRV TY D 120/240 060(SS)GS(N)SP(O)	EA	2.0	
0628	9001	STEP DOWN TRANSFORMER	EA	7.0	
0628	9002	STEP UP TRANSFORMER	EA	4.0	
0628	9003	MODIFY ELECTRICAL SERVICE	EA	11.0	
0628	9004	SAFETY SWITCH	EA	19.0	
0658	7018	INSTL DEL ASSM (D-SW)SZ 1(BRF)GF2	EA	85.0	
6005	9001	RVSD COMM CABLE	EA	2,150.0	
6005	9002	CCTV COMM CABLE	LF	165.0	
6005	9003	REMOVE RVSD COMM CABLE	LF	805.0	
6007	9001	BBU SYSTEM	EA	19.0	

6010	7005	RELOCATE RVSD	EA	3.0	
6010	9003	RVSD IN-CABINET EQUIPMENT	EA	15.0	
6011	7004	ITS POLE MNT CAB (TY 3)(CONF 2)	EA	18.0	
6011	7019	ITS POLE (30 FT)(90 MPH)	EA	2.0	
6011	9001	REMOVE SMALL EQUIPMENT ENCLOSURE POLE MNT	EA	8.0	
6011	9002	MODIFY SMALL EQUIPMENT ENCLOSURE TRUSS MNT	EA	6.0	
6011	9003	MODIFY SMALL EQUIPMENT ENCLOSURE POLE MNT	EA	1.0	
6011	9004	REMOVE DEVICE POLE	EA	2.0	
6018	9001	RELOCATE CCTV IN-CABINET EQUIPMENT	EA	7.0	
6027	7001	FIBER OPTIC CBL (SINGLE-MODE)(12 FIBER	LF	5,025.0	
6027	7004	FIBER OPTIC FUSION SPLICE	EA	150.0	
6027	7019	FIBER OPTIC CBL (SNGLE-MODE)(24 FIBER)	EA	265.0	
6027	7021	PRETERMINATED FIBER OPTIC PATCH PANEL (12 POSITION)	EA	21.0	
6027	9001	FIBER OPTIC SPLICE ENCLOSURE (TYPE 2)	EA	8.0	
6027	9002	MODIFY SPLICE ENCLOSURE	EA	3.0	
6050	7004	ITS GRND MNT CAB (TY 4)(CONF 2)	EA	1.0	
6058	9001	RELOCATE RWIS IN CABINET EQUIPMENT	EA	1.0	
RMA-7101	9001	ETHERNET MEDIA CONVERTER	EA	1.0	
RMA-7102	9001	F&I RPMU	EA	19.0	
RMA-7103	9001	FIELD ETHERNET SWITCH	EA	19.0	
		CONTINGENCY ALLOWANCE	LS	1.0	$240,000
		FORCE ACCOUNT	LS	1.0	$115,000

(**NOTE:** Bidders shall **not** remove this bidding form from attached documents.)

Central Texas Regional Mobility Authority

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290E METAL BEAM GUARD FENCE & ITS CABINET UPGRADES MAINTENANCE PROJECT
CTRMA CONTRACT NO. 25290E22701M

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290E METAL BEAM GUARD FENCE & ITS CABINET UPGRADES MAINTENANCE PROJECT CONTRACT

To the Central Texas Regional Mobility Authority
3300 N I-35, Suite 300
Austin, Texas 78705

Gentlemen:

I/we, the undersigned, declare: that no other person, firm or corporation is interested in this Bid; that I/we have carefully examined the Plans, Standard Specifications, Special Provisions, and all other documents pertaining to this Contract which form a part of this Bid as if set forth at length herein; that I/we understand that the quantities of items shown herein below are approximate only; that I/we have examined the location of the proposed work; that I/we agree to bind myself/ourselves, upon award to me/us by the Central Texas Regional Mobility Authority under this Bid, to enter into and execute a Contract, for the project named above; that I/we agree to start work within thirty (60) calendar days after the date stated in the written Notice-to-Proceed (Item 8.1 of the Specifications), to furnish all necessary materials, provide all necessary labor, equipment, tools and plant, pay for all required insurance, bonds, permits, fees and service, and do all required work in strict compliance with the terms of all documents comprising said Contract, and to fully complete the entire project within one hundred twenty (120) working days after Notice-to-Proceed; and that I/we agree to accept as full compensation for the satisfactory prosecution of this project the contractual bid amount after it is adjusted based on the terms and conditions specified in the contract.

The quantities shown in the above schedule of items are considered to be approximate only and are given as the basis for comparison of bids. The Authority may increase or decrease the amount of any item or portion of the work as may be deemed necessary or expedient. Any increase or decrease in the amount of any item or portion of work will be added or deducted from the total Contract bid price based on the terms and conditions specified in TxDOT Specification Item 4. It is understood that payment for this project will be by unit prices bid.

The cost of any work performed, materials furnished, services provided, or expenses incurred, whether or not specifically delineated in the Contract documents but which are incidental to the scope and plans, intent, and completion of this Contract, have been included in the price bid for the various items scheduled hereinabove.

Accompanying this Bid is a bid guaranty consisting of a Bid Bond (on the form provided) in the amount of at least five percent (5%) of the Official Total Bid Amount. It is hereby understood and agreed that said Bid Bond is to be forfeited as liquidated damages in the event that, on the basis of this Bid, the Authority should award this Contact to me/us and that I/we should fail to execute and deliver said Contract and the prescribed Contract Bond, together with the proof of proper insurance coverage and other necessary documents, all within fifteen (15) calendar days after award of the Contract; otherwise, said check or bond is to be returned to the undersigned.

Business Name of Bidder _____

Type of Organization
Individual □
Partnership □
Corporation □

Address of Bidder: _____

_____

Signature of Owner,
Partner or Corp. Officer: _____
Title: _____
Date: _____

Central Texas Regional Mobility Authority

_____

290E METAL BEAM GUARD FENCE & ITS CABINET UPGRADES MAINTENANCE PROJECT

CTRMA CONTRACT NO. 25290E22701M

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NON-COLLUSION AFFIDAVIT

STATE OF _____)

COUNTY OF _____)

I, _____, of the City of _____, County of _____ and State of _____, being of full age and duly sworn according to law on my oath depose and say:

That I am _____(Title) of _____, the Bidder making the Bid submitted to the Central Texas Regional Mobility Authority, on the 11th day of December, 2024, for Contract No. 25290E22701M in connection with 290E Metal Beam Guard Fence & ITS Cabinet Upgrades Maintenance Project; that I executed the said Bid with full authority to do so;

The said Bidder has not, directly or indirectly, entered into any combination or arrangement with any person, firm or corporation or entered into any agreement, participated in any collusion, or otherwise taken any action in restraint of free, competitive bidding or which would increase the cost of construction or maintenance in connection with the said Contract; that no person or selling agency has been employed or retained to solicit or secure the said Contract upon an agreement or understanding for a commission, percentage, brokerage or contingent fee, except bona fide full-time employees;

And that said Bidder is or has been a member of the following highway contractors' association during the preceding twelve months:

Name of Association	Location of Principal Office
_____	_____
_____	_____
_____	_____

I further warrant that all statements contained in said Bid and in this Affidavit are true and correct and made with full knowledge that the said Authority relies upon the truth of the statements contained in said Bid and in this Affidavit in awarding the said Contract.

Sworn to and subscribed
before me this_____
day of _____,
20___.

By:_____
Person Signing Bid

Print Name:_____
Title:_____

_____
Notary Public

My commission expires:_____

Central Texas Regional Mobility Authority

_____

290E METAL BEAM GUARD FENCE & ITS CABINET UPGRADES MAINTENANCE PROJECT

CTRMA CONTRACT NO. 25290E22701M

****

DEBARMENT AFFIDAVIT

STATE OF _____)

COUNTY OF _____)

I, _____, of the City of _____, County of _____ and State of _____, being of full age and duly sworn according to law on my oath depose and say:

That I am _____(Title) of _____, the Bidder making the Bid submitted to the Central Texas Regional Mobility Authority, on the 9th day of January, 2025, for Contract No. 25290E22701M in connection with the 290E Metal Beam Guard Fence & ITS Cabinet Upgrades Maintenance Project; that I executed the said Bid with full authority to do so;

The said Bidder has not been excluded or disqualified from doing business on State or Federal projects;

And that said Bidder is or has been a member of the following highway contractors' association during the preceding twelve months:

Name of Association	Location of Principal Office
_____	_____
_____	_____
_____	_____

I further warrant that all statements contained in said Bid and in this Affidavit are true and correct and made with full knowledge that the said Authority relies upon the truth of the statements contained in said Bid and in this Affidavit in awarding the said Contract.

Sworn to and subscribed
before me this_____
day of _____,
20___.

By:_____
Person Signing Bid

Print Name:_____
Title:_____

_____
Notary Public

My commission expires:_____

CHILD SUPPORT STATEMENT

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

CENTRAL TEXAS REGIONAL
MOBILITY AUTHORITY

CHILD SUPPORT STATEMENT FOR NEGOTIATED CONTRACTS AND GRANTS

Under Family Code, Section 231.006, _____ Name of Individual _____

Certifies that _____ Name of Business _____, _____ Vendor # _____,

as of _____ Date _____ is eligible to receive a grant, loan or payment and acknowledges that any contract may be terminated and payment may be withheld if this certification is inaccurate.

List below the name and social security number of the individual or sole proprietor and each partner, shareholder, or owner with an ownership interest of at least 25% of the business entity submitting the bid or application. This form must be updated whenever any party obtains a 25% ownership interest in the business entity.

NAME (*please print legibly, if handwritten*)	**SOCIAL SECURITY NUMBER**

Family Code, Section 231.006, specifies that a child support obligor who is more than thirty (30) days delinquent in paying child support and a business entity in which the obligor is a sole proprietor, partner, shareholder, or owner with an ownership interest of at least 25% is not eligible to receive payments from state funds under a contract to provide property, materials, or services; or receive a state-funded grant or loan.

A child support obligor or business entity ineligible to receive payments described above remains ineligible until all arrearage have been paid or the obligor is in compliance with a written repayment agreement or court order as to any existing delinquency.

Except as provided in Family Code, Section 231.302(d), a social security number is confidential and may be disclosed only for the purposes of responding to a request for information from an agency operating under the provisions of Subchapters A and D of Title IV of the federal Social Security Act (42 U.S.C. Sections 601 et seq. and 651 et seq.)

CERTIFICATION TO NOT BOYCOTT ISRAEL

Pursuant to Texas Government Code 2271.002, the Mobility Authority must include a provision requiring a written verification that the Contractor does not boycott Israel and will not boycott Israel during the term of the Contract. By signing the contract, the Contractor certifies that it does not boycott Israel and will not boycott Israel during the term of this contract.

Violation of this certification may result in action by the Mobility Authority.

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 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.

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 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.

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.

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 requirement will require replacement of the equipment at the contractor's expense.

Central Texas Regional Mobility Authority

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290E METAL BEAM GUARD FENCE & ITS CABINET UPGRADES MAINTENANCE PROJECT

CTRMA CONTRACT NO. 25290E22701M

****

BID BOND

KNOW ALL PERSONS MEN BY THESE PRESENTS, that_____, as Principal/Contractor, and _____, as Surety, legally authorized to do business in the State of Texas, are held and firmly bounded unto the Central Texas Regional Mobility Authority, as Authority, in the amount of at least five percent (5%) percent of the Total Bid amount, on which the Contract is awarded lawful money of the United States of America, for the payment of which, well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally and firmly by these presents:

WHEREAS, the Contractor is herewith submitting its Bid for Contract No. 25290E22701M, entitled 290E Metal Beam Guard Fence & ITS Cabinet Upgrades Maintenance Project, and

NOW, THEREFORE, the condition of this obligation is such, that if the Contractor shall be awarded the Contract upon said Bid and shall, within fifteen (15) calendar days after the date of written notice of such award, enter into and deliver a signed Contract and the prescribed Performance Bond for the faithful performance of the Contract, together with the required proof of proper insurance coverage and other necessary documents, then this obligation shall be null and void; otherwise, to remain in full force and effect, and the Contractor and Surety will pay unto the Authority the difference in money between the amount of the Total Amount written in the Bid of said Contractor and the amount for which the Authority may legally contract with another party to perform the said work, if the latter amount be in excess of the former; but in no event shall the Surety's liability exceed the penal sum hereof.

SIGNED AND SEALED this _____day of _____. 20____.

PRINCIPAL/CONTRACTOR

_____
Business Name

_____
Address

Witness or Attest: _____

_____ By:_____
Title:

(Affix Corporate Seal Here)

SURETY:

_____
Business Name

_____
Address

Witness or Attest: _____

_____ By:_____
Title:

(Attach evidence of Power of Attorney)

(Affix Corporate Seal Here)

Central Texas Regional Mobility Authority

_____

290E METAL BEAM GUARD FENCE & ITS CABINET UPGRADES MAINTENANCE PROJECT

CTRMA CONTRACT NO. 25290E22701M

****

CONTRACT AGREEMENT

THIS AGREEMENT, made this _____ day of _____, 20__, between the Central Texas Regional Mobility Authority, 3300 N. I-35, Suite 300, Austin, Texas, 78705, hereinafter called the "Authority" and _____, or his, its or their successors, executors, administrators and assigns, hereinafter called the Contractor.

WITNESSETH, that the Contractor agrees with the Authority for the consideration herein mentioned, and at his, its or their own proper cost and expense, to do all the work and furnish all the materials, equipment, teams and labor necessary to prosecute and complete and to extinguish all liens therefore, Contract No. 25290E22701M, entitled 290E Metal Beam Guard Fence & ITS Cabinet Upgrades Maintenance Project, in the manner and to the full extent as set forth in the Plans, Standard Specifications, Special Provisions, Bid (for the basis of award stated herein below) and other documents related to said Contract which are on file at the office of the Authority and which are hereby adopted and made part of this Agreement as completely as if incorporated herein, and to the satisfaction of the Authority or its duly authorized representative who shall have at all times full opportunity to inspect the materials to be furnished and the work to be done under this Agreement.

This Contract is awarded on the basis of the official total Bid Amount based on the unit prices bid of_____dollars and _____Cents ($_____).

In consideration of the foregoing premise, the Authority agrees to pay the Contractor for all items of work performed and materials furnished at the amount of the unit prices bid therefore in the Bid submitted for this Contract, subject to any percentage reductions in the total Contract amount that may be named in the Bid corresponding to the basis of award stated in the above paragraph, and subject to the conditions set forth in the Specifications.

The Contractor agrees as follows:

a. I/WE will not discriminate against any employee or applicant for employment because of race, religion, color, sex or national origin, except where religion, sex or national origin is a bona fide occupational qualification reasonably necessary to the normal operation of the Contractor.

b. I/WE agree it is the policy of the Company to assure that applicants are employed, and that employees are treated during employment, without regard to their race, religion, sex, color or 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 on-the-job training.

c. I/WE agree to post in conspicuous places, available to employees and applicants for employment, notices setting forth the provisions of this nondiscrimination clause.

d. I/WE in any solicitations or advertising for employees placed by or on behalf of itself, will state that it is an equal opportunity employer.

e. I/WE agree to adhere to all federal/state regulations including, but not limited to, American Disabilities Act, Equal Employment Opportunity, submitting certified payrolls, and participating in Contractor/Subcontractor labor standard reviews.

f. Notices and advertisements and solicitations placed in accordance with applicable state and federal law, rule or regulation, shall be deemed sufficient for the purposes of meeting the requirements of this section.

g. Contract Time - The contractor will have one hundred twenty (120) working days after the date stated in the written Full Notice-to-Proceed to Fully complete the project.

h. Failure by Contractor to fulfill these requirements is a material breach of the Contract, which may result in the termination of this Contract, or such other remedy, as the Authority deems appropriate.

IN WITNESS WHEREOF, the parties hereto have duly executed this Agreement the day and year written above.

Sworn to and Subscribed

before me this_____
day of _____, 20___.

_____
Notary Public

My commission expires:
_____

CENTRAL TEXAS REGIONAL MOBILITY AUTHORITY

By:_____
James Bass
Executive Director

CONTRACTOR:

_____

Business Name

_____

Address

_____

Sworn to and subscribed
before me this _____
day of_____,20___.

_____

by:_____

Notary Public

Title

My commission expires:

_____

(Affix Corporate Seal Here)

INFORMATION ABOUT PROPOSER ORGANIZATION

Proposer's business address:

(No.)	(Street)	(Floor or Suite)

(City)	(State or Providence)	(ZIP or Postal Code)	(Country)

State or County of Incorporation/Formation/Organization: _____

Signature block for a corporation or limited liability company:

Company: _____

By: _____

Printed Name: _____

Title: _____

Additional Requirements:

A. If the proposer is a corporation, enter state or country of incorporation in addition to the business address. If the proposer is a partnership, enter state or country of formation. If the proposer is a limited liability company, enter state or country of organization.

B. Describe in detail the legal structure of the entity making the Bid. If the proposer is a partnership, attach full name and addresses of all partners and the equity ownership interest of each entity, provide the aforementioned incorporation, formation and organization information for each general partner and attach a letter from each general partner stating that the respective partner agrees to be held jointly and severally liable for any and all of the duties and obligations of the proposer under the Bid and under any contract arising therefrom. If the proposer is a limited liability entity, attach full names and addresses of all equity holders and other financially responsible entities and the equity ownership interest of each entity. If the proposer is a limited liability company, include an incumbency certificate executed by a Secretary thereof in the form set on the following page listing each officer with signing authority and its corresponding office. Attach evidence to the Bid and to each letter that the person signing has authority to do so.

C. With respect to authorization of execution and delivery of the Bid and the Agreements and validity thereof, if any signature is provided pursuant to a power of attorney, a copy of the power of attorney shall be provided as well as a certified copy of corporate or other appropriate resolutions authorizing said power of attorney. If the Proposer is a corporation, it shall provide evidence of corporate authorization in the form of a resolution of its governing body certified by an appropriate officer of the corporation. If the Proposer is a limited liability company, evidence of authorization would be in the form of a limited company resolution and a managing member resolution providing such authorization, certified by an appropriate officer of the managing member. If the Proposer is a partnership, evidence of authorization shall be provided for the governing body of the Proposer and for the governing bodies of each of its general partners, at all tiers, and in all cases certified by an appropriate officer.

D. The Proposer must also identify those persons authorized to enter discussions on its behalf with the Authority in connection with this Bid, the Project, and The Agreement. The Proposer shall submit with its Bid a power of attorney executed by the Proposer and each member, partner of the Proposer, appointing and designating one or more individuals to act for and bind the Proposer in all matters relating to the Bid.

INCUMBENCY CERTIFICATE

The undersigned hereby certifies to the Central Texas Regional Mobility Authority that he/she is the duly elected and acting _____ Secretary of _____ (the "Company"), and that, as such, he/she is authorized to execute this Incumbency Certificate on behalf of the Company, and further certifies that the persons named below are duly elected, qualified and acting officers of the Company, holding on the date hereof the offices set forth opposite their names.

NAME:	OFFICE:
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

IN WITNESS WHEREOF, the undersigned has executed this Incumbency Certificate this _____ day of _____.

_____

_____Secretary

Central Texas Regional Mobility Authority

290E METAL BEAM GUARD FENCE & ITS CABINET UPGRADES MAINTENANCE PROJECT

CTRMA CONTRACT NO. 25290E22701M

****

PERFORMANCE BOND

STATE OF TEXAS
COUNTY OF _____

KNOW ALL MEN BY THESE PRESENTS: That _____

_____of the City of _____

County of _____, and State of _____, as principal, and

_____
authorized under the laws of the State of Texas to act as surety on bonds for principals, are held and firmly bound unto the Central Texas Regional Mobility Authority (Authority), in the penal sum of

_____Dollars

($_____) for the payment whereof, the said Principal and Surety bind themselves, their heirs, administrators, executors, successors, jointly and severally, by these presents:

WHEREAS, the Principal has entered into a certain written contract with the Authority, dated the _____day of _____, 20__ (the "Contract"), to which the said Contract, along with the Contract Documents referenced therein are hereby referred to and made a part hereof as fully and to the same extent as if copied at length herein.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH, that if the said Principal shall faithfully perform said Agreement and shall in all respects duly and faithfully observe and perform all and singular the covenants, conditions and agreements in and by the Contract agreed and covenanted by the Principal to be observed and performed, and according to the true intent and meaning of said Contract and the Contract Documents hereto annexed, then this obligation shall be void; otherwise to remain in full force and effect.

PROVIDED, HOWEVER, that this bond is executed pursuant to the provisions of Chapter 2253 of the Texas Government Code, as amended and all liabilities on this bond shall be determined in accordance with the provisions of said Chapter to the same extent as if it were copied at length herein.

SURETY, for value received, stipulates and agrees that no change, extension of time, alteration or addition to the terms of the Agreement or to the work performed thereunder, or to the Contract Documents referenced therein, shall in anyway affect the obligations on this bond, and it does hereby waive notice of such change, extension of time, alteration or addition to the terms on the Agreement, or to the work to be performed thereunder.

IN WITNESS WHEREOF, the said Principal and Surety have signed and sealed this instrument this _____ day of _____, 20___.

_____	_____
PRINCIPAL	SURETY
_____	_____
SIGNATURE	SIGNATURE
_____	_____
NAME & TITLE	NAME & TITLE
_____	_____
ADDRESS	ADDRESS
_____	_____
(_____) _____	(_____) _____
PHONE NUMBER	PHONE NUMBER

The name and address of the Resident Agency of Surety is:

_____

_____

(_____) _____	_____
PHONE NUMBER	SIGNATURE OF LICENSED LOCAL RECORDING AGENT appointed to countersign on behalf of Surety (Required by Art. 21.09 of the Insurance Code)

****

I,_____, having executed Bonds
SIGNATURE

for _____ do hereby affirm I have
NAME OF SURETY

verified that said Surety is now certified with Authority from either: (a) the Secretary of the Treasury of the United States if the project funding includes Federal monies; or (b) the State of Texas if none of the project funding is from Federal sources; and further, said Surety is in no way limited or restricted from furnishing Bond in the State of Texas for the amount and under conditions stated herein.

Central Texas Regional Mobility Authority

290E METAL BEAM GUARD FENCE & ITS CABINET UPGRADES MAINTENANCE PROJECT

CTRMA CONTRACT NO. 25290E22701M

****

PAYMENT BOND

STATE OF TEXAS
COUNTY OF _____

KNOW ALL MEN BY THESE PRESENTS: That _____

_____of the City of _____

County of _____, and State of _____, as Principal (hereinafter referred to as the "Principal"), and

_____
authorized under the laws of the State of Texas to act as Surety on bonds for principals (hereinafter referred to as the "Surety"), are held and firmly bound unto Central Texas Regional Mobility Authority, (hereinafter referred to as the "Authority"), in the penal sum of

_____Dollars

($_____) for the payment whereof, the said Principal and Surety bind themselves, their heirs, administrators, executors, successors and assigns, jointly and severally, by these presents:

WHEREAS, the Principal has entered into a certain written contract with the Authority, dated the _____day of _____, 20__ (the "Contract"), to which the said Contract, along with the Contract Documents referenced therein are hereby referred to and made a part hereof as fully and to the same extent as if copied at length herein.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH, that if the said Principal shall pay all claimants supplying labor and material to him or a subcontractor in the prosecution of the Work provided for in said Contract, then, this obligation shall be void; otherwise to remain in full force and effect.

PROVIDED, HOWEVER, that this bond is executed pursuant to the provisions of Chapter 2253 of the Texas Government Code, as amended and all liabilities on this bond shall be determined in accordance with the provisions of said Chapter to the same extent as if it were copied at length herein.

SURETY, for value received, stipulates and agrees that no change, extension of time, alteration or addition to the terms of the Contract or to the Work performed thereunder, or to the other Contract Documents accompanying the same, shall in anyway affect its obligation on this bond, and it does hereby waive notice of such change, extension of time, alteration or addition to the terms of the Contract, or to the work to be performed thereunder or to the other Contract Documents accompanying the same.

IN WITNESS WHEREOF, the said Principal and Surety have signed and sealed this instrument this _____ day of _____, 20___.

_____	_____
PRINCIPAL	SURETY
_____	_____
SIGNATURE	SIGNATURE
_____	_____
NAME & TITLE	NAME & TITLE
_____	_____
ADDRESS	ADDRESS
_____	_____
(_____)_____	(_____)_____
PHONE NUMBER	PHONE NUMBER

The name and address of the Resident Agency of Surety is:

_____

_____

(_____)_____	_____
PHONE NUMBER	SIGNATURE OF LICENSED LOCAL RECORDING AGENT appointed to countersign on behalf of Surety (Required by Art. 21.09 of the Insurance Code)

Central Texas Regional Mobility Authority

_____

290E METAL BEAM GUARD FENCE & ITS CABINET UPGRADES MAINTENANCE PROJECT

CTRMA CONTRACT NO. 25290E22701M

****

RECEIPT OF ADDENDA

Receipt of addendum, if issued, must be acknowledged electronically on the CivCast website.

Failure to confirm receipt of all addenda issued will result in the bid being deemed non-responsive.

_____ _____

Signature Date

Central Texas Regional Mobility Authority

_____

290E METAL BEAM GUARD FENCE & ITS CABINET UPGRADES MAINTENANCE PROJECT

CTRMA CONTRACT NO. 25290E22701M

****

ENGINEER'S SEALS

The enclosed 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 offence under the Texas Engineering Practice Act.

Project Number: 25290E22701M
County: Travis
Highway: 290 Toll

GENERAL NOTES:

GENERAL
Perform work during good weather. If work is damaged by a weather event, the Contractor is responsible for all costs associated with replacing damaged work.

Remove and replace, at the Contractor's expense, and as directed by the Engineer, all defective work, which was caused by the Contractor's workforce, materials, or equipment.

The "Engineer" shall be the Mobility Authority's consultant identified by the Mobility Authority at the pre-construction meeting.

References to manufacturer's trade name or catalog numbers are for the purpose of identification only. Similar materials from other manufacturers are permitted if they are of equal quality, comply with the specifications for this project, and are approved.

If work is performed at Contractor's option, when inclement weather is impending, and the work is damaged by subsequent precipitation, the Contractor is responsible for all costs associated with replacing the work, if required.

Equip all construction equipment used in roadway work with highly visible omnidirectional flashing warning lights.

Intelligent Transportation Systems (ITS) Infrastructure and Toll Collection System Infrastructure exists within the limits of this project and the system must remain operational throughout construction. Backbone and hub communication fiber links are critical and must be maintained during the duration of the project. Use caution if working in these areas to avoid damaging or interfering with existing facilities and infrastructure. In the event of TxDOT system damage, notify TxDOT at (512) 974-0883 and the Toll Operations Division at (512) 874-9177 within one hour of occurrence. In the event of Mobility Authority Toll system or ITS system damage, notify the Mobility Authority Director of Operations at (512) 996-9778 within one hour of occurrence. Failure of the Contractor to repair damage within 8 hours of occurrence to any infrastructure that conveys any corridor information to TxDOT/Mobility Authority will result in the Contractor being billed for the full cost of emergency repairs performed by others. Damage to any toll collection system infrastructure impacting the ability of the TxDOT/Mobility Authority to collect, process or transmit transactions will result in the Contractor being billed for lost revenue damages. Revenue damages will be based on historical revenue collected from the affected gantries.

Use a self-contained vacuum broom to sweep the roadway and keep it free of sediment as directed by the Engineer. The contractor will be responsible for any sweeping above and beyond the normal maintenance required to keep fugitive sediment off the roadway as directed by the Engineer. Consider subsidiary to pertinent items.

Protect all areas of the right of way (ROW), which are not included in the actual limits of the proposed construction areas, from disturbance. Restore any area disturbed because of the Contractor's operations to a condition as good as, or better than, before the beginning of work at no cost to the Mobility Authority.

Remove all loose Formwork and other Materials from the Floodplain or drainage areas, daily, which could float off in a Stormwater Event, as directed by the Engineer.

Damage to existing pipes, inlets, and SETs due to Contractor operations will be repaired at Contractor's expense.

All locations used for storing construction equipment, materials, and stockpiles of any type, within the ROW, will be as directed by the Engineer. Use of ROW for these purposes will be restricted to those locations where driver sight distance to businesses and side street intersections is not obstructed and at other locations where an unsightly appearance will not exist. The Contractor will not have exclusive use of ROW but will cooperate in the use of the ROW with the city/county, various public utility companies and other contractors as required.

Meet weekly with the Engineer to notify of planned work for the upcoming week. Provide a three-week "look ahead", as well as all work performed over the past week.

Coordinate and obtain approval for all work over existing roadways.

The Project Superintendent will always be available to contact when work is being performed, including subcontractor work. The Superintendent will be available and on-call 24 hours a day.

During evacuation periods for Hurricane events the Contractor will cooperate with the Mobility Authority and TxDOT for the restricting of Lane Closures and arranging for Traffic Control to facilitate Coastal Evacuation Efforts.

Overhead and underground utilities may exist in the vicinity of the project. The exact location of underground utilities may not be known. Refer to ITEM 5 – CONTROL OF THE WORK, for utility rates. If working near power lines, comply with the appropriate sections of Local Legal Requirements, Texas State Law, and Federal Regulations relating to the type of work involved.

Contractor is responsible for all toll charges incurred by Contractor vehicles.

Contractor shall refrain from using vehicles on the Shared Use Path project wide. No equipment, materials, etc. shall be on the SUP or blocking public access to SUP.

ITEM 4 – SCOPE OF WORK

Final cleanup will include the removal of excess material considered detrimental to vegetation growth along the front slope of the ditch. Materials, as specified by the Engineer, will be removed at the Contractor's expense.

ITEM 5 – CONTROL OF THE WORK

Provide a 48-hour advance email notice to AUS_Locate@txdot.gov to request illumination, traffic signal, ITS, or toll equipment utility locates on TxDOT's system (US 290). Provide 2-week advance notice to the Engineer to request locates on the Mobility Authority's system (290E).

Before the Mobility Authority or its contractor begins work on State right of way, the entity performing the work shall provide TxDOT with a fully executed copy of TxDOT's Form 1560 Certificate of Insurance verifying the existence of coverage in the amounts and types specified on

the Certificate of Insurance for all persons and entities working on State right of way. This coverage shall be maintained until all work on TxDOT right of way is complete. If coverage is not maintained, all work on State right of way shall cease immediately, and TxDOT may recover damages and all costs of completing the work.

Cooperate and coordinate with other Contractors working within the limits or adjacent to the limits.

Electronic Shop Drawing Submittals:
Submit electronic shop drawing submittals according using the Mobility Authority's Electronic Data Management System (EDMS), which will be established for the Project prior to commencing construction. Submittals will be addressed to the Engineer and additional staff, as appropriate.

ITEM 7 – LEGAL RELATIONS AND RESPONSIBILITIES

Refer to the Environmental Permits, Issues and Commitments (EPIC) plan sheets for additional requirements and permits. Erosion control and stabilization measures must be initiated immediately in portions of the site where construction activities have temporarily ceased and will not resume for a period of time exceeding 14 calendar days. Track all exposed soil, stockpiles and slopes. Tracking consists of operating 2 tracked vehicles or equipment up and down the slope, leaving track marks perpendicular to the direction of the slope. Re-track slopes and stockpiles after each rain event or every 14 days, whichever occurs first. This work is subsidiary.

Do not park equipment where driver sight distance to businesses and side street intersections is obstructed, especially after work hours. If it is necessary to park where drivers' views are blocked, make every effort to flag traffic accordingly. Give the traveling public first priority.

Perform maintenance of vehicles or equipment at designated maintenance sites. Keep a spill kit on-site during fueling and maintenance. This work is subsidiary.

Law Enforcement Personnel.
A maximum combined rate of $70 per hour for the law enforcement personnel and the patrol vehicle will be allowed. Any scheduling fee is subsidiary per Standard Specification 502.4.2.

Cancel law enforcement personnel when the event is canceled. Cancellation, minimums or "show up" fees will not be paid when cancellation is made 12 hours prior to beginning of the event. Failure to cancel within 12 hours will not be cause for payment for cancellation, minimums, or "show up" time. Payment of actual "show up" time to the event site due to cancellation will be on a case by case basis at a maximum of 2 hours per officer. Contractor must use CTRMA provided form to be reimbursed.

Alterations to the cancellation and maximum rate must be approved by the Engineer or pre-determined by official policy of the officers governing authority.

Back Up Alarm
For hours 9 P to 5 A, utilize a non-intrusive, self-adjusting noise level reverse signal alarm. This is subsidiary.

Project Number: 25290E22701M
County: Travis
Highway: 290 Toll

ITEM 8 – PROSECUTION AND PROGRESS

The Contractor will have 120 working days from NTP to have all installations complete.

Electronic versions of schedules will be saved in native format and delivered in native and PDF formats.

Working days will be charged based on a standard workweek.

Provide via email a 3-week look-ahead schedule in Gantt chart format. Submit weekly by noon on Friday. Designate each activity as night or day shift and include the name of the foreman or contractor. The chart shall have a specific section dedicated solely to lane closures and detours. Each lane closure and detour shall be an individual item on the schedule.

Lane Closure Assessments will be assessed as shown in the **Table 1** below.

Any unauthorized lane closures will be assessed to the Contractor as noted in **Table 1** below.

All Lane Closure Assessments for the Contractor will be subtracted from the value of the payment application for that associated period.

Table 1: Lane Closure Assessment Rates

Lane Closure Period	Late Charges (Per Lane)			
	290 Toll		US 290	
	Lane	Shoulder	Lane	Shoulder
>0-15 mins	$1,000	$1,000	$1,000	$1,000
>15-30 mins	$2,000	$2,000	$2,000	$2,000
>30-45 mins	$3,000	$3,000	$3,000	$3,000
>45-60 mins	$4,000	$4,000	$4,000	$4,000
Every additional 15-minute interval after 1 hour	$2,000	$2,000	$2,000	$2,000

For example: If the contractor has one lane of traffic closed on US 290 until Monday at 5:32 a.m., the contractor is 32 minutes outside of the allowable lane closure period. The late charges will be accrued as follows:

1 lane closed × [$1,000 + $1,000 + $1,000] = $3000

Emergency lane closures are not subject to lane closure assessments. Emergency lane closures are defined as closures caused by circumstances other than those caused by the contractor and shall be approved by the Mobility Authority.

Refer to Table 2. Allowable Lane Closure of Item 502 – Barricades, Signs, and Traffic Handling for available lane closure times.

Lane Closure Assessments for unauthorized shoulder closures will apply to both the main lane shoulders and to the general-purpose lane shoulders.

Project Number: 25290E22701M
County: Travis
Highway: 290 Toll

ITEM 9 – MEASUREMENT AND PAYMENT

Provide full-time, off-duty, uniformed, certified peace officers in officially marked vehicles, as part of traffic control operations, as directed by the Engineer.

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

No payment will be made for peace officers unless the Contractor completes the proper tracking form. Submit invoices that agree with the tracking form for payment at the end of each month, when approved services were provided. Request the tracking form from TxDOT.

No payment for officers used for moving equipment without prior written approval.

Cancel "Off-Duty" Peace Officers and their Motor Vehicle Units when the Scheduled Lane closures are canceled. Failure to cancel the Off-Duty Officers and their respective Motor Vehicle Units will not be the cause for payment, by Mobility Authority, for "Show Up" time.

ITEM 104 – REMOVING CONCRETE

Saw or mill existing asphalt and concrete pavement along neat lines where portions are to be left in place temporarily or permanently.

Properly dispose of unsalvageable material in accordance with federal, state, and local regulations.

Riprap must be disposed of on the same day as removal. At all times, the Contractor shall ensure that the temporary stockpiles are not left within the Clear Zone.

ITEM 164 – SEEDING FOR EROSION CONTROL

Obtain vegetation establishment of all seeded areas, including adequate coverage, prior to "Final Acceptance." If all other work is complete, time charges may be suspended, until adequate coverage is established.

Provide measurements for payment of seeding for erosion control quantities before seeding.

ITEM 168 – VEGETATIVE WATERING

Water all areas of project to be seeded or sodded at a rate of one quarter inch per week for a minimum of 12 weeks from the date the area is seeded or sodded.

Maintain the seedbed in a condition favorable for the growth of grass. Watering can be postponed immediately after a rainfall on the site of ½ inch or greater but will be resumed before the soil dries out. Continue watering until final acceptance.

Obtain water at a source that is metered (furnish a current certification of the meter being used) or furnish the manufacturer's specifications showing the tank capacity for each truck used. Notify the Engineer, each day that watering takes place, before watering, so that meter readings or truck counts can be verified.

Vegetative Watering is subsidiary to pertinent Sodding and Seeding Items.

Keep the Engineer informed of areas where Vegetative Watering has been performed.

ITEM 432 – RIPRAP
Mow strip riprap will be 4 in. and all other riprap will be 5 in. unless otherwise shown on the plans or in the pay items.

Saw-cut existing riprap then epoxy 12 in long No. 4 bars 6 in. deep at a maximum spacing of 18 in. in each direction to tie new riprap to existing riprap. This work is subsidiary.

ITEM 502 – BARRICADES, SIGNS, AND TRAFFIC HANDLING
Cover, relocate or remove existing signs that conflict with traffic control. Install all permanent signs, delineation, and object markers required for the operation of the roadway before opening to traffic. Use of temporary mounts is allowed or may be required until the permanent mounts are installed or not impacted by construction. Maintain the temporary mounts. This work is subsidiary.

Do not set up traffic control when the pavement is wet.

Maintain access to all streets and driveways at all times, unless otherwise approved. Considered subsidiary to the pertinent Items.

Table 2. Allowable Lane Closure

Roadway	Limits	Allowable Closure Time* Weekday
290 Toll	US 183 to East of Parmer Lane	9 PM to 5 AM
US 290	US 183 to East of Parmer Lane	9 PM to 5 AM

* Allowable Closure Time includes setup and cleanup time.

For roadways without defined allowable closure times, nighttime lane closures will be allowed from 8 P to 5 A. Unless stated, daytime or Friday night lane closures will not be allowed and one lane in each direction will remain open at all times for all roadways.

Full mainlane closures will not be allowed. Full ramp closures must be approved by the Engineer.

Law Enforcement Officers required for lane closures.

No closures will be allowed on Friday nights.

No closures will be allowed the weekends adjacent to, working day prior, and working day after the National Holidays defined in the Standard Specifications and Easter weekend. No closures will be allowed on Friday and the weekends for Austin City Limits Fest, Formula 1 United States Grand Prix, South by Southwest, UT home football games, Republic of Texas Rally, Rodeo Austin or other special events that could be impacted by the construction. All lanes will be open by noon of the day before these special events. The closure restrictions may be amended by the Engineer.

To account for directional traffic volumes, begin and end times of closures may be shifted equally by the Engineer. The closure duration will remain. Added compensation is not allowed.

Submit a request for a lane closure notification (LCN) to the Mobility Authority using the CTRMA's electronic document management system. Receive concurrence prior to implementation. Submit a cancellation of lane closures a minimum of 18 hours prior to implementation.

Blanket requests for extended periods are not allowed. Max duration of a request is 2 weeks prior to requiring resubmittal. Provide 2-hour notice prior to implementation and immediately upon removal of the closure.

Submit the request a minimum of 48 hours prior to the closure and by the following deadline immediately prior to the closure: 11A on Tuesday or 11A on Friday.

For all roadways: Submit request for traffic detours and full roadway closures 7 days prior to implementation.

Cancellations of accepted closures (not applicable to full closures or detours) due to weather will not require resubmission in accordance with the above restrictions if the work is completed during the next allowable closure time.

In the case of an unauthorized lane closure, all approved LCNs will be revoked until a meeting is held between the contractor and the Engineer. No lane closure notices will be approved until the meeting is concluded.

Meet with the Engineer prior to lane closures to ensure that sufficient equipment, materials, devices, and workers will be used. Take immediate action to modify traffic control, if at any time backup (queuing) becomes greater than 20 minutes. Have a contingency plan of how modification will occur. Consider inclement weather prior to implementing the lane closures.

Coordinate Main Lane closures with adjacent projects including those projects owned by other agencies and departments.

Maximum lane closure length shall be 2 miles.

Do not setup lane and/or shoulder closures on both sides of road at the same time.

Closures that conflict with adjacent contractor will be prioritized according to critical path work per latest schedule. Conflicting critical path or non-critical work will be approved for first LCN submitted. Denial of a closure due to prioritization or other reasons will not be reason for time suspension, delay, overhead, etc.

Maintain a minimum of 2 through lanes in each direction on the 290E mainlanes.

Shadow Vehicle with TMA is required for setup/removal of traffic control devices.

Project Number: 25290E22701M
County: Travis
Highway: 290 Toll

ITEM 503 – PORTABLE CHANGEABLE MESSAGE SIGN
Provide 4 "Electronic" Portable Changeable Message Sign(s) (EPCMS) as part of the traffic control operation for the duration of the project. All EPCMS will be exclusive to this project, unless otherwise approved. Placement location and message as directed by the Engineer.

Place appropriate number of "Electronic" Portable Changeable Message Signs (EPCMS) at locations requiring lane closures for one-week prior to the closures, or as directed by the Engineer. Obtain approval for the actual message that will appear on the boards. If more than two phases of a message are required per board, provide additional EPCMS's to meet the two-phases-per-board requirement. Provide a replacement within 12 hours. EPCMS will be available for traffic control, event notices, roadway conditions, service announcements, etc.

ITEM 505 – TRUCK MOUNTED ATTENUATOR AND TRAILER ATTENUATOR
A TMA/TA shall be used when installing and removing a TCP setup.

The contractor will be responsible for determining if one or more operations will be ongoing at the same time to determine the total number of TMA/TA required for the project.

TMA/TA used to protect damaged attenuators will be paid by the day using the force account item for the repair.

ITEM 506 – TEMPORARY EROSION, SEDIMENTATION, AND ENV CONTROLS
Install, maintain, remove erosion, sedimentation, and environmental control measures in areas of the right of way utilized by the contractor that are outside the limits of disturbance required for construction. Permanently stabilize the area. This work is subsidiary.

Consider the SW3P for this project to consist of the following item, as directed by the Engineer:

Erosion Control Logs

ITEM 540 – METAL BEAM GUARD FENCE
The modified standard GF(31)-19 (MOD) included in the plan set provides details for MBGF runs with post spacings reduced in half. MBGF with half post spacing shall be paid under bid item 540-7002 as shown on the reduced post spacing location plan sheets.

Adjust the limits of the Metal Beam Guard Fence (MBGF) to meet field conditions. Stake the locations for approval prior to installation. Install all permanent MBGF and delineators before opening the road to traffic.

Furnish round timber posts. Furnish steel posts at locations where the minimum embedment shown on the plans for wooden posts cannot be achieved or where the modified standard GF (31)-19(MOD) is specified. Field verify the steel post lengths before fabrication. Steel posts shall be subsidiary to Item 540.

Adjust MBGF placement to meet TxDOT Standard GF(31)MS-19. MBGF block-outs must be placed over the curb so that the W-beam is directly over or in front of the curb, refer to Curb Option (1)-(3) in the standard.

Backfill and shoulder up of area around fence and mow strip will be paid using embankment item

ITEM 542 – REMOVING METAL BEAM GUARD FENCE

Contractor may reuse steel posts, composite blocks, and metal beam rail elements that are undamaged, rust free, and dent free, and in compliance with current standards. Structurally sound rust spots with the largest dimension of 4 in. may be cleaned and repaired in accordance with 540.3.5 Galvanizing Repair. Contractor may punch or field drill holes in the metal rail element to accommodate post spacing. Additional holes for splice or connections are not allowed. The holes shall be spaced in accordance with the latest standard and shall not be closer than the minimum spacing shown on the standard. Reuse and repair work will not be paid separately.

Only remove metal beam guard fence that can be replaced in the same shift. Metal beam guard fence that is not replaced in the same shift must be protected by a TMA/TA. TMA/TA used to protect incomplete metal beam guard fence will not be paid and is considered subsidiary to pertinent items.

ITEM 600s – ITS, TOLLING, LIGHTING, SIGNING, MARKINGS, AND SIGNALS

Use materials from Material Producer List as shown on the TxDOT website (TxDOT.gov > Business > Resources). Furnish new material as required per Standard Specification.

Meet the requirements of the NEC, Texas MUTCD, TxDOT standards, and TxDOT Standard Specifications. If existing elements shown to remain do not meet the codes or specifications, provide notice to the Engineer.

Do not store any equipment or material of any kind in the vicinity of a tolling gantry without explicit approval from the Mobility Authority.

Prior to performing any work within or in the general vicinity of a toll pad or tolling gantry infrastructure contact the Mobility Authority to coordinate construction procedures and methods.

Provide all service, equipment and material required to provide a functional item and interface with existing equipment and software.

For CTRMA ITS contact Cory Bluhm (cbluhm@ctrma.org).

Provide a 30 -day advance email notice to the Engineer for equipment to be provided by CTRMA.

Provide equipment that requires CTRMA programming or configuration to the Mobility Authority thirty (30) days in advance. Prior to relief of maintenance, completion of a Test Period is required for signals and ITS equipment in accordance with Item 680.3.1.7. Response time to reported trouble calls shall be less than 2 hours.

Project Number: 25290E22701M
County: Travis
Highway: 290 Toll

Maintain the existing CTRMA and TxDOT ITS equipment and fiber optic communications and keep hub buildings operational during construction, unless otherwise approved by the Engineer. TxDOT ITS downtime is allowed from 12 AM to 4 AM and must be approved in advance by the Engineer. CTRMA ITS downtime is allowed from 10 PM to 6 AM with approval from the Mobility Authority. Downtime resulting from unplanned outages is restricted to one (1) time per hub or ITS equipment. Submit the request seven (7) days prior. When modifications to existing CTRMA ITS equipment result in downtime of devices, notify the Mobility Authority in advanced with the estimated outage duration for review and approval. In the event the outage duration exceeds seven (7) days, the Mobility Authority reserves the right to request temporary measures to establish connectivity and power to the device for functional operation.

City of Austin fiber optic communications are located within the project limits and shall be maintained as operational during construction, unless otherwise approved by the Engineer.

Definitions of abbreviations used to designate ITS equipment, material, etc. can be provided by the Engineer.

Provide email notice to the Mobility Authority sixty (60) business days prior to begin work that impacts tolling equipment. Attend a pre-construction meeting with the Mobility Authority prior to begin work.

Verify the location of all utilities (overhead and underground) and notify the Engineer of any discrepancies before beginning construction. Contact utility companies forty-eight (48) hours prior to construction and take “caution” in areas where utilities are close together to avoid damaging the utilities. Both TxDOT owned and CTRMA owned ITS and Electronic Toll Collection (ETC) systems infrastructure may exist within the limits of this project. All ITS and ETC systems must remain operational throughout project construction. The exact location of underground ITS infrastructure may not be known. Backbone and hub communication fiber links are critical and must be maintained for the duration of the project and beyond.

Throughout the project limits the existing ductbank contains fiber optic communications for CTRMA, TxDOT, and City of Austin. Prior to modifications of the cabling or ductbank, coordinate with the Mobility Authority for site specific direction on conduit assignments and cable identification. Ensure all cables within each UCV, ground box, and cabinet are properly labeled with waterproof tags with ten (10) feet of the entrance and exit point of the enclosure. Tags shall clearly and legibly identify the owner, origin and destination, date of installation, and strand count for fiber optic cables.

Tie new conduit into existing underground cable vaults (UCV) using an available conduit knockout. New drilled entries into the vault wall are prohibited with prior approval from the Engineer and Mobility Authority. For connections to existing UCV with operational fiber optic communications the Engineer is required to be present during all work. Notify the Engineer a minimum of five (5) days prior to proposed work to schedule on-site inspection.

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ITEM 618 – CONDUIT
Fit PVC and HDPE conduit terminations with bell ends.

The locations of conduit and ground boxes are diagrammatic, shift as directed to accommodate field conditions.

Install conduit in an area not exceeding 2 feet in any direction from a straight line.

Install open trench conduit at a minimum depth of 2 feet below finished grade. Installation of the conduit by jacking or boring method will be at a depth of at least 1 feet below the bottom of the base material of the roadway. Boring installations below MSE walls shall not disturb the area within or directly below the portion MSE wall earth file in which the wall soil reinforcement is placed. Maintain a minimum depth of 5 feet below the bottom of the MSE wall footing/levelling pad and reinforcement.

Provide a detailed installation plan for all proposed bores beneath roadways and structures, including MSE walls and spread footings, for review and approval by the Engineer. At a minimum, the installation plan shall include the installation date, bore pit locations, minimum depth to be maintained below roadways and MSE wall footings, and required temporary traffic control including roadway, shoulder, or lane closures.

Install a high tension, non-metallic pull rope in all conduit runs. The pull ropes are for future use. Cap all empty conduit using standard weather tight conduit caps as directed. This work is subsidiary.

Use a coring device when drilling holes through concrete structures.

When using existing conduit, ensure that all conduits have bushings and cleaned of dirt, mud, grease, and other debris. Re-strap existing or relocated conduit per the specification. This work is subsidiary.

Replacement of existing conduit that is unusable will be paid using the existing bid items.

Consider all fittings, brackets, and junction boxes necessary to complete the installations subsidiary to the pertinent Items.

All conduit trenches shall be back filled completely to provide safe crossing by the end of each working day or whenever the work zone becomes inactive. Any area that cannot be back filled in the same day/night operation shall not be opened.

Restore all conduit trenches to their original condition, including soil back fill and restoring turf vegetation.

In locations where existing hardscape, landscape, or other roadside features will be impacted by the installation of open trench conduit, bore conduits to avoid disturbance with approval from the Engineer.

Stakes or other physical method shall be installed to hold down conduit prior to placement of concrete/flow fill encasement.

Minimum distance between HDPE conduit joints will be 200 feet.

ITEM 620 - ELECTRICAL CONDUCTORS
Identify the conductors as shown on the Electrical Details Standard Sheets when two or more conductors are present in one conduit or enclosure. Use identification tag with two plastic straps. Each tag will indicate circuit number, letter, or other identification as shown on the plans.

Bond grounding conductors, which share the same conduit, junction box or structures, together at every accessible point, in accordance with the Electrical Detail Standard Sheets and the latest edition of the National Electrical Code (NEC).

All wiring will be in accordance with the National Electrical Code (NEC) and the appropriate Department standard sheets.

Installing electrical conductors within the same conduit as fiber optic communications is prohibited. The collocation of electrical conductors in the same conduit as low-voltage signal cabling is prohibited, unless otherwise approved by the Engineer.

ITEM 624 – GROUND BOXES
Ground box locations shown on the plans are approximate. The ground boxes shall not be placed in sidewalks or driveways unless otherwise shown in the plans. Alternate ground box locations shall be as directed by the Engineer.

New metal ground box covers, except those installed for fiber optic cable, shall be grounded.

All new ITS ground boxes, not in riprap or pavement, will be constructed with concrete aprons.

For CTRMA owned ground boxes legibly imprint each ground box cover with a permanently marked logo in letters at least 1 inch high as follows: “CTRMA ITS”, unless otherwise directed. Glue in logos are prohibited.

Aggregate for fill under the box shall be crushed, have a maximum size of ¾ in., minimum size of ¼ in., and requirements per Item 302 are waived.

ITEM 628 – ELECTRICAL SERVICES
Make arrangements with the utility company for all work and materials provided by the utility company. Accounts for Mobility Authority maintained lighting and ITS will be placed in the name of the Mobility Authority.

Place temporary electrical services in Contractor's Name. Costs for connection charges, meter charges, consumption charges, and other charges for temporary electrical service are not reimbursable for payment.

The service enclosures in this Contract will have provisions for pad locking the enclosure shut.

Modify Electrical Service

The work performed and materials furnished in accordance with this Item will be paid for at the unit price bid for "Modify Electrical Service." Electrical service modification includes all work performed, materials, and equipment necessary to modify the load-side of the electrical service to complete the work shown in the Plans. Work anticipated under this pay item, at a minimum, includes furnish and installation of new breakers into the service panel and disconnecting of existing circuits from the service panel.

Safety Disconnect Switch

Furnish and install switches that are HP rated and meet Federal and NEMA Specifications with NEMA Type 4X (stainless steel) enclosures, and with metal factory nameplates that are front cover mounted and contain a permanent record of switch type, catalog number, and HP rating. Provide switch with visible blades, reinforced fuse clips, and non-teasible, positive, quick make-quick break mechanisms. Provide switch assembly plus operating handle as an integral part of the enclosure base.

Use switches with defeat able door interlocks that prevent the door from opening when the operating handle is in the ON position, and whose handle position is easily recognizable and is pad lockable in the OFF position. Use heavy-duty switches with line terminal shields.

> Non-fusible Switch Assemblies: Furnish and install NEMA KS 1; HD type, load interrupter enclosed knife switch.
>
> Enclosures: Furnish and install NEMA KS 1 type enclosure as shown in the Contract Documents.
>
> Installation: Install safety disconnect switches where indicated in the Contract Documents or where required by the Engineer. Use separate conduits for line and load conductors. Install fuses in fusible safety disconnect switches. Install pole mounted service disconnects a minimum of 4 feet above grade when measured from the bottom of the disconnect.

Electrical Power Transformer

Provide a dry type, air-cooled, factory assembled transformer. All units must be UL listed under the requirements of UL 5085 and UL 1561, IEEE Standard 259, and meet the requirements of NEMA ST-20. Provide transformers for the primary and secondary voltages indicated on the Plans. Provide two 2.5% full capacity below normal taps and two 2.5% above normal taps on the primary side. All taps are full capacity taps

Enclosure: Use an enclosure conforming to NEMA Standards for Type 3R, made of hot-dip galvanized steel, aluminum, stainless steel or other materials approved by the Engineer. Electrical Rating: Transformer electrical ratings may range from 3 KVA to 300 KVA, 120V to 600 V, single phase or three phase, primary or secondary, as shown in the plans.

Temperature classifications: Transformers rated less than 15 KVA shall utilize Class 180 or 185 insulation systems, with a 115°C or lower winding temperature rise. Transformers rated 15 KVA and greater shall utilize Class 220 insulation systems, with a 150°C or lower winding temperature rise. The transformer shall utilize an insulation system that has been properly temperature classified in accordance with NEMA ST-20. Encapsulated transformers rated 15KV A to 25KV A using a Class 180 or 185 insulation system with a 115°C or lower winding temperature rise may be utilized if approved by the Engineer. Transformer windings shall be all aluminum or all copper.

Load rating: Furnish and install transformers with load ratings as described in the Plans. Transformers shall be capable of operating continuously at 100 percent of nameplate rating in an ambient temperature not exceeding 40°C. Transformers 5 KVA and above shall be capable of meeting overload requirements per ANSI C57.96 with normal life maintained.

Sound rating: Sound levels shall not exceed the following:

Transformer Rating (KVA)	Average Sound Level Decibels per NEMA ST-20
0-9	40
10-50	45
51-150	50
150-300	55

Installation: Follow installation procedures recommended by NEMA ST-20, National Electric Code (NEC), and National Electrical Safety Code (NESC). Set the ground mount transformer unit level on the pad and secured to the pad with bolts. Pole mount transformers are required to be fastened securely to the pole using bolts, stainless steel straps, or galvanized strut channel.

Conduct field acceptance testing in accordance with TxDOT Specifications. Perform local field inspection at each site to verify and confirm the following:

1. Check wiring connections for damage and torque, as applicable, prior to energizing the transformer. 872 FY 2024-25

2. Check grounding and bonding of transformer enclosure. Ensure that separately derived systems, which are required to be grounded by the NEC 250.30 or the

Plans, are fitted with an appropriately installed and sized system bonding jumper in accordance with the NEC 250.30.

3. Measure primary and secondary voltages under normal load conditions.

ITEM 6005 – NETWORKING INTELLIGENT TRANSPORTATION SYSTEM (ITS) COMMUNICATIONS CABLE

Reutilize existing ITS communication cabling for relocated field devices wherever feasible. Prior to removing cabling, measure the total length of the existing end-to-end cable run to determine if sufficient material is available to facilitate connection at the proposed location – including horizontal and vertical lengths and slack requirements. Splicing of ITS communications cable is prohibited. Install new run of cabling at all locations where the existing does not provide sufficient length.
Ensure RVSD communication cable is capable of transmitting RS-485 and is compatible with Wavetronix Smart Sensor and Wavetronix Smart Sensor HD devices and in-cabinet equipment.

Installation of cable includes termination of cable into in-cabinet equipment and end-device. Installation includes all cable, connectors, and any other equipment or materials required to interconnect the end device to in-cabinet equipment as shown in the Plans.

Removal of cable includes all work necessary to disconnect existing cable from the end device and in-cabinet equipment and remove the entire run of cable as shown in the Plans.

ITEM 6007 – BATTERY BACK UP UNIT FOR SIGNALS

The work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "BBU System". Provide an Alpha FXM 350 or equivalent. BBU assemblies shall be designed for installation into a TxDOT Type 3 ITS Cabinet, w/ a 19-inch EIA standard rack, to provide battery backup functionality for intelligent transportation system (ITS) devices. BBU assemblies shall include batteries provided by the UPS manufacturer or in accordance with manufacturer's requirements.

UPS assemblies used to provide backup power in an ITS cabinet shall provide a minimum of 350 watts (at 120 VAC) of continuous backup power for a minimum of two (2) hours.

ITEM 6010 – ITS RADAR VEHICLE SENSING DEVICE

Furnish and Install of RVSD In-Cabinet Equipment

The work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "ITS RVSD In-Cabinet Equipment". RVSD in-cabinet equipment shall be din-rail mounted and, at a minimum, include the following:

- Serial Device Server: Serial Comm ETH-SER-EE9 or equivalent
- 120VAC to 24VDC Power Supply: Puls Dimension CP5.241 or equivalent
- Cables, connectors, and associated equipment

This price is full compensation for furnishing, installing, and configuring all RVSD in-cabinet equipment. This price is also full compensation for testing the completed installation including RVSD equipment, serial device servers, power supplies, cables, connectors, and associated equipment; and for all labor, tools, equipment, documentation, testing, training, software, warranty, and incidentals necessary to complete the work.

Serial interconnect cabling between the RVSD field device and the in-cabinet equipment shall be paid for by bid item 6005 - "RVSD Comm Cable".

Relocation of RVSD Field Equipment

Relocate RVSD Field Equipment from the existing ITS pole to the new ITS pole. The work performed and materials furnished by the unit bid price for "ITS RVSD (Data Collection Only) (Relocate)" also includes the furnishing and installing of materials required to mount the existing device to the new ITS pole (e.g., stainless steel banding, pole adapter mounts, etc.). New RVSD in-cabinet equipment will be paid for by the unit bid price for "RVSD In-Cabinet Equipment".

Relocation of RVSD In-Cabinet Equipment

The work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "ITS RVSD In-Cabinet Equipment (Relocate)". RVSD in-cabinet equipment shall be din-rail mounted and, at a minimum, includes the serial device server, power supply (120VAC-24VDC), surge protection device(s), cabling, and any other materials within the RVSD subsystem. This price is full compensation for relocating all RVSD in-cabinet equipment and making existing RVSD field equipment fully operational; 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.

ITEM 6011 – INTELLIGENT TRANSPORTATION SYSTEM (ITS) POLE WITH CABINET

ITS Pole Mnt Cab (TY 3) (CONF 2)

The work performed and materials furnished in accordance with this Item will be paid for at the unit price bid for "ITS Pole Mnt Cab (TY 3) (CONF 2)." Unit price includes all work performed, materials, and equipment necessary to mount the cabinet to the pole or concrete column structure. For mounting to concrete column structures this pay item also includes furnishing and installing rigid galvanized steel (RGS) above ground conduit from the underground connection into the cabinet base, galvanized steel channel struts, and a 6" concrete maintenance pad as shown in the Plans; testing, delivery, and storage of components designated for salvage or reuse; and all testing, equipment, labor, materials, tools, and incidentals.

Remove Small Equipment Enclosure Pole

The work performed and materials furnished in accordance with this Item will be paid for at the unit price bid for "Remove Small Equipment Enclosure Pole Mnt". Removal is for 11.75" x 12.75" x 18" small equipment enclosure strap mounted to existing 4" aluminum pedestal pole.

Modify Small Equipment Enclosure

The work performed and materials furnished in accordance with this Item will be paid for at the unit price bid for "Modify Small Equipment Enclosure Truss Mnt". Unit price includes all work performed, materials, and equipment necessary to remove the back panel from the existing 11.75" x 12.75" x 18" small equipment enclosure. Following enclosure modification, the enclosure will remain to be utilized as a junction box as shown in the Plans.

Truss mounted enclosures are aerially mounted to the truss and column of an overhead sign bridge. Pole mounted enclosures are steel band mounted to existing CCTV or 4" aluminum device poles.

ITEM 6018 – DIGITAL CLOSED-CIRCUIT TELEVISION (CCTV) FIELD EQUIPMENT

Relocate CCTV – In Cabinet Equipment

The work performed and materials furnished in accordance with this Item will be paid for at the unit price bid for "Relocate CCTV In-Cabinet Equipment." CCTV in-cabinet equipment, at a minimum, includes the CCTV power supply, power-over Ethernet (POE) injector, cabling, and any other materials within the CCTV subsystem. This price is full compensation for relocating CCTV in-cabinet equipment from the existing cabinet/equipment enclosure into the new cabinet; making existing CCTV field equipment fully operational as shown on the plans; furnishing and installing additional cables, connectors, and surge protection devices as shown on the plans; testing, delivery, and storage of components designated for salvage or reuse; and all testing, equipment, labor, materials, tools, and incidentals.

Designation of existing CCTV communication interconnect cabling between the existing CCTV field device and POE injector is shown in the Plans. If CCTV communication cabling is to remain, this unit price bid includes all work performed and materials to protect the cabling during construction and terminate cabling to return CCTV field equipment to fully operational. All work performed and materials furnished to remove and replace existing CCTV communications cabling (i.e., CAT 5e Ethernet) shall be paid for by bid item 6005 - (ITS) Communications Cable.

ITEM 6027 – INTELLIGENT TRANSPORTATION SYSTEM (ITS) FIBER OPTIC CABLE

Perform all fiber work as shown in the plans. Fiber work shall be done on the Orange buffer tube only. Make no modifications to the blue, green, and brown buffer tubes.

Modifying the fiber optic splice tray shall include all work required to modify the existing fiber splicing configurations to match the Plans. Splice tray modifications do not include any proposed fiber optic fusion splicing.

Modifying the fiber optic splice enclosure shall include all work performed, materials, and equipment required to modify the existing fiber splice enclosure to match the Plans, including splice trays, buffer fan out kits, etc. Splice enclosure modifications do not include any proposed fiber optic fusion splicing.

ITEM 6050 – ITS GROUND MOUNTED CABINET

Provide an aluminum cabinet riser base with dimensions and bolt pattern to accommodate a TxDOT Standard Type 4 (Caltrans Type 332) for each ground mounted cabinet installation. Provide riser with a minimum height of eighteen (18) inches. Install a watertight gasket or silicone caulk sealant between the cabinet riser base and the Type 4 cabinet to prevent water intrusion.

Rigidly affix safety disconnect switch and electrical power transformer to the non-door side of the cabinet enclosure. Ensure all electrical equipment is provided a bonded ground connection in accordance with NEC. Install rigid galvanized steel conduit for aboveground installations terminating into the bottom of the enclosures with necessary connection hardware – including conduit bodies, locknuts, washers, and bushings. Provide flexible conduit to maneuver around the concrete cabinet foundation and transition to underground conduit, as necessary. Install aboveground to underground conduit transitions a minimum of six (6) inches below grade.

ITEM 6058 – ROAD WEATHER INFORMATION SYSTEM

The work performed and materials furnished in accordance with this Item will be paid for at the unit price bid for “Relocate RWIS In-Cabinet Equipment.” RWIS in-cabinet equipment, at a minimum, includes the Remote Processing Unit (RPU), serial media converter, power supply, cabling, and any other materials within the RWIS subsystem. This price is full compensation for relocating RWIS in-cabinet equipment from the existing cabinet/equipment enclosure into the new cabinet; making existing RWIS field equipment fully operational as shown on the plans; furnishing and installing additional cables, connectors, and surge protection devices as shown on the plans; testing, delivery, and storage of components designated for salvage or reuse; and all testing, equipment, labor, materials, tools, and incidentals.

Central Texas Regional Mobility Authority

290E METAL BEAM GUARD FENCE & ITS CABINET UPGRADES MAINTENANCE PROJECT

CTRMA CONTRACT NO. 25290E22701M

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SPECIFICATION LIST

PREFACE:

The "Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges" of the Texas Department of Transportation, 2024, as amended and augmented by the Supplemental Specifications following, shall govern the performance of the Contract. These specifications hereby are made a part of the Contract as fully and with the same effect as if set forth at length herein.

Attention is directed to the fact that any other documents printed by the Texas Department of Transportation modifying or supplementing said "Standard Specifications", such as Standard Supplemental Specifications, Special Provisions (by the Department), Notice to Bidders, etc., do not form a part of this Contract nor govern its performance, unless specifically so-stated in the Supplemental Specifications herein contained.

Attention is directed to the use of “Proposal” in standard TxDOT documents included in this contract (Standard Specifications, Special Provisions, & Special Specifications) is equivalent to “Bid” in the Mobility Authority's documents. This shall be accounted for when working contract documents prepared by the Mobility Authority with those standards prepared by TxDOT.

Attention is directed to the use of “Department” in standard TxDOT documents included in this contract (Standard Specifications, Special Provisions, & Special Specifications) is equivalent to “Mobility Authority” in the Mobility Authority's documents.

References made to specific section numbers in these Special Provisions, or in any of the various documents which constitute the complete Contract Documents, shall, unless otherwise denoted, be construed as referenced to the corresponding section of the "Standard Specifications" issued by the Texas Department of Transportation in 2024.

CONTRACT NO.: 25290E22701M
HIGHWAY: 290E
COUNTY: TRAVIS

CENTRAL TEXAS REGIONAL MOBILITY AUTHORITY

GOVERNING SPECIFICATIONS AND SPECIAL PROVISIONS

(STANDARD SPECIFICATIONS, SPECIAL PROVISIONS, AND SPECIAL SPECIFICATIONS)

WHERE DISCREPANCIES OCCUR BETWEEN THE TECHNICAL SPECIFICATIONS, THE FOLLOWING DESCENDING ORDER OF PRIORITY SHALL GOVERN: (1) SPECIAL CONDITIONS, (2) SPECIAL PROVISIONS TO SPECIAL SPECIFICATIONS, (3) SPECIAL SPECIFICATIONS, (4) SPECIAL PROVISIONS, AND (5) STANDARD SPECIFICATIONS.

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

STANDARD SPECIFICATIONS: ADOPTED BY THE TEXAS DEPARTMENT OF TRANSPORTATION SEPTEMBER 1, 2024. STANDARD SPECIFICATIONS ARE INCORPORATED INTO THE CONTRACT BY REFERENCE.

ITEMS 1-9 GENERAL REQUIREMENTS AND COVENANTS

ITEM 104 REMOVING CONCRETE

ITEM 164 SEEDING FOR EROSION CONTROL (162) (166) (168)

ITEM 168 VEGETATIVE WATERING

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

ITEM 500 MOBILIZATION

ITEM 502 BARRICADES, SIGNS, AND TRAFFIC HANDLING

ITEM 503 PORTABLE CHANGEABLE MESSAGE SIGN

ITEM 505 TRUCK-MOUNTED ATTENUATOR (TMA) AND TRAILER ATTENUATOR (TA)

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

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

ITEM 542 REMOVING METAL BEAM GUARD FENCE

ITEM 544 GUARDRAIL END TREATMENTS

ITEM 618 CONDUIT

ITEM 620 ELECTRICAL CONDUCTORS

ITEM 623 INTELLIGENT TRANSPORTATION SYSTEM (ITS) GROUND BOXES

ITEM 624 GROUND BOXES

ITEM 628 ELECTRICAL SERVICES

ITEM 658 DELINEATOR AND OBJECT MARKER ASSEMBLIES (445)

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

SPECIAL PROVISION TO ITEM 000 (000---001)

SPECIAL PROVISION TO ITEM 000 (000---016)

SPECIAL PROVISION TO ITEM 000 (000---017---RMA)

SPECIAL PROVISION TO ITEM 000 (000---019L)

SPECIAL PROVISION TO ITEM 000 (000---031)

SPECIAL PROVISION TO ITEM 001 (001---001---RMA)

SPECIAL PROVISION TO ITEM 002 (002---001)

SPECIAL PROVISION TO ITEM 002 (002---001---RMA)

SPECIAL PROVISION TO ITEM 003 (003---001---RMA)

SPECIAL PROVISION TO ITEM 004 (004---001---RMA)

SPECIAL PROVISION TO ITEM 004 (004---002---RMA)

SPECIAL PROVISION TO ITEM 005 (005---001---RMA)

SPECIAL PROVISION TO ITEM 006 (006---001---RMA)

SPECIAL PROVISION TO ITEM 007 (007---001---RMA)

SPECIAL PROVISION TO ITEM 008 (008---001)

SPECIAL PROVISION TO ITEM 008 (008---002---RMA)

SPECIAL PROVISION TO ITEM 008 (008---009---RMA)

SPECIAL PROVISION TO ITEM 009 (009---001---RMA)

SPECIAL SPECIFICATIONS:

SS 6005 NETWORKING INTELLIGENT TRANSPORTATION SYSTEM (ITS) COMMUNICATIONS CABLE

SS 6007 BATTERY BACK-UP SYSTEM FOR SIGNAL CABINETS

SS 6010 INTELLIGENT TRANSPORTATION SYSTEM (ITS) RADAR VEHICLE SENSING DEVICE

SS 6011 INTELLIGENT TRANSPORTATION SYSTEM (ITS) POLE WITH CABINET

SS 6018 DIGITAL CLOSED-CIRCUIT TELEVISION (CCTV) FIELD EQUIPMENT

SS 6027 INTELLIGENT TRANSPORTATION SYSTEM (ITS) FIBER OPTIC CABLE

SS 6050 INTELLIGENT TRANSPORTATION SYSTEM (ITS) GROUND-MOUNTED CABINET

SS 6058 ROADWAY WEATHER INFORMATION SYSTEM

SS 7101-RMA INTELLIGENT TRANSPORTATION SYSTEM (ITS) MEDIA CONVERTER

SS 7102-RMA INTELLIGENT TRANSPORTATION SYSTEM (ITS) REMOTE POWER MANAGEMENT UNIT (RPMU)

SS 7103-RMA INTELLIGENT TRANSPORTATION SYSTEM (ITS) FIELD ETHERNET SWITCH

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.

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.

The Texas Department of Transportation, as a recipient of federal financial assistance, and under Title VI and related statutes, ensures that no person will on the grounds of race, religion (where the primary objective of the financial assistance is to provide employment in accordance with 42 USC 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 Department.

3. NONDISCRIMINATION PROVISIONS

During the performance of this Contract, the Contractor agrees as follows.

3.1. **Compliance with Regulations**. The Contractor must comply with the Regulations pertinent to nondiscrimination in federally assisted programs of the United States Department of Transportation 49 CFR 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, regarding the work performed during the Contract, must 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 must 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, the Contractor must notify each potential subcontractor or supplier 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 must provide all information and reports required by the Regulations or directives issued pursuant thereto, and must permit access to its books, records, accounts, other sources of information, and facilities as may be determined by the Recipient or the Department 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 must so certify to the Recipient, or the Department as appropriate, and must 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 must impose such Contract sanctions as it or the Department may

determine to be appropriate, including, but not limited to actions defined in Article 7.1., “Ethics,” or Article 5.1., “Authority of Engineer.”

3.6. **Incorporation of Provisions**. The Contractor must include the provisions of Sections 3.1–3.6 in every subcontract, including procurements of materials and leases of equipment, unless exempt by the Regulations or directives issued pursuant thereto. The Contractor must take such action with respect to any subcontract or procurement as the Recipient or the Department may direct as a means of enforcing such provisions, including sanctions for noncompliance: 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 000
Important Notice to Contractors

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. DEFINISIONS

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 43 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 Division 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.

3. CONTRACTOR EVALUATIONS

In accordance with 43 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 noncompliance is final.

4. DIVISION OVERSIGHT

Upon request of the Construction Division 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 000
Certificate of Interested Parties (Form 1295)

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

- at contract execution for contracts awarded by the Mobility Authority;
- at any time there is an increase of $300,000 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 to Item 000
Small Business Enterprise in State-Funded Projects

1. DESCRIPTION

The purpose of this Special Provision is to implement the Texas Department of Transportation's policy of ensuring that SBEs have an opportunity to participate in the performance of Contracts. If the SBE goal is greater than zero, Section 2.1., "Article A—SBE Goal is Greater than Zero," will apply to this Contract; otherwise, Section 2.2., "Article B—No SBE Goal," will apply. The percentage goal for SBE participation in the work to be performed under this Contract will be in accordance with the proposal.

2. DEFINITIONS

A Small Business Enterprise (SBE) is a firm certified as such by the Texas Department of Transportation. Firms certified as Historically Underutilized Businesses (HUBs) by the Texas Comptroller of Public Accounts and as Disadvantaged Business Enterprises (DBEs) by the Texas Uniform Certification Program automatically qualify as SBEs.

2.1. **Article A—SBE Goal is Greater than Zero**.

2.1.1. **Policy**. The Owner is committed to providing contracting opportunities for small businesses. Therefore, it is the Owner's policy to develop and maintain a program to facilitate contracting opportunities for small businesses. Consequently, the requirements of the Owner's SBE Program apply to this Contract as follows.

The Contractor will make a good faith effort to meet the SBE goal for this Contract.

The Contractor and any subcontractors will not discriminate on the basis of race, color, national origin, age, disability, or sex in the award and performance of this Contract. These nondiscrimination requirements must be incorporated into any subcontract and purchase order.

After a conditional award is made to the low Bidder, the Owner will determine the adequacy of a Contractor's efforts to meet the Contract goal, in accordance with Section 2.1.2., "Contractor's Responsibilities." If the requirements in accordance with Section 2.1.2., "Contractor's Responsibilities," are met, the Contract will be forwarded to the Contractor for execution.

The Contractor's performance in meeting the SBE goal during the construction period of the Contract will be monitored by the Owner.

2.1.2. **Contractor's Responsibilities**. These requirements must be satisfied by the Contractor. An SBE Contractor may satisfy the SBE requirements by performing at least 25% of the Contract work with their own organization in accordance with Item 8, "Prosecution and Progress."

The Contractor must complete an SBE Commitment Agreement Form for each SBE-certified firm the Contractor intends to use to satisfy the SBE goal. The SBE Commitment Agreement Form must be submitted to the Owner so as to arrive no later than 5 P.M. on the 10th business day, excluding national holidays, after the conditional award of the Contract. When requested, additional time not to exceed 7 business days, excluding national holidays, may be granted based on documentation submitted by the Contractor.

A Contractor that cannot meet the Contract goal, in whole or in part, must document the good faith efforts taken to meet the SBE goal. The Owner will consider as good faith efforts all documented explanations that are submitted and that describe a Contractor's failure to meet an SBE goal or obtain SBE participation, including:

- advertising in general circulation, trade association, and minority- or women-focused media regarding subcontracting opportunities,
- dividing the Contract work into reasonable portions in conformance with standard industry practices,
- documenting reasons for rejection or meeting with the rejected SBE to discuss the rejection,
- providing qualified SBEs with adequate information pertinent to bonding, insurance, plans, Specifications, scope of work, and the requirements of the Contract,
- negotiating in good faith with qualified SBEs, not rejecting qualified SBEs that are also the lowest responsive Bidder; and
- using the services of available minorities and women; community organizations; Contractor groups; local, state, and federal business assistance offices; and other organizations that provide support services to SBEs.

The good faith effort documentation is due to the Owner at the time and place in accordance with this Section. The Owner will evaluate the Contractor's documentation. If it is determined that the Contractor has failed to meet the good faith effort requirements, the Contractor will be given an opportunity for reconsideration by the Owner.

Should the Bidder to which the Contract is conditionally awarded refuse, neglect, or fail to meet the SBE goal or demonstrate to the Owner's satisfaction sufficient efforts to obtain SBE participation, the proposal guaranty filed with the bid will become the property of the Owner, not as a penalty, but as liquidated damages to the Owner.

The Contractor must not terminate an SBE subcontractor submitted on a commitment agreement for a Contract with an assigned goal without the prior written consent of the Owner.

The Contractor must designate an SBE contact person who will administer the Contractor's SBE program and who will be responsible for submitting reports, maintaining records, and documenting good faith efforts to use SBEs.

The Contractor must inform the Owner of the representative's name, title, and telephone number within 10 days of beginning work.

2.1.3. **Eligibility of SBEs**. The Texas Department of Transportation certifies the eligibility of SBEs.

Firms certified as SBEs are listed on the Texas Department of Transportation's online directory located at https://txdot.txdotcms.com/.

Only firms certified at the time of letting or at the time the commitments are submitted are eligible to be used in the information furnished by the Contractor in accordance with Section 2.1.2., "Contractor's Responsibilities."

Certified HUBs and DBEs are eligible as SBEs.

The Texas Department of Transportation's SBE Program is governed by 43 TAC, Chapter 9, Subchapter K, "Small Business Enterprise (SBE) Program."

2.1.4. **Determination of SBE Participation**. SBE participation will be counted toward meeting the SBE goal in this Contract in accordance with the following.

A Contractor will receive credit for all payments actually made to an SBE for work performed and costs incurred in accordance with the Contract, including all subcontracted work.

An SBE Contractor or subcontractor may not subcontract more than 75% of a Contract. The SBE must perform no less than 25% of the value of the Contract work with their own organization in accordance with Item 8.

An SBE may lease equipment consistent with standard industry practice. An SBE may lease equipment from the prime Contractor if a rental agreement, separate from the subcontract specifying the terms of the lease arrangement, is approved by the Owner before the SBE starting the work in accordance with the following.

- If the equipment is of a specialized nature, the lease may include the operator. If the practice is generally acceptable with the industry, the operator may remain on the lessor's payroll. The operator of the equipment must be subject to the full control of the SBE, for a short term, and involve a specialized piece of heavy equipment readily available at the jobsite.
- For equipment that is not specialized, the SBE must provide the operator and be responsible for all payroll and labor compliance requirements.

2.1.5. **Records and Reports**. The Contractor must submit monthly reports of SBE payments (including payments to HUBs and DBEs) to the Owner's Office after work begins. These reports will be due within 15 days after the end of a calendar month.

These reports will be required until all SBE subcontracting or supply activity is completed. The SBE Progress Report must be used for monthly reporting. Upon completion of the Contract and before receiving the final payment, the Contractor must submit the SBE Final Report to the Owner's Office. These forms may be obtained from the Owner and reproduced as necessary. The Owner may verify the amounts being reported as paid to SBEs by randomly requesting copies of invoices and cancelled checks paid to SBEs. When the SBE goal requirement is not met, documentation supporting good faith efforts, in accordance with Section 2.1.2., "Contractor's Responsibilities," must be submitted with the SBE Final Report.

SBE subcontractors and suppliers should be identified on the monthly report by SBE certification number, name, and the amount of actual payment made to each during the monthly period. These reports are required regardless of whether SBE activity has occurred in the monthly reporting period.

All such records must be retained for 3 yr. following completion of the Contract work and be available at reasonable times and places for inspection by authorized representatives of the Owner.

2.1.6. **Compliance of Contractor**. To ensure compliance with SBE requirements of this Contract, the Owner will monitor the Contractor's efforts to involve SBEs during the performance of this Contract. This will be accomplished by a review of monthly reports submitted by the Contractor indicating their progress in achieving the SBE Contract goal and by compliance reviews conducted by the Owner.

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 Owner reserves the right to employ remedies as the Owner deems appropriate in the terms of the Contract.

2.2. **Article B—No SBE Goal**.

2.2.1. **Policy**. It is the Owner's policy that SBEs will have an opportunity to participate in the performance of Contracts.

2.2.2. **Contractor's Responsibilities**. If there is no SBE goal, the Contractor must offer SBEs an opportunity to participate in the performance of Contracts and subcontracts. If an SBE is used, the requirements in accordance with Section 2.1.4., "Determination of SBE Participation," will apply.

2.2.3. **Prohibit Discrimination**. The Contractor and any subcontractor will not discriminate on the basis of race, color, national origin, religion, age, disability, or sex in the award and performance of Contracts. These nondiscrimination requirements must be incorporated into any subcontract and purchase order.

2.2.4. **Records and Reports**. The Contractor must submit annual reports pertinent to SBEs (including HUBs and DBEs) to the Owner's Office by August 31 or at project completion, whichever comes first.

These reports will be required until all SBE subcontracting or supply activity is completed. The SBE Progress Report must be used for reporting. Upon completion of the Contract and before receiving the final payment, the Contractor must submit the SBE Final Report to the Owner's Office. These forms may be obtained from the Owner and reproduced as necessary. The Owner may verify the amounts being reported as paid to SBEs by randomly requesting copies of invoices and cancelled checks paid to SBEs.

SBE subcontractors and suppliers should be identified on the report by SBE certification cumber, name, and the amount of actual payment made.

All such records must be retained for 3 yr. following completion of the Contract work and be available at reasonable times and places for inspection by authorized representatives of the Owner.

Special Provision 000
Schedule of Liquidated Damages

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	760
1,000,000	3,000,000	968
3,000,000	5,000,000	1107
5,000,000	15,000,000	1527
15,000,000	25,000,000	2095
25,000,000	50,000,000	3072
50,000,000	Over 50,000,000	5093

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

Special Provision to Item 1
Abbreviations and Responsibilities

Item 1, "Abbreviations and Definitions," 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 1. is supplemented with the following:

1.0. General Statement:

For this Contract, the Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges, September 1, 2024 (the "Texas Standard Specifications"), all documents referenced therein, and all manuals, bulletins, supplements, specifications, and similar materials issued by the Texas Department of Transportation ("TxDOT"), or any predecessor or successor thereto, which are applicable to this Contract, are hereby modified with respect to the terms cited below and no others are changed hereby.

> The term "State", "State of Texas", "State Highway Agency", "State Highway Department Of Texas", "State Department of Highways and Public Transportation", "Texas State Department Of Highways and Public Transportation", "Texas Department of Transportation", "Department", "Texas Turnpike Authority", "State Department of Highways and Public Transportation Commission", "Texas Department of Transportation Commission", "Texas Transportation Commission", or "State Highway Commission", shall, in the use of The Texas Standard Specifications, Special Provisions and Special Specifications and General Notes and Specification Data pertaining thereto, and required contract provisions for Federal-Aid construction contracts, for all work in connection with Central Texas Regional Mobility Authority, projects and all extensions enlargements, expansions, improvements, and rehabilitations thereto, be deemed to mean Central Texas Regional Mobility Authority, unless the context clearly indicates a contrary meaning.

Article 2, "Abbreviations," is supplemented with the following:

> CTRMA Central Texas Regional Mobility Authority

Article 3.28., "Commission", is voided and replaced by the following:

> 3.28. Commission. The Central Texas Regional Mobility Authority Board or authorized representative.

Article 3.33., "Construction Contract", is voided and replaced by the following:

> 3.33. Construction Contract. The agreement between the Central Texas Regional Mobility Authority and the Contractor establishing the obligations of the parties for furnishing of materials and performance of the work prescribed in the Contract Documents.

Article 3.46., "Debar (Debarment)", is voided and replaced by the following:

> 3.46 Debar (Debarment). Disqualification of an entity from bidding on or entering into a Contract with the Mobility Authority, federal government or state government, from participating as a subcontractor under a Contract with the Mobility Authority, federal government or state government, and from participating as a supplier of materials or equipment to be used under a Contract with the Mobility Authority, federal government or state government. Refer to 43 TAC 1.2, "Definitions".

Article 3.47., "Department", is voided and replaced by the following:

3.47. Department. Central Texas Regional Mobility Authority, unless the context clearly indicates a contrary intent and meaning.

Article 3.48., "Departmental Material Specifications", is voided and replaced by the following:

3.48. Departmental Material Specifications (DMS). Reference specifications for various materials published by the Texas Department of Transportation Materials and Tests Division (MTD).

Article 3.55., "Engineer", is hereby deleted and replaced by the following:

3.55 Engineer. The Central Texas Regional Mobility Authority Coordinator or their duly authorized representative.

Article 3.77., "Letting Official", is hereby deleted and replaced by the following:

3.77. Letting Official. An employee of the Central Texas Regional Mobility Authority empowered by the Central Texas Regional Mobility Authority to officially receive bids and close the receipt of bids at a letting.

Article 3.107., "Proposal Form", is voided and replaced by the following:

3.107. Proposal Form. The document issued by the Central Texas Regional Mobility Authority for a proposed Contract that includes:

- the specific locations (except for non-site-specific work) and description of the proposed work;
- an estimate of the various quantities and kinds of work to be performed or materials to be furnished;
- a schedule of items for which unit prices are requested;
- the number of working days within which the work is to be completed (or reference to the requirements); and
- the special provisions and special specifications applicable to the proposed Contract.

Article 3.113., "Referee Tests", is voided and replaced by the following:

3.113. Referee Tests. Tests requested to resolve differences between Contractor and Engineer test results. The referee laboratory is a mutually agreed to 3rd party commercial laboratory.

Article 3.135., "State", is voided and replaced by the following:

3.135. State. Central Texas Regional Mobility Authority.

3.163. Mobility Authority. The Central Texas Regional Mobility Authority, an agency created under Texas Transportation Code Chapter 370 and approved by the Texas Transportation Commission, together with its members, partners, employees, agents officers, directors, shareholders, representatives, consultants, successors, and assigns. The Mobility Authority's principal office is presently located at 3300 N. I-35, Suite 300, Austin, Texas 78705.

3.164. Bid Form. The form provided by the Mobility Authority used by the bidder to submit a bid. Electronic bid forms for the project shall be submitted via the project's CivCast website.

3.165. Full Completion of all Work (or to Fully Complete all Work). The completion of all work specified under this Contract as evidenced by the Formal Acceptance thereof by the Mobility Authority.

3.166. Standards. Whenever the Plans and/or Specifications refer to "Standard Sheets" or "Design Details" such reference shall be construed to mean the set of drawings issued by the Design Divisions, Texas Department of Transportation, and entitled "Standard Sheets". Only those standards or standard drawings specifically referred to by number on the Plans or in the various Contract Documents are applicable to work on this Contract.

Whenever in the various Contract Documents term, "Department" or "State" appears, it shall be replaced by the term," Central Texas Regional Mobility Authority." Similarly, the term, "Executive Director" shall be replaced by the term, "Central Texas Regional Mobility Authority Coordinator".

Whenever in the Texas Department of Transportation Specifications and Standard Drawings the term, "Department" or "Texas Department of Transportation" appears, it shall be replaced by the term, "Central Texas Regional Mobility Authority," except in references to said Texas Department of Transportation as being the author of certain Specifications and Standard Drawings, and in reference to said Department as the agency prequalifying prospective Bidders.

Whenever in the Texas Department of Transportation Specifications and Standard Drawing the term, "District Engineer" appears, it shall be replaced by the term, "Central Texas Regional Mobility Authority Coordinator.

3.167. **Substantial Completion.** Substantial Completion shall be defined as occurring when all of the following conditions are met:

- All project work requiring lane or shoulder closures or obstructions is completed, and traffic is utilizing the lane arrangement as shown on the plans for the finished roadway.
- All signs, traffic control devices, and pavement markings are in their final position at this time.
- All sidewalks and shared use paths are opened for public use.

3.168. Provisional Award. Award given by the Mobility Authority to the Contractor after the Board of Directors approves the contract and is contingent on TxDOT approval. The Contractor is not required to provide bonds, insurance or their SBE Commitment Agreement Form.

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 2.2., "Eligibility of Bidders," is supplemented by the following.

2.3. **Technical Qualification**. The Department will not accept bids from Bidders that have not met the technical qualifications established by the Traffic Safety Division. Technical qualification is required for certain categories of Intelligent Transportation Systems (ITS) work. This technical qualification is in addition to all other Bidder qualifications required by the Department.

Electronically submit ITS Technical Qualification Forms and supporting documentation demonstrating the capability of the Bidder or the Bidder's proposed subcontractors to successfully perform the categories of work in accordance with Sections 2.3.1.–2.3.7 of this Specification. Use the ITS Technical Qualification Form pertinent to each work category. Submit the forms and supporting documentation by 12:00 P.M. (CST), 10 calendar days before bid opening, to ITS_Tech_Qual@txdot.gov. Incomplete submittals or submittals that do not meet the technical qualifications will be rejected, and additional information will be required. Failure to submit the qualification forms and supporting documentation by the deadline will be sufficient reason for declaring the bid nonresponsive in accordance with Article 2.7., "Nonresponsive Bid." The categories of work pertinent to this Contract are listed in "Important Notice to Contractors" Special Provisions in the Contract.

ITS Technical Qualification Forms and additional information on becoming a qualified Bidder may be found on the Department's website or by contacting the Traffic Safety Division by email at ITS_Tech_Qual@txdot.gov or by calling (512) 416-3118.

Once a Bidder or the Bidder's proposed subcontractor has been approved as having met the requirements of this Special Provision, any substitutions or replacement contractors must be submitted to the Traffic Safety Division for approval before performing work on the pertinent work category.

A Bidder or the Bidder's proposed subcontractor must have the level of expertise needed to successfully complete the work. The experience requirements for each work category listed below include three completed projects, one of which must have been completed within the past 5 yr. Vendor reference statements for equipment experience are required under certain work categories but may be waived if the Bidder has acceptable documentation from a vendor demonstrating their experience installing the equipment without onsite assistance.

2.3.1. **Category A. Pulling Fiber Optic Cable**. Meet the following experience requirements.

- **Minimum Experience**. Three yr. 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
- **Completed Projects**. 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 at least 1 yr.

2.3.2. **Category B. Splicing and Testing of Fiber Optic Cable**. Meet the following experience requirements.

- **Minimum Experience**. Three 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 the following:
  - termination of at least 48 fibers within a fiber distribution frame,
  - optical time-domain reflectometer (OTDR) testing and measurement of end-to-end attenuation of single-mode and multi-mode fibers,
  - system troubleshooting and maintenance,
  - training of personnel in system maintenance,
  - use of watertight splice enclosures, and
  - fusion splicing of fiber optic cable that meets the tolerable decibel (dB) losses shown in Table 1; and

Table 1
Sample Table

Mode	dB Loss Range
Single mode	0.05–0.10
Multi-mode	0.20–0.30

- **Completed Projects**. Three completed projects where the personnel performed fiber optic cable splicing and terminations, system testing, and system troubleshooting and maintenance during 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 at least 1 yr.

2.3.3. **Category C. System Integration**. Meet the following experience requirements.

- **Minimum Experience**. Three yr. 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
- **Completed Projects**. Three completed projects requiring system integration and configuration of hardware including, but not limited to, Ethernet switches, video encoders and decoders, and radios.

2.3.4. **Category D. Dynamic Message Sign (DMS) Installation**. Meet the following experience requirements.

- **Minimum Experience**. Three yr. continuous existence offering services in the installation of DMS signs;
- **Completed Projects**. Three completed projects consisting of at least two signs in each project where the personnel installed, integrated, and tested DMS on outdoor, permanently mounted overhead structures and pertinent sign control equipment. The completed sign system installations must have been in continuous satisfactory operation for at least 1 yr.; and
- **Equipment Experience**. One project (may be one of the three projects in the preceding bulleted item) 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 that was referenced in the qualification documentation.

2.3.5. **Category E. Closed-Circuit Television (CCTV) Equipment Installation**. Meet the following experience requirements.

- **Minimum Experience**. Three yr. continuous existence offering services in the installation of CCTV camera systems;
- **Completed Projects**. Three completed projects consisting of at least five cameras in each project where the personnel installed, tested, and integrated CCTV cameras on outdoor, permanently mounted

structures and pertinent camera control and transmission equipment. The completed CCTV camera system installations must have been in continuous satisfactory operation for at least 1 yr.; and

- **Equipment Experience**. One project (may be one of the three projects in the preceding bulleted item) 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 that was referenced in the qualification documentation.

2.3.6. **Category F. Wireless Communications**. Meet the following experience requirements.

- **Minimum Experience**. Three yr. 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 (local area network [LAN] and wide area network [WAN]), which include cabling, switch or router configuration, and network analysis;
- **Completed Projects**. Three projects consisting of wireless communications installation, troubleshooting, and repair. Each project must include transmitting signals over a minimum 1-mi. distance and installation of at least three devices; and
- **Equipment Experience**. One project (may be one of the three projects in the preceding bulleted item) 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 that was referenced in the qualification documentation.

2.3.7. **Category G. Radar Detection Systems**. Meet the following experience requirements.

- **Minimum Experience**. Three yr. 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;
- **Completed Projects**. Three projects consisting of installation, configuration, and setup of radar detection systems; and
- **Equipment Experience**. One project (may be one of the three projects in the preceding bulleted list) 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 that was referenced in the qualification documentation.

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," first two sentences are replaced with the following:

Mobility Authority will issue an Official Bid Form to a prequalified Bidders. The online bid form will be made available to the prequalified bidders on the CivcastUSA website:https://www.civcastusa.com/project/66febaccb78f62c65ffa353e/summary

Prequalification requirements:

- Be registered with State of Texas,
- Be fully prequalified by Texas Department of Transportation (TxDOT),
- Have a bidding capacity per TxDOT prequalification system of $3,000,000,
- Email a valid Non-Collusion Affidavit, Debarment Affidavit, , and Child Support Statement to Barath.PasupathyNathan@atkinsrealis.com and Beteseb.Shibikom @atkinsrealis.com and include a phone number, email address and physical address for point of contact.

Article 2.3., "Issuing Proposal Forms," is supplemented by the following:

The Department may not issue a proposal form if one or more of the following apply:

- The Contractor has been defaulted in accordance with Article 8.7., "Default of Contract" (a default for performance) on a previous Contract with the Department within the last 3 years
- The Contractor is not in compliance with Texas Government Code Sections 2155.089 and 2262.055.

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.

Article 1, "Award of Contract," is deleted in its entirety and replaced with the following:

The Mobility Authority will award or reject the Contract within 60 calendar days after the opening of the proposal at the sole discretion of the Mobility Authority.

Article 4.3., "Insurance," is supplemented by the following:

The Contractor shall be the named insured, and the following entities shall be endorsed as additional insureds on a primary and non- contributory basis: Central Texas Regional Mobility Authority, Texas Department of Transportation.

These entities shall be additional insureds to this policy with respect to liability arising out of the acts, errors, and omissions of any member of the Contractor and Subcontractors whether occurring on or off of the site, notwithstanding any other provisions of the Contract Documents.

The Authority Board, the Authority, Texas Department of Transportation, the State of Texas, the Commission and their respective successors, assigns, officeholders, officers, directors, commissioners, consultants and employees shall be listed as "additional insureds" with respect to any insurance for which the contractor must obtain an "additional insured" rider or amendment.

The Commercial General Liability, Automobile Liability and Excess Liability policies shall be endorsed to name CTRMA as an additional insured for any claims arising out of this project. The Contractor shall provide CTRMA with certificates of insurance from all contractors and subcontractors. The certificates shall state that each Contractor waives all rights of subrogation against the CTRMA and that coverage shall not be modified or cancelled without thirty (30) days written notice to CTRMA.

Table 2 is deleted in its entirety and replaced with the following:

Type of Insurance	Amount of Coverage
Commercial General Liability Insurance	Including products/completed operations liability and contractual liability , in the amount of $1,000,000 per occurrence for bodily injury and property damage
Business Automobile Policy	In the amount of $1,000,000 per occurrence for bodily injury and property damage
Workers' Compensation	Providing statutory benefits, and Employers Liability with limits of $1,000,000
Excess Liability Insurance	In the amount of $5,000,000 per occurrence and aggregate

Special Provision to Item 4

Scope of Work

Item 4, "Scope of 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 4.4., "Changes in the Work," Delete the following two paragraphs:

> "If the changes in quantities or the alternations do not significantly change the character of the work under the Contract, the altered work will be paid for at the Contract unit price. If the changes in quantities or the alterations significantly change the character of the work, the Contract will be amended by a change order. If no unit price exists, this will be considered extra work and the Contract will be amended by a change order. Provide cost justification as requested, in an acceptable format.
>
> Payment will not be made for anticipated profits on work that is eliminated."

and replace with the following:

> "The Engineer may require deviations to the Work through a written directive. Payment for the deviations and quantity overruns will be made through the Contingency Allowance. Deviations and quantity overruns will be paid for at the unit prices submitted at the bidding stage. Deviations requiring new unit prices will be negotiated and made through the Contingency Allowance. Costs exceeding the Contingency Allowance will be addressed using the change order process.
>
> Upon completion of the Work, the total contract value will be adjusted to provide for the difference, if any, between the total amount of expenditures from the Contingency Allowance and the original amount of the Contingency Allowance. The Contractor is not entitled to all or any part of an unexpended balance of the Contingency Allowance.
>
> When changes are made that do not fall under the Contingency Allowance, the Contract will be amended by a Change Order. Provide cost justification as requested, in an acceptable format. Payment will not be made for anticipated profits on work that is eliminated."

Special Provision to Item 4

Scope of Work

Item 4, "Scope of 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 4.7., "Dispute or Claims Procedure," Delete the paragraphs under this article in their entirety and replace with the following:

> "The dispute resolution policy promotes a cooperative attitude between the Engineer, Contractor, and Contractor's subcontractors working through the Contractor. Emphasis is placed on resolving issues while they are still current, at the project office, and in an informal manner with the Engineer. Open sharing of information is encouraged by all parties involved so the information provided completely and accurately reflects the issues and facts. If information is not shared, decisions may be limited to relying on the documentation that is available for review.
>
> If the dispute cannot be resolved at the project level, initiate the Contract claims procedure by submitting a claim to the Mobility Authority's Director of Engineering.
>
> If the claim cannot be resolved between the Contractor and the Director of Engineering, the contractor may escalate the claim by submitting the claim to the Executive Director of the Mobility Authority.
>
> The Contractor, or subcontractor through the Contractor, will file a Contract claim request and a detailed report that provides the basis for the claim. The detailed report will include relevant facts of the claim, cost or other data supporting the claim, a description of any additional compensation requested, and documents supporting the claim.
>
> The claim must include the following certification: "I certify that the claim is made in good faith; that the supporting data are accurate and complete to the best of my knowledge and belief; that the amount requested accurately reflects the contract adjustment for which the Contractor believes the Mobility Authority is liable; and that I am duly authorized to certify the claim on behalf of the Contractor."
>
> If a claim has been submitted and the Contractor wishes to resume negotiations with the Engineer, notify the Director of Engineering in writing of the intent to resume negotiations at the Engineer level and request review of the claim be suspended by the Director of Engineering pending the outcome of the negotiations.
>
> File a claim after completion of the Contract or when required for orderly performance of the Contract. For a claim resulting from enforcement of a warranty period, file the claim no later than 1 yr. after expiration of the warranty period. For all other claims, file the claim no later than 1 yr. after the date the Mobility Authority issues notice to the Contractor that they are in default, the date the Mobility Authority terminates the Contract, or the date of final acceptance of the Contract. It is the Contractor's responsibility to submit requests in a timely manner.

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 5.12., "Final Acceptance," is supplemented by the following:

Contractor warrants all materials and workmanship and that the work is in conformance with the Bid Documents and Plans included in this Contract for a period of one year from the date of the Certificate of Final Acceptance of the entire project. Said warranty binds Contractor to correct any work that does not conform with such Bid Documents and Plans or defects in workmanship or materials furnished under this Contract which may be discovered within said one year period. Contractor must, at its own expense, correct any such defect within 30 days after receiving written notice of such defect from Mobility Authority by repairing the same to the condition called for in the Contract. Should Contractor fail or refuse to repair such defect within said 30-day period or to provide acceptable assurances that such repair work will be completed within a reasonable time thereafter, Mobility Authority may repair or cause to be repaired any such defect by calling the Contractor's Warranty Bond.

Special Provision to Item 6
Control of Materials

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:

Quality Control testing of all materials, construction items, or products incorporated in the work shall be performed by the Contractor according to the contract specifications at the Contractor's expense.

Quality Assurance sampling and testing for acceptance will be performed by the Mobility Authority's Construction Representative/Observer in accordance with the Quality Control (QC) / Quality Assurance (QA) program outlined in the Quality Assurance Plan (QAP). The cost of such tests will be incurred by the Mobility Authority and coordinated by the Mobility Authority's Construction Representative/Observer through funds made available to the Construction Representative/Observer under his/her agreement with the Mobility Authority for the professional services related to construction engineering and inspection on the Project.

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.

Under **Article 7.3., "Laws To Be Observed", Article 7.5., "Patented Devices, Materials and Processes", Article 7.12., "Responsibility For Hazardous Materials", and Article 7.15., "Responsibility For Damage Claims",** "State" is voided and replaced by "Central Texas Regional Mobility Authority and TxDOT".

Article 7.3., "Laws To Be Observed," is supplemented by the following:

By entering into Contract, the Contractor agrees to provide or make available to the Mobility Authority records, including electronic records related to the Contract for a period of 3 years after the final payment. No person or entity other than TxDOT may claim third -party beneficiary status under this Contract or any of its provisions, nor may any non-party sue for personal injuries or property damage under this 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.

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 shown on the plans or portion thereof, per lane, regardless of the length of lane closure or obstruction.

6.1.1. **Definition of Terms**. For this Contract, the following definitions apply.

6.1.1.1. **Time Increment**. Any continuous defined increment of time or portion thereof for a period beginning at that point when lanes are closed or obstructed by the Contractor's operations.

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.

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 shown on the plans.

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.

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 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 8.5., "Project Schedules" is supplemented by the following

The progress schedule required for this project is the critical path method schedule (CPM schedule) as described herein. The Contractor shall prepare and submit for review and acceptance a cost loaded schedule of proposed working progress for the entire contract duration. The Engineer will provide a template with milestones from other contracts and non-construction activities for the Contractor to use in the development of their schedule. The Engineer shall also provide a Work Breakdown Structure (WBS) as well as the required report layouts for the Contractor to use to develop the progress schedule for this Contract.

Immediately after receipt of notice of award, the Division Engineer and the Contractor will establish a mutually agreeable date on which the preconstruction meeting will be held. The Contractor's project superintendent and other individuals representing the Contractor who are knowledgeable of the Contractor's proposed progress schedule or who will be in charge of major items of the work shall attend the preconstruction conference.

After work on the project has begun, construction conferences will be held periodically. The construction conferences are to be scheduled at times that are mutually agreeable to both the project superintendent and the Resident Engineer. It shall be the superintendent's responsibility to attend the conferences.

Section 8.5.2 "Progress Schedule" is supplemented by the following:

The Contractor shall provide a schedule that shows the various activities of Work in sufficient detail to demonstrate a reasonable and workable plan to complete the Project by the Original Contract Completion Date and any interdependent milestones identified by the Engineer or required by Contract. Show the order and interdependence of activities and the sequence for accomplishing the Work. Describe all activities in sufficient detail so that the Engineer can readily identify the Work and measure the progress of each activity.

Section 8.5.3 "Schedule Format" is supplemented by the following:

The Contractor shall use a compatible version of Oracle Primavera P6 or comparable scheduling software to generate the CPM schedule. It is the Contractor's responsibility to verify with the Engineer the software and version being used for this project and shall maintain the required version for the entire contract duration. The use of Microsoft Project and Primavera Project Planner (P3) and other scheduling software is prohibited.

The progress schedule shall contain the following Administrative Identifier Information:

(1) Project Name
(2) Contract Number
(3) Date of Contract
(4) Construction Completion Date
(5) Contractor's Name
(6) Contractor's Contact Information

The CPM schedule must reflect the scope of work and include the following:

(1) Clear identification of tasks to be completed based on Section or Special Provisions included in the Project Manual and as listed in Pay Items, including subcontractor work activities.
(2) Include calculations of resources required (Cost, Labor, Equipment) for constructing all facilities within the Contract duration. Specific calculations shall be provided to show quantities, manpower / crews, and equipment to support the critical path. The Contractor shall be capable of calculating the maximum crew size anticipated if any activities become critical, so the Contractor is prepared when a critical path changes or a new path occurs.
(3) Float for each Activity.
(4) Activities for submittals (shop drawings).
(5) Punchlist activities with sufficient duration for the Engineer's inspection and acceptance before the final completion date
(6) Activities for submittal review time by the Engineer, including time range showing start and end dates.
(7) Working and shop drawing preparation, submittal, and review for acceptance.
(8) Material and equipment procurement, fabrication and delivery; identify any long lead items as separate activities.
(9) Owner furnished and/or installed materials and equipment shall be identified as separate activities.
(10) NTP / Start of construction
(11) Required phasing
(12) Maintenance of traffic requirements as required by the contract (if any)
(13) Intermediate completion dates (if any)
(14) Identified interdependent milestones (if any)
(15) Seasonal limitation/observation periods/moratoriums
(16) Beginning and end of each traffic control work area and road openings
(17) Other similar activities and project milestones established in the Contract Documents.
(18) Substantial Completion Date
(19) Final Acceptance Date
(20) All required Reports layouts as requested by the Engineer

Section 8.5.4 "Activity Format" is supplemented by the following:

Activity requirements are discussed in further detail as follows:

(1) Activity Identification (ID) - Assign each activity a unique identification number. The format for the identification number will be provided by the Engineer. All activities must begin with the same activity ID prefix as provided by the Engineer.
(2) Activity Description - Assign each activity an unambiguous descriptive word or phrase. For example, use "Excavate Area A," not "Start Excavation."
(3) Activity Codes – The Engineer will provide the activity code dictionary in the template. The Contractor will assign the appropriate codes to each activity.
(4) Activity Original Duration - Assign a planned duration in working days for each activity. Do not exceed a duration of 10 working days for any activity unless accepted by the Engineer. Each activity shall have a minimum duration of 1 working day. Do not represent the maintenance of traffic, erosion control, and other similar items as single activities extending to the Completion Date. Break these Contract Items into component activities in order to meet the duration requirements of this paragraph.
(5) Finish-to-Start Relationships - Unless allowed in writing by the Engineer, use only finish-to-start relationships with no leads or lags to link activities. All activities, except the first activity, shall have a predecessor(s). All activities, except the final activity, shall have a successor(s).
(6) Calendars – The Engineer will provide pre-defined calendars as part of the template. The Contractor shall assign these pre-defined calendars to the appropriate activities. The Contractor may create new project specific

calendars to represent their standard work schedule using the pre-defined calendars as a basis. The Contractor may not edit pre-defined calendars.

(7) Constraints – Unless allowed in writing by the Engineer, do not use constraints in the schedule.

(8) Resources – Manpower and equipment shall be reflected for all activities. Incidental costs to construction shall be equally spread out across all activities. Front loaded schedules are not allowed.

(9) The schedule shall show the total cost of performing each activity and shall include the total labor, material, equipment and general conditions.

(10) The sum of cost for all activities shall equal the total Contract.

(11) The summed value of that portion of the activities allocated to each Contract bid item shall equal the total value of the corresponding Contract bid item.

(12) The Contractor shall allocate a value for unit price or lump sum contract bid items to each activity in the schedule. No Lump sum amounts should exceed $100,000.

Section 8.5.5.2 "Critical Path Method" The first paragraph is voided and replaced by the following:

The Contractor shall submit to the Engineer within the timeframes specified the baseline CPM schedule in a bar chart format showing the critical path in red, using both hard copy and in electronic formats. Electronic formats shall be compatible with the Engineer's computer systems. Also, submit the following information:

(1) Written narrative – Explains the sequence of work, the controlling operations, intermediate completion dates, milestones, project phasing, anticipated work schedule and estimated resources. In addition, explain how permit requirements, submittal tracking and coordination with subcontractors, utility companies, railroads and other third party entities will be performed. The narrative shall itemize and describe the critical path (i.e. access limitations, constraints, shift work), and compare early and late date or Contract Milestone activities, and describe any critical resources.

(2) CPM Schedule in a Bar Chart Format – Include the Administrative Identifier Information discussed above on the first page of the schedule. For each activity on the chart, indicate the Activity ID, Activity Description, Original Duration, Remaining Duration, Changes to Duration, Total Float, Early Start Date, Early Finish Date, and Calendar Name. Use arrows to show the relationships among activities.

(3) Identify the critical path of the project on the bar chart. The critical path is defined as; 1) the sequence of activities that must be completed "on time" to ensure that the project finished on time. 2) the longest path of activities in the project that determines the project finish date.

(4) No more than 10% of activities may be critical or near critical. Critical Activities will have a total float equal to zero. "Near critical" is defined as float in the range of 1 to 10 working days.

(5) Six Week Look Ahead CPM Schedule in a Bar Chart Format – This schedule will have all the same requirements of the CPM schedule in bar chart format except that it shall be limited to those activities that have an early start or early finish within a six-week period of the data date.

(6) Logic Diagram – Submit a diagram in PERT chart format showing the logic of the CPM schedule.

(7) Activity ID Sort – Submit a listing of all activities included in the CPM schedule sorted by ascending Activity Identification Number.

(8) Total Float Sort – Submit a listing of all activities included in the CPM schedule sorted by increasing total float and by early start date.

(9) All float belongs to the Project and is a shared commodity between the Contractor and the Mobility Authority and is not for the exclusive use or benefit of either party. The Contractor shall notify the Engineer in writing for acceptance before using any float.

(10) Detailed Predecessor/Successor Sort – Submit a listing of all activities included in the CPM schedule indicating the activities that immediately precede and immediately succeed that activity in the schedule logic.

(11) Scheduling Statistics Report – Submit a report of CPM schedule statistics, including number of activities, number of activities on the longest path, number of started activities, number of completed activities, number of relationships, percent complete, and number and type of constraints.

(12) A resource curves / Metric tracking reports (EVM) corresponding to the milestones and work activities established above.

Section 8.5.5.2.2 "Baseline Schedule" The second paragraph is voided and replaced by the following:

The Contractor shall submit a progress schedule for the entire duration of the Contract to the Engineer 30 calendars days following the contract award date. After review of the schedule the Engineer shall schedule a Baseline CPM Schedule meeting with the Contractor to review the schedule and identify any changes or corrections. Within 7 calendar days of the CPM Schedule meeting, the Contractor shall make any necessary adjustments to address all review comments and resubmit network diagrams and reports for the Engineer's review. The complete baseline schedule shall be submitted and accepted no later than (45) forty-five days after contract award date. The complete progress schedule shall be accepted by the Engineer before any payments will be processed for the project.

Section 8.5.5.2.3 "Progress Schedule" is supplemented by the following

The Engineer may withhold pay estimates if the updated CPM schedule is not submitted as required by this section. For each updated CPM schedule, identify the actual start and finish dates for all completed activities, the actual start date and remaining duration for all activities in progress, the difference in duration of all activities since the last update and any exceptional reports associated with the update. Only accepted changes will be incorporated into the monthly progress schedule update. The schedule should represent the actual work performed and should be progressed with actuals for all the schedule activities. The final schedule will be utilized as the project actual "As Built" schedule.

Provide a written narrative that identifies any changes or shifts in the critical path and submit reasons for the changes or shifts in the critical path. Identify any changes in logic for the updated CPM schedule and submit reasons for changes to the schedule logic. In addition to the written narrative, submit the following with each updated CPM schedule:

(1) CPM Schedule in Bar Chart Format
(2) Four Week Look Ahead CPM Schedule in Bar Chart Format
(3) Logic Diagram
(4) Activity ID Sort
(5) Total Float Sort
(6) Detailed Predecessor/Successor Sort
(7) Schedule Metrics and Earned Value (Schedule, Cost, Labor) Reports

The Contractor must submit a statement that there were no changes in the schedule logic, activity durations, or calendars since the previous update in lieu of submission of items (3), (5), and (6). Acceptance of schedule updates by the Engineer does not revise the Contract Documents.

A monthly schedule update meeting shall be held each month following Notice to Proceed to review monthly schedule update submittals, critical path items and recovery schedules. The Contractor shall be represented in the meeting by the Contractor's scheduler, project manager and general superintendent. As necessary the Contractor may be also asked to attend a coordination meeting to discuss the schedule impacts to other contractors.

If the Project completion date changes or if the project schedule overrun is anticipated to exceed 5%, the Contractor shall submit a revised progress schedule to the Engineer for review and acceptance. If plan revisions are anticipated to change the sequence of construction in such a manner as will affect the progress, but not the completion date, then the Contractor may submit a revised progress schedule for review and acceptance. The Project completion date shall remain unchanged.

Section 8.5.5.3 "Notice of Potential Time Impact" is supplemented by the following

"Contractor shall not be eligible for Change Order(s) for additional compensation for additional costs, including costs for developing and executing a Recovery Schedule(s), and delay and disruption damages, or additional Days incurred directly or indirectly from the virus known as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and the disease known as COVID-19, including any disruptions to, and delays or interruptions in, construction of the Project in accordance with the Contract and any approved Baseline Schedule."

Section 8.5.5 "Schedule Types" is supplemented by the following:

Section 8.5.5.5 Recovery Schedule

If the progress schedule projects a finish date for the Project beyond the original Completion Date, the Contractor shall submit a revised schedule showing a plan to finish by the original Completion Date. The Mobility Authority will withhold Pay Estimates until the Engineer accepts the revised schedule. No additional compensation for developing and executing a recovery schedule(s) shall be reimbursed to the Contractor. The Engineer will use the schedule to evaluate time extensions and associated costs requested by the Contractor.

(1) In the event Work or related construction activities shown on the Contractor's Progress Schedule fall behind schedule to the extent that dates established as contractual Completion Dates are in jeopardy, the Contractor shall prepare and submit to the Engineer, at no additional cost or time to the Mobility Authority, a Recovery Schedule showing intent to remedy delays and to regain originally scheduled time of completion of Work within a timely manner. This includes delays due to unforeseen conditions.

(2) Recovery Schedule shall be submitted in such form and detail appropriate to the delay or delays, explaining and displaying how the Contractor intends to reschedule those activities and reestablish compliance with the accepted baseline Construction Progress Schedule during the immediate subsequent pay period or as permitted by Engineer. This shall include a schedule diagram comparing the original and the revised sequence of activities, identifying all affected activities.

(3) Upon determining the requirement for a Recovery Schedule:

a. Within five (5) calendar days, the Contractor shall present to Engineer a proposed Recovery Schedule. The Recovery Schedule shall represent the Contractor's best judgment as to how to best reorganize the Work and achieve progress to comply with the accepted Construction Progress Schedule.

b. Changes to Contractor's means and methods, such as increased labor force, working hours, overtime, additional equipment and other means shall not constitute the basis for changes to the Contract Sum or Contract Time.

c. Recovery Schedule shall show remedies to bring Work back on schedule up-to-date within the immediate subsequent pay period.

d. The Recovery Schedule shall be prepared to a similar level of detail as the Construction Progress Schedule.

e. Five (5) calendar days prior to the expiration of the Recovery Schedule, Contractor shall document to the Engineer that the Work schedule has regained, or is on-track to regain, compliance with the Construction Progress Schedule.

(4) Failure to submit Recovery Schedule in a timely manner may result in Termination of the Contract for Cause as determined by the Engineer.

(5) Failure to achieve compliance with the accepted Construction Progress Schedule despite implementing Recovery Schedule may result in Termination of the Contract for Cause as determined by the Engineer.

(6) Termination of Contract For Cause: In the event Contractor defaults on the terms of the Contract, including failure to maintain the Construction Progress Schedule, Engineer will assess the level of completion of the Work achieved by the Contractor and compare amount of available funds against anticipated costs required for the Mobility Authority to complete the Work, including anticipated Liquidated Damages resulting from delay, if any. Engineer will determine amount of payment due to Contractor for Work completed prior to date of Termination of Contract for Cause, if any. In the event available funds are not sufficient for the Mobility Authority to complete the Work, the Mobility Authority will withhold such funds from the amount due the Contractor.

(7) If, in the opinion of the Engineer, the Contractor has sufficiently regained compliance with the Construction Progress Schedule, the use of the Construction Progress Schedule will be resumed. Contractor shall update and submit the Construction Progress Schedule clearly identifying Work to date and how the Contractor intends to achieve timely completion for the remainder of the Work in accordance with the Construction Documents.

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.

Article 9.5., "Progress Payments," Delete this section of the Specifications in its entirety and substitute with the following:

Partial payments will be made once each month covering work performed and materials complete-in-place in accordance with the Contract. The invoice form to be submitted each month will be provided to the Contractor in Microsoft Excel format. The Contractor must be able to use Microsoft Excel to complete the invoice form. Partial payments will be made on the value of work performed based on approximate estimates prepared by the Engineer, provided, however, that no estimate shall be certified or payment made where the net amount receivable by the Contractor is less than Five-hundred Dollars ($500.00).

The Engineer will review the partial payment estimate with the Contractor's representative prior to each partial payment.

Total Contract value shall be considered to mean the original amount of the Contract, except when the Contract is increased or decreased by a supplemental agreement in which case the adjusted total shall be used.

The Mobility Authority reserves the right to withhold the payment of any partial or final estimate voucher or any sum or sums thereof from such vouchers in the event of the failure of the Contractor to promptly make payment to all persons supplying equipment, tools or materials, or for any labor used by the Contractor in the prosecution of the work provided for in the Contract, and for any other cause as determined by the Mobility Authority in its sole discretion, including overpayment on previous partial payments.

Article 9.8., "Retainage," is supplemented with the following:

The Mobility Authority shall not withhold funds from payments to be made to Contractor for the Work until such time as 95% of the Adjusted Contract Price has been paid to the Contractor. Following completion of and payment for 95% of the Adjusted Contract Price, the Mobility Authority shall withhold, the remaining 5% of the Adjusted Contract Price pursuant to the terms described below.

The remaining 5% for the Work, subject to reduction as specified below, shall be held by the Mobility Authority until Final Acceptance. At such time, and provided the Contractor is not in breach or default hereunder, the Mobility Authority shall release to Contractor all withheld in connection with the Work other than amounts applied to the payment of Losses or which the Mobility Authority deems advisable, in its sole discretion, to retain to cover any existing or threatened claims. The Contractor must further warrant, to the satisfaction of the Mobility Authority, that there are no outstanding claims or liens by any subcontractors or other parties with respect to the Work.

The prime contractor shall make full payment of amounts due to subcontractors within 10 calendar days following the satisfactory completion of the subcontractor's work. Satisfactory completion of the subcontractor's work shall be defined as approval, acceptance, and payment for the subcontractor's work by the Mobility Authority including the submittal and acceptance of all information, deliverables or other documents required by the contract.

Prior to the release of the remaining 5% by the Mobility Authority pursuant to the terms hereof, such amounts shall be held by the Mobility Authority. Upon the release of the remaining 5%, the Contractor shall not be entitled to any interest income that has accrued upon the amounts of the remaining 5% released to Contractor.

Article 9.9., "Payment Provisions for Subcontractors," is supplemented with the following:

The Mobility Authority may pursue actions against the Contractor, including withholding of estimates and suspending the work, for noncompliance with the subcontract requirements of this Section upon receipt of written notice with sufficient details showing the subcontractor has complied with contractual obligations as described in this Article.

These requirements apply to all tiers of subcontractors. Incorporate the provisions of this Article into all subcontract or material purchase agreements.

Special Specification 6005

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 be in accordance with 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 be in accordance 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 three 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 three 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 conformance 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 in conformance with the manufacturer published specifications for a period of 1 yr. after final acceptance of the project by the Department. Provide for "on-site" repair or replacement within two 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 foot of cable or by each connector.

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)," "ITS Communication Cable (Serial)," and "ITS Communication Cable Connector." 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 6007
Battery Back-Up System for Signal Cabinets

1. DESCRIPTION

Install a battery back-up (BBU) system for traffic signals that provides reliable emergency power in case of utility power failure or interruption. The BBU system should also function as a power conditioner or voltage regulation device.

The BBU system should consist of inverter/charger, manual bypass switch, power transfer switch or automatic bypass switch, batteries, battery monitoring device, wiring, external cabinet or stand-alone cabinet, concrete pad, all necessary hardware and software, and any associated equipment required to operate in a field environment.

The BBU system should be able to operate a light-emitting diode- (LED-) only signalized intersection (700-W load) for 4 hr. of full runtime when utility power is disabled and under ambient temperature of 25°C. The BBU system should switch the intersection to flash mode of operation when approximately 40% of battery charge is remaining, using relay contact connection points on the front panel of the unit. The BBU system should operate the intersection in the flash mode of operation (300-W load) for an additional 2 hr. BBU system components must be rated for a minimum 1,400-W load capacity.

Design the BBU system for outdoor applications in accordance with NEMA TS2-2003, Section 2. All components of the BBU system should be rated to operate under temperature extremes of -34°C–+74°C.

2. DEFINITIONS

2.1. **Automatic Bypass Switch**. A unit connected between the utility power supply and the inverter/charger that can automatically switch power to the controller cabinet service panel from inverter output power to utility line power.

2.2. **BBU System**. Includes, but is not limited to, a manual bypass switch, automatic bypass switch or power transfer switch, inverter/charger, batteries, battery monitoring device, wiring, external cabinet, and any necessary hardware for system operation.

2.3. **BBU System Software**. All software associated with operation, programming, and functional requirements of the BBU system.

2.4. **Battery Monitoring Device**. The device that monitors battery temperatures and charge rate of the batteries used in the BBU system.

2.5. **Batteries**. Standard 12-V batteries wired in series to create 36-V DC – 96-V DC storage.

2.6. **Boost**. When enabled, the BBU system inverter/charger should automatically switch into this mode to raise the utility line voltage when it drops below a preset limit. The limit may be user-defined or use manufacturer default settings (typically 100 V AC).

2.7. **Buck**. When enabled, the unit should automatically switch into this mode to reduce the utility line voltage when it rises above a preset limit. The limit may be user-defined or use manufacturer default settings (typically 135 V AC).

2.8. **External or Stand-Alone Cabinet**. The structure that houses the system components or batteries.

2.9. **Inverter/Charger**. The unit that converts the DC voltage input into 120-V AC output for the traffic signal cabinet to operate. At minimum, the inverter/charger should be rated for 1,400 W.

2.10. **Inverter Line Voltage**. The power supplied from the BBU system inverter to the traffic signal cabinet.

2.11. **Manual Bypass**. Manual switch that allows user to bypass BBU power to service system equipment. The manual bypass switch switches utility line power directly to cabinet.

2.12. **Power Transfer Switch**. A unit connected between the utility power supply and the inverter/charger that can automatically switch from utility line power to inverter output power. The power transfer relay may be a separate unit or combined with the manual bypass switch. In case of battery voltage loss, the power transfer switch must automatically return to utility line power.

2.13. **Signal Operation Mode**. A signalized intersection generating a 700-W load when running in normal operation.

2.14. **Signal Flash Mode**. A signalized intersection generating a 300-W load when running in the flash mode of operation.

2.15. **Utility Line Voltage**. The 120-V AC power supplied to the BBU system.

3. EQUIPMENT

Ensure electrical materials and construction methods conform to NEC and additional local utility requirements. Furnish BBU systems prequalified by the Department. The Traffic Operations Division maintains an MPL of prequalified BBU systems. Ensure all materials and construction methods conform to the details shown on the plans, this Specification, and the pertinent requirements of the following Items.

- Item 420, “Concrete Substructures”
- Item 620, “Electrical Conductors”

Provide and install a BBU system that can fulfill the following requirements.

3.1. **Method of Operation**. The BBU system should operate using one or more of the following methods.

3.1.1. **Buck-and-Boost Method**. When the buck-and-boost functions are enabled, they should set the upper and lower control limit allowable for the utility line voltage.

If the utility line voltage fluctuates above or below the buck-and-boost values, the BBU system should raise or lower the voltage by approximately 10%–15% of the utility line voltage to bring the voltage back within the upper and lower control limits. Provide a buck-and-boost system with preset manufacturer defaults.

If the utility line voltage falls above or below the functional capabilities of buck and boost, then the BBU system must transfer power from the utility line voltage to the inverter line voltage.

3.1.2. **Standby Method**. The standby method should set upper and lower control limits for the utility line power. If the utility line voltage falls above or below the upper or lower control limits, then the BBU system should transfer power from the utility line voltage to the inverter line voltage.

3.1.3. **Continuous Operating Mode, Double Conversion Method**. The continuous method always supplies the cabinet with inverter line voltage. This method requires the disabling of buck-and-boost functions.

3.2. **BBU System Capabilities**. The BBU system should be able to provide 1,400-W peak load, with at least 80% inverter efficiency, for at least 10 sec.

The BBU system should be able to provide 700-W signal operation load for at least 4 hr., and then switch to and provide 300-W signal flash load for an additional 2-hr. minimum, when batteries are fully charged.

When the BBU system runs on battery power, the inverter/charger should enable a user to select the voltage at which the transition from normal operating load to flash mode occurs (usually 47.5 V), using relay contacts and connection points on the front panel of the inverter/charger.

The allowed transfer time, from disruption of normal utility line voltage to stabilized inverter line voltage from batteries, should be less than 65 milliseconds. The same allowable transfer time must also apply when switching from inverter line voltage to utility line voltage.

The BBU system should bypass utility line voltage whenever the voltage is outside the manufacturer's default, or a user-programmed voltage range, ±2 V AC.

When the utility line power has been restored to a normal operating voltage for more than a user-defined setting (default 30 sec.), the BBU system should transfer from inverter line voltage to utility line voltage. The BBU system should be equipped to prevent malfunction feedback to the cabinet or the utility service.

Provide a BBU system that is compatible with TS1, TS2, and Model 170/2070 controllers and cabinet components for full runtime operation.

Unless the plans indicate otherwise, provide a BBU system in an external battery cabinet. When indicated by the plans, provide a BBU system that can be shelf-mounted in NEMA TS-1 and NEMA TS-2 cabinets, or rack-mounted for Model 170/2070 332 cabinets. Provide a manual bypass that can be shelf-mounted or attached to the side of the signal cabinet. Provide interconnect cables that are no less than 10 ft. long.

Relay contact wiring for each set of NO/NC relay contact closure terminals should be no less than 6 ft. long and #18 AWG wire. Use manufacturer recommendations for size of wire for any cable's lengths greater than 10 ft.

The BBU system should have lightning surge protection compliant with IEEE/ANSI C 62.41 and UL 1449. Provide lightning surge protection to the utility line voltage entering the inverter/charger. The surge protection device should be easily accessible and mounted externally from the inverter/charger.

The BBU system, including batteries and hardware, should be easily replaceable and should not require any special tools for installation.

The BBU system should operate in automatic fail-safe mode. Should a breaker trip the inverter/charger or power transfer switch on, the system must automatically operate from utility line power and bypass the BBU system.

As stated above, in addition to the inverter/charger, provide BBU with an external manual bypass switch and either an external automatic transfer switch or external automatic bypass switch.

The BBU system must be able to log up to 100 events. Events should date- and time-stamp faults with utility line voltage and battery voltages. At a minimum, the BBU system should log an event when:

- the utility line voltage falls above or below the upper or lower control limits,
- the BBU system automatically switches to battery power, or
- self-monitoring BBU system components fail.

3.3. **Displays, Controls, Diagnostics, and Maintenance**. The BBU system should include a front panel display. All applicable programmable functions of the operational methods described in this Specification should be viewable from the front panel display.

All events described in Section 3.2., "System Capabilities," should be viewable from the front panel display.

The BBU system software should be programmable from the front panel of the inverter/charger using a keyboard or momentary buttons, allowing user to step through menu-driven software.

Provide a 10/100 Ethernet port on the front panel of the inverter/charger.

Provide a RS232 port on the front panel of the inverter/charger.

Include software for the BBU system's operational needs. The user/operator should be able to access the system software via the Ethernet and RS232 ports on the front panel of the inverter/charger. The user should be able to read logged events and change programmable parameters from the keyboard, laptop, or local area network by the Ethernet port.

System software must be upgradeable by the RS232 port on the front panel of the inverter/charger.

3.4. **Inverter/Charger**. The inverter/charger is the unit that provides voltage regulation, conditioning of utility line power, DC voltage input conversion into 120-V AC output for the traffic signal cabinet to operate, emergency backup power upon loss of utility power, and temperature-compensated battery charging. At a minimum, the inverter/charger should be rated for 1,400 W. Provide at least six sets of Normally Open (NO) and Normally Closed (NC) single-pole double-throw dry contact relay closures on the front face of the inverter/charger, labeled to identify each contact. The relay closures should consist of NO/NC contact closures energized whenever the unit switches to battery power (label or mark contacts as "on battery" or equivalent), and a second set of NO/NC contact closures should be energized whenever the battery approaches 40% remaining capacity (label or mark contact as "low battery" or equivalent), which must determine when the unit will switch from normal operation to flash. A third set of NO/NC contact closures should be energized after a user-settable time after the unit switches to battery power. The contact may be labeled "timer." The remaining relays should be user-definable.

Operating temperature range for the inverter/charger and power transfer relay should be -34°F–+74°F. When battery power is used, the BBU system output voltage must be between 110 V AC and 125 V AC, pure sine wave output, ≤3% THD, 60 Hz ±3 Hz.

3.5. **Manual Bypass Switch**. The manual bypass switch should be provided as a separate unit external to the inverter/charger unit. The manual bypass switch must consist of housing, two-position switch, terminal blocks, internal wiring, service outlet, circuit breakers, and mounting hardware. The components should be rated at least 240 V AC/30 A. Provide the manual bypass switch with No. 8 terminal blocks. The manual bypass switch should be two-position and allow the user to switch utility line power directly to the cabinet service panel. The switch positions must provide the following functions.

- In the "Bypass" position, the inverter is bypassed, and utility power is removed from the BBU and passed directly to the signal power panel.
- In the "UPS" position, the inverter/switch is powered, and the signal circuits are supplied by the output of the inverter.

When the manual bypass switch is in the "Bypass" position, the user may replace the automatic bypass switch (or transfer switch) and the inverter/charger without interrupting power to the intersection. Provide the manual bypass switch with overcurrent protection (20-A circuit breaker).

3.6. **Power Transfer Switch**. These requirements are for BBU systems provided with a power transfer switch. The power transfer switch must operate such that the inverter/charger input and cabinet power panel are supplied with power from the utility line. If the utility line power is lost or requires conditioning (buck or boost), the power transfer switch must automatically connect the inverter/charger output to the cabinet power panel such that the inverter/charger output provides the power. In case of inverter/charger failure, battery failure, or complete battery discharge, the power transfer should revert to the NC (de-energized) state, where utility line power is connected to the cabinet service panel.

Size the wire going to the power transfer switch from the manual bypass switch, to and from the inverter/charger, and from the manual bypass switch to utility power service according to the system requirements.

3.7. **Automatic Bypass Switch**. These requirements are for BBU systems provided with an automatic bypass switch. The automatic bypass switch must operate such that the inverter/charger input is supplied with power from the utility line and the cabinet power panel is supplied with power from the output of the inverter/charger. In case of inverter/charger failure, battery failure, or complete battery discharge, or other loss of power from the output of the inverter/charger, the automatic bypass switch should revert to the NC (de-energized) state, where utility line power is connected to the cabinet service panel.

3.8. **Batteries**. Provide batteries from the same manufacturer and vendor as the BBU system.

Individual batteries should be 12-V type, easily replaceable, and available for purchase, or common off-the-shelf equivalent.

Select batteries sized and rated to operate a 700-W load for 4 hr. (normal operation) followed by a 300-W load for 2 hr. (flash operation), for a total of 6 hr.

Battery configuration should consist of 12-V batteries arranged for total voltages of 36, 48, 60, 72, 84, or 96.

Batteries should be deep-discharge, sealed prismatic lead-calcium based, valve-regulated, and maintenance-free.

Batteries should operate over a temperature range of -34°F–+74°F.

Batteries should indicate maximum recharge data and recharging cycles, and manufacturer defaults on the inverter/charger should not allow the recharging process to exceed the batteries' maximum values.

Connect the battery interconnect wiring to the inverter unit using a modular harness with red and black cabling that terminates into a typical power-pole style connector. Equip the harness with mating power flag-style connectors for batteries and a single insulated plug-in style connection to inverter/charger unit. Harness should allow batteries to be quickly and easily connected in any order, and keyed to ensure proper polarity and circuit configuration. Size the fusible link or device accordingly with BBU system requirements. To protect against currents exceeding each battery current rating, provide links within 3 in. of the negative and positive leads of each battery. Provide fusible links made of insulated stranded wire.

Provide insulated covers at the connection points (posts) to prevent accidental shorting.

Provide battery cables to connect battery to battery harness main cable at least 18 in., or long enough to accommodate the battery covers provided with the battery ground box, whichever is longer. Size the battery harness accordingly with BBU system requirements.

3.9. **Battery Monitoring System**. The BBU system should use a temperature-compensated battery charging system. The charging system should compensate over 2.5 mV/°C–4.0 mV/°C per cell.

Use a temperature sensor to monitor the temperature and regulate the charge rate of the batteries. Unless required otherwise by the plans, provide a temperature sensor wire as follows.

- 8 ft. long if external side-mounted cabinet is attached to existing controller cabinet
- 8 ft. long if batteries are housed in traffic signal base used for cabinet foundation and are stored on shelf within base
- 8 ft. long if a stand-alone cabinet is used

Should the temperature sensor fail, the inverter/charger should not allow the BBU system to overcharge the batteries. The BBU system should provide an alarm should the temperature sensor fail.

Recharge time for the batteries to obtain 80% or more of full battery charge capacity should not exceed 20 hr. at 70°F.

Batteries should not be allowed to charge when the battery temperature exceeds 50°F.

The BBU system should monitor battery strings within a system and set a fault indicator if the battery voltage falls below normal operating voltage.

3.10. **Battery Housing**. Unless plans require otherwise, provide an external battery cabinet or stand-alone BBU and battery cabinet as specified below.

3.10.1. **External Battery Cabinet**. The external cabinet should be NEMA Type 3R all-aluminum with stainless steel hardware, or approved equivalent. Design the external cabinet to attach on the side of a TS2 Size 6 base-mount cabinet. Mount the batteries, inverter, transfer switches, manual bypass, and associated hardware in the external cabinet.

Equip the external cabinet with proper ventilation, electric fan, and air filter in accordance with NEMA TS2.

Equip external cabinets with a door opening to the entire cabinet. Attach the door to the cabinet with a full-length stainless steel piano hinge or four two-bolts-per-leaf hinges. Provide a door with the same latch and lock mechanism as required for a standard traffic signal cabinet. In addition, provide a padlock clasp.

When using battery ground boxes, an external cabinet is required for the non-battery components.

3.10.2. **Stand-Alone BBU and Battery Cabinet**. When required for installation by the plans, provide a stand-alone cabinet conforming to the specifications of the external BBU and battery cabinet, except that it must not mount to the controller cabinet. Design the stand-alone cabinet to attach to a concrete pad.

3.11. **Concrete Pad**. Provide a Class B concrete pad as a foundation for stand-alone cabinets. For external cabinets, extend the controller foundation to provide a Class B concrete pad under the external cabinet.

3.12. **Documentation**. Provide operation and maintenance manuals. The operation manual should include a block diagram schematic of system hardware components. The manual should include instructions for programming and viewing software features. The manual should also include uploading and downloading (communications protocol) requirements by RS232 or Ethernet port.

Provide board-level schematics when requested.

Provide battery documentation and replacement information.

3.13. **Testing**. The Department reserves the right to test BBU systems to ensure quality assurance on unit before installation and random sampling of units being provided to the State. BBU systems that fail must be removed from the Qualified Products List (QPL).

Department QPL testing procedures must check compliance with the criteria of this Specification, including the following.

- Event logging for fault and alarm conditions
- Demonstrated use of one or more of the operating methods described in Section 3.1., “Method of Operation”
- Testing of ability to power a 700-W load for 4 hr., transfer to flash mode, and power a 300-W load for additional 2 hr., at an ambient temperature of +75°F
- Testing of all components in environmental chamber (temperature ranges from -30°F–+74°F) following NEMA TS2 2003, Section 2.

3.14. **Warranty, Maintenance, and Support**. Provide a BBU with a warranty that requires the manufacturer to replace failed BBUs when non-operable due to defect in material or workmanship within 5 yr. of date of purchase from manufacturer. Supply a BBU with no less than 95% of the manufacturer’s warranty remaining on the date when the BBU is installed and begins operating. The replacement BBU must meet this Specification. The Contractor must manage any warranty issues until the date of final acceptance.

Batteries should be warranted for full replacement for 5 yr. Batteries must be defined as bad if they are not able to deliver 80% of battery rating.

4. MEASUREMENT

This Item will be measured by each BBU system 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 "BBU System" of the type of BBU cabinet specified. This price is full compensation for furnishing, installing, and testing the completed BBU system and associated equipment; mounting hardware; Class B concrete pad; software; conduit; conductors; and equipment, labor, tools, and incidentals.

Special Specification 6010

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, and
- 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 ft. 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 20 sec. to 15 min. 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 hr. of data for all data collected over eight travel lanes at 20-sec. 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% 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 (RTS) and clear to send (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 10 W 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 be in accordance with 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 before 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 conformance 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 before 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 ten 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 one 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 accessories 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 before 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 conformance 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 before removal. Conduct testing in accordance with Section 4.9, “Relocation and Removal.” Remove and deliver equipment that fails inspection to the Department.

Before 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 it can be relocated. Remove existing RVSD field equipment as shown on the plans only at such time as authorized.

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) 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 before removal. Conduct testing in accordance with Section 4.9, “Relocation and Removal.”

Disconnect and isolate any existing electrical power supply before 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) 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.

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 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.

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 before testing for each test required on this project. Include the sequence of the tests in the procedures. The Engineer must approve test procedures before 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., “Accuracy,” 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., “Accuracy,” 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 ten vehicles. Speed data must meet the speed data accuracy requirements in Section 2.5., “Accuracy,” 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., “Accuracy.”

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 two copies of the system operations manual before the system integration test. Notify the Engineer ten 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 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 enough 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 ten days. Review time is calendar days. Conduct all tests in conformance with the approved test procedures.

Conduct basic functionality testing before 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 before removal and after installation. 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 that failed after relocation but passed before 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 before the day the tests are to begin. Obtain Engineer’s approval of test procedures before submission of equipment for tests. Send at least one 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. 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 day's notice before 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 6011

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 are in accordance 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”
- Item 740, “Graffiti Removal and Anti-Graffiti Coating.”

2.1. **Anchor Bolts**. Provide anchor bolts, nuts, and washers that are in accordance with the details shown on the plans, the requirements of this Item, and 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 is in accordance with 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 Section 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 setup 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 conformance 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 conformance 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 conformance 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 Section 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 appropriately 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 conformance 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 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 enough 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 three conductors are brought to any one 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 one 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 two momentary, pin type door switches for each door provided with the cabinet. Wire one 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 three 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 two 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 two-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 two 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 two 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 one 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 conformance 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 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 conformance 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 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 three 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 (8×20 µs)	<150 Vpk
24 VAC	30-55 V	N/A	5kA per mode (8×20 µs)	<175 Vpk
48 VDC	60-85 V	N/A	5 kA per mode (8×20 µs)	<200 Vpk
Coaxial Composite Video	4-8 V	Up to 1.5 GHz	10 kA per mode (8×20 µs)	<100 Vpk
RS422/RS485	8-15 V	Up to 10 Mbps	10 kA per mode (8×20 µs)	<30 Vpk
T1	13-30 V	Up to 10 Mbps	10 kA per mode (8×20 µs)	<30 Vpk
Ethernet Data	7-12 V	Up to 100 Mbps	3kA per mode (10×1000 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, “Galvanizing.”

Provide two 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. 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 conformance 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 are in accordance with 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 be in accordance 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 are in accordance with the requirements of ASTM 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 two 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 two keys for the door and two 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 two stainless steel machine screws. Provide cabinet doors with a catch mechanism to hold the door open at two 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 ensure 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.

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.

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, 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 conformance 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.

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 enough 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 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 five copies of the test procedures to include tests identified in Section 4.4.2. through Section 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 conformance 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 ten 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 five 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 enough 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. 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 Section 4.4.2.1. Furnish test data forms containing the sequence of tests including all 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 one 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,
- weatherheads,
- anchor bolts,
- material list,
- lightning suppression,
- 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,
- power distribution panel,
- shelves,
- surge suppression,
- door,
- back panel,
- gasket,
- outlets,
- door look,
- circuit breakers,
- materials list,
- power cable terminals,
- exterior finish,
- wiring diagrams,
- ventilation,
- cabinet grounding,
- terminal strips,
- environmental parameters,
- harnesses,
- filter, 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 two 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 five years or in conformance 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 6018
Digital 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 to interface with the existing equipment and software located in the Department's Traffic Management Control (TMC) Centers across the state.

CCTV field equipment must 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
- Video and camera control and power cable connectors and assemblies
- Video, data, and power surge suppression
- Built-in ID generator

2.2. **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.

2.2.1. **General**.

2.2.1.1. **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
- Built-in ID generator, with white letters on black outline minimum or approved equivalent

2.2.1.2. **Image Pickup Device**. Progressive scan digital CCD or CMOS sensor, 1.2-megapixel (1,200,000 pixels) or better.

2.2.1.3. **Resolution**. Support the following resolutions.

- 720p (1,280-pixel × 720-pixel array)
- 1,080p (1,920-pixel × 1,080-pixel array)
- D1 (720-pixel × 480-pixel array)
- CIF (352-pixel × 240-pixel array)
- VGA (640-pixel × 480-pixel array) at minimum depending on video stream configuration

2.2.1.4. **Frame Rate**. Allow user-selectable frame rates at 30, 15, seven, four, two, and one frame per second.

2.2.1.5. **Data Rate**. Scalable from 64 Kbps to 8 Mbps.

2.2.1.6. **Video Stream Format**. Allow simultaneous encoding and transmission of at least two configurable digital video streams in conformance with Moving Picture Experts Group- (MPEG-) 4, Part 10 (H.264). Support configuration of the following at minimum.

- H.264
- H.265
- H.264 + H.264

2.2.1.7. **Video Stream**. Support uni-cast (one-to-one) and multi-cast (one-to-many).

2.2.1.8. **Aspect Ratio**. Support width-to-height aspect ratio of 16:9.

2.2.1.9. **Image Quality**. Ensure that video produced by the camera is true; accurate; distortion-free; and free of transfer smear, oversaturation, and any other image defect that negatively impacts image quality under all lighting and weather conditions in color and monochromatic modes.

2.2.1.10. **Wide Dynamic Range (WDR)**. Operation with manual override option.

2.2.1.11. **Overexposure Protection**. Minimize glare and incur no permanent damage to the camera when pointed directly at strong light sources, including the sun, for brief periods.

2.2.1.12. **Geometric Distortion**. Zero.

2.2.1.13. **Signal-to-Noise Ratio (AGC Off**). Minimum 50 dB (weighted at 4.5 MHz).

2.2.1.14. **Electronic Shutter Speed**. Automatic shutter that is user selectable down to at least 1/10,000 sec.

2.2.1.15. **Electronic Image Stabilization**. User-selectable on or off electronic image stabilization at 5 Hz and 10 Hz minimum.

2.2.1.16. **Day (Color) and Night (Mono)**. Auto and manual switchover and iris control with user-selectable modes for auto and manual control capabilities.

2.2.1.17. **Auto White Balance**. Color quality that is maintained by a continuous through-the-lens automatic white balance for color temperatures from 2,850 K to greater than 5,100 K with less than 10-IRE unit unbalance.

2.2.1.18. **Inverted Operation**. Automatic image inversion or “flip” when rotating through 0° or 180° vertical tilt positions when not an integrated unit.

2.2.1.19. **Mean Time Before Failure**. At least 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
- 12X auto and manual digital zoom minimum
- Automatic and manual focus and iris control

Provide lenses with capabilities for remote control of the zoom, focus, and iris operations. Provide mechanical or electrical means to protect the motors from over-running in extreme positions. Lens and controller system must be capable of auto iris and remote manual iris operation. Lens must be capable of

auto and manual zoom and focus control. Use motorized iris as opposed to auto iris type for system control capability.

2.2.3. **Network Interface Requirements**. Provide CCTV field equipment that can integrate with the Department's Lonestar™ software and into the Department's TMC CCTV control sub-systems by 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 IEEE 802.3 for 10/100 Ethernet connections for half-duplex or full-duplex, and provide auto negotiation. Provide equipment with at least one Ethernet port that has a 10/100 Base-TX connection. Provide connectors that conform to EIA and TIA requirements.

Support, at minimum, RTP, RTSP, UDP/IP, TCP/IP, IPv4, HTTP, IGMPv2, DHCP, NTP, IEEE 802.1x, Ethernet 802.3u, SNMP, RADIUS Key, 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 must be achieved by 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. **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 may 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.

2.3.1. **Ethernet**. Provide a shielded twisted pair (STP) Category 6 (or equivalent) at minimum rated for outdoor use in conformance with TIA/EIA 568B. Cable must not exceed an attenuation of 30 dB per 300 ft. of cable at 100 MHz.

2.3.2. **Power**. Provide three-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 using Power over Ethernet (PoE) by a power supply or mid-span PoE injector, that must be considered part of the camera unit, and must conform to IEEE 802.3af or IEEE 802.3at 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 must be considered part of the camera unit.

Provide any necessary data, video, or power conversion hardware to successfully integrate the camera unit into the field equipment cabinet hardware components and onto the communications backbone.

2.4. **Video Encoding Interoperability**. Video encoding and decoding equipment may be used by 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 at least two other manufacturer's software or hardware decoders that are in use by the Department. Contact the Department for decoders supported before procurement of camera unit.

2.5. **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 25 lb.

Construct viewing window so 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.

2.6. **Pan-Tilt Unit**. Furnish and install a medium-duty anodized aluminum weatherproof pan-tilt unit at each camera site, conforming to 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 at least 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 drive accuracy and drive repeatability of less than 1° and 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, that can maintain static position and does not move by more than 1° 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 when not integral to the camera unit and housing.

2.7. **Preset Functions**. Provide a camera unit capable of storing at least 62 presets for pan, tilt, zoom, and focus settings.

Provide a camera unit capable of user-programmable tours with at least four 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 at least eight zones allowing right and left pan limitations.

Provide a camera unit capable of user-programmable privacy zones with at least eight zones and click-and-drag position control by software.

2.8. **Connectors**. Provide and install connectors that are compatible with the communications equipment interfaces identified in Section 2.2.3. Network Interface and Section 2.3. Cable Assembly. Supply all mating connectors. Provide all connector pins and mating connectors that are plated to achieve good electrical connection and resistance to corrosion.

2.9. **Source ID Generator**. Use a built-in ID generator to insert camera ID over each of the camera-generated videos.

Provide at least two lines of alphanumeric, case-specific text supporting at least 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 at least camera, preset, privacy mask, low-pressure warning, compass, and time and date.

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 is 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 signal loss or video signal failure, ID generator must automatically pass through failure message to display over video.

Submit list of available text displays to the Department as part of the documentation requirements.

2.10. **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.
- Provides 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.

2.11. **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.
- **Power and Control Cable Surge Protector**. Integrated into cabinet surge protection system.

2.12. **Power Requirements**. Provide CCTV field equipment meeting all its specified requirements when the input power is 115 VAC ±20%, 60 Hz ±3 Hz. Maximum power required must 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 require operating voltages other than 115 VAC ±20%, such as 24 VAC or 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.

2.13. **Primary Input Power Interruption**. Provide CCTV field equipment that meets NEMA TS2, Section 2.1.4., "Power Interruption," for traffic control system or most current version.

2.14. **Power Service Transients**. Provide CCTV field equipment that meets NEMA TS2, Section 2.1.6., "Transients, Power Service" or most current version.

2.15. **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 subject to current loads more than their respective design limits upon failure of any single circuit element or wiring.

2.16. **Modular Design**. Provide CCTV field equipment hardware installed inside the cabinet that is modular in design and 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.

2.17. **Connectors and Harnesses**. Make all external connections using 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 corrosion-resistant plated pins and mating connectors to improve conductivity. All connectors using 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.

2.18. **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.

2.18.1. **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°F–165°F
- Temperature shock not exceeding 30°F per hour
- Relative humidity of 0%–100%

  Moisture condensation on all exterior surfaces caused by temperature changes

Provisions for a heater and blower function are required to maintain internal temperatures within the manufacturer's operating temperatures for temperature ranges internal to the camera unit not conforming to NEMA TS2, Section 2.1.5.1.

2.18.2. **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–30 Hz up to 0.5 g applied in each of three mutually perpendicular planes for 30 min.

2.18.3. **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.

2.18.4. **Environmental Contaminants**. Provide equipment that conforms to IEC 60529, Section 14.2.6, or most current version, for IP-66 or greater rating when providing a pressurized unit.

Provide equipment that conforms to IEC 60529, Section 14.2.7., or most current version, for IP-67 or greater rating when providing a non-pressurized unit.

2.18.5. **External Icing**. Provide equipment that is tested to conform to NEMA 250-2003, Section 5.6 or latest revision.

2.18.6. **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).

2.18.7. **Wind Rating**. Equipment must be 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 using 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 on the plans or in the ITS standards.

- ITS pole
- Overhead sign bridge or cantilever overhead sign structure
- Retaining wall
- Concrete column or parapet

Provide mounting bracket design with documentation submitted for approval before 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 (e.g., 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 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 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 must 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 before removal. Conduct a pre-removal test in accordance with the testing requirements contained in this Specification to document operational functionality. Remove and deliver to the Department existing CCTV field equipment that fails inspection.

Before 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 it can be relocated. Remove existing CCTV field equipment as shown on the plans only when authorized.

Use care to prevent damage to any support structures. Any portion of CCTV field equipment or camera pole structure damaged or lost must be replaced by the Contractor at their expense. Contractor must document and report to the Department any existing damage to equipment before removal.

Make all arrangements for connection to the power supply and communication source, including any permits required for the work 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 before removal of existing CCTV field equipment**.**

Perform removal in strict conformance with this Specification and the lines, grades, details, and dimensions shown on the plans. Completion of the work must present a neat, workmanlike, and finished appearance.

Any portion of the CCTV field equipment or cabinet internal components damaged or lost must be replaced by the Contractor (with items requiring approval) 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 in the General Notes. The Contractor is fully responsible for any removed equipment until released.

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 at least five cameras in each project where the personnel installed, tested, and integrated CCTV cameras on outdoor, one or more permanently mounted structures and related camera control and transmission equipment. The completed CCTV camera system installations must have been in continuous satisfactory operation for at least 1 yr.

3.6.3. **Equipment Experience**. Three projects (may be the three in Section 3.6.2., "Completed Projects") in which the personnel worked in cooperation with technical representatives of equipment suppliers to perform specific stages of work. The Contractor is not required to furnish equipment on this project from the supplier that furnished documentation demonstrating this experience.

Submit the names, addresses, and telephone numbers of the references that can be contacted to verify the experience requirements.

3.7. **Documentation Requirements**. Provide at least two 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 troubleshooting 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.
- Certification documentation verifying conformance with environmental and testing requirements contained in the Special Specification. Certifications may be provided by the manufacturer or independent laboratories.

Identify material that is copyrighted or proprietary in nature as part of the documentation submittal. The Department will comply with sensitive material, 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 five copies of the test procedures, including tests identified in Section 3.8.1.2. "Design Approval Test," Section 3.8.1.7. "Consequences of Test Failure," 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 must resubmit if necessary rejected test procedures for final approval within 10 days. Review time is in 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 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 one design prototype is manufactured, perform this test on that unit. If supplying multiple types of 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 this Specification. Failure of independent tests to comply with 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 herein when subjected to the power service transients as specified in NEMA TS2, 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 herein when subjected to the following conditions in the order specified below.

- Stabilize the equipment at -30°F and test as specified in NEMA TS2, Section 2.2.7.3, "Low-Temperature Low-Voltage Tests," and Section 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 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, Section 2.2.7.5, "High-Temperature High Voltage Tests," and Section 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 herein 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 NEMA TS2, 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 herein when subjected to nominal input voltage variations as specified in NEMA TS2, 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 and 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 this Specification.

3.8.1.3.2. **Continuity Tests**. Check the wiring to determine conformance with the requirements of the appropriate paragraphs of this Specification.

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 this Specification.

3.8.1.4. **Field Acceptance (Stand-Alone) Test**. Conduct a field acceptance test for each unit after installation as required by the Engineer to demonstrate compliance with the functional requirements of this Specification. 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 connected to an oscilloscope waveform monitor, to ensure 75-ohm output impedance to conform to NTSC standards.

Using 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 at 40 IRE.

3.8.1.4.3.2. **Luminance**. Document the white level and correct brightness setting at 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 a video signal cause bars to be present on the video picture.

Document video image is present and free of oversaturation and any other image defect in color and monochrome modes.

Document video support of uni-cast and multi-cast 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 by ping or Telnet session from a remote PC.

3.8.1.4.5. **Pan-Tilt Mechanism**. Exercise pan, tilt, zoom, and focus on all directions, and execute at least three 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 involve documenting settings used to meet functional requirements while providing a margin for adjustment when future conditions change. Use the Department control software (when available) to perform subsystem testing. At minimum, use this software to verify commands and confirmations, as well as detector actuations and occupancy dwell time. The Contractor must be 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, stand-alone test, and system integration test for all subsystems, provide completed data forms containing all 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, 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 prior approval. 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 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, for the system and each component of the network.

Provide all additional test results for review once a successful data communications test has been completed. If all the requirements of this Specification have been satisfied, Contract time must stop, and all subsystems must be placed into operation and operate as a complete system for 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 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 hr. 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 subsystems integration test results and resume Contract time. Provide any necessary corrections and resubmit subsystems integration test results and a request to begin a final acceptance test that may include as-built plans and a data communications test.

The CCTV field equipment under this Specification will not be accepted until the system, including all subsystems, has operated satisfactorily for 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 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. If a unit requires replacement, provide a new unit, and then repeat the test until successfully completed. Major discrepancies that will delay receipt and acceptance of the unit will be enough 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. 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, on 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 system 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 more than 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 five copies of the test procedures, including 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 must resubmit if necessary rejected test procedures for final approval within 10 days. Review time is in calendar days. Conduct all tests in accordance with the approved test procedures.

Conduct basic functionality testing before removal of CCTV field equipment. Test all functional operations of the equipment in the presence of Contractor and Department representatives. Ensure that both representatives sign the test report indicating that the equipment has passed or failed each function. Once removed, the equipment will become the responsibility of the Contractor until accepted by the Department. Compare test data before removal and test data after installation. 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 that failed after relocation but passed before removal.

3.8.2.2. **Post-Test**. Testing of the CCTV field equipment is to relieve the Contractor of system maintenance. 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 is not 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 the data taken as well as quantitative results for all tests. Submit the test data forms at least 30 days before the day the tests are to begin. Obtain approval of test procedures before submission of equipment for tests. Send at least one copy of the data forms to the Engineer.

Conduct an approved stand-alone test of the equipment installation at the field site. At minimum, exercise all stand-alone (non-network) functional operations of the field equipment with all the equipment installed per the plans as directed. Complete the approved data forms with test results and submit to the Engineer for review and either acceptance or rejection of equipment. Provide at least 30 working days' notice before all tests to permit the Engineer or their 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 must, at minimum, exercise all remote control functions and display the return status codes from the controller.

If any unit fails to pass a test, prepare and deliver a 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 the Contract period.

3.9. **Warranty**. Warrant the equipment against defects or failure in design, materials, and workmanship for at least 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 must be repaired or replaced at the Contractor's expense before 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 on installation, operations, programming hardware settings, IP programming, port settings, testing, maintenance, troubleshooting, and repair of all equipment specified herein for at least 24 hr., unless otherwise directed, for up to 10 representatives designated by the Department. 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. Consider operations using 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 price bid 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 price bid 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 price bid 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 price bid 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; 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 price bid 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; testing, delivery, and storage of components designated for salvage; and all testing training, software, equipment, labor, materials, tools, and incidentals.

Special Specification 6027

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 conformance with the details shown on the plans and in these Specifications.

Furnish, install, splice, and test new fiber optic cable. Provide 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 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 fiber optic cable from the same manufacturer and confirm the manufacturer is ISO-9001 certified. Ensure the cables meet or exceed United States Department of Agriculture Rural Utilities Service (RUS) CFR § 1755.900, ANSI/ICEA S-87-640, and Telecommunications Industry Association/EIA- (TIA/EIA-) 492CAAB.

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 microns (µm) ±0.7 µm and a cladding diameter of 125 µm ±0.7 µm. 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 and Clad Concentricity**. Provide an offset between the center of the core and cladding less than 0.5 µm.

2.3.3. **Mode Field Diameter**. Provide single-mode fiber optic cable with the effective area or mode field diameter of the fiber 9.2 µm ±0.4 µm at 1,310 (nanometers [nm]) and 10.5 µm ±1.0 µm at 1,550 nm.

2.3.4. **Primary Coating**. Provide fiber with a coating diameter of 250 µm ±15 µm.

2.3.5. **Attenuation**. Provide single-mode fiber optic cable with nominal attenuation of 0.35 dB/km maximum at a wavelength of 1,310 nm and nominal attenuation of 0.25 dB/km maximum at a wavelength of 1,550 nm.

Attenuation at water peak must be less than 0.35 dB/km at 1,383 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 1,310 nm, and
- 18 ps/nm-km at a wavelength of 1,550 nm.

Zero-dispersion wavelength must be between 1,300 nm and 1,324 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 1,260 nm for single mode fibers specified to operate at 1,310 nm. The cutoff wavelength must be less than 1,480 for single mode fibers specified to operate only at 1,550 nm or higher.

The macrobend attenuation per 100 turns must not exceed 0.05 dB at 1,310 nm and 1,550 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 -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 the NESC, for the maximum span and sag information as shown on 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 1.0–3.0 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 them 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 one set of fibers while the others remain continuous. 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 that 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 ultraviolet (UV) protection for the cable. Ensure each cable is marked with the manufacturer's name, the date of manufacture (mo. and yr.), 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 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 conformance 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–158°F.

3.2. **Fiber Optic Accessories**.

3.2.1. **Splice Enclosures**. Furnish and install one of three 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**. Four cable entry ports total—two ports to accommodate backbone fiber of up to 144 fibers and two ports for drop cables of up to 48 fibers.
- **Type 2**. Six cable entry ports total—four ports to accommodate backbone or arterial cables of up to 144 fibers and two ports for drop cables of up to 48 fibers.
- **Type 3**. Eight cable entry ports total—four ports to accommodate backbone or arterial cables of up to 144 fibers and four 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 on the plans. Suspend 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.

Comply with the Telcordia Technologies' GR-711-CORE standard and applicable NEC requirements.

Contain optical fiber splices within a splice enclosure, providing storage for fiber splices, non-spliced fiber, and buffer tubes. Provide enough space inside the enclosure to prevent micro-bending 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 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 on 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 at least four cables, sized to accommodate the cables shown on the plans plus future expansion.

Provide splice enclosures containing mounting brackets with a minimum of four 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. Furnish and install factory-pre-terminated simplex connector patch panel modules with integrated pigtail cable in a protective housing at locations called for in the plans to accommodate the cables being terminated at that point. Each module needs to have a minimum of six fiber termination or connection capabilities. Provide modules with a removable cover having six 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 on the plans. Furnish patch panel housing with an epoxy fill material that is environmentally and temperature stable to permanently secure the connectors and the cable inside the housing to protect the fiber optic components from vibration and shock. Provide housing with strain relief boot around the exiting pigtail cable to provide bend radius protection and short-term retention of at least 200 lbf. Provide housing with integrated mounting notches. Provide patch panel with ST connectors and dust caps installed by the manufacturer. 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 or 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 can 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. Document the designation of each connector on labels and charts. Place charts in the cabinet in an approved heavy plastic envelope.

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 eight connector panel module housings or eight 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 six fiber termination or connector capabilities. Use a pre-assembled compact modular unit with a removable cover for the snap-in simplex connector panel module having six 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 or 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 can must 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-µm coated fiber. The fan-out must occur within the splice tray (no splicing of the fiber required). Allow each tube to fan out each fiber for ease of connectorization. Label 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 three 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-µm 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.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 can be supported when installed in the aerial rack apparatus and the minimum bending radius cannot 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.

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.

Use 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 components for testing and measurements. Take 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 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 include the date of manufacture, cable characteristics (e.g., size, attenuation, and bandwidth), factory test results, cable identification number, and any other pertinent information. Ensure that 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 before 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 600 V. 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, resulting in 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 two-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 enough 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. 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 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.
- 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 into existing or proposed conduit, using 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 the plans for details. Test each optical fiber in the cable for performance and for loss at existing terminations or splices before cutting and removal. Retest following removal and following reinstallation to ensure the removal and reinstallation have not affected the optical properties of the cable. Any fiber optic cable damaged by the Contractor that is to be re-used must be replaced by the Contractor at no cost to the Department, with new fiber optic cable meeting approval. 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 before 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 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, before 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., "OTDR Tests." Record splice losses on a tabular form and submit for approval.

4.9. **Termination Requirements**. Provide matching connectors with 900-µm buffer fiber pigtails of enough 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 with 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 connector-to-connector mating using similar fibers. Ensure that the connector operating range is -40ºF–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 tubes and place coiled fibers into a splice tray. Clean the water blocking compound from optical fibers destined for splice tray use.

Install cable tags at 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 before 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 conformance with the following.

- At least 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, enclosures, or buildings.
- Completion of at least three projects where the personnel pulled at least 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 at least 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 conformance with the following.

4.11.2.1. **Minimum Experience**. At least 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, enclosures, or buildings. Experience must include 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 watertight splice enclosures
- Fusion splicing of fiber optic cable that meets the tolerable decibel (dB) losses within the range of 0.05 dB–0.10 dB for single mode

4.11.2.2. **Completed Projects**. At least three completed projects where the personnel performed fiber optic cable splicing and terminations, system testing, and system troubleshooting and maintenance during the project, and provided training on system maintenance. Each project must have consisted of at least 5 mi. of fiber optic cable installed and measured by project length, not linear feet, of fiber installed. The completed fiber optic cable systems must have been in continuous satisfactory operation for at least 1 yr.

4.12. **Documentation Requirements**. Provide at least two complete sets of fiber optic equipment submittal literature documenting compliance with the requirements of this Specification, including operation and maintenance manuals in bound hard copy format and an electronic version in Adobe PDF format on a CD/DVD or removable flash drive, including 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 Specification, 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
- Proof of minimum experience and completed projects

4.12.1. **Installation Practice**. Submit for approval an electronic copy of the Contractor's installation practices 30 working days before 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 Specification.

4.12.3. **Test Procedures**. Submit test procedures and data forms for the pre-installation, post-installation, subsystem, end-to-end test, and loss budget calculations for approval. Test procedures will require approval before performing tests. Submit one copy of 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 OTDR traces and clearly identifying each event (e.g., fusion splice, jumper, and connector) with the measured loss identified.

4.13. **Testing**. Perform tests in accordance with testing requirements in this Specification, USDA RUS CFR § 1755.900, and TIA/EIA-455-61 test specifications. For tests, provide test forms to be used that compare measured results with threshold values.

4.13.1. **Test Methods**.

4.13.1.1. **OTDR Tests**. Use the OTDR to measure fiber optic cable for overall attenuation (signal loss dB/km); measure fiber cable length; and identify fiber optic cable anomalies, such as breaks. Perform the following four OTDR tests.

- Pre-installation test (Acceptance test)
- Post-installation test
- Post-termination test
- Final end-to-end test

OTDR settings:

- generate a file name for each OTDR scan. The file name must indicate the location or direction from which the test was run, 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 two windows for single-mode cable: 1,310 nm and 1,550 nm.

Provide the current OTDR calibration certificate for the device used, showing the unit has been calibrated within the last year. Show 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 before 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 (1,310 nm and 1,550 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 part one of the final end-to-end test using OTDR as follows.

- Measure the overall fiber cable system length
- Measure the overall system attenuation
- Check for anomalies

Perform part two of the final end-to-end test using a PMLS as follows:

- Measure the absolute power of the fiber optic signal across all links
- 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 × 0.1 dB/splice
- Connector loss budget = number of connectors × 0.75 dB/connector
- Length loss budget = length of fiber optic cable (measured by OTDR) × 0.35 dB/km for 1,310-nm wavelength or 0.25 dB/km for 1,550 nm wavelength

- 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 (at least 16 hr.) for up to 10 representatives designated by the Department on procedures of installation, operations, testing, maintenance, and repair of equipment specified within this Specification. Submit 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. 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
- Methods of recording installation and test data

4.15. **Warranty**. Provide a warranty for materials furnished in this Specification. Ensure that the fiber optic cable, the splice enclosures, splice centers, and cable markers have at least a 2-yr. manufacturer's warranty and that 95% of that warranty remains at the date of final acceptance. If the manufacturer's warranties for the components are for a longer period, those longer period warranties must apply. Guarantee that the materials and equipment furnished and installed for this project perform 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 foot. Fiber optic splice enclosures, rack-mounted splice enclosures, fiber optic patch panels, pre-terminated fiber patch panels, fiber patch panel units, and fiber optic jumpers 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 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.

This price is full compensation for furnishing and installing enclosures whether aerial or underground, 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 "Rack Mounted Splice Enclosure." This price is full compensation for furnishing and installing enclosures in the building as shown in the plans; for the splice housing with doors, splice trays, and hardware; 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 or as directed and performed. This price is full compensation for splicing; testing; and 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 Patch Panel" of the various types and sizes specified. This price is full compensation for furnishing and installing patch panels with connector panel modules with factory pre-connectorized fiber pigtails, patch panel housing with doors, and terminating fibers on the panel as shown on the plans or as directed, 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 "Preterminated Fiber Patch Panels" of the various types and sizes specified. This price is full compensation for furnishing and installing in the cabinet pre-terminated fiber patch panels with pre-connectorized fiber pigtails and terminating fibers on the panel as shown on the plans or as directed, 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 Unit." This price is full compensation for furnishing and installing in the building the 7-ft. high 19-in. rack system with supports, rack end caps, inter-bay storage units, and hardware, 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 Jumpers." This price is full compensation for furnishing and installing the fiber optic jumpers with factory-terminated connectors as shown on the plans or as directed, and for materials, equipment, labor, tools, documentation, warranty, training, and incidentals.

Conduit will be paid for under Item 618, "Conduit" and Item 619, "Intelligent Transportation System (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 price bid 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 materials, equipment, labor, tools, documentation, warranty, training, and incidentals.

Conduit will be paid for under Item 618, "Conduit" and Item 619, "Intelligent Transportation System (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 cable, regardless of cable size; for pulling through conduit or duct; aerial installation; terminating; testing; and 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 cable for salvage, regardless of cable size or number of cables; testing; returning to the Department; and materials, equipment, labor, tools, documentation, and incidentals.

Special Specification 6050
Intelligent Transportation System (ITS) Ground-Mounted Cabinet

1. DESCRIPTION

Furnish, fabricate, deliver, install, and test intelligent transportation system (ITS) ground-mounted cabinets, install Department-furnished ITS ground-mounted cabinets, relocate existing ITS ground-mounted cabinets, or remove existing 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,
- wireless Ethernet radio,
- closed-circuit television (CCTV) field equipment,
- Bluetooth reader,
- automatic vehicle identification,
- loop detection equipment,
- dynamic message sign (DMS) equipment,
- DMS controller,
- lane control signal controller units,
- drop or insert multiplexor or 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,
- Solar power assembly,
- environmental sensor station,
- highway advisory radio,
- terminal servers,
- surge arrestors,
- hardened Ethernet switches, and
- codecs.

Provide each cabinet complete with internal components, back and side panels, terminal strips, harnesses, and connectors. Provide 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. Electronic Industries Alliance (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 Section 2.1., “Electrical Requirements,” of this Specification)
- All necessary installation and mounting hardware

Ensure cabinets are identical in size, shape, and quality for each type as provisioned in the plans or as directed. Equip and configure the cabinet setup 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 before 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 must be simple handheld tools, basic meters, and oscilloscopes.

2. MATERIALS

Provide new materials that comply with the details shown on the plans, the requirements of this Specification, and the pertinent requirements of the following Items.

- Item 421, “Hydraulic Cement Concrete”
- Item 440, “Reinforcement for Concrete”
- Item 449, “Anchor Bolts”
- Item 618, “Conduit”
- Item 620, “Electrical Conductors”
- Item 656, “Foundations for Traffic Control Devices”
- Item 740, “Graffiti Removal and Anti-Graffiti Coating”

2.1. **Electrical Requirements**.

2.1.1. **Primary Input Power Interruption**. Use material that meets the requirements in Section 2.1.4., “Power Interruption,” of NEMA TS 2 for traffic control system, or most current version.

2.1.2. **Power Service Transients**. Use material that meets the requirements in Section 2.1.6., “Transients,” of NEMA 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 its 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 six NEMA Type 5-15R receptacles with surge suppression. Plug outlet strip into GFCI duplex receptacle and label for personnel use.

2.1.4.3. **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 UL-489 listed circuit breakers capable of operating in accordance with Section 2, "Environmental Standards and Test Procedures," of NEMA TS 2-2003, 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.

2.1.4.3.1. **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 conformance with the most current version of the NEC.

2.1.4.3.2. **Accessory Breaker**. Minimum 15 A. Size accessory circuit breaker to protect lighting, door switches, fans, and GFCI duplex receptacle in conformance with the most current version of the NEC.

2.1.4.3.3. **Equipment Breakers**. Minimum 15 A. Size equipment breaker to protect ITS equipment and duplex receptacles in conformance with the most current version of the NEC.

2.1.4.3.4. **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 three-terminal lightning arrestor to protect the load side of 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.

2.1.4.4. **Power Line Surge Protection**. Provide and install power line surge protection devices that meet the requirements of NEMA TS 1, Section 2.1.6, "Transients, Power Service."

2.1.4.5. **Power Cable Input Junction Terminals**. Provide power distribution blocks suitable for use as a power feed and junction points for two- and three-wire circuits. Accommodate up to No. 4 AWG conductors on the line side of each circuit. Provide appropriate size 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 conformance with the most current version of the NEC.

Use the back panel to distribute and properly interconnect 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. 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 must be obtained from the power distribution terminal board located on the left side panel, which must be 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. Panel must 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 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 enough level of detail so that a translating sheet will not be required to identify the type and size of wire.

Cut 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 wiring containing line voltage AC separately, or shield from low voltage; i.e., control circuits. Cover conductors and live terminals or parts, which could be hazardous to maintenance personnel, with suitable insulating material.

Provide AC internal cabinet wiring identified in conformance 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 conformance 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 Thermoplastic High Heat-resistant Nylon-coated in conformance with the most current version of the NEC. Ensure the insulation has at least a thickness of 10 mm. Ensure 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 two-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 terminals with legends permanently affixed and attached to the terminal blocks.

Ensure not more than three conductors are brought to any one terminal screw.

Ensure no electrically energized components or connectors extend beyond the protection afforded by the barriers.

Locate 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 inter-wiring connections, but not for field connections, are secure conductors by means of a No. 5-32 nickel-plated brass binder head screw.

Terminate connections to and from the electronic equipment to an inter-wiring type block. These blocks will act as intermediate connection points for electronic equipment input and output.

Provide termination panels that are used to distribute and properly interconnect 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 functions available at the equipment terminals that are carried in the connector cable harness.

2.1.10. **Cabinet Internal Grounding**. The cabinet internal ground must consist of at least one 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–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
- Engage cabinet light when the door is opened

Provide two momentary, pin-type door switches for each door provided with the cabinet. Wire one 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, as shown in Table 1.

Table 1
Minimum Cabinet Dimensions

Type	Depth (in.)	Width (in.)	Height (in.)
4	30	24	66
5	26	44	54
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 three-layer graded-pleated type filter with a minimum size of 16 in. (high) × 16 in. (wide) and a thickness of 1 in. For Type 5 cabinet, provide two 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°F–110°F. Provide a press-to-test switch to test the operation of the fan.

Provide at least four commercially available fans with a capacity of at least 110 cu. ft. per minute 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 at least 15-W fluorescent light fixtures above each door inside the cabinet, each with clear shatterproof lens. NEMA TS-2 rated light-emitting diode fixtures are acceptable instead of fluorescent light fixtures. Determine the appropriate number of fixtures to achieve at least 1,000 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.

2.2.5. **Serial Number**. Provide the cabinets with a serial number unique to the manufacturer, preceded by an assigned two-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 righthand 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 one EIA 19-in. rack cage, sized appropriately based on cabinet type inside height dimension. Provide a rack with at least one 1RU (rack unit) horizontal power strip. Provide two Unistrut or DIN rail channels on each sidewall of the cabinet for mounting power panel and auxiliary ITS equipment.

Provide Type 5 and Type 6 cabinets with two side-by-side EIA 19-in. racks, sized appropriately based on cabinet type inside height dimension. Provide a rack with at least one 1RU horizontal power strip. Provide two Unistrut or DIN rail channels on each sidewall 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 1RU 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 at least 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 one slide-out drawer with telescoping drawer guides to allow full extension from the rack frame. Provide at least 1.75-in. (high) × 16-in. (wide) × 14-in. (deep) drawer with a hinged lid to allow access to storage space.

2.3. **Surge Protective Devices (SPDs)**. Provide SPDs to protect electronics from lightning, transient voltage surges, and induced current. Install SPDs on 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 electronic devices. Keep leads as short as possible with 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 conformance with manufacturer's recommendations.

Provide UL-listed Type 1 or Type 2 SPD labeled "UL1449 Third Edition," posted at UL.com, under Certifications UL Category Code VZCA, with a 20-kA I-nominal rating. Provide SPD rated as NEMA 4. SPD with integral electromagnetic interference/radio frequency interference 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, 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 (MOVs) exceeding 32 mm in diameter with thermal safety disconnectors. Gas tube and spark gap SPDs are not 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 used 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 the cabinet on the power distribution to the equipment. Keep leads as short as possible with 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 conformance with manufacturer's recommendations.

Provide UL-listed Type 1 or Type 2 SPD labeled "UL1449 Third Edition," posted at UL.com, under Certifications UL Category Code VZCA, with a 20-kA I-nominal rating. Provide SPD rated as NEMA 4.

Do not exceed 700 V on the VPR on any mode (L-N and N-G).

Do not exceed 150 V on the 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 SCCR.

Provide SPD with directly connected MOVs exceeding 32 mm in diameter with thermal safety disconnectors. Gas tube and spark gap SPDs are not permitted. Ensure each MOV's operational status can be monitored via visual indicator, including N-G mode.

Provide SPD with one set of NO, NC Form C contacts for remote monitoring.

2.3.3. **Low-Voltage Power, Control, Data and Signal Systems SPD.** Install a specialized SPD on 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 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).

Table 2
SPD Minimum Requirements

Circuit Description	MCOV	Frequency/ Bandwidth/ Data Rate	Surge Capacity	Maximum Let-Through Voltage
12 VDC	15 V–20 V	–	5 kA per mode (8 µs × 20 µs)	<150 Vpk
24 VAC	30 V–55 V	–	5 kA per mode (8 µs × 20 µs)	<175 Vpk
48 VDC	60 V–85 V	–	5 kA per mode (8 µs × 20 µs)	<200 Vpk
Coaxial composite video	4 V–8 V	Up to 1.5 GHz	10 kA per mode (8 µs × 20 µs)	<100 Vpk
RS422/RS485	8 V–15 V	Up to 10 Mbps	10 kA per mode (8 µs × 20 µs)	<30 Vpk
T1	13 V–30 V	Up to 10 Mbps	10 kA per mode (8 µs × 20 µs)	<30 Vpk
Ethernet data	7 V–12 V	Up to 100 Mbps	3 kA per mode (10 µs × 1,000 µs)	<30 Vpk

2.4. **Environmental Design Requirements**. Provide cabinets that meet the functional requirements of this Specification during and after subjection to any combination of the following requirements.

- Ambient temperature range of -30°F–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°F–110°F
- Operates with moisture condensation on 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 conformance with the manufacturer's equipment specifications after being subjected to the vibration test as described in NEMA TS 2, Section 2.2.8, "Vibration Test," or the most current version.

3. FABRICATION

3.1. **Ground-Mounted Cabinet**. Continuously weld exterior seams for cabinet and doors. Fill edges to a radius of 0.03125 in. minimum. Smooth exterior welds.

Welding on aluminum cabinets must be by the gas metal arc (metal inert gas) or gas tungsten arc (tungsten inert gas) process using bare aluminum welding electrodes. Ensure electrodes are in accordance with the requirements of AWS A 5.10 for ER5356 aluminum alloy bare welding electrodes.

Procedures, welding machines, and welding machine operators for welding on aluminum must be qualified and be in accordance with the requirements of AWS B 3.0, "Welding Procedures and Performance Qualification," and with the practices recommended in AWS C 5.6.

Construct 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 buildup inside the cabinet. Construct sunshield of 0.125-in. thick aluminum and provide at least 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 using 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 are in accordance with the requirements of ASTM 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 using at least three 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 No. 2 Corbin lock and aluminum or chrome-plated handle with at least a 3/8-in. drive pin and a three-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. Provide a locking ring for a padlock. Provide two keys for the door and two 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 two stainless steel machine screws. Provide cabinet doors with a catch mechanism to hold the door open at three positions: 90°, 120°, and 160°.

Fabricate the door and door stop mechanism to withstand a simulated wind load of 5 lb. per square foot applied to 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 ensure a uniformly dust and weather-resistant seal around the entire door facing.

3.1.2. **Mechanical Components**. Ensure external screws, nuts, and locking washers are stainless steel. Do not use self-tapping screws unless specifically approved.

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 conformance with the ITS ground-mounted cabinet standards. Safety railing will be supplemental to this Specification. 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, unless otherwise specified.

Concrete maintenance pads have been integrated into the foundation design found in 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 will 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 will be supplemental to this Specification.

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. Place wiring in a neat and orderly manner grouped 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 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.

Ground the cable shield after testing and in conformance 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. 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 handheld tools, basic meters, and oscilloscopes.

Mount cabinet plumb in all directions.

4.4. **Removal and Replacement of Curbs and Walks**. The Contractor must secure approval 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 must 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 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. 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 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.

Supply 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 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, respectively, to surrounding objects or individuals. Deliver the cabinet to an address supplied by the Department.

Remove the existing foundation to a depth of 2 ft. below grade with 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.

4.7. **Testing**.

4.7.1. **Installation**. Unless otherwise shown on the plans, perform the following tests on cabinets supplied through this Specification.

4.7.1.1. **Test Procedures Documentation**. Provide five copies of the test procedures, including tests identified in NEMA, Section 4.9.2.–Section 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 on, approve, or reject test procedures within 30 days after

Contractor submittal of equipment for tests. Contractor must resubmit if necessary rejected test procedures for final approval within 10 days before testing. Review time is in calendar days. Conduct tests in conformance with the approved test procedures. The Department may witness 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 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 found 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% 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 is 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 the tests. Perform the following tests.

4.7.1.2.1. **Power Service Transients**. Provide equipment that meets the performance requirements, specified herein, 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 herein, when subjected to the following conditions in the order specified below.

- Stabilize the equipment at -30°F and test as specified in NEMA TS 2, Section 2.2.7.3, “Low-Temperature Low-Voltage Tests,” and Section 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 TS 2, Section 2.2.7.5, “High-Temperature High Voltage Tests,” and Section 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 herein, 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 conformance with the manufacturer’s equipment specifications after being subjected to the vibration tests as described in NEMA TS 2, 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 herein, when subjected to nominal input voltage variations as specified in NEMA TS 2, 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 stand-alone (non-network) functional operations consisting of the following, at 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
- "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 are 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. 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 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 functional operations of the equipment 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
- "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 is 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 is not required to pay for electrical energy consumed by the system.

After existing ITS equipment has been installed, perform the same functional operation test described under NEMA, Section 4.9.2.1. Furnish test data forms containing the sequence of tests, including 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 approval of test procedures before submission of equipment for tests. Send at least two 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 for repair or replacement of those components within the system that failed after relocation but that 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 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 Specification 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 lock
- 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
- Connectors

Submit shop drawings, signed, sealed, and dated by a licensed 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 two 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, Radio-Electronics-Television Manufacturers Association, or EIA
- Pictorial of component layout on circuit board
- Complete maintenance and troubleshooting procedures
- Complete stage-by-stage explanation of circuit theory and operation
- Recovery procedures for malfunction
- Instructions for gathering maintenance assistance from manufacturer

Identify material that 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 at least 5 yr. or in conformance with the manufacturer's standard warranty if warranty period is greater. Assign, to the Department, manufacturer's normal warranties or guarantees on 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 equipment within 30 days of notification of failure by the Department.

5. MEASUREMENT

This Item will be measured by 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 conformance with this Item and measured as provided 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 for 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 or Item 619, "Intelligent Transportation System (ITS) Multi-Duct Conduit."

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 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 for 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 or Item 619.

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 "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; for removing existing foundations; for backfilling and surface placement; for hauling and installing ITS ground-mounted cabinets; for furnishing and placing anchor bolts, nuts, and washers; for appropriately grounding the cabinet; and for 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 or Item 619.

6.4. **Remove**. The work performed and materials furnished in accordance with this Item and measured as provided for "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; for removing existing foundations; for backfilling and surface placement; for loading and hauling; and for equipment, materials, labor, tools, and incidentals necessary to complete the removal of existing ITS ground-mounted cabinets.

Special Specification 6058
Roadway Weather Information System

1. DESCRIPTION

Furnish and install a Roadway Weather Information System (RWIS) to monitor weather conditions at the locations as shown on the project plans. The RWIS must include bridge deck pavement sensors; pavement sensors with integrated pavement temperature probes; and complete weather station to monitor wind information, air temperature humidity, and other items defined in this Item. The system must be specifically designed for monitoring and displaying pavement surface conditions, pavement temperature, freeze point temperature, pavement friction coefficient, and subsurface temperature. Nonintrusive sensors must be installed at the RWIS sites to monitor roadway surface status conditions, including dry, wet, chemical wet, ice watch, ice warning roadway temperature, and roadway grip or friction coefficient.

Atmospheric or meteorological conditions monitored may include any of the following.

- Air temperature,
- Relative humidity,
- Barometric pressure,
- Accumulated precipitation, and
- Wind or speed direction.

The information from the RWIS sites will be transmitted back to the Transportation Management Center by the Department's Intelligent Transportation System (ITS) network, where the data will be presented to the operations staff. The Department's Lonestar™ software will poll the RWIS to ask for data on a preset time interval specified by the Department to transfer and refresh with current conditions. Data from the RWIS must comply with standard National Transportation Communications for Intelligent Transportation System Protocol (NTCIP).

The RWIS must include all hardware, software, and licenses to operate as follows.

- Nonintrusive surface sensors will measure bridge deck or roadway pavement surface temperature, roadway grip or friction coefficient, and surface wetness, and communicate the data to the remote processing unit (RPU).
- Roadway atmospheric sensors will measure their respective weather parameters and communicate the data from each sensor to the RPU.
- Atmospheric weather sensors will measure their respective weather parameters and communicate the data from each sensor to the RPU.
- RPU will acquire data from all connected sensors. The RPU will process and temporarily store the output from the pavement sensors and atmospheric sensors.
- RWIS server will poll the RPU of each local RWIS system on a scheduled basis. The RPU will respond to the poll and transfer all its data to the RWIS server.
- All data transfers between the RWIS server and local RWIS must be compliant with federal standard NTCIP Environmental Sensor Station (ESS) protocols.
- RWIS user displays will include all sensor and historical data in a Windows-based graphical user interface or browser-based data display format.

2. MATERIALS

2.1. **RWIS RPU**. Furnish and install a controller-mounted RPU at locations as shown on the project plans.

The RPU must gather, process, and store data from all connected atmospheric sensors, pavement sensors, and camera. The data must be transmitted to Lonestar™ upon polled request by NTCIP ESS protocols.

The RPU must be a ruggedized industrial PC with an operating system using Windows-CE. The unit must have an integrated LCD touch screen; size must be at least 7 in. The integrated LCD touch screen display will allow any person at the site to work on the RWIS site without the need for a service laptop in case of such onsite activities as setups, firmware-uploads data views, extensions, or parameter settings. The RPU must be fully NTCIP-compliant. The RPU must be password-protected.

Integration of new sensors must be accomplished by plugging in digital or analog modules along a DIN rail.

The RPU and module units must allow for the following.

- Galvanic isolation between sensor supply and communication,
- Host communication by RS232 (PC/GPRS-modem), RS485 (EAK),
- Small housing with top hat rail mounting and bus connection,
- Firmware update by RS232,
- Common power supply (24V) for UMB modules and (heated) sensors,
- Online data transfer (no memory),
- Network with up to 32 modules,
- Communication watchdog for reliable sensor function (reset),
- Overvoltage protection for all interfaces,
- LED indication for operation mode,
- Power supply 20 VDC–28 VDC,
- Power consumption 10 VA,
- Ambient temperature -22°F–140°F,
- Relative humidity <90%,
- USB Interface USB2.0B,
- CDMA modem, GPRS modem, Ethernet connectivity, and UMB bus interfaces,
- Display size 7- in.,
- Display resolution 800 × 480 pixel,
- DIN rail and modules,
- Power supply 12 VDC–26 VDC,
- Power consumption <100 mA,
- Ambient temperature -22°F–140°F,
- Relative humidity <95%,
- Protection type Ingress Protection (IP) 20,
- Module width 1-in.,
- RS232 connector DSUB9, and
- Sensor connector screw-type.

The RPU must have the capability of being modified to use solar power or other power sources in place of conventional commercial electric power. Solar-powered RPU sites must operate at least 72 hr. without sunlight or solar charging of the batteries. Autonomy will be calculated based on the type and quantity of sensors as indicated by the plans or as directed and in accordance with Specifications.

The RPU hardware and software must meet the following technical specifications.

The RPU must be able to collect data from all connected sensors and remote pavement sensors, and process, store, and transmit these data to the RWIS server upon polled request. The RPU must be capable of collecting data from the following sensors.

- Wired precipitation radar-based type sensor,
- Wired air temperature and relative humidity sensor,

- Wired road surface and subsurface sensors,
- Wired subsurface sensor,
- All-in-one smart atmospheric sensor,
- Nonintrusive pavement condition and temperature sensor,
- Nonintrusive Doppler radar water level sensor,
- Rain sensor,
- Mechanical and ultrasonic wind speed and direction sensor,
- Barometric pressure sensor, and
- Wired pan-tilt-zoom camera.

The RPU must include an IP66, NEMA 4X-rated lockable aluminum steel AISI 316 enclosure that is resistant to weather, sunshine, deicing chemicals, corrosion, and damage from falling debris (ice, small rocks, and tree branches) and vandalism. The enclosure must be capable of being mounted on poles with an outside diameter range of 6 in.–24 in. The enclosure must house all RPU electronics, power supplies, and communication equipment, and not exceed 30-in. height × 24-in. width × 12-in. depth dimensions.

RPU communication with the server must use federal standard NTCIP ESS protocol, with some manufacturer-specific objects. The server must poll the RPU by one of the following communications modes.

- Ethernet,
- PMPP leased line,
- PMPP spread spectrum radio, or
- PMPP serial fiberoptic.

The RPU must incorporate watchdog circuitry, monitor its own operation, and reset itself if the RPU software enters an indeterminate state. The RPU must also have the capability to be reset by a “user administrator” from the server.

2.2. **RPU Mounting Requirements**. The RPU panel must be enclosed inside an RWIS-specific communication cabinet, traffic signal controller cabinet, ITS cabinet, or communications building as shown on the plans.

2.3. **All-in-One Atmospheric Sensor (Air Temperature/Relative Humidity/Barometric Pressure/Ultrasonic Wind Speed and Direction)**. The sensor design must be an all-in-one design within one sensor housing to allow ease of installation, maintenance, and upgrades. The sensors form factor must be of one integrated unit. Multiple sensors are not allowed. The sensor must support remote firmware upgrades without the need for personnel to be onsite; include wind detection with birdproof construction; and be a compact all-in-one weather sensor with low power, heater, aspirated radiation shield, maintenance-free operation, and open communication protocol.

The sensor must measure temperature, relative humidity, precipitation intensity, precipitation type, precipitation quantity, air pressure, wind direction, and wind speed.

The measurement technology must be Ultrasonic/Wind, NTC/T, Capacitive/RH, MEMS Capacitive/Pressure, 24-GHz Doppler Radar/Precipitation.

The ultrasonic wind sensor must be precise and maintenance-free while delivering measurement of wind velocity and wind direction, as well as calculation of acoustic virtual temperature. The digital or analog output must deliver instantaneous, average, minimum or maximum value with a flexible measuring rate. The unit must be heated to remove frost and ice formation from the sensor.

The sensor must operate within a minimum temperature range of -40°F–140°F at 0%–100% relative humidity and meet an IP66 rating. The sensor must operate to Specifications at cable lengths up to 324 ft. from the RPU.

The sensor must operate within a power range of 11 VDC–32 VDC. The sensor must include RS-485 two-wire serial data communication and resistance level outputs.

Communication and power cable connecting the combined sensor to the RPU must be shielded, with ultraviolet (UV) stable jacket rated for outdoor use. The Contractor is responsible for providing the correct length of cable based on the planned installation.

The sensor must include all mounting hardware necessary to complete the installation.

2.3.1. **Temperature**.

- **Principle**. NTC.
- **Measuring Range**. -58°F–140°F.
- **Accuracy**. ±0.2 (-4°F–122°F), otherwise ±0.5 (>-22°F).

2.3.2. **Relative Humidity**.

- **Capacitive**.
- **Measuring Range**. 0%–100%.
- **Accuracy**. ±2%.

2.3.3. **Precipitation (Liquid)**.

- **Principle**. 24-GHz Doppler radar.
- **Droplet Size**. 0.011 in.–19 in.
- **Detection Sensitivity**. 0.0003 in/h.
- **Particle Velocity**. 0.2 mph–34.6 mph.
- **Precipitation Types**. Rain/snow.
- **Solid Precipitation**. 0.20 in.–~1.18 in.
- **Intensity Range**. 0.00196 in/h–0.00780 in/h.
- **Intensity Resolution**. 0.00039 in/h.
- **Amount Resolution**. 0.0039 in.
- **Accuracy**. 20% under laboratory conditions.
- **Reproducibility**. Typical >90% under laboratory conditions.

2.3.4. **Air Pressure**.

- **MEMS Capacitive**.
- **Measuring Range**. 300 hPa–1,200 hPa.
- **Accuracy**. ±0.5 hPa (32°F–104°F).

2.3.5. **Wind Direction**.

- **Ultrasonic**.
- **Measuring Range**. 0°–359.9°.
- **Accuracy**. <3° RMSE >2.2 mph.
- **Resolution**. 0.1.
- **Startup Threshold.** 0.67 mph.

2.3.6. **Wind Speed**.

- **Ultrasonic**.
- **Measuring Range**. 0 mph–134 mph.
- **Accuracy**. ±0.67 mph or ±3% (0 mph–78 mph) ±5% (>78 mph) RMSE.
- **Resolution**. 0.22 mph.
- **Startup Threshold**. 0.67 mph.

2.4. **Precipitation Sensor (Standalone Sensor)**. Precipitation detection sensors must be versatile instruments that can function as a precipitation classifier and a precipitation rate meter. The radar-based precipitation sensor must be able to differentiate type, size, and intensity of falling precipitation. The precipitation sensor must sense the onset and cessation of precipitation in the form of rain, snow, sleet, and freezing rain, and must indicate when precipitation is occurring. The sensor must provide all precipitation classification and measurements of intensity. The sensor must operate within a minimum temperature range of -40°F–140°F at 0%–100% relative humidity and meet an IP66, IP67 rating. The sensor must operate to Specifications at cable lengths up to 100 ft. from the RPU.

The sensor must operate within a power range of 12 VDC–30 VDC and use no more than 5W of power. The sensor must include RS-232, RS-485 data communication and 4-mA–20-mA outputs, and be capable of operating to Specifications at cable lengths up to 100 ft. from the RPU.

Communication and power cable connecting the sensor to the RPU must be shielded, with UV stable jacket rated for outdoor use. The Contractor is responsible for providing the correct length of cable based on the planned installation.

Optical precipitation sensors are not allowed. The measuring technology must be Doppler radar. The sensor must support remote firmware upgrades without the need for personnel to be onsite.

2.5. **Air Temperature and Relative Humidity Sensor (Standalone Sensor).** The air temperature and relative humidity sensor must have an air-temperature sensing element that measures temperatures within a minimum range of -40°F–140°F with an accuracy within 1° of actual temperature. The relative humidity sensing element must be of the capacitance type and have a measuring range of 10%–100% within 1% of actual humidity levels. The sensor must be protected by UV-stabilized white thermoplastic solar- and wind-radiation shield and meet IP66 rating.

System dew point temperature will be calculated by the system from the air temperature and relative humidity. Both atmospheric sensing elements must be mounted on the RWIS tower at the standard meteorological height of approximately 6 ft. above ground level.

The sensor must operate within a power range of 7 VDC–30 VDC and use no more than 5W of power. The sensor must include RS-485 two-wire serial data communication, 0V–10V, and resistance-level outputs, and be capable of operating to Specifications on cable lengths up to 100 ft. from the RPU.

Communication and power cable connecting the combined sensor to the RPU must be shielded, with UV stable jacket rated for outdoor use. The Contractor is responsible for providing the correct length of cable based on the planned installation.

The sensor must include all mounting hardware necessary to complete the installation.

2.6. **In-Pavement Roadway Sensor.** Furnish and install intrusive pavement sensors as shown on the project plans or as directed. The intrusive sensor supplied must be a single solid-state electronic device that is installed in the roadway or bridge deck pavement at the locations as shown on the plans or as directed. Exact sensor placement will be as determined by the Engineer with guidance from the equipment supplier.

The sensor must be constructed of materials that have thermal characteristics similar to common pavement materials. The top of the sensor must be installed with epoxy sealer so the top is flush with the surrounding roadway surface. The sensor must be thermally nonintrusive, providing stable operation over a temperature range of -40°F–140°F. Weather conditions, traffic, or ice control chemicals must not degrade its performance. The sensor must be supplied with 300 ft. of attached molded cable that is waterproofed and sealed as an integral part of the assembly. Each sensor must be capable of operating at extended cable lengths up to 4,000 ft. from the RPU by splicing to direct-burial sensor extension cable.

The in-pavement sensors must allow for the removal of the electronics after installation of the sensor in the roadway. This must be accomplished without the use of coring or other pavement-altering means. The electronics must be field-replaceable. The sensor must support remote firmware upgrades without the need

for personnel to be onsite. Although only one may be required, the in-pavement sensor must allow for two subsurface probes to extend from the housing. Separate subsurface probes from the passive sensor are not allowed.

The sensor must operate within a power range of 9 VDC–14 VDC, typically 12 VDC. The sensor must include RS-485 two-wire serial data communication, baud rate from 2,400 bit/s–38,400 bit/s, Standard 19200. The sensor must meet IP68 rating.

The sensor must electronically sample the following pavement parameters.

- Detectable road conditions (dry/damp/wet/ice or snow/residual salt content/freezing wetness).
- Surface temperature at the sensor head.
- Pavement surface conductivity, friction coefficient.
- Road surface temperature and below-ground temperature, with depth of subsurface up to 3 ft.
- Water film height using radar technology up to a resolution of 0.0004 in.
- Dry is absence of moisture on the surface sensor.
- Trace moisture is when pavement moisture is above freezing (no precipitation).
- Wet is when precipitation has occurred and there is a continuous film of moisture on the pavement sensor.
- Chemically wet is continuous film of water and ice mixture at or below freezing (32°F) with enough chemical to keep the mixture from freezing, and precipitation is not occurring.
- Ice warning is continuous film of ice and water mixture at or below freezing (32°F) with insufficient chemical to keep the mixture from freezing (active precipitation).
- Ice watch is thin or spotty film of moisture at or below freezing (32°F), and precipitation is not occurring.

After bid opening and before Contract execution, the successful Contractor must supply actual field test documentation that substantiates pavement sensor performance.

2.7. **Subsurface Temperature Probe**. Furnish and install the subsurface temperature probes in the roadway at a depth of 18 in. The probe will measure the ground temperature below the roadway pavement surface. The temperature-sensing element of the probe must operate over a temperature range of -40°F–140°F.

The probe must be supplied attached to the in-pavement sensor canister with cable that is waterproofed and sealed as an integral part of the assembly. Each sensor must be capable of operating at extended cable lengths up to 4,000 ft. from the RPU.

The wired subsurface sensor must be installed per manufacturer's recommendations to detect temperature at a depth of 18 in. Exact placement of the sensor must be as determined by the field engineer with guidance from the manufacturer. All cabling for the sensor, where it is not embedded in the road, must be installed in conduit at a minimum depth of 36 in. Installation must eliminate all cable splicing. The sensor must be configured and calibrated to function as designed with the RPU.

2.8. **Nonintrusive Pavement Condition and Temperature Sensor**. The noninvasive road weather sensor must work with optical technology and measure surface conditions such as wetness, ice, snow, or frost, as well as water film height, ice percentage, and freeze point temperature. It must also provide friction coefficient and optional freeze point data of the pavement and roadway surface. The sensor must support remote firmware upgrades without the need for personnel to be onsite. The sensor must measure the roadway parameters using infrared technology. Laser technology is not permitted.

The sensor must be capable of accurate measurements within a minimum range of 7 ft.–40 ft. The sensor must operate in a minimum temperature range of -40°F–140°F at 0%–100% relative humidity. The sensor must measure road surface temperature from -40°F–158°F. The sensor must measure water film height using optical technology for a range of 0 in.–0.0787 in. for water and 0 in.–0.3937 in. for snow. The sensor must meet IP65 rating.

The sensor must be powered from a 9-VDC–30-VDC source and use no more than 4W of power. The sensor must provide RS-232 and RS-485 serial data communication interfaces and be capable of operating to Specifications at cable lengths up to 300 ft. from the RPU for RS-232 and 495 ft. from the RPU for RS-485.

If the RWIS is greater than 25 ft. from the white edge line of the roadway being measured, then the nonintrusive pavement condition sensor must include a steel pole with breakaway assembly per Department standards and underground conduit to install the sensor at an appropriate height to detect conditions of the closest lane of travel.

Communication and power cable connecting the sensor to the RPU must be shielded, with UV stable jacket rated for outdoor use. The Contractor is responsible for providing the correct length of cable based on the planned installation.

The sensor must include all mounting hardware necessary to complete the installation. The quantity of nonintrusive pavement condition sensors and desired sensor detection location must be provided on the plans or directed.

The sensor must include all mounting hardware necessary to complete the installation.

2.9. **Wind Speed Sensor (Standalone Sensor)**. The wind monitor sensor must be installed at the standard meteorological height of approximately 30 ft. above ground level. The sensor must be mounted such that birds are not able to perch or nest on the sensor. The sensor may be a combination wind speed and direction sensor of lightweight corrosion-resistant construction. The sensor must be based on three-transducer ultrasonic technology and not have any moving parts.

The sensor must have an operating range of 0 ft./sec.–200 ft./sec., with a survival operation limit of 279 ft./sec. Accuracy must be +1 ft./sec. Wind speed resolution must be 1.0 ft./sec. Wind direction accuracy must be +2%. Wind direction resolution must be 1°. The sensor must operate within a minimum temperature range of -40°F–140°F, and the sensor must meet IP66 and IP67 ratings.

The sensor must operate within a power range of 9 VDC–40 VDC and use no more than 30W of power. The sensor must include 0-mV–5,000-mV analog and RS-232/RS-485 digital outputs and be capable of operating to Specifications on cable lengths up to 100 ft. from the RPU.

Communication and power cable connecting the sensor to the RPU must be shielded, with UV stable jacket rated for outdoor use. The Contractor is responsible for providing the correct length of cable based on the planned installation.

The sensor must include all mounting hardware necessary to complete the installation.

2.10. **Pan-Tilt-Zoom Camera (Optional)**. The pan-tilt-zoom camera must be furnished by the Department and installed per manufacturer recommendations on the RWIS approximately 3 ft. below the top of the structure or on top of the structure or as directed, and configured for a minimum of two preset positions as determined. The installation of the pan-tilt-zoom camera will be paid for under bid item 6010-6011 CCTV FIELD EQUIP (DIGITAL)(INSTL ONLY).

The Contractor is responsible for using the appropriate communication protocol based on RPU-to-sensor connection to maximize communications reliability.

All sensor and camera cables connecting to the RPU must be secured to themselves and the structure every 3 ft. Cables should enter through the bottom of the RPU enclosure, be labeled by sensor type and location where applicable, and connect to the appropriate port on the RPU. All cabling must be installed in a neat and workmanlike manor.

2.11. **Nonintrusive Surface Water Level Flood Sensor (Optional Sensor for Roadway Flood Detection)**. This device is a surface water measurement sensor that uses maintenance-free radar measurement technology.

The sensor must measure water level and distance to water. The measurement technology must be noncontact pulse radar. Measurement range must be from 1.3 ft.–115 ft. The sensor must be capable of measuring water level or depth to water from a bridge, pier, or mounting arm.

The sensor must operate within a temperature range of -40°F–140°F and meet IP67 rating. The sensor must operate within a power range of 5 VDC–28 VDC. The sensor must include RS-485 serial data communication interface using SDI-12 interface.

Communication and power cable connecting the sensor to the RPU must be shielded, with UV stable jacket rated for outdoor use. The Contractor is responsible for providing the correct length of cable based on the planned installation. The sensor must include all mounting hardware necessary to complete the installation.

3. CONSTRUCTION

Install the RWIS in accordance with the RWIS vendor's recommendations; the plans; Standard Specifications; and all federal, state, and local codes and requirements. The Contractor is responsible for providing all traffic control and safety work zones for the installation of the roadway sensors in conformance with Department traffic control requirements.

To be able to add future measuring points or capabilities into the system, which could include, but not be limited to, data communication, visualization, and alerting by the system, the entire data structure of the system must be provided. This includes, but is not limited to, sensor protocols, RPU protocols, and administrative rights to the system. This will allow a third party, other than the manufacturer, to perform integration into the data structure and software visualization.

3.1. **RWIS System Commissioning**. Upon completion of the RWIS system equipment installation, the system vendor must provide an onsite field engineer to start up and test the entire system. This engineer will make all final sensor connections to the RPU and perform all final system checks, sensor alignments, software setup, and software configuration to provide a fully operational RWIS system.

3.2. **RWIS System Vendor**. Furnish a detailed description (technical cut sheets) of the RWIS to be supplied by the Contractor and the experience of the vendor or manufacturer in supplying such RWIS to other like agencies.

Before any award, the Department may require the Contractor to demonstrate the proposed RWIS can provide interoperability and connectivity to the existing statewide RWIS system. The RWIS equipment vendor chosen by the Contractor must have at least 10 successful RWIS system installations in North America. As part of the equipment approval process, the Department may ask the Contractor to provide the names of at least five agencies, with names, telephone numbers, and contact person to verify said RWIS installations were successful.

3.3. **Warranty**. Provide a limited, onsite warranty covering all equipment for a 24-mo. period from the RWIS commissioning date and 1-yr. telephone technical support at no additional charge to the Department. The technical support must include access to a trained service representative who can respond within 24 hr. to questions related to all RWIS-related equipment problems and maintenance issues.

3.4. **RWIS System Equipment Warranty**. Furnish all RWIS system equipment for this project that will be state-of-the-art and in current manufacture at the time of purchase. The vendor must factory-warranty the RPU and sensors for not less than 36 mo. Batteries will be supported by their respective manufacturer's warranty.

3.5. **Training**. Provide at least 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.

The training session must be conducted by the vendor representative. 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. The Department will determine the training location and provide the training facility. Provide one copy of the course material for each person.

Provide training in the following areas of interest and as shown on the plans or as directed.

- Hands-on operation for each type of equipment;
- Explanation of all system commands, their function, and use;
- Required preventive maintenance procedures;
- All equipment servicing procedures; and
- System troubleshooting or problem identification procedures.

4. MEASUREMENT

This Item will be measured by the complete RWIS installed and by each individual RWIS component installed. The cable will be subsidiary to each component 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 bid price for "Furnish and Install Roadway Weather Information System," "All-in-One Atmospheric Sensor," "Precipitation Type Sensor," "Air Temperature/Relative Humidity Sensor," "Road Surface Sensor," "Subsurface Sensor," "Non-Intrusive Pavement Condition and Temperature Sensor," "Rain Sensor," "Windspeed/Direction Sensor," "Barometric Pressure Sensor," and "Non-Intrusive Surface Water Level Flood Sensor." This price is full compensation for furnishing, placing, and testing all materials and equipment; mounting equipment; accessories; software licensing; and all tools, labor, supplies, and incidentals. All incidental items, including costs associated with arranging for the manufacturer's representative to be onsite during installation, commissioning, and testing, will not be paid for separately, but will be subsidiary to "Furnish and Install Roadway Weather Information System."

Special Specification 7101-RMA

Intelligent Transportation System (ITS) Media Converter

1. DESCRIPTION

Furnish, install, and test media converter of the type specified in designated Intelligent Transportation System (ITS) field equipment cabinets as shown on the plans.

An Ethernet media converter is defined as a device that transmits and receives data by means of Ethernet communication and converts Ethernet RJ-45 electrical signals to single mode optical format and from single mode optical format to Ethernet RJ-45 electrical format.

A serial media converter is defined as a device that transmits and receives data by means of serial communication and converts RS-232 communication media for transport over TCP/IP through an Ethernet RJ-45 port. A serial media converter is commonly referenced in the industry as a field terminal server or port server.

2. MATERIALS

2.1. **Ethernet Media Converter.**

2.1.1. **Functional Requirements**. Provide a Ethernet media converter that supports data transmission over Ethernet communication and operates over two single mode or multimode fibers and be full duplex. Provide a media converter with fiber ports to support the network topology as identified on the plans.

Furnish a media converter that is stable, easily configurable with minimal effort, and able to communicate with other media converters through optical modulation. The media converter must have a fail-safe design such that device failure does not cause failure of any other equipment.

Provide a media converter with diagnostic light emitting diodes (LED) for power, receive optical signals present or absent, transmit laser current/over current, and data activity levels (link/speed) for the transmitter and the receiver portion of the device.

2.1.2. **Electrical Requirements.**

2.1.2.1. **Power Requirements.** Provide a separate power supply providing a maximum 48 VDC for each media converter, to be provided as part of this Item. Maximum power draw must be less than 10 W each.

Provide each separate power supply capable of operating at 120 VAC ± 15 VAC at 60 Hz.

2.1.2.2. **Surge Protection.** Install media converter in an environment that has protection from power surges and sags.

2.1.2.3. **Power Service Transients.** Supply equipment in accordance with the requirements in the National Electrical Manufacturers Association (NEMA) Standard TS-2 for Traffic Control System, Sec. 2.1.6, “Transients” or latest revision.

2.1.2.4. **Wiring.** Meet the requirements of the most current version of the National Electric Code (NEC). Provide wires that are cut to proper length before assembly. No splicing of cables permitted. Provide cable slacks to facilitate removal and replacement of assemblies, panels, and modules. Doubling back of any wire to take up slack is not permitted. Lace wires neatly together with nylon lacing or outdoor rated plastic straps. Secure the cables inside the cabinet with outdoor rated plastic straps.

2.1.3. **Ethernet Port Configuration.** Provide a media converter with one copper Ethernet RJ-45 port that has the following characteristics:

2.1.3.1. **Interface.** 10/100Base-TX (100 Mb) or 10/100/1000 Base-TX (Gigabit) Ethernet, automatic half/full duplex setting, and link fault pass through with a female RJ-45 connector as shown on the plans.

2.1.3.2. **Medium Dependent Interface.** Automatic Medium Dependent Interface (MDI) and Medium Dependent Interface-Crossed (MDI-X).

2.1.3.3. **Bandwidth.** Up to 328 ft. cable length at 10 Mbps on Category 3, 4, or 5 unshielded twisted-wire pair cable. Up to 328 ft. cable length at 100 Mbps on Category 5e and 6 unshielded twisted-wire pair cable.

2.1.3.4. **Diagnostics.** Provide port with LED link status indicator.

2.1.4. **Fiber Optic Port Configuration.** Provide a media converter with fiber optic interface port as required for the network topology that has the following features:

2.1.4.1. **Interface.** 10/100 Base-X (100 Mb) or 10/100/1000Base-X (Gigabit) Ethernet as shown on the plans.

2.1.4.2. **Optical Connectors.** Provide connectors of the same connector type to be compatible with the fiber interface requirements on patch panel equipment as shown on the plans or as directed.

2.1.4.3. **System bandwidth.** 10/100Base-X up to 2 km at 100 Mbps on multimode fiber optic cable, and up to 20 km at 100 Mbps on single mode fiber optic cable.

10/100/1000Base-X up to 20 km at 1000 Mbps on single mode fiber optic cable.

2.1.4.4. **Media Wavelength.** Media converter must operate in the 1310 nm wavelength for single mode fiber optic cable. Media converter must operate in the 850 nm or 1310 nm wavelength for multimode fiber optic cable as shown on the plans or as directed.

2.1.4.5. **Link Budget/Attenuation.** Single mode and multimode fiber operates over 0 to 21 dB path attenuation.

2.1.5. **Protocols Supported.** Provide a media converter that supports the following protocols:

- IEEE 802.3,
- IEEE 802.3ab 1000Base-T,
- IEEE 802.3u 100 Base-T,
- IEEE 802.3i 10 Base-T, and
- IEEE 802.3x for flow control.

2.1.6. **Visual Indicators.** Provide a media converter that has the following visual indicators:

- power,
- fiber link/activity
- UTP link/activity, and
- full/half duplex.

2.1.7. **Regulatory Approvals.** Provide a media converter that has been certified to the following regulatory standards.

- Product Safety: Underwriters Laboratories (UL) Standard 1950 and 60950,
- Electromagnetic Emissions: Federal Communications Commission (FCC) Part 15, Class A, National
- Electrical Manufacturers Association TS2, or latest revision, and
- Institute of Electrical and Electronic Engineers (IEEE) 802.3 compliant.

2.2. **Serial Media Converter.**

2.2.1. **Functional Requirements.** Provide a serial media converter that supports data transmission over serial and Ethernet communication. Serial data received must be full duplex and conform to all requirements of Electronic Industries Associations (EIA) Standard RS-232, RS-422, and RS-485 governed by the Electronic Components Associations (ECA). Provide a serial media converter that can integrate with existing ITS field equipment and hardware in the field.

Furnish a serial media converter that is stable, capable of plug-and-play operation, and able to communicate with other media converters through optical modulation. The media converter must have a fail-safe design such that device failure does not cause failure of any other equipment.

Provide a serial media converter with diagnostic LED for power, transmit and receive signals present or absent, transmit laser current/over current, and data activity levels (link/speed) for the transmitter and the receiver portion of the device.

2.2.2. **Electrical Requirements.** Meet the requirements specified under Section 2.1.2.

2.2.3. **Ethernet Port Configuration.** Provide a serial media converter meeting the requirements specified under Section 2.1.3, except as modified below:

2.2.3.1. **Interface.** Provide one 10/100Base-TX (100 Mb), automatic half/full duplex setting, and link fault pass through with a female RJ-45 connector as shown on the plans.

2.2.4. **Serial Port Configuration.** Provide a serial media converter with the number of serial ports as shown on the plans.

2.2.4.1. **Interface.** Serial data received must be full duplex and conform to all requirements of Electronic Industries Associations (EIA) Standard RS-232, RS-422, and RS-485 governed by the Electronic Components Associations (ECA).

Provide EIA-232 compatible ports with a minimum of one EIA-422 and EIA-485 switch selectable port.

Provide a RJ-45 to DB-9 crossover cable with each unit for configuration in the field.

2.2.4.2. **Bandwidth.** Cable length drives up to 50 ft. on minimum of 24 American Wire Gauge (AWG) cable at 115 kbps (RS-232).

Cable length drives up to 4000 ft. on minimum of 24 AWG cable at 115 kbps (RS-422/485).

2.2.5. **Protocols Supported.** Provide a serial media converter that supports the following protocols:

- IEEE 802.3,
- IEEE 802.3u 100 Base-T,
- IEEE 802.3i 10 Base-T,
- IEEE 802.3x for flow control,
- Transport Control Protocol (TCP)/User Datagram Protocol (UDP) Socket Services,
- UDP Multicast,
- Telnet (both standard and raw data transfer),
- Reverse Telnet (both standard and raw data transfer),
- Point-to-Point Protocol (PPP),
- Secure Shell (SSH) version 2,
- Secure Sockets Layer (SSL)/Transport Layer Security (TLS),
- Hyper Text Transport Protocol (HTTP), and
- Simple Network Management Protocol (SNMP) version 2.

2.2.6. **Visual Indicators.** Meet the requirements specified under Section 2.1.6.

2.2.7. **Regulatory Approvals.** Meet the requirements specified under Section 2.1.7.

2.2.8. **Additional Features.** Provide a serial media converter that has the following additional features:

- maximum of 50 ms of end-to-end forwarding delay (serial in on one serial server to serial out on the
- other serial server) for any character in the data stream when used for a serial over IP tunnel,
- maximum of 10 ms of Ethernet-to-serial forwarding delay (from receipt of Ethernet packet to start of serial transmission) for any character in the data stream when used for serial to IP conversion,
- each serial port is accessible using a unique TCP port and IP address combination,
- support simultaneous connections to all serial ports on the unit,
- able to use a raw connection with no Telnet negotiation or interpretation of the data stream,
- able to pass a serial data stream bi-directionally without affecting the content of the data stream, and
- performance is not affected by the content of the data stream.

2.2.9. **Management.** Provide a serial media converter that provides the following management capabilities:

- web browser/HTTP configuration and management,
- telnet configuration and management,
- serial port configuration and management, and
- allow multiple management sessions or automatically terminate existing session when a new session is requested.

2.3. **Mechanical Requirements.**

2.3.1. **Modular Design.** Provide equipment modular in design to allow for ease of component replacement in the field.

Mechanically key sockets and connectors to prevent insertion of unlike functions into the wrong socket or connector.

Clearly identify all modules and assemblies with name, model number, serial number, and any other pertinent information required to facilitate equipment maintenance, inventory, and tracking. All identifying information markings must be permanent, UV resistant and intended for harsh environments

2.3.2. **Connectors.** Make all external connections by means of connectors. Key the connectors to preclude improper hookups. Color code or appropriately mark all wires to and from the connectors. Serial data interface connections must be RS-232, 425, or 485 DB connector types as required for compatibility with the intended device communications protocol.

Plate each and every conductive contact surface or pin with a minimum of 20 microns of gold.

For all installations supply fiber optic patch cables necessary to integrate the Ethernet media converter with the communication equipment and patch panel as shown on the plans, or as directed by the Engineer at no additional cost to the Mobility Authority.

2.3.3. **Copper Connectors.** Input and output connectors must be via pinned connectors configured in a format compatible with the interface requirements of the data communications equipment.

2.3.4. **Harnesses.** Provide connecting harness of appropriate length and terminated with matching connectors for interconnection with the terminal equipment shown on the plans, or as directed by the Engineer.

2.3.5. **Housing.** Provide standard compact serviceable modules.

2.4. **Environmental Design Requirements.** Ensure that equipment conforms to NEMA TS-2-2003 (R2008) and NEMA 250-2008, or most current revision, for the following categories:

2.4.1. **Temperature.** Provide equipment that conforms to NEMA TS-2 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 -29°F to 165°F,
- temperature shock not exceeding 30°F per hour,
- relative humidity of 0 to 95%, and
- moisture condensation on all exterior surfaces caused by temperature changes.

2.4.2. **Vibration.** Provide equipment that conforms to NEMA TS-2 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 0.5g's applied in each of 3 mutually perpendicular planes for 30 min.

2.4.3. **Shock.** Provide equipment that conforms to NEMA TS-2 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 10g applied in each of three mutually perpendicular planes for 30 min.

3. CONSTRUCTION

3.1. **General.** Utilize the latest available techniques with a minimum number of parts, subassemblies, circuits, cards, and modules to maximize standardization and commonality.

Design for ease of maintenance, with all component parts readily accessible for inspection and maintenance.

Provide test points for checking essential voltages and waveforms.

3.2. **Mechanical Components.** Use stainless steel for all external screws, nuts, and locking washers. No self tapping screws are allowed unless specifically approved by the Engineer.

Provide corrosion resistant parts, such as plastic, stainless steel, anodized aluminum or brass.

Protect all materials used in construction from fungus growth and moisture deterioration.

Separate all dissimilar metals by an inert dielectric material.

3.3. **Mounting.** Provide all mounting hardware as shown on the plans, or as directed by the Engineer at no additional cost to the Department.

3.4. **Documentation Requirements.** Provide a minimum of 2 complete sets of operation and maintenance manuals, at least 45 days prior to testing, 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:

- complete network configuration diagram which documents locations of installed equipment, serial and model numbers, communication protocol settings, IP address, cabling, power service connections, and fiber assignments,
- complete installation procedures,
- compliance matrix documenting conformance to this specification,
- complete parts list including names of vendors for parts not identified by universal part number such as JEDEC, RETMA, or EIA,
- operations manuals,
- warranty documentation,
- complete maintenance and trouble-shooting procedures,
- testing procedures identifying threshold values,
- 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 this special specification. Certifications may be provided by the manufacturer or through independent certified labs.

3.5. **Testing.**

3.5.1. **General.** Unless otherwise shown on the plans, perform the following tests on the applicable equipment or systems.

3.5.1.1. **Test Procedures Documentation**. Provide 5 copies of the test procedures to include tests identified in Section 3.5.1.2 through Section 3.5.1.7 inclusive and blank data forms to the Engineer for review and comment at least 45 days prior to 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 prior to testing. Review time is calendar days. Conduct all tests in accordance with the approved test procedures.

Record measured test data on the data forms against threshold values, 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.

3.5.1.2. **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 are grounds for rejection of any certification.

Provide a copy of the certification to the Department. 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:

3.5.1.2.1. **Power Service Transients**. The equipment shall meet the performance requirements 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 TS 2 standard, most current version.

3.5.1.2.2. **Temperature and Condensation**. The equipment shall 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 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, 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 TS 2 standard, most

current version.

3.5.1.2.3. **Relative Humidity**. The equipment shall 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.

3.5.1.2.4. **Vibration**. The equipment shall show no degradation of mechanical structure, soldered components, or plugin components and shall 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, most current version.

3.5.1.2.5. **Power Interruption**. The equipment shall meet 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 TS 2 standard, most current version.

3.5.1.3. **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:

3.5.1.3.1. **Examination of Product**. Examine each unit carefully to verify that the materials, design, construction, markings and workmanship comply with the requirements of this Item.

3.5.1.3.2. **Continuity Tests**. Check the wiring to determine conformance with the requirements of the appropriate paragraphs in this Item.

3.5.1.3.3. **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.

3.5.1.4. **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. The test shall 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:

3.5.1.4.1. **Physical Construction.** Verify physical construction is completed in accordance with the plans and specification.

3.5.1.4.2. **Electrical and Communication**. Verify that all connectors for grounding, surge suppression, and

electrical distribution are tightened correctly. 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.

3.5.1.4.3. **Communication Link Quality.** Conduct signal tests for each communication link, including data transmit, data receive, bandwidth, proper operation of alarm and switches, and bit error rate. Document results in a written report to the Engineer.

3.5.1.5. **System Integration Test**. Conduct a system integration test on the complete functional system. Demonstrate all control and monitor functions for each system component for 24 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 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 24 hr. period during the system integration test.

3.5.1.6. **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 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 plan operates with application software provided by the Department.

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 special provision have been satisfied, contract time shall be suspended and all subsystems shall be placed into operation and operate as a complete system for a period of at least 90 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.

3.5.1.7. **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 14 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 substantially delay receipt and acceptance of the unit are 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.

3.5.1.7.1. **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.

3.5.1.7.2. **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.

3.5.1.7.3. **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.

3.5.1.7.4. **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.

3.5.1.7.5. **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 has not operated for 72 consecutive hours free of defects, extend the 30 day test period by an amount of time equal to 72 consecutive hours to demonstrate performance, in addition to the number of days required to complete the performance requirement of the individual point of failure.

3.6. **Training.** Conduct a training class (minimum of 1 hr., up to 4 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 for each type of unit provided. 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.

3.7. **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 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.

Media converters must be repaired or replaced at the Contractor's expense prior beginning 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.

4. MEASUREMENT

This Item will be measured by each ethernet media converter or serial media converter

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 for "Ethernet Media Converter" and "Serial Media Converter" of the type specified. This price is full compensation for furnishing and installing units including all equipment, all cables and connectors, all documentation and testing; and will include the cost of furnishing all labor, materials, training, warranty, equipment, and incidentals.

Special Specification 7102-RMA

Intelligent Transportation System (ITS) Remote Power Management Unit (RPMU)

1. DESCRIPTION

Furnish, install, and test remote power management (RPMU) as shown in the Plans.

2. MATERIALS

2.1 **General.** Furnish and install a 19" rack mounted CyberPower PDU41001 or equivalent.

2.2 **Configuration and Management.** Provide a RPMU that supports local and remote configuration and management, including access to all user-programmable features as well as alarm monitoring, event logging, and diagnostic utilities

Configuration and management functions shall be password protected. The RPMU shall include an event scheduler that can store a minimum of 60 events.

The RPMU shall include LED indicators for relay inputs and outlet status.

Upon loss of communications the RPMU shall maintain each receptacle and relay in its currently stored state of operation.

Upon restoration of electrical power after an outage the RPMU shall automatically restore each receptacle and relay to its previously stored state of operation and all configurable parameters shall be retained. The unit shall support SNMP v2c, including trap notifications of receptacle state changes.

2.3 **Communication Interfaces.** The RPMU shall have an Ethernet port (RJ45) for local control using a laptop PC and remote control via a network connection.

2.4 **Management Capability.** The FES shall support all Layer 2 management features and certain Layer 3 features related to multicast data transmission and routing. These features shall include, but not be limited to:

2.5 **Mechanical Requirements.** All parts shall be made of corrosion-resistant materials such as plastic, stainless steel, anodized aluminum, brass, or gold-plated metal. All fasteners exposed to the elements shall be Type 304 or 316 passivated stainless steel.

2.6 **Electrical Requirements.** The RPMU shall have a minimum of 8 NEMA 5-15R receptacles, nominal 120 VAC. The RPMU shall have a minimum current capacity of 12 amperes (amps).

2.7 **Environmental Requirements.** The RPMU shall operate properly during and after being subjected to the environmental testing procedures described in NEMA TS 2-2021, Sections 2.2.7, 2.2.8, and 2.2.9.

2.8 **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).

3. CONSTRUCTION

3.1 **General.** Install the RPMU in accordance with the manufacturer's recommendations. Include a RPMU operation and maintenance manual in the cabinet where the RPMU is installed that includes cabinet wiring schematics, electrical interconnection drawings, parts layout and parts lists.

3.2 **Field Acceptance Testing.** Provide a field acceptance test plan to the Engineer for approval at least 14 days

prior to commencement of testing. After approval of the acceptance test plan, perform testing of the installed RPMU equipment. Furnish all equipment, software, and supplies necessary for conducting the test.

4.2 **Warranty.** Ensure the RPMU includes a manufacturer's warranty covering defects for a minimum of 3 years from the date of final acceptance in accordance with TxDOT specifications.

3. MEASUREMENT

This Item will be measured by each RPMU.

4. 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 for "Remote Power Management Unit". This price is full compensation for furnishing and installing units including all equipment, all cables and connectors as specified in the Plans; all documentation and testing; and will include the cost of furnishing all labor, materials, training, warranty, equipment, and incidentals.

Special Specification 7103-RMA

Intelligent Transportation System (ITS) Field Ethernet Switch

1. DESCRIPTION

Furnish, install, and test field ethernet switch as shown on the plans.

2. MATERIALS

2.1 **General.** Furnish and install a 19" rack mounted Cisco IE-4010-4S24P Industrial Ethernet Switch or equivalent.

The Field Ethernet Switch (FES) shall be compliant with the Code of Federal Regulations Section 200.216 Prohibition on certain telecommunications and video surveillance services or equipment https://www.ecfr.gov/current/title-2/subtitle-A/chapter-II/part-200/subpart-C/section-200.216.

The FES provides wire-speed fast Ethernet connectivity at transmission rates of 100 megabits per second. Each FES shall be managed individually and as a group for switch configuration, performance monitoring, and troubleshooting.

The FES shall include Layer 2+ capabilities, including, Quality of Service (QoS), IGMP, rate limiting, security filtering, and general management.

The FES shall support half and full duplex Ethernet communications.

The FES shall provide 99.999% error-free operation.

The FES shall comply with the EIA Ethernet data communication requirements using single-mode fiber optic transmission medium and Category 5E copper transmission medium.

The FES shall have a minimum mean time between failures (MTBF) of 10 years, or 87,600 hours, as calculated using the Bellcore/Telcordia SR-332 standard for reliability prediction.

Ensure that the field Ethernet switch (FES) provides Ethernet connectivity between devices, systems, and locations as required by the Contract Documents

Ensure that the ITS network administrator will be able to manage each FES individually and as a group for switch configuration, performance monitoring, and troubleshooting.

Ensure that the FES is fully compatible and interoperable with connected Ethernet devices and the intelligent transportation system network.

Ensure the FES provides a switched Ethernet connection for each connected device and at least one open RJ45 Ethernet port for technician access.

2.2 **Networking Standards.** The FES shall comply with all applicable IEEE networking standards for Ethernet communications, including but not limited to:

- IEEE 802.1Q standard for Local and Metropolitan Area Networks - Bridges and Bridged Networks used with port-based Virtual Local Area Networks (VLANs) and Rapid Spanning Tree Protocol (RSTP).
- IEEE 802.1P standard for QoS.
- IEEE 802.3 standard for LAN and Metropolitan Area Network (MAN) access and physical layer specifications.
- IEEE 802.3u supplement standard regarding 100 Base TX/100 Base FX.
- IEEE 802.3x standard regarding flow control with full duplex operation.

2.3 **Optical Ports.** All fiber optic link ports operate at 1,310 or 1,550 nanometers in single mode. All optical ports are Type ST, SC, LC, or FC only. Mechanical transfer registered jack (MTRJ) type connectors are not allowed.

FES shall provide a minimum of four optical 100 Base FX ports capable of transmitting data at 100 megabits per second. FES shall provide optical ports designed for use with a pair of fibers; one fiber will transmit (TX) data and one fiber will receive (RX) data.

The optical ports shall have an optical power budget of at least 15 dB.

2.4 **Copper Ports.** FES shall include a minimum of twenty four copper ports. All copper ports shall be Type RJ-45 and shall auto-negotiate speed (i.e., 10/100 Base) and duplex (i.e., full or half). All 10/100 Base TX ports shall meet the specifications detailed in this section and shall be compliant with the IEEE 802.3 standard pinouts. Ethernet over very high speed digital subscriber line (EoVDSL) ports shall support standard telephone-grade twisted copper pair and automatically negotiate the fastest data rate possible depending on cable length and quality.

2.5 **Management Capability.** The FES shall support all Layer 2 management features and certain Layer 3 features related to multicast data transmission and routing. These features shall include, but not be limited to:

- An FES that is a port-based VLAN and supports VLAN tagging that meets or exceeds specifications as published in the IEEE 802.1Q standard and has a minimum 4-kilobit VLAN address table.
- A forwarding/filtering rate that is a minimum of 14,880 packets per second for 10 megabits per second and 148,800 packets per second for 100 megabits per second.
- A minimum 4 kilobit MAC address table.
- Support of, at a minimum, IGMP Version 2.
- Support of remote and local setup and management via secure shell (SSH) and secure Web-based GUI.
- Support of the Simple Network Management Protocol (SNMP) version 1/2/3. Verify that the FES can be accessed using the resident EIA-232 management port or a telecommunication network.
- Support of Remote Authentication Dial-In User Service (RADIUS) or Terminal Access Controller Access-Control System Plus (TACACS+)
- Support of remote monitoring (RMON) of the Ethernet agent and the ability to be upgraded to switch monitoring (SMON), if necessary.
- Support of Secure Copy (SCP) or Secure File Transfer Protocol (SFTP) and either Network Time Protocol (NTP) or the Simple Network Time Protocol (SNTP). Ensure that the FES supports port mirroring for troubleshooting purposes when combined with a network analyzer.

2.6 **Mechanical Requirements.** Every conductive contact surface or pin shall be gold-plated or made of a noncorrosive, nonrusting, conductive metal. Do not use self tapping screws on the exterior of the assembly. All parts shall be made of corrosion-resistant materials, such as plastic, stainless steel, anodized aluminum, brass, or gold-plated metal.

2.7 **Electrical Requirements.** The FES shall operate on a nominal Voltage of 120 VAC. Supply an appropriate voltage converter for devices that require operating voltages of less than 120 VAC. The FES shall have diagnostic Light Emitting Diodes (LEDs), including link, TX, RX, and power LEDs.

2.8 **Environmental Requirements.** FES shall operate properly during and after being subjected to the environmental testing procedures described in NEMA TS 2 2021, Sections 2.2.7, 2.2.8., and 2.2.9.

2.9 **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).

3. CONSTRUCTION

3.1 **General.** Install network devices at the locations shown in the Plans. Ensure that network devices are mounted securely and are fully accessible by field technicians. Ensure that all unshielded twisted pair/shielded twisted

pair Ethernet network cables are compliant with the EIA/TIA-568-B standard.

3.2 **Field Acceptance Testing.** Conduct inspection and testing at the installed equipment location according to the approved test plan. Perform the following:

- Verify that physical construction has been completed as detailed in the Plans.
- Inspect the quality and tightness of ground and surge protector connections.
- Verify proper voltages for all power supplies and related power circuits.
- Connect devices to the power sources.
- Verify all connections, including correct installation of communication and power cables.
- Verify network connection and FES configuration using a laptop PC.

3.3 **Warranty.** Ensure FES have a manufacturer's warranty covering defects for 1 year from the date of final acceptance. Ensure that the manufacturer will furnish replacements for any part or equipment found to be defective during the warranty period at no cost to the Department within 10 calendar days of notification.

3. MEASUREMENT

This Item will be measured by each field ethernet switch.

4. 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 for "Field Ethernet Switch". This price is full compensation for furnishing and installing units including all equipment, all cables and connectors, all documentation and testing; and will include the cost of furnishing all labor, materials, training, warranty, equipment, and incidentals.