

**UNIFORM STANDARD SPECIFICATIONS
CLARK COUNTY AREA**

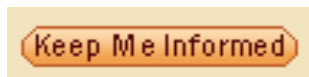
SPECIFICATION - YEAR 2008 REVISIONS

Section	Title	Nature of Change	Effective Date
101	"Abbreviations"	Deletion of Subsection 101.01, "Abbreviations" to create list of acronyms which can be updated without the requirement of Commission approval.	1/1/08
601	"Pipe Culverts – General"	Revision to Section 601, "Pipe Culverts – General" to reference video inspection standards of the National Association of Sewer Services Companies (NASSCO) Pipeline Assessment and Certificate Program and clarify plans sheet reference in measurements.	1/1/08
603	"Reinforced Concrete Pipe"	Revision to Section 603, "Reinforced Concrete Pipe" to clarify the size limit or tolerance of cracks in concrete pipe and correct gasketed joints.	1/1/08
680	"Fiber Optic Cable"	Revision to Section 680, "Fiber Optic Cable" to clarify fiber optics and equipment specifications.	1/1/08
681	"Fiber Optic Splice and Distribution Equipment"	Revision to Section 681, "Fiber Optic Splice and Distribution Equipment" to clarify fiber optics and equipment specifications.	1/1/08
682	"Fiber Optic Transceiver"	Revision to Section 682, "Fiber Optic Transceiver" to clarify fiber optics and equipment specifications.	1/1/08
683	"Video Optical Transceiver with Bi-Directional Data Channel"	Revision to Section 683, "Video Optical Transceiver with Bi-Directional Data Channel" to clarify fiber optics and equipment specifications.	1/1/08
684	"Layer 2 Field-Hardened Ethernet Switch"	Addition of Section 684, "Layer 2 Field-Hardened Ethernet Switch" to clarify fiber optics and equipment specifications.	1/1/08
685	"Video Encoder"	Addition of Section 685, "Video Encoder" to clarify fiber optics and equipment specifications.	1/1/08
686	"Video Decoder"	Revision to Section 686, "Video Decoder" to clarify fiber optics and equipment specifications.	1/1/08
687	"Closed Circuit Television (CCTV) Field Equipment"	Addition to Section 687, "Closed Circuit Television (CCTV) Field Equipment" to clarify fiber optics and equipment specifications.	1/1/08
688	"Remote Data Radio Communication System"	Revision to Section 688, "Remote Data Radio Communication System" to clarify fiber optics and equipment specifications.	1/1/08

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DIVISION I**GENERAL REQUIREMENTS****SECTION 101****DEFINITIONS AND TERMS****101.01 BLANK**

101.02 ADDENDUM: A supplemental addition or deletion to the contract documents prior to the advertised bid opening.

101.03 ADVERTISEMENT: The public announcement, as required by law, inviting bids for work to be performed or materials to be furnished.

101.04 ASSESSMENT ACT CONTRACT: A contract financed by special assessments authorized under, or implemented by, an act of the Legislature of the State or procedural ordinance of a City or the County.

101.05 AWARD: The acceptance by the Contracting Agency of a bid.

101.06 BASE COURSE: The layer or layers of specified or selected material of designated thickness on a sub-base or a subgrade to support a surface course.

101.07 BIDDER: An individual, partnership, firm, corporation, or any acceptable combination thereof, or joint venture, submitting a bid for the advertised work.

101.08 BOARD: The officer or body constituting the awarding authority for the Contracting Agency.

101.09 BRIDGE: A structure, including supports, erected over a depression or an obstruction, as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads and having a length measured along the center of roadway of more than twenty (20) feet between under copings of abutments or extreme ends of openings for multiple boxes.

Length: The length of a bridge structure is the overall length measured along the line of survey stationing back to back of back walls of abutments, if present, otherwise end to end of the bridge floor; but in no case less than the total clear opening of the structure.

Roadway Width: The clear width measured at right angles to the longitudinal centerline of the bridge between the bottom of curbs or guard timbers or in the case of multiple height of curbs, between the bottoms of the lower risers and in the case of no curbs or guard timbers, between the inner faces of parapet or railing at the bottom.

101.10 CALENDAR DAY: Every day shown on the calendar.

101.11 CONTRACT CHANGE ORDER OR FIELD CHANGE ORDER: A written order issued by the Engineer or Contracting Agency as provided in the contract documents, to the Contractor, covering changes in the plans, specifications or quantities or both, within the scope of the contract and establishing the basis of

payment and time adjustments for the work affected by the change.

101.12 CHANNEL: A natural or artificial water course.

101.13 CONTRACT: The written agreement between the Contracting Agency and the Contractor setting forth the obligations of the parties thereunder, including, but not limited to the performance of the work, the furnishing of labor and materials, and the basis of payment.

The contract includes the invitation for bids, proposal, contract form and contract bond, standard specifications, supplemental specifications, special provisions, general and detailed plans, notice to proceed, and any change orders and supplemental agreements that are required to complete the construction of the work in an acceptable manner, including authorized extensions and basis of payment thereof, all of which constitute one instrument.

101.14 CONTRACTING AGENCY: The party of the first part to a contract which may be any of the following entities: Boulder City, Nevada; City of Henderson, Nevada; City of Las Vegas, Nevada; City of North Las Vegas, Nevada; City of Mesquite, Nevada; Las Vegas Valley Water District, Las Vegas, Nevada; Clark County Sanitation District, Las Vegas, Nevada; and Clark County, Nevada.

101.15 CONTRACT ITEM (PAY ITEM): An item of work specifically described and for which a price, either Unit or Lump Sum, is provided. It includes the performance of all work and the furnishing of all labor, equipment, and materials described in the text of a specific item included in the contract or described in the Standard Specifications, Supplemental Specifications or Special Provisions of the contract. Contract items are numbered so that the first three digits of the item number corresponds to the section of the same number. Thus, in Item No. 203.01.00, which is the item number for roadway excavation, the number 203 is the section number and corresponds to Section 203 of the Standard Specifications, Supplemental Specifications and Special Provisions.

Each contract item shall be constructed under the specifications contained in the section of the same number, i.e., the number proceeding aforementioned last four digits.

101.16 CONTRACTOR: The person, firm, partnership, corporation, permittee, subdivider, or other entity who has entered into a contract or agreement with the Contracting Agency. Where work is done under permit issued by the Contracting Agency, the permittee shall be construed to be the Contractor. Also, a subdivider who does land development and other work under contract with the Contracting Agency.

101.17 CONTRACT TIME: The number of days allowed for completion of the contract, including authorized time extensions.

101.18 CULVERT: Any structure not classified as a bridge which provides an opening under the roadway.

101.19 DETOUR: A temporary route for traffic around a closed portion of road.

101.20 DIVIDED HIGHWAY: A highway with separated roadways for traffic in opposite directions.

101.21 EMPLOYEE: Any person working on the project mentioned in the contract of which these specifications are a part, and who is under the direction and control, or received compensation from the Contractor or his subcontractor.

101.22 ENGINEER: The Chief Engineer of the Contracting Agency or other person designated by the Board acting directly and through his duly authorized representative.

101.23 EQUIPMENT: All machinery and equipment, together with the necessary supplies for upkeep and maintenance, also tools and apparatus necessary for the proper construction and acceptable completion of the work.

101.24 EXTRA WORK: An item of work not provided for in the contract as awarded but found essential by the Contracting Agency, to the satisfactory completion of the contract within its intended scope.

101.25 FRONTAGE ROAD OR FRONTAGE STREET: A local street or road auxiliary to and located generally on the side of an arterial highway for service to abutting property and adjacent areas and for control of access.

101.26 GUARANTEE BOND: The approved form of security executed by the Contractor and his surety of sureties guaranteeing the work against defect and failures.

101.27 HIGHWAY: A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way.

101.28 HOLIDAYS: Any day established by law or agreed as a holiday for employees of the contracting agency.

101.29 INSPECTOR: The Engineer's or Contracting Agency's authorized representative assigned to make detailed inspections of contract performance.

101.30 INTERAGENCY QUALITY ASSURANCE COMMITTEE (IQAC): An ad hoc multi-jurisdictional and agency committee established for the purpose of simplifying the material approval process and promoting the consistent enforcement of the Uniform Standard Specifications and Drawings, Clark County Area, Nevada.

101.31 LABORATORY: The testing laboratory of the Contracting Agency or of any other testing laboratory which may be designated by the Engineer.

101.32 MAJOR CONTRACT ITEM: A "Major Item" shall be construed to be any individual bid item included in the proposal that has a total cost equal to or greater than \$50,000 or 5 percent of the total contract cost, whichever is the lesser amount. The total contract cost shall be computed on the basis of the proposal quantities and contract unit prices.

101.33 MATERIALS: Any substances specified for use in the construction of the project and its appurtenances.

101.34 MEDIAN: That portion of a divided highway separating the travel ways for traffic, generally in opposite directions.

101.35 NOTICE TO BIDDERS: The official notice inviting bids for the proposed work or materials.

101.36 NOTICE TO PROCEED: A written notice to the Contractor to proceed with the contract work including, when applicable, the date of beginning of contract time.

101.37 PAVEMENT STRUCTURE: The combination of base course and surface course placed on a subgrade to support the traffic load and distribute it to the roadbed.

101.38 LABOR AND MATERIAL BOND: The approved form of security executed by the Contractor and his surety or sureties to guarantee the payment of persons furnishing materials or persons performing labor under the contract.

101.39 PERFORMANCE BOND: The approved form of security executed by the Contractor and his surety or sureties to guarantee the faithful performance of all work under said contract within the prescribed time limit and that materials and workmanship will be free from original or developed defects.

101.40 PLANS: The approved project plans and Standard Drawings, profiles, typical cross sections, working drawings, and supplemental drawings, or exact reproductions thereof, which show the location, character, dimensions, and details of the work to be performed. All such documents are to be considered as a part of the plans whether or not noted in the Special Provisions.

In the above definition, the following terms are defined as follows:

- (a) Standard Drawings - The Standard Drawings of the Contracting Agency.
- (b) Project Drawings - The Project Drawings are specific details and dimensions peculiar to the work and are supplemented by the Standard Plans insofar as the same may apply.

101.41 PROFILE GRADE: The trace of a vertical plane intersecting the top surface of the proposed structural section as shown on the plans. Profile grade means either elevation or gradient of such trace according to the context.

101.42 PROJECT: The specific improvement to be constructed together with all appurtenances and construction to be performed thereon at the prices quoted.

101.43 PROPOSAL: The offer of a bidder, on the prescribed form, to perform the work and to furnish the labor and materials at the prices quoted.

101.44 PROPOSAL FORM: The approved form on which the Contracting Agency requires bids to be prepared and submitted for the work.

101.45 PROPOSAL GUARANTEE: The security furnished with a bid to guarantee that the bidder will enter into the contract if his bid is accepted.

101.46 QUALITY ASSURANCE (QA): Planned and systematic operations conducts to ensure that the operations and/or product meets specifications. QA encompasses the Engineer's review and oversight of the Contractor's "Quality Control"; verifying the results of "Quality Control"; and inspecting for conformance to plans and specifications. QA is the responsibility of the "Engineer".

101.47 QUALITY CONTROL (QC): Planned and specified operations necessary to construct items that will meet the requirements for quality and performance as specified. QC includes, but should not be limited to controlling the quality of raw materials, produced materials assemblies, components, finished product and construction process. QC is the responsibility of the “Contractor”.

101.48 RIGHT-OF-WAY OR EASEMENT: A general term denoting land, property or interest therein, usually in a strip, acquired for or devoted to a highway or other improvements.

101.49 ROAD: A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way.

101.50 ROADBED: The graded portion of a highway within top and side slopes, prepared as a foundation for the pavement structure and shoulders.

101.51 ROADSIDE: A general term denoting the area adjoining the outer edge of the roadway. Extensive areas between the roadways of a divided highway may also be considered roadside.

101.52 ROADSIDE DEVELOPMENT: Those items necessary to the complete improvement which provides for the preservation of landscape materials and features; the rehabilitation and protection against erosion of all areas disturbed by construction through seeding, sodding, mulching, and the placing of other ground covers; such suitable planting and other improvements as may increase the effectiveness and enhance the appearance of the improvement.

101.53 ROADWAY: The portion of a highway within limits of construction.

101.54 SHOULDER: The portion of the roadway contiguous with the traveled way for accommodation of stopped vehicles, for emergency use, and for lateral support of base and surface courses.

101.55 SIDEWALK: That portion of the roadway primarily constructed for the use of pedestrians.

101.56 SPECIAL PROVISIONS: Additions and revisions to the standard and supplemental specifications covering conditions peculiar to an individual project.

101.57 SPECIFICATIONS: The directions, provisions, and requirements contained in the Standard Specifications and supplemental specifications as modified by the Special Provisions. Whenever the term "these specifications" is used in this book, it means the provisions set forth in this book.

101.58 STREET: A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way.

101.59 SUBCONTRACTOR: Any individual, firm, or corporation to whom the Contractor, with the consent of the Contracting Agency, sublets any part of the contract.

101.60 SUBGRADE: The top of a roadbed upon which the base courses and/or the pavement structure and shoulders are constructed.

Rev. November 08, 2007

101.61 SUBSTRUCTURE: All of that part of the structure below the bearings of simple and continuous spans, skewbacks or arches, and tops of footings or rigid frames, together with backwall, wingwalls, and wing protection railings.

101.62 SUPERINTENDENT: The Contractor's authorized representative in responsible charge of the work, present on the work at all times during the progress to supervise and direct the construction, to receive and fulfill instructions from the Engineer, and to accept orders for changed and extra work.

101.63 SUPERSTRUCTURE: The entire structure except the substructure.

101.64 SUPPLEMENTAL AGREEMENT: A written agreement within the scope of the project made and entered into by and between the Contractor and the Contracting Agency covering work not otherwise provided for, revisions in or amendments to the terms of the contract, or conditions specifically prescribed in the specifications as requiring supplemental agreements. Such supplemental agreements become a part of the contract when approved and properly executed.

101.65 SUPPLEMENTAL SPECIFICATIONS: Additions and revisions to the Standard Specifications that are adopted subsequent to the issuance of the printed book.

101.66 SURETY: The corporation, partnership, or individual, other than the Contractor, executing a bond furnished by the Contractor.

101.67 SURFACE COURSE: The top layer of an improvement.

101.68 TRAFFIC LANE: The portion of a traveled way for the movement of a single line of vehicles.

101.69 TRAVELED WAY: That portion of roadway for the movement of vehicles, exclusive of shoulders and auxiliary lanes.

101.70 UTILITY: Tracks, overhead or underground wires, pipelines, conduits, ducts, or structures, sewers or storm drains owned, operated, or maintained in or across a public right-of-way or private easement.

101.71: BLANK:

101.72 WORK: Work will mean furnishing all labor, materials, equipment, and other incidentals necessary or convenient to the successful completion of the project and the carrying out of all of the duties and obligations as imposed by the contract.

101.73 WORKING DAY: A day on which weather and other conditions not under the control of the Contractor will permit construction operations to proceed for the major part of the day (five (5) hours) with the normal working force engaged in performing the controlling item or items of work which would be in progress at that time, exclusive, however, of Saturdays, Sundays, holidays and any day that is incumbent upon the Contractor, by means of a labor union, to observe as a holiday. However, if the Contractor elects to work on such days, those days will be considered as a working day.

Attention is directed to Subsections 108.04, "Limitation of Operations" and 108.08, "Determination and Extension of Contract Time."

101.74 WORKING DRAWINGS: Stress sheets, shop drawings, erection plans, falsework plans, framework plans, cofferdam plans, bending diagrams for reinforcing steel, or any other supplementary plans or similar data which the Contractor is required to submit to the Engineer for approval.

101.75: In order to avoid cumbersome and confusing repetition of expressions in these specifications, it is provided that whenever anything is, or is to be, done, if, as, or, when, or where "contemplated, required, determined, directed, specified, authorized, ordered, given, designated, indicated, considered necessary, deemed necessary, permitted, reserved, suspended, established, approval, approved, disapproved, acceptable, unacceptable suitable, accepted, satisfactory, unsatisfactory, sufficient, insufficient, rejected, or condemned," it shall be understood as if the expression were followed by the words "by the Contracting Agency."

SECTION 601
PIPE CULVERTS – GENERAL

DESCRIPTION

601.01.01 GENERAL: These specifications include general requirements that are applicable to all type culvert pipes irrespective to the material or culvert use with the following exceptions:

1. Structural plate pipe,
2. Water distribution systems and sanitary sewer system specifications will specify the pipe to be used in their respective installations.

This work shall consist of furnishing and installing pipe culverts, siphons, end sections, end walls, etc., as may be required to complete the work shown on the plans or established by the Engineer.

The pipe shall comply with AASHTO Design and Construction LRFD Specifications most current edition and these specifications. The more stringent requirements shall apply.

601.01.02 REFERENCE CODES AND STANDARDS:

- (a) Uniform Standard Specifications for Public Works’ Construction Off-Site Improvements, Clark County Area, Nevada that will henceforth be referred to as “USS” Specifications and Drawings.
- (b) Contract Special Provisions and Drawings.
- (c) NRS 338.176, NAC 625.550.
- (d) Most current ASTM, AASHTO, or NDOT test procedures.
- (e) Related Interagency Quality Assurance Committee (IQAC) procedures at:

www.accessclarkcounty.com/depts/public_works/Pages/iqac.aspx

MATERIALS

601.02.01 GENERAL: The materials used shall be those prescribed or used for the several items which constitute the finished work and shall conform to the requirements in the following subsections:

Table 1- List of Pipe Types

Material Type	Section or Subsection
Bituminous Coated Corrugated Metal Pipe and Pipe Arches	709.03.02
Clay Pipe	708.03.04
Corrugated Aluminum Pipe	709.03.05
Corrugated Metal Pipe and Pipe Arches	709.03.01
Grout and Mortar Sand	706.03.04
Nonreinforced Concrete Pipe	708.03.02
Portland Cement	701
Reinforced Concrete Pipe	708.03.01
Rubber Gaskets	707.03.02
Thermoplastic Pipe	709.03.09

When the location of manufacturing plants allows, the plants will be inspected periodically for compliance with specified manufacturing methods. Material samples will be obtained for laboratory testing for compliance for materials quality requirements as specified in the referenced specifications. This can be the basis for acceptance of manufacturing lots.

All materials will be subject to inspection for acceptance as to condition at the latest practicable time the Engineer has the opportunity to check for compliance prior to or during incorporation of materials in the work.

The lengths shown on the plans are approximate.

For structural plate pipe and arches, attention is directed to Section 606, "Structural Plate Pipe, Pipe Arch, and Arch Culverts."

CONSTRUCTION

601.03.01 EARTHWORK: Excavation and backfill shall conform to the requirements of Section 206, "Structure Excavation" and 207, "Structure Backfill," or Section 208, "Trench Excavation and Backfill" when the culvert is placed in a trench. The pipe shall be bedded as shown in the standard specifications and/or drawings appended to the plans or as specified in the Special Provisions. When no bedding class is specified, the requirements for normal bedding as shown in the Uniform Standard Drawings shall apply. The lines and grades will be established by the Engineer or as designated in the contract provisions.

Where pipes are to be installed in new embankments on a steep slope or in a difficult location, the height of new embankments may be varied as directed by the Engineer before installing pipes.

When headwalls are not required and granular materials are used for backfilling, the fill at the ends of the structure shall be sealed against the infiltration of water by bedding the ends of the structure using class II CLSM or concrete.

601.03.02 HEADWALLS: Where shown on the plans, inlet and outlet headwalls shall be constructed or installed in connection with culvert pipes. Where such headwalls are constructed or installed, the ends of pipes shall be placed flush or cut off flush with the headwall face, unless otherwise permitted by the Engineer. Headwalls are to be constructed to conform to the applicable requirements of Sections 501, "Portland Cement Concrete" and 502, "Concrete Structures."

601.03.03 END SECTIONS: The bed for the end section shall be excavated to the required width and grade. For metal end sections with toe plates, a trench shall be excavated for the toe plate in a manner to permit the toe plate from being against the inner face of the trench when the end section is in its final position. After end sections have been properly secured to the pipe, this trench shall be backfilled and firmly compacted.

Precast concrete end section shall be placed with its tongue (or groove) fully entered in the groove (or tongue) of the pipe.

Thermoplastic pipe greater than 30" shall not be used at the open-end sections.

601.03.04 JACKED PIPES: Culvert pipe to be jacked in place between the limits shown on the plans shall conform to the requirements of the respective section of pipe culverts.

The strength of pipe or gage of pipe will be determined for vertical load only in embankment conditions. Any additional reinforcement or strength required to withstand jacking pressure shall be determined and furnished by the Contractor at his expense.

Variation from theoretical alignment and grade at the time of completion of placing shall not exceed 0.2 foot (6.1 centimeters) for each 20 feet (6.1 meters) of pipe placed.

The diameter of the excavated hole shall not be more than 0.1 foot (3 centimeters) greater than the outside diameter of the pipe. Sluicing and jetting with water will not be permitted. When the material tends to cave in from outside these limits, a shield shall be used ahead of the first section of pipe or the face of excavation shall not extend beyond the end of the pipe greater than 1-1/2 feet (0.46 meters) unless permitted by the Engineer.

Areas resulting from caving or excavating outside the above limits shall be backfilled with sand or grout by a method, which will fill the voids.

601.03.05 LAYING CULVERT PIPE: Laying of culvert pipe shall conform to the requirements of the respective sections of culvert pipe.

601.03.06 EXTENDING EXISTING CULVERTS: Where shown on the plans or directed by the Engineer, existing culverts shall be extended in accordance with the provisions for installing new culverts and the following additional provisions.

Existing headwalls shall be demolished and removed and disposed of or moved to the extended location as indicated on the plans or ordered by the Engineer. Attention is directed to Section 202, "Removal of Structures and Obstructions."

A headwall that is not to be reset shall be demolished without injury to the existing culvert and removed and disposed of in accordance with the provisions of Section 202, "Removal of Structures and Obstructions." If shown on the plans or ordered by the Engineer, a new concrete headwall shall be constructed in accordance with the provisions of Section 501, "Portland Cement Concrete" of these specifications or a flared end section shall be attached thereto.

601.03.07 VIDEO INSPECTION: Unless otherwise approved by the entity, all video inspection shall be completed by a National Association of Sewer Service Companies (NASSCO) certified operator, certified at the user level minimum. The user must have completed the Pipeline Assessment and Certificate Program (PACP). Video inspection reports must follow the NASSCO format and use standard sewer defect codes.

METHOD OF MEASUREMENT

601.04.01 MEASUREMENT: The materials to be paid for under these specifications will be listed in the contract items by size, class, type, gage, or whatever information is necessary for identification.

The quantity of culvert pipe to be measured for payment will be the actual number of linear feet (meters) of pipe including the stub on end sections, complete and in place. When pipes are cut to fit a structure or slope, the quantity to be paid for will be the length of pipe necessary to be placed before cutting, measured in even 2-foot (61 centimeters) increments.

Culvert pipe bends, wyes, tees, and other branches will be measured and paid for by the linear foot (meter) for the sizes of pipes involved. Wyes, tees, eccentric reducers, and other branches will be measured along centerlines to the point of intersection.

Structure excavation and structure backfill, Portland cement concrete and reinforcement required for headwalls, end walls, structures, and other items of work required by the plans and special provision to complete the work, will be measured and paid for as separate items as provided for under their respective sections of these specifications, or the contract documents. Structure excavation and backfill will not be measured for payment on preformed end sections.

No separate measurement or payment will be made for constructing jacking pits and backfilling all pits after the pipe is jacked, or for excavation and backfill between the limits shown on the plans for jacking the pipe. Full compensation therefore will be considered as included in the price paid for jacked pipe.

Culvert pipe to be placed outside the limits for jacked pipe shall conform to the requirements of the respective section of pipe culverts. The limits for payment of structure excavation and backfill will be the original ground line before jacking pits are excavated.

All measurements will be made in accordance with Subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

601.05.01 PAYMENT: The accepted quantities of culvert pipe measured as specified in Subsection 601.04.01, "Measurement," will be listed under the respective sections of pipe culverts.

When any of the various sizes, types, and gages of pipe is installed by the jacking method, the contract price paid per linear foot (meter) for jacked pipe shall include full compensation for furnishing the pipe, excavating, jacking, furnishing and placing backfill material, and all incidentals and for doing all the work involved in jacking the pipe, as specified.

Full compensation for furnishing pipe with end finish, including distortion if required, will be considered as included in the price paid per linear foot (meter) for the pipe involved and no additional compensation will be allowed therefore. Full compensation for bedding will be considered included in the price paid per cubic yard (cubic meter) for backfill or granular backfill as the case may be and such payment shall include compensation for all the materials, labor, tools, and incidentals necessary to complete the work.

Provisions for handling of whatever water may be encountered at the site shall be an obligation of the Contractor, and payment therefore shall be considered as subsidiary to the items involved, and no further compensation will be allowed therefore.

All payments will be made in accordance with Subsection 109.02, "Scope of Payment."

SECTION 603**REINFORCED CONCRETE PIPE****DESCRIPTION**

603.01.01 GENERAL: This work shall consist of furnishing circular or elliptical, reinforced concrete pipe, siphons, and conduits of the size, classes, and dimensions and at locations shown on the plans or established by the Engineer and in accordance with the requirements of ASTM C76, C655, or C507 with design basis in accordance with Section 708, "Concrete and Clay Pipe and Drains" and where indicated in these specifications. The installation shall conform to the requirements of AASHTO LRFD Construction Specifications and where indicated in these specifications.

603.01.02 REFERENCE CODES AND STANDARDS:

- (a) Uniform Standard Specifications for Public Works' Construction Off-site Improvements, Clark County Area, Nevada that will henceforth be referred to as "USS" Specifications and Drawings.
- (b) Contract Special Provisions and Drawings.
- (c) NRS 338.176, NAC 625.550.
- (d) Most current ASTM, AASHTO, ACI or NDOT test & inspection procedures.
- (e) Related Interagency Quality Assurance Committee (IQAC) procedures at:

www.accessclarkcounty.com/depts/public_works/Pages/iqac.aspx

MATERIAL

603.02.01 GENERAL: Materials and their use shall conform to the applicable requirements of Subsection 601.02.01 of Section 601, "Pipe Culverts - General," and in addition thereto, the following requirements shall apply.

Prior to the use of these materials, the Contractor shall submit to the Engineer for approval a document certifying that the material meets these specifications and Section 708, "Concrete and Clay Pipe and Drains," from an authorized source approved by the Interagency Quality Assurance Committee (IQAC).

Flared end sections (precast) shall conform to the details and dimensions shown on the plans and, except for shape, shall conform to the material requirements of this section for reinforced concrete pipe.

Rubber gaskets are required for all circular pipes and mastic for elliptical, and shall conform to the requirements of Subsection 707.03.01, "Rubber Gaskets."

If Joint mortar is required, it shall be as specified in Subsection 501.03.11, Class "C".

Sand shall conform to the requirements of Subsection 706.03.04, "Grout and Mortar Sand" of these specifications.

The materials shall be mixed to a consistency suitable for the purpose intended. All mortar shall be used within 30 minutes after the mixing water has been added.

Admixtures of hydrated lime, fire clay, diatomaceous earth, or other approved inert material may be used in the mortar to facilitate workability if the Contractor elects. The amount of admixture to be added shall be the quantity determined by the Engineer.

CONSTRUCTION

603.03.01 GENERAL: Construction methods shall conform to the requirements of Subsections 601.03.01 through 601.03.06 of Section 601, "Pipe Culverts - General" and in addition thereto, shall meet the following requirements. All pipe installations shall conform to the workmanship and inspection requirements of AASHTO LRFD Bridge Construction Specifications and this specification as applicable.

No pipe shall be laid which is excessively cracked per subsection 603.03.07, checked, spalled, or damaged, and all such sections of pipe shall be permanently removed from the work. Pipes, which show defects due to handling, shall be rejected at the site of the installation regardless of prior acceptance.

603.03.02 EARTHWORK: Where pipes are to be installed in new embankment (projection), the embankment shall first be constructed to the required elevation as set forth below. The height of embankment to be constructed in advance of installing the pipe may be varied when permitted by the Engineer.

In the case of pipes 24 inches (600 millimeters) or less in diameter the roadway embankment shall be constructed to an elevation of 6 inches (150 millimeters) above the grade proposed for the top of the pipe, after which the trench shall be excavated and the pipe installed.

In the case of pipes more than 24 inches (600 millimeters) in diameter, the roadway embankment shall be constructed to an elevation of 30 inches (750 millimeters) above the grade proposed for the bottom of the pipe, after which the trench shall be excavated and the pipe installed.

When pipe having bells or hubs is used, cross trenches shall be excavated for them to prevent non-uniform loading of the joints.

603.03.03 LAYING CULVERT PIPE: Construction installation shall comply with the AASHTO LRFD Bridge Construction Specifications, Section 208, "Trench Excavation and Backfill", and this subsection. The installation shall be conducted by a certified supervisor/foreman at the crew level who is responsible for the work. The certified person is the designated installation inspector for the contractor and shall generate a daily report attesting to the workmanship for the pipe zone locations as described in Table 2. This does not relieve the contractor responsibility for other Quality Control aspects of this and other specifications.

Installation Components:

- (a) Bedding.
- (b) Pipe Condition.
- (c) Pipe Installation.
- (d) Haunch Compaction.
- (e) Complete Pipe Zone Compaction.

The bottom of the trench shall be graded and prepared to provide a firm and uniform bearing throughout the entire length of the pipe. Blocking shall not be used to bring the pipe to grade.

Pipe sections shall be checked for alignment and grade at the time of joining the sections. Pipe laying shall begin at the downstream end of the pipeline except for extensions of existing pipes. Place the bottom of the pipe in contact with the shaped bedding throughout its full length. The first section of pipe to be laid shall be firmly placed to the designated line and grade at the outlet end with the groove end or bell end pointing in the direction to be followed by the pipe laying. Maintain the manufacturer's recommended minimum and maximum cover at all times unless otherwise shown in the contract. Pipe will be inspected before any backfill is placed. Ensure that no rocks greater than 75 mm (3 in.) or other rigid or jagged material is present in the bedding

material where pipe may be laid directly on the material. Take up and relay or replace pipe that is out of alignment, unduly settled, or damaged.

The interior of the pipe shall be kept free of dirt, and other foreign material as the pipe laying progresses, and left clean at the completion of the work. Any pipe, which is not in true alignment or which shows any undue settlement after laying, or is damaged, shall be taken up and re-laid at the Contractor's expenses.

Backfill: Prior to placing backfill material, all handing holes in concrete culverts shall be completely filled with grout.

603.03.04 RUBBER GASKETED JOINTS: Circular reinforced concrete culvert pipe, shall use rubber or neoprene gasketed joints.

Rubber gaskets shall not be exposed to the direct rays of the sun for more than 72 hours.

The contractor shall make every effort to provide a concrete-to-concrete connection and pull the pipe completely home. Should gapping occur due to changes or corrections in horizontal or vertical alignment or radius turns, the gaps shall not exceed the gap tolerance indicated in Table 1. If pipes are laid that exceed these tolerances, the inner annular space between the pipe sections shall be completely filled with cement mortar (where pipe diameters allow for entry). If pipes are laid that exceed the tolerances in Column 2, the pipe will need to be removed and re-laid or an acceptable concrete collar will need to be installed.

Table 1 - Maximum Joint Gap Tolerances¹

Inner Diameter of Pipe	Column 1 Maximum Joint Gap Tolerance	Column 2 Maximum Joint Gap Tolerance (with Grouting)
12" to 36"	5/8"	3/4"
42" to 48"	7/8"	1-1/8"
54" to 90"	1.0"	1-1/4"
96"	1- 5/8"	1-3/4"
Sizes above 96" up to 144"	As recommended by Manufacturer	As recommended by Manufacturer

Where reinforced concrete collars or bells with rubber gaskets are used at the pipe joints, mortar will not be required in the outer annular space. Where pipes are used with exposed metal surfaces at the joint, both the inner and outer annular joint spaces between pipe sections must be completely filled with cement mortar, except that pipes less than 24 inches (61 centimeters) in diameter may be pointed inside by brushing smooth and removing all surplus mortar. The rubber gasket shall be the sole element depended upon to make the joint watertight for the purposes intended.

603.03.05 SIPHONS AND PRESSURE PIPE: Reinforced concrete pipe used for siphons or pressure pipe shall be laid in accordance with the above provisions, be connected by flexible, watertight rubber gasket joint, and prior to backfilling, be subject to the following hydrostatic test:

The pipeline shall be filled with water at a hydrostatic head of that required to maintain the designed pressure. The pressure head shall be maintained for a period of not less than 24 hours and any visible leak or other defects, which develop under test, shall be corrected by the Contractor at his expense. Sweating that

¹ In no case shall maximum joint gap tolerance exceed 1/2 of the length where the gasket seats within the pipe

does not develop into a flow or drip will not be considered as leakage. The test shall be repeated until all leaks or other defects are eliminated

603.03.06 JUNCTIONS: All junctions of laterals with a main line or junctions of 2 or more main lines, which are not made in a manhole or concrete junction structure, shall be in a manufactured wye or tee of the same material as the conduits to which they are joined, and shall have the same or greater stiffness as the pipe.

603.03.07 INSPECTION: All pipe joints and lengths shall be 100 percent inspected. Inspection and Testing by the contractor during and after installation to ensure proper performance. Installation of bedding and backfill materials, as well as their placement and compaction, shall adhere to the requirements of this section. During the initial phases of the installation process, inspection shall concentrate on detecting improper practice and poor workmanship. Errors in line and grade, as well as any improper assembly or backfill techniques, shall be corrected prior to placing significant backfill or trench fill. Bell/spigot joints shall be properly assembled to prevent the infiltration of soil fines. Gaskets shall be properly seated to prevent groundwater infiltration and should appear uniformly oriented around the pipe. Shallow cover installations shall be checked to ensure the minimum cover level is provided.

After the pipe has been bedded and backfilled to subgrade level, internal quality inspection shall be paid for and performed by the Contractor a minimum of 30 days after final backfill has been placed and prior to final acceptance by the Contracting Agency. The line shall be cleaned and inspected for cracks and joint gaps using visual physical measurement or other devices, including but not limited to calibrated television or video cameras, subject to approval by the Engineer. Cracks in pipes (both longitudinal and circumferential) that are less than 0.10 inch in width are generally considered non-structural flaws and need not be repaired. Cracks that are equal to or exceed 0.10 inch in width shall require an evaluation by a Nevada licensed professional engineer. The Contractor's engineer shall provide a recommendation regarding removal or repair subject to approval by the Contracting Agency. Pipe joints and lengths that do not meet the specification shall be repaired or pipe replaced at the contractors expense. All inspection results shall be submitted and approved by the Engineer before final payment. Any replacement pipe shall also be subject to the same testing. All inspection and testing results shall be submitted to the Engineer for approval. The Agency Engineer shall be allowed access to randomly inspect at least 10 percent of the total number of pipe runs.

METHOD OF MEASUREMENT

603.04.01 MEASUREMENT: Method of measurement shall conform to the requirements of Subsection 601.04.01, "Measurement" and in addition thereto, the following requirements shall apply.

The quantity of precast end sections, culvert pipe or oval pipe measured for payment will be the number of units of each size of each class complete and in place. Pre-cast pipe and cast-in-place sections that are an integral part of the manhole will not be included in the linear foot measurement for reinforced concrete pipe.

The measurement for the quantity of radius RCP will be measured as standard RCP of the equivalent size.

All measurements will be made in accordance with Subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

603.05.01 PAYMENT: Payment shall conform to the requirements of Subsection 601.05.01, "Payments," and in addition thereto, the following requirements shall apply.

The accepted quantities of reinforced concrete pipe measured as specified in Subsection 603.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot (meter) for reinforced concrete pipe of the class and size specified, which shall be full compensation for removal of existing pavement (only if pavement removal is not included with roadway excavation) trench excavation, furnishing and placing bedding and backfill material, Type II aggregate base, compaction, furnishing and placing pipe and jointing mortar, covering open ends of laterals with plywood, cut and join connections, de-watering of trench, shoring, disposal of excess excavated material, protection and restoration, potholing to determine location of existing utilities, temporary pavement, video inspection cost, related items of work not otherwise provided for, and for all labor, tools, and equipment necessary to complete the work as shown on the plans, as specified herein, and as directed by the Engineer. End sections will be paid for at the contract unit price bid per each for the kind and sizes specified complete and in place, which payment shall include structure excavation and backfill for precast end sections.

All payments will be made in accordance with Subsection 109.02, "Scope of Payment."

Payment will be made under:

PAY ITEM	PAY UNIT
(Size) Reinforced Concrete Pipe (class)	Linear Foot (Meter)
(Size) Oval Reinforced Concrete Pipe (class)	Linear Foot (Meter)
(Size) Reinforced Concrete Siphon Pipe (class)	Linear Foot (Meter)
(Size) Reinforced Concrete Pipe (class) Jacked.....	Linear Foot (Meter)
(Size) Precast End Section	Each
(Size) Precast Oval End Section	Each

SECTION 680

FIBER OPTIC CABLE

DESCRIPTION

680.01.01 GENERAL: The work under this section shall consist of furnishing, installing, and testing all underground and outdoor fiber optic cables.

All equipment and cable selection, mounting, and installation, as well as the cable management plan must be approved by the Freeway & Arterial System of Transportation (FAST) Director or designee, prior to installation.

MATERIALS/EQUIPMENT

680.02.01 FIBER OPTIC CABLE: All fiber optic cable shall be Single Mode Fiber Optic (SMFO) cable that is of loose tube construction, filled with a water-blocking material, and constructed by a certified International Organization of Standardization (ISO) 9001 or 9002 manufacturer.

Fiber optic cable shall be dielectric and comply with the requirements of Rural Utilities Service Standards (RUS) 1755.900 except as modified by these specifications.

Fiber optic cable shall comply with the following requirements:

- | | | |
|------|---|--|
| (1) | Number of fibers: | Minimum 72 strands, 6 tubes of 12 fibers each |
| (2) | Cladding diameter: | 125± 1.0 µm |
| (3) | Core-to-cladding offset: | ≤ 0.8 µm |
| (4) | Cladding non-circularity: | ≤ 1.0% |
| (5) | Maximum attenuation: | ≤ 0.40 dB/km at 1310 nm;
≤ 0.30 dB/km at 1550 nm |
| (6) | Microbend attenuation
(1 turn, 32 mm diameter): | ≤ 0.05 dB at 1550 nm |
| (7) | Microbend attenuation
(100 turns, 75 mm diameter): | ≤ 0.05 dB at 1310 nm |
| (8) | Mode-field diameter
(matched cladding): | 9.3 ± 0.5 µm at 1310 nm; 10.5 ± 1.0 µm at 1550 nm |
| (9) | Maximum chromatic dispersion: | ≤ 3.2 ps/(nm x km) from 1285 nm to 1330 nm and
< 18 ps/(nm x km) at 1550 nm |
| (10) | Fiber polarization mode dispersion: | 0.5 ps/(km) 1/2 |
| (11) | Fiber coating: | Dual layered, UV cured acrylate |
| (12) | Coating diameter: | 245 µm ± 10 µm |
| (13) | Min storage temperature range: | -40° C to +70° C (-40° F to 158° F) |
| (14) | Min operating temperature range: | -20° C to +70° C (-4° F to 158° F) |
| (15) | Rated life: | Certify a 20-year life expectancy when installed to
manufacturer's specifications |

- (a) **Buffer Tubes:** Each buffer tube shall be filled with a non-nutritive to fungus, electrically non-conductive, water-blocking material that is free from dirt and foreign matter. The water-blocking material shall allow free movement of the fibers, without loss of performance, during installation and normal operation including expansion and contraction of the buffer tubes. The water-blocking material shall be readily removable with conventional nontoxic solvents. Buffer tubes shall be stranded around a central member using the reverse oscillation or "S-Z" stranding process. The use of filler rods in the fiber optic cable when required to lend symmetry to the cable section is mandatory.
- (b) **Central Strength Member:** The fiber optic cable shall have a central strength member designed to prevent buckling of the cable.
- (c) **Cable Core:** The fiber optic cable shall utilize a dry water-blocking material to block the migration of moisture inside the cables.
- (d) **Tensile Strength Members:** The fiber optic cable shall have tensile strength members designed to minimize cable elongation due to installation forces and temperature variation. Underground fiber optic cable shall withstand a 2700 N (600 lbf) tensile load where the change in attenuation does not exceed 0.2 dB during loading and 0.1 dB after loading. The cable shall be rated for an installed tensile service load of 890 N (200 lbf) or more.
- (e) **Cable Jacket:** The fiber optic cable jacket shall be constructed of a High or Medium Density Polyethylene (HDPE/MDPE) jacket that has been applied directly over the tensile strength members and water-blocking material. The jacket shall have at least 1 ripcord designed for easy sheath removal. This cable will be rated for use in both underground and overhead installations.
- (f) **Conductive Line Locating Material:** A 6 pair Polyethylene (PE) 39 No. 22 (American Wire Gauge) AWG interconnect cable, shall be directly adjacent to the cable in every conduit containing fiber optic cables to aid in locating of the conduit once it is in place. This is not required if an existing interconnect cable is in place. Any other method of providing a conductive tracer wire must be approved of by the FAST Director or designee, prior to installation.
- (g) **Environmental:** The cable shall be capable of withstanding the following conditions without damage or decrease in function:
 - (1) Total immersion in water with natural mineral and salt contents.
 - (2) Salt spray or salt-water immersion for extended periods.
 - (3) Wasp and hornet spray.

CONSTRUCTION

680.03.01 INSTALLATION – GENERAL: The cable shall not be installed in any pull box until the pull box has been approved for pulling by the contracting agency. Cabinets shall be installed prior to cable installation. Installation of fiber optic cable shall be preformed by individuals who are experienced and certified by a nationally recognized fiber optic installation certification organization. Certifications must be approved by the FAST Director or designee, prior to construction. Installation of fiber optic cable shall be continuous and without splices unless approved by the FAST Director, or designee. The Contractor shall perform all final length measurements and order cable accordingly.

The Contractor shall handle fiber optic cable carefully taking care not to pull cable along the ground, over or around obstructions or through unnecessary curves or bends. The Contractor shall not exceed fiber optic cable

bend radius at any time. Manufacturer approved pulling grips, cable guides, feeders, shoes, blowing devices, pulleys, and bushings shall be used to prevent damage to the cable during installation.

Prior to installing any fiber optic cable, the Contractor shall furnish recommended procedures, maximum pulling tension, a list of the cable manufacturer's approved pulling lubricants, and the lubricant manufacturer's procedures for use. The Contractor shall adhere to the cable and lubricant manufacturer's installation procedures.

The Contractor shall ensure that the tensile load on the cable does not exceed the allowed maximum manufacturer's specification by using a system that includes a means of alerting the installer when the pulling or blowing tension approaches the limit and/or displays the actual tension on the cable (pulling load / tension system as approved by the cable manufacturer). Contractor may supplement this procedure with a breakaway tension limiter set below the recommended tensile limit of the cable being pulled or blown. A device known as a "Mechanical Cable Tugger" may be used with appropriate tension limiter, and at no time shall any type of vehicle be used for pulling the fiber optic cable.

When removing cable from the reel prior to installation, place it in a figure eight configuration to prevent kinking or twisting. Take care to relieve pressure on the cable at crossovers by placing cardboard shims (or equivalent method) or by creating additional figure eights.

If cables are to be installed in conduit with existing cables or wires that shall remain, the Contractor shall not damage the existing cables or wires. The Contractor shall disconnect, remove, reinstall, and reconnect the existing cables and wires if necessary to facilitate the installation of the new cable without any additional cost. The Contractor shall be responsible for any damage to the existing cables or wires caused by this operation. New and existing conductors shall be terminated and the labeling shall be reconciled as part of this process. 2 weeks prior to disconnecting any existing cables, the Contractor shall submit a schedule, for approval by the FAST Director or designee, with the accurate timeframes of when the existing cables are to be disconnected.

In all locations where fiber enters a pull box, for each cable entering the pull box or vault, cable slack shall be loosely looped through in a figure eight or a loose loop with a minimum of 30 feet of slack in all pull boxes smaller than a Type 200 Vault, unless approved by the FAST Director or designee, prior to installation. The Contractor shall leave a minimum of 60 feet of slack per conduit entrance in all Type 200 Vaults or other pull boxes where fiber optic cable is to be spliced, allowing the splicing activities to take place outside the pull box above ground in a controlled environment.

If the pull box has racks and hooks, the Contractor shall attach the cables to them with industry standard cable ties immediately upon entering the box. In all cases each cable shall be labeled, then looped and tied independently of one another. The labeling on the fiber optic cable shall be approximately 2 feet from the entry point, and must note the direction of the cable along with its next point of entry (i.e. FAST FIBER North to XYZ St. or FAST FIBER West to ABC Blvd.). Cable ties should be tightened so that they prevent cable slippage but do not deform or damage the cable sheath.

The Contractor shall follow the requirements of local building codes and National Electrical Code (NEC) Article 770, inclusive of the Fine Print Notes (FPN) when installing indoor fiber optic cable.

The Contractor shall furnish attachment hardware, installation guides, and other necessary equipment, not specifically listed herein, as necessary to install the fiber optic cable.

680.03.02 TESTING:

- (a) Fiber optic cable shall meet the following test requirements. All testing is to be performed by an experienced and certified tester of a nationally recognized certification organization.
 - (1) Factory Testing: The Contractor shall submit factory test data and related documentation from the manufacturer to the Engineer and the FAST Director or designee, prior to installing the cable. This includes the "index of refraction" of the cable to be installed. This test shall demonstrate that the attenuation for each fiber string comply with the loss budgets required by these Specifications. Test blue and slate fibers at 1,310 nm and 1,550 nm. Submit factory

results for approval by the FAST Director or designee, prior to installing the cable.

- (2) Pre-Installation Testing: The Contractor shall test all cable prior to installation. Any cable that is found to have visual cladding damage shall be rejected. Test fibers at 1,310 nm and 1,550 nm. Submit Optical Time Domain Reflectometer (OTDR) trace results for approval by the FAST Director or designee, prior to installing the cable. OTDR results must be approved by the FAST Director or designee, prior to installation.
- (3) Post-Installation Testing: Testing shall conform to the American National Standards for "Measurement of Optical Fiber Cabling Components Standard" latest revision. After installation, the Contractor shall perform the following tests using the procedures of "Measurement of Optical Power Loss on Installed Single-Mode Fiber Cable Plant" latest revision and all standards and procedures invoked therein, subject to the following clarification:
 - (A) OTDR Tests: Conduct tests using an OTDR for each fiber. Demonstrate that the attenuation for each fiber string comply with the loss budgets required by these Standards. Test fibers at 1,310 nm and 1,550 nm. Submit OTDR trace results for approval and acceptance by the FAST Director, or designee.
 - (B) Power meter readings are required from all fibers. Submit power meter results for approval and acceptance by the FAST Director, or designee.
- (b) The Contractor shall test all fibers on the cables, identify any unacceptable losses, and make corrective actions at no additional cost. The Contractor shall replace any cable in its entirety that is not compliant with these specifications at no additional cost.
- (c) Following completion of all testing, and approval by the FAST Director or designee, the Contractor shall compile and submit one organized test notebook in hard copy format, as well as a single electronic copy in Microsoft® Excel that includes all required test results, summary tables, splice details, circuit diagrams, and OTDR traces and power meter results of each fiber by each cable tested. The test notebook and electronic copy shall also include the following:
 - (1) Identification number and name as appropriate.
 - (2) A summary sheet that clearly illustrates length and measured loss versus budgeted loss for each fiber or connected fiber string as appropriate; and
 - (3) Calculations and notations for each fiber and wavelength that include total loss, measured dB/km loss and any anomalies over 0.1 dB.
- (d) FAST must have in its possession all pre- and post-testing data prior to final approval and acceptance.

METHOD OF MEASUREMENT

680.04.01 MEASUREMENT: The quantity of Fiber Optic Cable (72-strand) will be measured per linear foot installed, in place, complete and operational, and successfully tested. The cable shall be measured by the marking on the exterior cable sheath. No separate measurement will be made for lubricant in this item.

BASIS OF PAYMENT

680.05.01 PAYMENT: The accepted quantity of Fiber Optic Cable (72-strand) will be paid for at the contract unit price bid per linear foot, which shall be full compensation for installing the cable and appurtenances, complete in place, and for providing labor, hardware, cable ties, single mode fiber optic cable, lubricant, conductive line locating material, water blocking material, and labeling, all as specified, as shown on the drawings, and as required by the Engineer. All materials required to complete the system shall be incidental to the cable including the approval, furnishing, and installation of racks and hooks in pull boxes, for each type installed. Payment for the fiber optic cable installation shall also include the cost of all fiber optic termination strips, terminations, and labeling as incidental to the item requiring the work. Testing, warranty, documentation, and spare parts are considered incidental to the item requiring the work.

All other components of the approved Communications Distribution Cable Assembly (CDCA) shall be specified and paid under Section 681, "Fiber Optic Splice and Distribution Equipment." Testing, temporary connectors for testing, warranty, documentation, training, and spare parts are considered incidental to the item requiring the work.

Payment will be made under:

PAY ITEM:

PAY UNIT

Fiber Optic Cable (72-strand)Linear Foot

SECTION 681

FIBER OPTIC SPLICE AND DISTRIBUTION EQUIPMENT

DESCRIPTION

681.01.01 GENERAL: The equipment under this section shall consist of furnishing the fiber optic cable equipment or accessories including connectors, connector panels, splice trays, patch panels, jumper cables, cable troughs, underground splice closures, termination strips, branch cables, closet housings, pigtails, and Communications Distribution Cable Assembly (CDCA) for each splice location as determined by the drawings and specifications.

All other equipment not used shall be delivered to the Freeway & Arterial System of Transportation (FAST) Traffic Management Center (TMC) prior to project acceptance. No partial shipments will be accepted for deliveries to the TMC. All equipment supplied on this project will be delivered as part of a single delivery, and shall be labeled clearly with the project and location designation.

All equipment shall be approved by the FAST Director or designee, prior to purchase.

MATERIALS/EQUIPMENT

681.02.01 UNDERGROUND SPLICE ENCLOSURES: Underground splice enclosures shall be cylindrical, butt-end style, corrosion resistant, gel sealed, and meet the requirements of GR-771-CORE. Underground splice enclosures shall gel seal, bond, anchor, and provide efficient routing, storage, organization, and protection for fiber optic cable and splices. The splice enclosure shall provide an internal configuration and single end cap with a minimum of 6 ports of 72 strand backbone, trunk, and branch line cables. A Tyco Model # Fiber Optic Splice Closure (FOSC) 450-B6-6-24-6-B3V, or equivalent as approved by the FAST Director or designee.

All splice trays, cable baskets, and related equipment shall be supplied with the underground splice enclosure.

The enclosure shall have 6 stackable single fusion trays for 24 splices each to accommodate a total 144 splices, and each shall be designed specifically for housing 24 single-mode fusion splices protected by heat-shrink sleeves. The splice trays shall be easy to install and remove, and have provisions for a minimum entry of 4 buffer tubes. A storage basket for storing loose buffer tubes or single fiber shall be installed and delivered with the enclosure.

Splice enclosures shall have a gel seal design with both the cable jackets and core tubes sealed, without the use of other water-blocking material. The splice enclosures shall be capable of being opened and completely resealed without loss of performance.

681.02.02 COMMUNICATIONS DISTRIBUTION CABLE ASSEMBLY: The Contractor shall provide and install Single Mode Gator Patch (CDCA) Intelligent Transportation System (ITS) Drop Cable or equivalent which is factory terminated cable with epoxy filled patch panel with 12 fiber optic Straight Tip (ST) connectors as approved by the FAST Director or designee,. The (CDCA) is to be used between the fiber optic trunk line and controller at lengths as shown on the plans, with the required slack or 20 feet to 25 feet in each splice vault and pull box, as well as the 20 feet slack neatly coiled in the controller cabinet.

Drop cable shall be designed with an Optical Fiber Non-Conductive Riser (OFNR)-rated, all-dielectric cable that is ultraviolet-resistant and fully waterproof for outdoor applications. Cable shall have a single 3.0 mm buffer tube containing 12 color-coded fibers.

CONSTRUCTION

681.03.01 GENERAL: The Contractor shall provide all of the equipment for splices as noted on the drawings and in the quantities in the bid schedule. Additionally, the CDCA shall be installed in the conduit from the above ground facility to the splice vault and it shall be splice ready. Once the CDCA is installed and accepted following testing, all permanent splices of the CDCA, installed by the Contractor, to the trunk line will be performed in the communications vault.

681.03.02 LABELING: The Contractor shall label all cables to allow effective splicing. Labeling shall be done in a neat, professional manner using permanent methods and products approved by the FAST Director or designee. The labels shall include all necessary information to properly identify the cable and it’s mating connection.

681.03.03 TESTING: Testing of the CDCA and related hardware in this section is included in the testing procedure in Section 680, “Fiber Optic Cable”, of the Standard Specification.

METHOD OF MEASUREMENT

681.04.01 MEASUREMENT: The quantity of Underground Splice Enclosures will be measured for payment per each supplied, complete and operational, and successfully tested.

The quantity of CDCA will be measured for payment per each installed, in place, complete and operational, and successfully tested.

Branch line cables, splice trays, warranty, documentation, training and labeling are considered incidental to the item requiring the delivery of the needed equipment. The branch line cable shall adhere to the specifications described in Section 680, “Fiber Optic Cable”, and will be paid as specified in this section.

BASIS OF PAYMENT

681.05.01 PAYMENT: The accepted quantity of Underground Splice Enclosures delivered complete and associated cable/hardware measured as provided above, will be paid for at the Contract unit price bid per each, which price shall be full compensation for the underground splice closures including gel, splice trays, cable baskets, single fusion trays, sleeves and storage baskets.

The accepted quantity of CDCA installed and tested positively will be paid for at the contract unit price bid per each, which price shall be full compensation for the cable assemblies including hardware, 12 ST connectors per each assembly, labor and tools for complete installation, testing, labeling, documentation, training, warranty, and splicing, all as accepted by the FAST Director or designee.

Payment will be made under:

PAY ITEM: **PAY UNIT**

Underground Splice Enclosures..... Each
Communication Distribution Cable Assembly (CDCA) and Permanent Fiber Splicing Each

SECTION 682

FIBER OPTIC TRANSCEIVER

DESCRIPTION

682.01.01 GENERAL: The contractor shall furnish a Fiber Optical Transceiver/Self Healing (OTR/SH) that interfaces the traffic controllers with the central control system using Single Mode Fiber Optic (SMFO) cable. This communications device shall contain a self-healing optical ring and perform remote control of master/slave functions. The OTR/SH provides an electrical signal interface for an Electronic Industry Association (EIA)-232/422/485 port and 4 SMFO interfaces (2 transmit and 2 receive) that support fault tolerant, optical counter rotating ring as well as add/drop/repeat capability allowing field controllers to be interconnected in a multi-dropped configuration. The device shall be an International Fiber Systems (IFS) Model #D19130SHR, or equivalent, as approved by the Freeway & Arterial System of Transportation (FAST) Director or designee.

This specification is for equipment only, no installation, to be delivered to the FAST Traffic Management Center (TMC) for testing and approval prior to final acceptance. The agency Project Director shall be notified prior to the delivery to the TMC. No partial shipments will be accepted. All equipment supplied on this project will be delivered during a single delivery, and shall be labeled clearly with the project and location designation.

All equipment selection shall be approved prior to purchase by the FAST Director or designee.

MATERIALS/EQUIPMENT

682.02.01 GENERAL: The OTR/SH shall require no user adjustments other than switch selection of the desired interface, anti-streaming time, and Master/Slave operation. When the OTR/SH is installed in a rack mounted card cage, the unit shall be hot-swappable with no adverse affects to itself or other units in the cage.

All equipment supplied shall have a full lifetime replacement/repair warranty.

682.02.02 MECHANICAL: The OTR/SH shall be a surface mount device (field), or rack mount (hub) configurations, when specified. The field mounted Video Optical Transceiver (VOTR) shall be enclosed in corrosion resistant housing that protects the internal circuitry from the environment. The housing shall be provided with suitable holes for mounting to a flat surface.

When it is specified, the rack mounted OTR/SH shall occupy no more than 4 Rack Units (RU) 7 inches of space and be of the same manufacturer and compatible with the 19-inch rack-mountable card cage. The rack mounted OTR/SH shall be able to obtain all necessary power from the card cage assembly without the use of external power cables.

All OTR/SH shall have external, silk screened, labeling of: The device type, model number, part number, serial number, Light Emitting Diode (LED) status indicators, connector functions, and manufacturer on the front panel and/or the housing. Internal labeling shall be provided to clearly identify all dipswitches and jumper positions.

The OTR/SH shall have LED status indicators for the following signals:

- (a) A looped locked, Forward Direction.
- (b) A loop locked, Reverse Direction.
- (c) B looped locked, Forward Direction.
- (d) B loop locked, Reverse Direction.
- (e) Transmit Data A.

- (f) Receive Data A.
- (g) Transmit Data B.
- (h) Receive Data B.
- (i) Power (PWR).

682.02.03 OPTICAL:

- (a) The OTR/SH shall have the following characteristics:
 - 1) Laser diodes operating at 1,310 nanometers.
 - 2) Link loss budget of 20 dB (minimum).
 - 3) Less than 2 μ sec optical repeating delay.
 - 4) Straight Tip (ST) connectors 4.
 - 5) Minimum connection of 0.67 meters (2 feet) of cable with no optical attenuation.
 - 6) Anti-Streaming Function.
- (b) The OTR/SH shall provide fault-tolerant self-healing data communication paths for the following scenarios:
 - 1) Scenario 1: A self-healing ring configuration is functioning, then a cable break occurs on the working ring between 2 OTR/SH's.
 - 2) Scenario 2: A self-healing ring configuration is functioning, then 2 cable breaks occur, 1 on the working ring and 1 on the protect ring between 2 OTR/SH's.
 - 3) Scenario 3: A self-healing ring configuration is functioning, then a single slave OTR/SH failure occurs.

682.02.04 ELECTRICAL SIGNAL INTERFACES:

- (a) Data:
 - 1) Bi-directional data communication (simplex and full duplex operating modes).
 - 2) Switch selectable EIA-232, EIA-422, or EIA-485 multi-dropped interfaces.
 - 3) Data rates from DC to 100 kbps.
 - 4) Bit error rate of 10^{-11} .
 - 5) DB-25 connector with standard EIA 232 pinout.
 - 6) Switch selectable anti-streaming (4 - 64 seconds, or disabled).
- (b) The OTR/SH shall be designed such that there is no command "echo" of the original command received by the host computer. The OTR/SH master shall be capable of communication with at least 32 slave units on the self-healing ring.

682.02.05 CONTROL: The OTR/SH shall operate in either the "Master" mode or "Slave" mode. The OTR/SH master shall transmit digital signals from a hub location to a number of field (slave) OTR/SH locations. Both master and slave units shall be identical. The determination of master or slave shall be accomplished by either a manual switch on the OTR/SH or by remote contact closure. A "closed" remote contact closure would put the OTR/SH in the Master mode.

682.02.06 POWER: The OTR/SH shall operate to specification when supplied with 120 ± 15 VAC, 60 ± 3 Hz single-phase power. The use of transformers to reduce the 120 VAC prime power input to a lower level used by the OTR/SH is acceptable.

682.02.07 ENVIRONMENTAL: The OTR/SH shall be designed to operate from -40° C (-40° F) to $+74^{\circ}$ C (165° F) with no cooling airflow, 0-95 percent relative humidity, non-condensing. The OTR/SH shall be compliant with National Electronics Manufacturers Association (NEMA) TS-1/TS-2 and Caltrans Traffic Signal Control Equipment Specifications for shock, vibration, and voltage transient protection.

682.02.08 19-INCH RACK MOUNTED CARD CAGE: When required at a hub location, the OTR/SH shall be able to be installed in a 19-inch rack mounted card cage. The cage height shall not exceed 4-RU. The cage shall contain a fault tolerant power converter compatible with OTR/SH module power requirements. The cage shall include provisions for interconnecting cabling and be designed to accommodate a minimum of 12 OTR/SH modules that shall be easily mountable and removable from the cage. When installed in the cage, the OTR/SH modules shall be securable. The module's maintenance indications shall not be distributed after being mounted in the drawer. A failure of one OTR/SH module shall not impact the operation of other OTR/SH modules installed within rack mounted cage.

682.02.09 FIBER OPTIC JUMPER CABLES: 4 fiber optic jumper cables shall be delivered with each transceiver supplied, and the fiber optic jumper cables shall meet the following requirements:

- (a) 250 μ m buffering of each fiber.
- (b) 900 μ m buffering of each fiber applied after the initial 250 μ m buffering.
- (c) Maximum factory measured insertion loss of 0.5 dB per EIA/Telecommunications Industry Association (TIA) 455-171.
- (d) Less than 0.2 dB loss when subjected to EIA/TIA-455-1B, 300 cycles, 0.5 kg.
- (e) Aramid yarn strength member.
- (f) Rugged 3 millimeters (0.12 inch) (approximate) Polyvinyl Chloride (PVC) sheathing.
- (g) Minimum bend radius of 320 millimeters (12 inches) following installation, 640 millimeters (25 inches) during installation.
- (h) Minimum tensile strength of 444N (100 lbs).
- (i) And ST connectors that are factory terminated with strain relief.

CONSTRUCTION

682.03.01 INSTALLATION OF EQUIPMENT: Though no physical construction is part of this deliverable, the Contractor shall furnish all mounting hardware (i.e., machine screws, nuts, locking washers) to install the OTR/SH securely in the cabinet. Mounting methods using tape, Velcro, and sticky back material will not be permitted. All necessary power adapters and cabling needed to obtain power from the power distribution assembly shall be provided.

As noted above, the Contractor shall also supply the 4 simplex fiber optic jumper cables needed to be installed from the field termination panel (field mounted) or from the fiber optic patch panel (rack mounted) to the 4 optical inputs of the OTR/SH. Contractor shall also supply the data cables for the DB-25 data connector. This consists of a 60 inch DB-25 M-M connector to plug into the OTR/SH on one end and the 2070N traffic signal controller on the other.

All OTR/SH shall be provided with protective covers on all optical connectors. The Contractor shall ensure that the protective covers remain on the optical connectors at all times when each connector is not being used.

METHOD OF MEASUREMENT

682.04.01 MEASUREMENT: The quantity of Shelf Mount Fiber Optic Transceivers with Cables will be measured per each complete and successfully tested.

The quantity of Rack Mount Fiber Optic Transceivers with Cables will be measured per each complete and successfully tested.

The quantity of 19-inch Rack Mounted Card Cage will be measured per each, complete and successfully tested.

Each card cage or OTR/SH will be measured as a unit for furnishing each OTR/SH, complete in delivery, in accordance to the quantities on the Bid Schedule.

Mounting hardware and power conversion hardware, if required are incidental to the OTR/SH bid item and will not be measured or paid separately.

The equipment delivered will be tentatively accepted pending testing by the FAST Director or designee. Only after a series of bench tests of the devices will the final acceptance be made and documented.

BASIS OF PAYMENT

682.05.01 PAYMENT: The accepted quantity of Shelf Mount Fiber Optic Transceivers with Cables will be paid for at the contract unit price bid per each, which shall be full compensation for the equipment, measured as provided under Measurement, complete including warranty, delivery to FAST, optical transceiver(s), SMFO cable, hardware, housing, 4 fiber optic jumper cables per optical transceiver, data connectors, optical connector covers, and testing of the equipment; as specified and as shown on the drawings.

The accepted quantity of Rack Mount Fiber Optic Transceivers with Cables will be paid for at the contract unit price bid per each, which shall be full compensation for the equipment, measured as provided under Section 682.04.01, "Measurement," complete including warranty, delivery to FAST, optical transceiver(s), SMFO cable, hardware, 4 fiber optic jumper cables per optical transceiver, data connectors, optical connector covers, and testing of the equipment; as specified and as shown on the drawings.

The accepted quantity of 19-inch Rack Mounted Card Cage will be paid for at the contract unit price bid per each, which shall be full compensation for the equipment, measured as provided under Section 682.04.01, "Measurement," complete including warranty, delivery to FAST, rack mounted card cage, hardware, and testing of the equipment; as specified and as shown on the drawings.

Payment will be made under:

PAY ITEM:	PAY UNIT
Shelf Mount Fiber Optic Transceivers (OTR/SH) with Cables	Each
Rack Mount Fiber Optic Transceivers (OTR/SH) with Cables	Each
19-Inch Rack Mounted Card Cage.....	Each

SECTION 683

VIDEO OPTICAL TRANSCEIVER WITH BI-DIRECTIONAL DATA CHANNEL

DESCRIPTION

683.01.01 GENERAL: The Contractor shall furnish the designated quantity of Video Optical Transceiver (VOTR) pairs that interface the Closed Circuit Television (CCTV) cameras with the central control system over Single Mode Fiber Optic (SMFO) cable. Each VOTR pair delivered shall provide 1 unidirectional National Television Standards Committee (NTSC) color video channel from the CCTV field location to another designated point and 1 bi-directional data channel between both locations. There will be a designated video transmitter and a video receiver. The devices shall be International Fiber Systems (IFS) Model #VT4930WDM and IFS Model #VR4930WDM, or equivalent, as approved by the Freeway & Arterial System of Transportation (FAST) Director or designee.

This specification is for equipment only, no installation, to be delivered to the FAST Traffic Management Center (TMC) for testing and approval prior to final acceptance. No partial shipments will be accepted. All equipment supplied on this project will be delivered during a single delivery, and shall be labeled clearly with the project and location designation.

The VOTR will be able to be connected to each end of one single mode optical fiber with Straight Tip (ST) connections to establish a point-to-point communication topology for the locations shown on the drawings. VOTR's designed for mounting in card cages shall be hot swappable.

All equipment selection shall be approved by the FAST Director or designee.

MATERIALS/EQUIPMENT

683.02.01 GENERAL: All equipment supplied will have a full manufacturer's warranty.

683.02.02 MECHANICAL: The VOTR shall be a surface mount device (field), or rack-mount (hub) configurations, when specified. The field mounted VOTR shall be enclosed in corrosion resistant housing that protects the internal circuitry from the environment. The housing shall be provided with suitable holes for mounting to a flat surface.

When it is specified, the rack-mounted VOTR shall occupy no more than 4 Rack Units (RU) (7 inches) of space and be of the same manufacturer and compatible with the 19-inch rack-mountable card cage. The rack-mounted VOTR's shall obtain all necessary power from the card cage assembly without the use of external power cables.

All VOTR's shall have external, silk screened, labeling of: the device type, model number, part number, serial number, Light Emitting Diode (LED) status indicators, connector functions, and manufacturer on the front panel and/or the housing. Internal labeling shall be provided to clearly identify all dipswitches and jumper positions.

The VOTR shall have LED status indicators for presence of video carrier, input power, and data transmission.

683.02.03 OPTICAL:

- (a) Laser both directions (wavelength 1310/1550 nm) over 1 single mode fiber.
- (b) Link loss budget of 23dB (minimum).

- (c) ST Connectors only.
- (d) Minimum connection of 0.67 meters (2 feet) of cable with no optical attenuation.

683.02.04 DATA:

- (a) Bi-directional data communications (simplex and full duplex operating modes).
- (b) Selectable Electronic Industry Association (EIA)-232, EIA-422, or 2-wire EIA-485 interfaces.
- (c) Data rates from DC to 100kbps.
- (d) Bit error rate of 10^{-9} .
- (e) Data receiver output (EIA-232/422) defaults to a "low" state in the event of a fiber break or failed data transmitter.

683.02.05 VIDEO:

- (a) NTSC Color, compliant with EINTIA-250-C for Medium-Haul Transmission and EIA-170 Video Standards.
- (b) Bandwidth range of 5Hz to 6.5MHz.
- (c) Signal-to-Noise Ratio > 60 dB.
- (d) Differential Gain < 3 percent.
- (e) Differential Phase < 3 degrees.
- (f) Tilt < 1 percent.
- (g) BNC Connection.

683.02.06 POWER: The VOTR shall operate to specification when supplied with 120 ± 15 VAC, 60 ± 3 Hz single-phase power. The use of transformers to reduce the 120 VAC prime power input to a lower level used by the VOTR is acceptable. This transformer shall be supplied if necessary.

683.02.07 ENVIRONMENTAL: The VOTR shall be designed to operate from minus -40°C (-40°F) to $+74^{\circ}\text{C}$ (165°F) with no cooling airflow, 0-95 percent relative humidity, non-condensing.

The VOTR shall be compliant with National Electronics Manufacturers Association (NEMA) TS-1/TS-2 and Caltrans Traffic Signal Control Equipment Specifications for shock, vibration, and voltage transient protection.

683.02.08 19-INCH RACK MOUNTED CARD CAGE: When required at a hub location, the VOTR shall be able to be installed in a 19-inch rack mounted card cage. The cage height shall not exceed 4 RU. The cage shall contain a fault tolerant power converter compatible with VOTR module power requirements. The cage shall include provisions for interconnecting cabling and be designed to accommodate a minimum of seven VOTR modules that shall be easily mountable and removable from the cage. When installed in the cage, the VOTR modules shall be securable. The module's maintenance indications shall not be distributed after being mounted in the drawer. A failure of 1 VOTR module shall not impact the operation of other VOTR modules installed within rack-mounted cage.

683.02.09 FIBER OPTIC JUMPER CABLES: 4 fiber optic jumper cables shall be delivered with each transceiver supplied, and the fiber optic jumper cables shall meet the following requirements:

- (a) 250 μm buffering of each fiber.
- (b) 900 μm buffering of each fiber applied after the initial 250 μm buffering.
- (c) Maximum factory measured insertion loss of 0.5dB per EIA/Telecommunications Industry Association (TIA) 455-171.
- (d) Less than 0.2dB loss when subjected to EIA/TIA-455-1B, 300 cycles, 0.5 kg.
- (e) Aramid yarn strength member.
- (f) Rugged 3 millimeters (0.12 inch) (approximate) Polyvinyl Chloride (PVC) sheathing.
- (g) Minimum bend radius of 320 millimeters (12 inches) following installation, 640 millimeters (25 inches) during installation.
- (h) Minimum tensile strength of 444 N (100 lbs.).
- (i) And ST connectors that are factory terminated with strain relief.

CONSTRUCTION

683.03.01 GENERAL: Though no physical construction is part of this deliverable, the Contractor shall furnish all mounting hardware (i.e., machine screws, nuts, locking washers) to install the VOTR's securely in the cabinet. Mounting methods using tape, Velcro, and sticky back material will not be permitted. All necessary power adapters and cabling needed to obtain power from the power distribution assembly shall be provided and secured.

As noted above, the Contractor shall also supply the 1 simplex fiber optic jumper cable needed to be installed from the field termination panel (field mounted) or from the fiber optic patch panel (rack mounted) to the single optical inputs of the VOTR.

All VOTR's shall be provided with protective covers on all optical connectors. The Contractor shall ensure that the protective covers remain on the optical connectors at all times when each connector is not being used.

METHOD OF MEASUREMENT

683.04.01 MEASUREMENT: The quantity of Shelf Mounted VOTR's with Cable will be measured for payment per each delivered, complete and operational, and successfully tested.

The quantity of rack mounted VOTR's with cable will be measured for payment per each delivered, complete and operational, and successfully tested.

The quantity of 19-inch rack mounted card cage will be measured for payment per each delivered, complete and operational, and successfully tested.

Mounting hardware, power conversion hardware (if required), and the VOTR rack mountable card cage in the hub is incidental to the VOTR bid item and will not be measured or paid separately.

The equipment delivered will be tentatively accepted pending testing by the FAST Director or designee. Only after a series of bench tests of the devices will the final acceptance be made and documented.

BASIS OF PAYMENT

683.05.01 PAYMENT: The accepted quantity of Shelf Mounted VOTR's with cable delivered complete will be paid for at the contract unit price bid per each, which price shall be full compensation for the VOTR(s), SMFO cable, housing(s), 4 fiber optic jumper cables per video transceiver, hardware, 1 simplex fiber optic jumper cable per video transceiver, warranty, and delivery to the FAST Director or designee.

The accepted quantity of rack mounted VOTR's with cable delivered complete will be paid for at the contract unit price bid per each, which price shall be full compensation for the VOTR(s), SMFO cable, 4 fiber optic jumper cables per video transceiver, hardware, 1 simplex fiber optic jumper cable per video transceiver, warranty, and delivery to the FAST Director or designee.

The accepted quantity of 19-inch rack mounted card cage delivered complete will be paid for at the contract unit price bid per each, which price shall be full compensation for the rack mounted card cage, hardware, warranty, and delivery to the FAST Director or designee.

Payment will be made under:

PAY ITEM:	PAY UNIT
Shelf Mounted Video Optical Transceivers with Cable	Each
Rack Mounted Video Optical Transceivers with Cable.....	Each
19-Inch Rack Mounted Card Cage.....	Each

SECTION 684

LAYER 2 FIELD-HARDENED ETHERNET SWITCH

DESCRIPTION

684.01.01 GENERAL: This specification describes the functional, performance, environmental, submittal, documentation and warranty requirements, as well as the method of measurement and basis of payment, for a Layer 2 Field-Hardened Ethernet Switch, herein called the field switch.

The Field Switch shall comply with the requirements stated within this specification so as to operate within the Freeway and Arterial System of Transportation (FAST) Arterial Management System (AMS) and Freeway Management System (FMS).

This specification is for equipment only, no installation, to be delivered to the FAST Traffic Management Center (TMC) for testing and approval prior to final acceptance. The agency Project Manager shall be notified prior to the delivery to the TMC. No partial shipments will be accepted. All equipment supplied on this project will be delivered during a single delivery, and shall be labeled clearly with the project and location designation.

All equipment shall be approved prior to purchase by the FAST Director or designee.

MATERIALS/EQUIPMENT

684.02.01 FUNCTIONAL REQUIREMENTS: The field switch shall comply with the following standards:

- (a) Institute of Electrical and Electronic Engineers (IEEE) 802.IQ Local and Metropolitan Area Networks – Virtual Bridged Local Area Networks.
- (b) IEEE 802.1P: Traffic Class Expediting and Dynamic Multicast Filtering – Draft 8.
- (c) IEEE 802.3X: IEEE Standards for Local and Metropolitan Area Networks; Specifications for 802.3 Full Duplex Operation.
- (d) IEEE 802.1W: IEEE Standards for Local and Metropolitan Area Networks – Common Specifications – Part 3; Media Access Control (MAC) Bridges – Amendment 2 Rapid Configuration.
- (e) Federal Communications Commission (FCC) Rules and Regulations Vol. II, Part 15 for Class A Equipment Electronic Compatibility and Susceptibility (Product electromagnetic compatibility is required).
- (f) National Electronics Manufacturers Association (NEMA) TS – 1 Section 2 – Traffic Control System. The following clauses apply:
 - (1) 2.1.2: Voltage.
 - (2) 2.1.3: Frequency Range.
 - (3) 2.1.4: Power Interruption.
 - (4) 2.1.5: Temperature and Humidity, as modified herein.
 - (5) 2.1.6: Transients, Power Service.

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- (6) 2.1.7: Transients, Input-output terminals.
- (7) 2.1.8: Nondestruct Transient Immunity.
- (8) 2.1.12: Vibration.
- (9) 2.1.13: Shock.
- (g) Underwriters Laboratory (UL) 60950 Safety Requirements for Information Technology (IT) Equipment (applicable to equipment safety).
- (h) Military Handbook MIL-HDBK-217F-2 Military Handbook for “Reliability Prediction of Electronic Equipment”, Notice 2.

Detailed Requirements

- (i) The field switch shall:
 - (1) Be 6 port (minimum) 10/100 Base TX RJ-45.
 - (2) Have a minimum of 2 100 Base FX fiber optical ports.
 - (3) Operate non-blocking, at full wire speed.
 - (4) Support remote reset and remote management.
 - (5) Support IGMP snooping.
 - (6) Support IP Multicast filtering.
 - (7) Support remote turn on/off Base TX ports.
- (j) The field switch shall also meet the following functionality and requirements:
 - (1) 10/100 Base TX port shall connect via RJ-45 connector. The ports shall operate as half-duplex or full-duplex (IEEE 802.3x) over 100m segment lengths and provide auto-negotiation and Medium Dependent Interface/ Medium Dependent Interface, Crossover (MDI/MDIX) capability.
 - (2) Each 100 Base Fiber Transmission (FX) port shall connect via fiber connectors and 9/125um single-mode fiber. Fiber connectors shall be available as Straight Tip (ST). The ports shall operate as full duplex (IEEE 802.3x) over 15 km segment lengths. The minimum link loss budget (OPB = Rx (min) – LED aging) shall be greater than or equal to 15 dB.
 - (3) The field switch shall provide the following advanced Layer 2 functions: IEEE 802.1Q VLAN with support for a minimum of 128 Virtual Local Area Networks (VLAN), IEEE 802.1P priority queuing, IEEE 802.1W rapid spanning tree (required), IEEE 802.3X flow control greater than or equal to 1,028, support automatic address learning of a minimum 4,096 Medium Access Control (MAC) addresses and greater than or equal to 1,028 static MAC address.
 - (4) The field switch shall provide the following port security function: ability to configure static MAC addresses, ability to disable automatic address learning per ports; known hereafter as secure port, secure ports only forward statically configured MAC addresses, trap and alarm upon any unauthorized MAC address and shutdown for programmable

duration. Port shutdown requires administrator to manually reset the port before communications are allowed, all the above activities are done remotely.

- (5) The field switch shall provide the following network management functions: SNMPv3 (RFC 2273), RMON (RFC 1757), Port Mirroring (RFC 1757), Spanning Tree (IEEE 802.1D), Rapid Spanning Tree (IEEE 802.1W).
 - (6) The field switch shall support telnet, Trivial File Transfer Protocol (TFTP) or File Transfer Protocol (FTP), Command Line Interface (CLI) and Simple Network Management Protocol (SNMP).
- (k) The field switch shall have an integrated web interface. Reset/Reboot and firmware shall be supported via all methods listed above. All parameters and settings (network management, security, Layer 2 features, etc) shall be user configurable through the maintenance port, web interface Telnet and all other supported remote management tools.
- (l) The field switch shall allow for stand-alone shelf mounting unit and DIN rail mounting.
- (m) The field switch shall support the following:
- (1) Power: Nominal 120 VAC, 60 Hz. The unit shall be provided with all power conversion and regulation necessary to support electronics operation. The power input circuitry shall be designed to protect the electronics from damage by a power surge or under-voltage condition. Power consumption shall not exceed 20 Watts.
- (n) The field switch shall include a power status indicator.
- (o) Physical Characteristics:
- (1) 6 Port.
 - (2) The field switch shall not exceed 3" high x 17.25" wide or 10" deep (3" x 17.25" x 10").
 - (3) The weight shall not exceed 6 lbs.
- (p) Environmental: The field switch shall conform to functional and performance specifications as defined herein when operated in the following environment.
- (1) Temperature: -20°C. to 74°C.
 - (2) Humidity: 5 to 95 percent relative humidity, non-condensing.
- (q) Cooling shall be by convection with case acting as heat sink. No cooling fan shall be used.
- (r) The field switch shall have the following minimum indicators:
- (1) Power: On, Off.
 - (2) Network status per port: Transmit, receive, link, speed.
- (s) Status indicators shall be Light Emitting Diode (LED).
- (t) All connectors, indicators and replaceable components shall be permanently marked and traceable to the supplied documentation, including schematics and parts list. The external markings shall include the product function name, model number, serial number and manufacturer's name.
- (u) The field switch shall have a minimum Mean Time Between Failures (MTBF) of 40,000 hours.

- (v) Each unit shall have a unique MAC address, MAC address shall be derived from an address space of 10,000 sequential addresses.
- (w) Documentation: Upon delivery, the following minimum documentation shall be provided by the vendor with each field switch provided:
 - (1) Initial configuration (This document shall provide both hardware and software settings).
 - (2) Setup and configuration manual.
 - (3) Users manual.
- (x) Warranty: The field switch shall be warranted for a minimum of 3 years. The warranty shall guarantee the field switch to be free from defects from assembly, fabrication and materials. The warranty will begin upon acceptance by the contracting agency.

METHOD OF MEASUREMENT

684.03.01 MEASUREMENT: The Layer 2 Field-Hardened Ethernet Switch shall be measured per each. The mounting hardware and cabling and network management software are considered incidental and will not be measured or paid separately to the unit.

BASIS OF PAYMENT

684.04.01 PAYMENT: The accepted quantity of Layer 2 Field-Hardened Ethernet Switch (s) will be paid at the contract unit price per each. The unit will include furnishing and configuration, and all labor, material and equipment required for facilitating an operational field switch.

Payment will be made under:

PAY ITEM:

PAY UNIT

Layer 2 Field-Hardened Ethernet Switch..... Each

SECTION 685

VIDEO ENCODER

DESCRIPTION

685.01.01 GENERAL: This specification describes the functional, performance, environmental, submittal, documentation and warranty requirements, as well as the method of measurement and basis of payment, for a rugged field deployable and user selectable Moving Picture Experts Group (MPEG)-2 and MPEG-4 video encoder. This video encoder will transmit data via RS-232/422 and accept standard National Television Standards Committee (NTSC) composite video signal as input, digitally compress it and transmit it over the Freeway and Arterial System of Transportation (FAST) communication network. The video encoder shall comply with the requirements stated within this specification so as to operate within the FAST Arterial Management System (AMS) and Freeway Management System (FMS).

This specification is for equipment only, no installation, to be delivered to the FAST Traffic Management Center (TMC) for testing and approval prior to final acceptance. The agency Project Manager shall be notified prior to the delivery to the TMC. No partial shipments will be accepted. All equipment supplied on this project will be delivered during a single delivery, and shall be labeled clearly with the project and location designation.

All equipment shall be approved prior to purchase by the FAST Director or designee.

MATERIALS

685.02.01 FUNCTIONAL REQUIREMENTS: The video encoder shall comply with the following standards:

- (1) National Electronics Manufacturers Association (NEMA) TS – 1 Section 2 – Traffic Control System.
The following clauses apply:
 - a) 2.1.2: Voltage.
 - b) 2.1.3: Frequency Range.
 - c) 2.1.4.1: Power Interruption.
 - d) 2.1.5: Temperature and Humidity, as modified herein.
 - e) 2.1.6: Transients, Power Service.
 - f) 2.1.7: Transients, Input-output terminals.
 - g) 2.1.8: Nondestruct Transient Immunity.
 - h) 2.1.12: Vibration.
 - i) 2.1.13: Shock.
- (2) International Organization for Standardization: (ISO) 9001 Quality Assurance, MPEG-2 ISO/13818-2 Video Compression.
- (3) Institute of Electrical and Electronic Engineers (IEEE) 802.3: Part 3 CSMA/CD Access Method and Physical Layer Specifications.
- (4) Federal Communications Commission (FCC) Rules and Regulations Vol. II, Part 15 for Class A Equipment Electronic Compatibility and Susceptibility (Product electromagnetic compatibility is required).

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(5) Underwriters Laboratory (UL) 60950 Safety Requirements for IT Equipment (Applicable to equipment safety).

(6) Military Handbook MIL-HDBK-217F-2 Military Handbook for “Reliability Prediction of Electronic Equipment,” Notice 2.

Detailed Requirement:

- (a) The video encoder shall support the following video features:
 - (1) Signal format: 30 fps, NTSC color.
 - (2) Resolution: 720 x 480 (full Resolution).
 - (3) Video Settings: Contrast, saturation, brightness and hue.
- (b) The video encoder shall support bi-directional serial communications over ethernet via the following methods:
 - (1) Encoder serial port to decoder serial port data stream.
 - (2) Internet Protocol (IP) socket to encoder serial port.
 - (3) The video encoder shall support full-duplexed serial interface and data rates up to 57.6 kbps. The baud rate, stop bits, data bits and flow control shall be user configurable. The serial interface shall be transparent to the device (i.e. no additional or special protocols shall be required to communicate between the Closed Circuit Television (CCTV) control interface and the encoder).
- (c) The video encoder shall support the following:
 - (1) Encoding Formats: The unit shall be capable of being soft configured to perform MPEG-2 ISO/13818-2 video compression and MPEG-4 ISO/14496 video compression.
 - (2) The encoder shall be capable of being soft configured to produce elementary, or transport stream.
 - (3) Bandwidth: 1.5 Mbps – 10 Mbps for MPEG - 2 and 64 Kbps to 5 Mbps for MPEG - 4 (The data rate shall be defined as the maximum committed bandwidth to be utilized, which includes bursting). The default bandwidth for the video encoder shall be set to 5 Mbps for MPEG - 2 and 1 Mbps for MPEG - 4.
 - (4) Latency: The end-to-end latency between the video encoder and the video decoders shall be no more than 250 ms while operating at a rate of 5 Mbps.
- (d) The video encoder shall support the following network features:
 - (1) Ethernet Interface (10/100 Mbps, Full-Duplex, Auto Negotiate (802.3), (RJ-45).
 - (2) Static IP Addressing (Class A, B and C).
 - (3) SNMP (MIB2).
 - (4) Unicast and Multicast (IGMP V2).
 - (5) Gateway Configuration.
 - (6) Adjustable Packet Payload Size.
- (e) The video encoder shall support:
 - (1) Command Line Interface (CLI).
 - (2) Telnet.
 - (3) Trivial File Transfer Protocol (TFTP) or FTP (new firmware download).
 - (4) The video encoder shall have an integrated web interface, which provides remote configuration.

- (5) Reset/Reboot and firmware upload shall be supported via all methods listed above.
- (6) All video (i.e. resolution, contrast, etc.), data (i.e. baud rate, parity, etc.), encoder (i.e. bandwidth, etc) and network (i.e. IP, subnet mask, gateway, etc.) parameters and settings shall be user configurable through the maintenance port, web interface, Telnet and all other supported remote management tools.
- (7) All configurations and settings shall be downloadable/exportable in a document form. As a minimum, the exported settings shall include video, network, and data settings.

Failure and Reset Recovery: The recovery time of a hard or soft reset shall be less than 45 seconds.

Electrical:

- (a) The video encoder shall support the following:
 - (1) Power: Nominal input voltage of 120 VAC 60 Hz. The unit shall contain all power conversion and regulation necessary to support electronics operation.
 - (2) Power consumption: Shall not exceed 70 Watts.
 - (3) All supplied video encoders shall have the same power connectors. Each unit shall be provided with a power cable that is at least 5 feet (1.5 meters) in length and terminated with a male, 3 prong UL-listed power connector for interface with the previously stated power system.

Ports:

- (a) The video encoder shall have the following ports:
 - (1) Network: 10/100 Mbps RJ-45.
 - (2) Video: Composite Bayonet Neill-Concelman (BNC) and S-Video.
 - (3) Data: 2 Electronics Industry Association (EIA)-RS232/422/485, DB-9* (Female). These ports shall provide data pass thru for serial control (i.e. PTZ camera control). If EIA RS422 is not provided natively by the port, an EIA RS232 to 422 converter meeting all encoder environmental requirements shall be supplied.
 - (4) Data: 1 EIA-232 DB-9* (Female). This port shall provide maintenance interface for local configuration.

*RJ-45 may be provided in place of DB-9. For each RJ-45 port, a RJ-45 to DB-9 converter shall be supplied.

Status Indicators:

- (a) The video encoder shall have the following minimum indicators:
 - (1) Activity.
 - (2) Power.
 - (3) Video Loss.
 - (4) Transmit.
 - (5) Receive.
- (b) Status indicators shall be LED.

Physical Characteristics:

- (a) The video encoder shall not exceed 2 ½" high x 12" wide x 13 "deep (2 ½" x 12"-x 13".)
- (b) The weight shall not exceed 10 lbs.

External Markings:

All connectors, indicators, and replaceable components shall be permanently marked and traceable to the supplied documentation, including schematics and parts list. The external markings shall include the product function name, model number, serial number and manufacturer's name.

Environmental:

- (a) The video encoder shall conform to the performance specification when operated in the following environment:
 - (1) Temperature: -20°C to +70°C (-4° F to 165° F)
 - (2) Humidity: 5 to 95 percent relative humidity, non-condensing.
 - (3) The video encoder shall be conformal coated to prevent damage from blowing sand and dust.
- (b) The video encoder shall have a minimum Mean Time Between Failures (MTBF) of 60,000 hours.

MAC Address:

Each unit shall have a unique MAC address, MAC address shall be derived from an address space of 10,000 sequential addresses.

Network Management Software:

All custom Management Information Base's (MIB's) required for network management shall be provided for use with third party network management software.

IP Addressing:

Each unit shall support and be delivered with 2 user settable IP addresses, 1 for command and control, and 1 for video multicasting.

685.03.01 SUBMITTALS: The following shall be submitted by the Vendor to the contracting agency:

- (a) Acceptance Test Procedures (stand-alone and operational).
- (b) Training Syllabus.
- (c) Users Manual.
- (d) Parts List.
- (e) Description of MAC addresses scheme/space.
- (f) Certifications/Statement of: Conformance to all standards listed in this section of the Uniform Standard Specifications. Testing for compliance will be performed by an independent party.

TESTING

685.04.01 TESTING: Prior to acceptance by the contracting agency the video encoder shall require testing as described below. The supplier shall absorb all costs associated with the testing including and not limited to shipping and handling, all material and equipment and any labor required from the bidder. Prior to acceptance of any video encoder the following tests shall be performed:

- (a) Stand Alone Acceptance Test (SAT): Using the FAST approved vendor-supplied test procedures, FAST will perform the SAT in a test area provided by FAST. A vendor representative may be present during the SAT. The Vendor will be provided with a schedule of the test, including time and place.
- (b) The SAT will be performed as follows:
 - (1) The video encoder will be assembled and connected to power in a stand-alone configuration.
 - (2) The video encoder will be powered up and allowed to initialize, boot and run self-diagnostic tests as defined in the FAST approved test procedures.
 - (3) After the video encoder has started and initialized, any additional test procedures will be executed.
 - (4) After the test procedures have been executed, the video encoder will be allowed to run, uninterrupted, for a burn-in period of 72 hours.
 - (5) At the end of the burn-in period, the unit will be restarted and configuration verified.
 - (6) Upon completion of all test procedures, the Vendor will be notified of SAT acceptance or failure.
- (c) Operational Test: After successful completion of the SAT, FAST will configure and connect the video encoder to the FAST test network. A FAST provided CCTV assembly will be connected (video and data) to the video encoder. Along with the video encoder, the network will also have a video decoder unit with a video monitor, and a Personal Computer (PC) operating the video decoder software and camera control application provided by the County. The following tests will be performed by FAST:
 - (1) Video Image (subjective quality acceptable to FAST).
 - (2) Serial Data Channel both point-to-point (encoder to decoder), and IP.
 - (3) User programmable parameters and functions.
 - (4) Network management.
- (d) While connected to the network, the video encoder shall not, in any way compromise the function or functions or any other connected network device(s).
- (e) Upon completion of all the tests, the Vendor will be notified of operational test acceptance or failure. If the unit fails the test, the Vendor shall supply a new unit and the test shall be restarted.

685.05.01 WARRANTY: The video encoder shall be warranted for a minimum of 3 years. The warranty shall guarantee the video encoder to be free from defect from assembly, fabrication, and materials. The FAST and contracting agency may exercise the option of purchasing an extended warranty for an additional 2 years utilizing the video encoder extended 2 year warranty item as indicated in Section 685.07.01 "Payment."

The warranty shall be provided in writing. If the normal manufacturers warranty extends for a longer period, the video encoder shall be warranted for that period.

The warranty shall be measured from the date of receipt by the contracting agency. The manufacturer shall be responsible for maintaining a list of equipment supplied and warranty information during the period of the warranty contract. A report shall be submitted to FAST annually which details the status of equipment warranties.

Video encoders found to be defective during the warranty period shall be replaced free of charge by the manufacturer. The vendor shall be responsible for all shipping and handling costs for equipment under warranty.

The manufacturer shall also provide technical support coverage for all equipment and software furnished. This support shall as a minimum include the following:

- (a) Software and firmware upgrades.
- (b) Software patches.

METHOD OF MEASUREMENT

685.06.01 MEASUREMENT: The video encoder shall be measured per each. The unit will include furnishing all material required for facilitating an operational video encoder including all necessary jumpers. The video encoder-extended 2 year warranty shall be measured by lump sum.

BASIS OF PAYMENT

685.07.01 PAYMENT: The accepted quantity of video encoder will be paid at the contract unit price per each. The unit will include furnishing and configuration, and all labor, material and equipment required for facilitating an operational video encoder. The lump sum price for video encoder-extended 2 year warranty shall be full compensation for the extended warranty.

Payment will be made under:

PAY ITEM:	PAY UNIT
Video Encoder	Each
Video Encoder extended 2 year warranty	Lump sum

SECTION 686
VIDEO DECODER

DESCRIPTION

686.01.01 GENERAL: This specification describes the functional, performance, environmental, submittal, documentation and warranty requirements, as well as the method of measurement and basis of payment, for a rugged field deployable and user selectable Moving Picture Experts Group (MPEG)-2 and MPEG-4 video decoder. This video decoder will accept serial data signal and the digitally compressed video over the Freeway and Arterial System of Transportation (FAST) Communication Network Ethernet (TCP/IP) network from a video encoder, and output the decoded video as a standard National Television Standards Committee (NTSC) composite video signal and the serial data as RS-232/422.

The video decoder shall be of the same manufacturer and fully compatible with the video encoder provided under Specification 685 "Video Encoder".

The video decoder shall comply with the requirements stated within this specification so as to operate within the FAST Arterial Management System (AMS) and Freeway Management System (FMS).

This specification is for equipment only, no installation, to be delivered to the FAST Traffic Management Center (TMC) for testing and approval prior to final acceptance. The agency Project Manager shall be notified prior to the delivery to the TMC. No partial shipments will be accepted. All equipment supplied on this project will be delivered during a single delivery, and shall be labeled clearly with the project and location designation.

All equipment shall be approved prior to purchase by the FAST Director or designee.

MATERIALS/EQUIPMENT

686.02.01 FUNCTIONAL REQUIREMENTS: The video decoder shall comply with the following standards:

- (a) International Organization for Standardization: (ISO) 9001 Quality Assurance, MPEG-2 ISO/13818-2 Video Compression and MPEG-4 ISO/14496 Video Compression.
- (b) Institute of Electrical and Electronic Engineers (IEEE) 802.3: Part 3: CSMA/CD Access Method and Physical Layer Specifications.
- (c) Federal Communications Commission (FCC) Rules and Regulations Vol. II, Part 15 for Class A Equipment Electronic Compatibility and Susceptibility (Product electromagnetic compatibility is required).
- (d) Underwriters Laboratory (UL) 60960 Safety Requirements for IT Equipment (Applicable to equipment safety).
- (e) Military Handbook MIL-HDBK-217F-2 Military Handbook for "Reliability Prediction of Electronic Equipment", Notice 2.

Detailed Requirements:

- (a) The video decoder shall inter-operate with the video encoders, as defined in Section 685 "Video Encoder".

- (b) The video decoder shall support the following video features:
 - (1) The unit shall be capable of being soft configured to perform MPEG- 2 ISO/13818-2 video decoding and MPEG- 4 ISO/14496 video decoding.
 - (2) The unit shall be capable of being soft configured to produce elementary or transport stream.
 - (3) Video stream of up to 10 Mbps, auto-detecting.
 - (4) Video frame rate up to 30 fps and resolution of 720x480 pixels.
 - (5) 30 fps NTSC color video output.
 - (6) The end-to-end latency between the video encoder and the video decoders shall be no more than 250 ms while operating at a rate of 5 Mbps.
- (c) The video decoder shall support the following network features:
 - (1) Ethernet Interface 10/100 Mbps, Half/Full-Duplex, Auto Negotiate (802.3), (RJ-45).
 - (2) Static Internet Protocol (IP) Addressing (Class A, B and C).
 - (3) Simple Network Management Protocol (SNMP) (M1B1, MIB2).
 - (4) Unicast and Multicast (IGMP V2).
 - (5) Gateway Configuration.
- (d) The video decoder shall support:
 - (1) Command Line Interface (CLI).
 - (2) Telnet.
 - (3) Trivial File Transfer Protocol (TFTP) or FTP (new firmware download).
 - (4) The video decoder shall have an integrated web interface, which provides remote configuration and management features.
 - (5) Reset/Reboot and firmware upload shall be supported via all methods listed above.
 - (6) All video (i.e. resolution, contrast, etc.), data (i.e. baud rate, parity, etc), encoder (i.e. bandwidth, etc) and network (i.e. IP, subnet mask, gateway, etc.) parameters and settings shall be user configurable through the maintenance port, web interface, Telnet and all other supported remote management tools.
 - (7) All configurations and settings shall be downloadable/exportable in a document form. As a minimum, the exported settings shall include video, network, and data settings.

Failure and Reset Recovery:

The recovery time of a hard or soft reset shall be less than 45 seconds.

Electrical:

- (a) The video decoder shall support the following:
 - (1) Power: Nominal input voltage of 120 VAC 60 Hz. The unit shall contain all power conversion and regulation necessary to support electronics operation.
 - (2) Power consumption: Shall not exceed 70 Watts.
 - (3) All supplied video decoders shall have the same power connectors. Each unit shall be provided with a power cable that is at least 5 feet (1.5 meters) in length and terminated with a male, three-prong UL-listed power connector for interface with the previously stated power system.

Ports:

- (a) The video decoder shall have the following ports:

- (1) Network: 10/100 Mbps RJ-45.
- (2) Video: Composite Bayonet Neill-Concelman (BNC) and S-Video.
- (3) Data: 2 Electronics Industry Association (EIA)-RS232/422/485, DB-9* (Female) (supporting up to 57.6 kbps). These ports shall provide data pass thru for serial control (i.e. PTZ camera control).
- (4) Data: 1 EIA-232 DB-9* (Female). This port shall provide maintenance interface for local configuration.

*RJ-45 may be provided in place of DB-9. For each RJ-45 port, a RJ-45 to DB-9 converter shall be supplied.

Status Indicators:

- (a) The video decoder shall have the following minimum indicators:
 - (1) Activity.
 - (2) Power.
 - (3) Video Loss.
 - (4) Transmit.
 - (5) Receive.
- (b) Status indicators shall be Light Emitting Diode (LED).

Physical Characteristics:

- (a) The video decoder shall not exceed 2 ½” high x 12” wide x 13” deep (2 ½” x-12” x 13”).
- (b) The weight shall not exceed 10 pounds.

External Markings:

All connectors, indicators, and replaceable components shall be permanently marked and traceable to the supplied documentation, including schematics and parts list. The external markings shall include the product function name, model number, serial number and manufacturer’s name.

Environmental:

- (a) The video decoder shall conform to the performance specification when operated in the following environment:
 - (1) Temperature: 0° C (+32° F) to (+40°) C (104° F).
 - (2) Humidity: 5 to 95 percent relative humidity, non-condensing.
- (b) The video decoder shall have a minimum Mean Time Between Failures (MTBF) of 60,000 hours.

MAC Address:

Each unit shall have a unique MAC address, MAC address shall be derived from an address space of 10,000 sequential addresses.

Network Management Software:

All custom Management Information Base (MIB’s) required for network management shall be provided for use with third party network management software.

IP Addressing:

Each unit shall support and be delivered with 2 user settable IP addresses, 1 for command and control, and 1 for video multicasting.

686.03.01 SUBMITTALS: The following shall be submitted by the Vendor to the contracting agency:

- (a) Acceptance Test Procedures (stand-alone and operational).
- (b) Training Syllabus.

- (c) Users Manual.
- (d) Parts List.
- (e) Description(s) of MAC address scheme/space.
- (f) Certifications/Statement of: Conformance to all standards listed in this section. Testing for compliance will be performed by an independent party.

686.04.01 TESTING: Prior to acceptance by the contracting agency, the video decoder shall require testing as described below. The vendor shall absorb all costs associated with the testing including and not limited to shipping and handling, all material and equipment and any labor. Prior to acceptance of any video decoder the following tests shall be performed:

- (a) Stand Alone Acceptance Test (SAT): Using the FAST approved vendor-supplied test procedures, FAST will perform the SAT in a test area provided by FAST. A vendor representative may be present during the SAT. The Vendor will be provided with a schedule of the test, including time and place.
- (b) The SAT will be performed as follows:
 - (1) The video decoder will be assembled and connected to power in a stand-alone configuration.
 - (2) The video decoder will be powered up and allowed to initialize, boot and run self-diagnostic tests as defined in the FAST-approved test procedures.
 - (3) After the video decoder has started and initialized, any additional test procedures will be executed.
 - (4) After the test procedures have been executed, the video decoder will be allowed to run, uninterrupted, for a burn-in period of 72 hours.
 - (5) At the end of the burn-in period, the unit will be restarted and configuration verified.
 - (6) Upon completion of all test procedures, the Vendor will be notified of SAT acceptance or failure. If the unit fails the test the Vendor shall supply a new unit and the test shall restart.
- (c) Operational Test: After successful completion of the SAT, FAST will configure and connect the video decoder to the FAST Test Network. Along with the video decoder, the network will also have a video encoder unit as specified in Section 685 and a Personal Computer (PC) operating the video decoder software, as specified by FAST, and the camera control application provided by FAST.
- (d) The following tests will be performed by FAST:
 - (1) Video Image (subjective quality acceptable to FAST).
 - (2) Serial Data Channel both point-to-point (encoder to decoder), and IP.
 - (3) User programmable parameters and functions.
 - (4) Network management.
- (e) While connected to the network, the video decoder shall not, in any way compromise the function or functions or any other connected network device(s).
- (f) Upon completion of all the tests, the Vendor will be notified of operational test acceptance or failure. If the unit fails the test, the Vendor shall be disqualified and the Agency will proceed with the next low qualified bidder.

686.05.01 WARRANTY: The video decoder shall be warranted for a minimum of 3 years. The warranty shall guarantee the video decoder to be free from defect from assembly, fabrication, and materials. The FAST and contracting agency may exercise the option of purchasing an extended warranty for an additional 2 years utilizing the item number as indicated in Section 686.07.01, "Payment."

The warranty shall be provided in writing. If the normal manufacturers warranty extends for a longer period, the video decoder shall be warranted for that period.

The warranty shall be measured from the date of receipt by the contracting agency. The manufacturer shall be responsible for maintaining a list of equipment supplied and warranty information during the period of the warranty contract. A report shall be submitted to FAST annually which details the status of equipment warranties.

Video decoders found to be defective during the warranty period shall be replaced free of charge by the manufacturer. The vendor shall be responsible for all shipping and handling costs for equipment under warranty.

The manufacturer shall also provide technical support coverage for all equipment and software furnished. This support shall as a minimum include the following:

- (a) Software and firmware upgrades.
- (b) Software patches.

METHOD OF MEASUREMENT

686.06.01 MEASUREMENT: The video decoder shall be measured per each. The unit will include furnishing all material required for facilitating an operational video encoder including all necessary jumpers. The video decoder, extended 2 year warranty shall be measured by lump sum.

BASIS OF PAYMENT

686.07.01 PAYMENT: The accepted quantity of video decoder will be paid at the contract unit price per each. The unit will include furnishing and configuration, and all labor, material and equipment required for facilitating an operational video decoder. The lump sum price for video decoder extended 2 year warranty shall be full compensation for the extended warranty.

Payment will be made under:

PAY ITEM:

PAY UNIT

Video Decoder	Each
Video Decoder extended 2 year warranty.....	Lump sum

SECTION 687**CLOSED CIRCUIT TELEVISION (CCTV) FIELD EQUIPMENT****DESCRIPTION**

687.01.01 GENERAL: This specification shall govern the furnishing of Closed Circuit Television (CCTV) field equipment of a CCTV microprocessor unit at designated field locations and equipment cabinets as shown on the plans. This equipment will be installed by the Contractor at designated sites, and all hardware, software, and assorted components needed for the proper operation of the units shall be supplied. All materials furnished, assembled, fabricated or installed under this item shall be new, corrosion-resistant and in strict accordance with the specifications. The equipment design and construction shall utilize the latest techniques with a minimum number of parts, subassemblies, circuits, cards, and modules to maximize standardization and commonality. The equipment shall be designed for ease of maintenance. All component parts shall be readily accessible for inspection and maintenance.

MATERIALS/EQUIPMENT

687.02.01 FUNCTIONAL REQUIREMENTS: The CCTV Field Equipment together with the CCTV central equipment in the Traffic Management Center (TMC) will form a complete CCTV system which shall meet the following requirements.

The video camera positioning system shall provide dual mode, day (color) and night (monochrome) video camera with optical zoom lens and a high speed positioning system. The lens has a focal length of 3.4mm to 119mm (35:1) with auto/manual focus. A digital zoom range of up to 12X provides an effective zoom ratio of 350:1. The effective focal length is 3.4mm to 1190mm. The ¼" format Progressive Scan CCD image sensor and lens combination results in an effective horizontal angle of view of 55.8° wide angle to 17° max. telephoto. The camera shall provide Wide Dynamic Range (WDR) by use of dual shutter exposure technique.

In addition, the camera shall be provided with electronic stabilization using the 2 motion-frequency selectable stabilization method. The pan function shall provide 360° of continuous rotation, with a variable speed from 0.1° per second to 160° per second. The tilt function shall provide 180° of movement 0° to +90° to -90°, with a variable speed from 0.1° per second to 40° per second. Up to 64 presets shall be available for storing and recalling zoom, pan and tilt positions. The positioner shall be capable of 8 or 16-point compass annotations with primary direction spelled out and intermediate directions abbreviated with 2 letters and a tour sequence defined using up to 64 preset positions. All camera and pan & tilt functions are operable via RS-422 serial communications. Communications protocol command set shall be the Freeway and Arterial System of Transportation (FAST) protocol.

Features

- (a) ¼" Progressive Scan Color Sensor.
- (b) Horizontal Resolution of 540 TV Lines.
- (c) 35:1 (3.4mm to 119mm) optical zoom lens.
- (d) Continuous digital zoom with selectable range from OFF to 10X.

- (e) Effective overall focal length of 3.4mm to 1190mm.
- (f) Electronic Image Stabilization.
- (g) Auto/Manual Focus.
- (h) Selectable long-term integration to 1/2 second with frame store video output.
- (i) Selectable shutter speeds from 1/2 second to 1/30,000 second.
- (j) Composite video output; NTSC format.
- (k) Adjustable color balance.
- (l) Crystal or Internal phase adjust line-lock, software adjustable.
- (m) Programmable on screen character generator.
- (n) Wide Dynamic Range (WDR) by use of dual shutter exposure technique.
- (o) RS-422 serial control protocol command set to FAST protocol.
- (p) Camera Addressing via serial control.
- (q) 8 or 16 point compass annotation.
- (r) 3 1/2" diameter Sealed enclosure Pressurized with dry nitrogen.
- (s) Continuous rotation capability in either direction.
- (t) Variable pan speed from 0.1°/sec. to >160°/sec. (Preset Mode).
- (u) Variable tilt speed from 0.1°/sec. to 40°/sec.
- (v) 64 zoom, focus, pan & tilt preset positions, each with a unique user programmable Preset ID.

Camera Specifications

- (a) Imager: Interline Transfer Progressive Scan CCD with mosaic-type color compensating filter.
- (b) Image Area: 1/4" Format 3.6mm (H) x 2.7mm (V).
- (c) Resolution: 520 horizontal; 350 vertical.
- (d) Picture Elements (total) 811 (H) x 508 (V).

- (e) Video Output: NTSC, 1 V p-p @ 75 ohms, unbalanced.
- (f) Maximum Lens Aperture: f/1.4 (wide) to f/4.2 (tele).
- (g) Optical Zoom Range: 35X, 3.4mm to 119mm.
- (h) Digital Zoom Range: 1X (Off) through 12X, Smooth transition from Optical to Digital Zoom.
- (i) Effective Digital Focal Length: 119 mm to 1190mm.
- (j) Optical Zoom Speed: 2 speeds, from approximately 2.9 seconds to 5.8 seconds full range.
- (k) Horizontal Angle of View: Optical: 55.8° to 1.7°; At 10X Digital: 55.8° to 0.17°.
- (l) Minimum Focus Distance: 40" in tele, 0.4" in wide angle.
- (m) Electronic Stabilization: 2 motion-frequency selectable stabilization method.
- (n) Digital Compass: 8-point compass annotation with primary direction spelled out and intermediate directions abbreviated with two letters.
- (o) Auto Focus: Selectable Auto/Manual.
 - (1) Minimum Scene Illumination for Reliable Auto Focus, 30% video.
- (p) Manual Focus Speed: One speed, approximately 2.0 seconds to full range.
- (q) Zoom & Focus Presets: 64 preset positions, focus is auto, if programmed, shall display the Preset ID.
- (r) Flash Memory: Update firmware and new features via serial communication.
- (s) Long Term Integration Range: (Short Shutter).
- (t) Provides manual selection of integration duration for enhanced sensitivity. Integration times are 1/2 second, 1/4 second, 1/8 second, 1/15 second, and 1/30 second. Frame Store video output provides continuous video output, updated at the integration rate.
- (u) Manual Shutter:
 - (1) Selectable shutter speeds of 1/60; 1/120; 1/180; 1/250; 1/500; 1/1,000; 1/2,000; 1/4,000; 1/10,000; 1/30,000 second.
- (v) Auto Iris:
 - (1) Iris automatically adjusts to compensate for changes in scene illumination to maintain constant video level output within sensitivity specifications.
- (w) Manual Iris:

- (1) Changing the video level shall do the effect of open iris/close iris. To give the effect of open iris, a decrease in the video level value shall change and to give the effect of close iris an increase in the video level shall change.
- (x) Gamma: 0.45.
- (y) AGC: 028 dB.
- (z) Color Balance: Auto Tracking Color Balance/Manual with adjustable Red and Blue Levels.
- (a1) Signal to Noise Ratio: > 50 dB.
- (b1) Synchronization: Crystal or Phase-Adjust Line Lock on 60Hz.
- (c1) Sensitivity: (3200K): Scene Illumination @ F1.4, Wide Angle:
- | | | |
|--------------------|--------------|------------------------------|
| 0.5 Lux @ 1/60Sec. | F1.4 Shutter | Color I.R. Cut On |
| 0.05 Lux @ 1/2Sec. | F1.4 Shutter | Color I.R. Cut On |
| 0.2 Lux @ 1/60Sec. | F1.4 Shutter | Monochrome mode I.R. Cut Off |
| 0.01 Lux @ 1/4Sec. | F1.4 Shutter | Monochrome mode I.R. Cut Off |

Camera Housing

The camera housing shall be a corrosion resistant and tamperproof sealed and pressurized housing with five pounds psi dry nitrogen with Schrader purge fitting and 20-psi relief valve for each camera. The size of the housing shall be 3 1/2" diameter or smaller.

The camera housing shall include a loss of pressure sensor that will trigger an alarm message that will be inserted in the video output signal.

The enclosure shall be constructed from 6061-T6 standard aluminum tubing with a wall thickness of 0.25 inches +/- 0.03 inches. Internal components shall be mounted to a rail assembly. A copper plated spring-steel ring shall be used to ensure electrical bonding of the rail assembly and components to the camera housing. The housing exterior shall be finished by pre-treatment with conversion coating and baked enamel paint. The camera enclosure shall be designed to withstand the effects of sand, dust, and hose-directed water.

The internal humidity of the housing shall be less than 10 percent, when sealed and pressurized. Desiccant packs shall be securely placed inside the housing to absorb any residual moisture and maintain internal humidity at 10 percent or less. A sun shield shall be provided to shield the entire housing from direct sunlight.

Mechanical Specifications (DSP Camera Assembly)

- (a) Weight: 4.2 lbs.
- (b) Dimensions:
- (1) Length (less connectors): 12.0".
 - (2) Housing Diameter: 3.5".

(3) Height (Including mounting base): 5.13”.

(c) Mounting: 4 mounting nuts on bottom of base.

Character Generator Specifications

- (a) ID Characters are White with a Black border.
- (b) A maximum of 6 lines of user programmable alphanumeric text can be displayed, plus 2 fixed lines for low-pressure indicator and Privacy Zones.
- (c) Text can only be displayed in uppercase characters.
- (d) Camera ID: Up to 2 lines, each up to 24 characters long. If both lines are programmed Line 1 of Camera ID shall always appear above Line 2 of Camera ID regardless of top or bottom selection.
- (e) Preset ID: 1 line, up to 24 characters long, user programmable for each of the 64 preset positions. When a preset position is recalled the corresponding preset ID is displayed. The preset ID shall remain displayed until a pan, tilt, zoom, manual focus, auto focus select, or another preset command is received.
- (f) Compass Annotation: 8-point or 16-point compass annotation shall be settable for a true north position. Display shall include North, NE, East, SE, South, SW, West, and NW. Position shall be able to be grouped with the site location or separate from site location and shall be user selectable for 3 second time out or permanent display and for enable/disable.
- (g) Azimuth and Elevation: Position shall be displayed in 0 –359 degrees for AZ position and +95 to –95 in EL elevation and shall be user selectable for 3-second time out or permanent display and for enabled/disabled.
- (h) Low Pressure Indicator: 1 line, “Low Pressure”, messages can be displayed in “blinking” or “non-blinking” mode and be displayed when activated by low internal pressure. Adjustable set points by altitude shall be provided via the serial port to activate low-pressure. Message shall be enabled or disabled. In maintenance mode readings of the internal pressure of the camera housing shall be displayed from 5 down to 1 psi, in 0.1 psi increments.
- (i) Internal Temperature Indicator: 1 line, in degrees C numeric messages can be displayed in “blinking” or “non-blinking” mode. Message shall be enabled or disabled. In maintenance mode, camera readings of the internal temperature of the camera housing in 1 degree increments.
- (j) Sector Message: Up to 16 sectors in 360° may be defined with up to 24 characters long. Message shall be programmable via the RS-422 serial communications.

Message Positioning

- (a) Right side positioning is accomplished by padding left side of message with spaces.

- (b) Messages can be positioned at either the top or the bottom of display.
- (c) Blank lines are not displayed. Any programmed line being displayed shall fill in toward the top if top positioning is selected or toward the bottom if bottom position is selected.

Privacy Zones

Video blanked out for up to 8 privacy zones shall be provided. The video shall be blanked out for privacy. 1-line and numeric messages can be displayed. Message shall be displayed in “blinking” or “non-blinking” mode and be enabled or disabled. Privacy Zones shall be programmed via the RS-422 serial communications.

Communication and Camera Addressing Protocol

- (a) Control and addressing shall be via RS-422/RS-232 optically isolated serial communications. Additional protocols shall consist of Cohu, American Dynamics, Javelin, Philips/Bosch, Vicon and Pelco-D. The National Transportation Communications for ITS Protocol (NTCIP) 1205 protocol communications protocol shall be included as an option. Refer to NTCIP 1205 protocol for detailed description. This allows for migration to the NTCIP standard, while still maintaining operation of existing CCTV system protocols.
- (b) Upon receipt of any given command, the Camera Positioning System shall not take longer than 1.0 second to respond.
- (c) All programmable functions shall be stored in non-volatile memory and shall not be lost if a power failure occurs. System configurations such as video privacy zones, preset text and sector ID shall be able to be stored in a computer file and a camera personality can be cloned or uploaded into a camera in the event that a camera replacement is necessary.

Pan and Tilt Positioning Specifications

- (a) Continuous rotation capability in either direction.
- (b) 180° of tilt movement, +90° to -90° unobstructed.
- (c) Pan Speed (Operator Control): Variable from 0.1°/sec. to 80°/sec.
- (d) Pan Speed (Preset Control): >160°/sec.
- (e) Tilt Speed (Operator Control): Variable from 0.1°/sec. to 40°/sec.
- (f) Tilt Speed (Preset Control): 40°/sec.
- (g) 64 Pan and Tilt preset positions with repeatability within $\pm 0.5^\circ$.
- (h) The positioning system shall be invertible for mounting to a ceiling.

Tour Specifications

- (a) 8 tour sequence can be defined.
- (b) The tour is programmed by selecting the preset position by number, and then selecting a dwell time. The presets can be used in any order, and the same preset may be used more than once as long as the total number of preset positions used does not exceed 32.
- (c) The dwell time defines the length of time paused at each preset position. It can be from 1 second to 60 seconds. The dwell time can be changed individually for all stops on the tour.
- (d) If the appropriate preset ID is programmed, it shall be displayed for each preset position used on the tour.
- (e) The tour shall stop upon receipt of a pan command.
- (f) All programmable functions shall be stored in non-volatile memory.

Power Requirements

- (a) Operating Voltage: 89VAC to 135VAC, 120VAC Nominal 50/60 Hz. (± 3.0 Hz)
National Electrical Manufacturers Association (NEMA) standard TS-2 (1998) for traffic control system 2.1.2.

The line variation specifications shall be tested to meet these specifications by an outside agency, other than the camera manufacturer. The tests shall be provided upon request.

- (b) Primary Input Power Interruption: This is defined in section 2.1.4 “power interruption” NEMA standard TS-2 (1998).

Transients Power Service: The CCTV field equipment shall meet the requirements of section 2.1.6 “transients, power service” of the NEMA standard TS-2 (1998). The surge specifications shall be tested to meet these specifications by an outside agency, other than the camera manufacturer. The tests shall be provided upon request.

- (c) Power consumption shall not exceed a total of 30Watts for camera/receiver/P&T driver (pan and tilt in motion).

Environmental Specifications

- (a) Ambient Temperature Limits (Operating): -34°C to $+74^{\circ}\text{C}$ (-30°F to 165°F), NEMA 2.1.5.1 Standard TS-2 (1998).
- (b) Ambient Temperature Limits (Storage): -45°C to $+85^{\circ}\text{C}$ (-50°F to 185°F), NEMA 2.1.5.1 Standard TS-2 (1998).

- (c) The environmental specifications shall be tested to meet these specifications by an outside agency, other than the camera manufacturer. The tests shall be provided upon request.
- (d) Humidity: Up to 100% relative humidity (per MIL-E-5400T, paragraph 3.2.24.4), IP 67 Rating.
- (e) Other: Withstands exposure to sand, dust, fungus, and salt atmosphere per MIL-E-5400T, paragraph 3.2.24.7, 3.2.24.8, and 3.2.24.9.
- (f) Shock: Up to 10G's, 11ms, in any axis under non-operating conditions, MIL-E-5400T, paragraph 3.2.24.6.
- (g) Vibration: Sine vibration from 5 to 30 Hz, 1/2g, 3 axis 1 hour without damage.
- (h) Wind Loading: 150 Wind load survivability, operability to 70 mph.

Mechanical Specifications

- (a) Weight: Shall not exceed 19 lbs.
- (b) Dimensions: 11" (h) x 13.3" (w).

Mounting Configurations

The Camera Positioning System shall include 5 possible mounting configurations, a wall mount, pole mount, parapet mount, corner mount or pedestal mount version.

Main Interface Connector

The main interface connector shall be equivalent to an Amphenol 206036-3 with back shell 206070-1 and mating connector equivalent to an Amphenol 206037-11 with clamp 206070-1.

687.03.01 LOCAL INTERSECTION CAMERA CONTROL UNIT: The control unit shall provide convenient on-site camera control of camera positioning systems. The unit shall offer system protocol from most major CCTV camera manufacturers. The unit shall withstand the harsh operating environment associated with roadside installations. Local control functions are accomplished using front panel switches that include: pan and tilt, lens zoom, focus and iris. Focus and iris shall include an auto/manual toggle with LED indication of the current state. Also included is a local /remote switch that transfers control from the central system to the control unit. This function has a built-in five minute timer that automatically transfers control back to the remote mode if left unintentionally in the local mode.

A front panel RS-232 port shall be provided to connect to a laptop PC for programming advanced camera site settings, and allows extended camera control functions. 2 rear panel DB9 connectors shall provide both RS-422 and RS-232 formats for control system data connections. The unit shall support most CCTV camera manufacturer's communications protocols.

Electrical

Operating voltage - 89 VAC to 135 VAC, 47 to 63 Hz, NEMA TS- 2 Std 2.1.2.
Mounting - EIA standard 19" cabinet, 1 RU.

Front Panel Controls

Pan - 3 position momentary switch (pan right, stop, pan left).
Tilt - 3 position momentary switch (tilt down, stop, tilt up).
Zoom - 3 position momentary switch (tele, stop, wide).
Focus Mode - 2 position momentary switch (auto-manual) with LED indication of manual mode.
Focus control - 3 position momentary switch (near, stop, far).

Rear Panel Connectors

Camera - single multi-pin AMP for camera video, RS-422 data and 20 VAC power.

687.04.01 WARRANTY: The camera shall include a 2 year warranty that includes parts and labor. The 2-year period shall begin at the time of acceptance of the project.

687.05.01 CABLE HARNESS: The cables used for CCTV control, video, and 120 VAC power shall be installed as an integrated unit. Cohu, model number CA295H wiring harness or approved equal shall be used. The wiring shall be installed from the CCTV unit to the In-Cabinet Control unit. The contractor shall be responsible for determining the length needed, and order the correct size accordingly. Connectors at both ends of the cable are required.

687.06.01 DOCUMENTATION: Complete documentation of the system, as it is built, shall be provided by the Contractor.

- (a) A minimum of 2 copies of descriptive manuals and brochures for each type of electronic equipment and apparatus proposed for this project shall be supplied.
- (b) These documents shall contain sufficient technical data for complete evaluation. The quality, function, and capability of each deliverable item shall be described.
- (c) Manuals or brochures shall be originals or copies equal to originals.

687.07.01 OPERATIONAL TESTING:

- (a) Upon completion of the system integration testing the CCTV Field Equipment shall be required to complete a 30-day period of acceptable operation.
 - 1) The system operational test shall fully and successfully demonstrate all system functions using live data and controlling all system activities.
 - 2) Failure in any hardware item during the test period, with the exception of expendable items such as fuses and minor equipment as determined by the Engineer, shall necessitate restarting the 30-day test period for its full 30-day duration upon repair.
 - 3) Any failure of system software, or discovery of a software deficiency that causes a system malfunction, or discovery of software operation which is not in compliance with the

specifications, shall cause the 30-day test to be restarted in its entirety after correction of the software problem.

- 4) No intermittent hardware, software, communication or control operation or other malfunctions not related to a specific hardware or software malfunction shall be permitted to persist during the test period. Diagnostic testing which does not result in changes to system hardware or software shall result only in the loss of acceptable test time.

METHOD OF MEASUREMENT

687.08.01 MEASUREMENT: The quantity of CCTV field equipment shall be measured per each. This item shall include the video camera, zoom lens, pan/tilt drive, camera housing, pole mount, receiver/driver, surge protection devices, and all cables, connections and hardware. All pre-assembly of any CCTV equipment shall be considered incidental to CCTV field equipment.

BASIS OF PAYMENT

687.09.01 PAYMENT: The accepted quantity of CCTV field equipment will be paid at the Contract unit price bid per each which shall be full compensation for the equipment, measured as provided under Measurement, complete including warranty, delivery to FAST and testing of the equipment as specified and shown on the drawings.

Payment will be made under:

PAY ITEM

PAY UNIT

CCTV Field Equipment	Each
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SECTION 688**REMOTE DATA RADIO COMMUNICATION SYSTEM****DESCRIPTION**

688.01.01 GENERAL: The data radio unit for installation at remote intersection traffic signal control shall be of solid state design. It shall provide the capability of receiving digital signal transmissions from a master station data radio unit and returning transmissions to the master station data radio unit as required by the Freeway and Arterial System of Transportation (FAST) data radio system. The remote station data radio unit shall be Microwave Data System (MDS) – MDS 9710A (or approved equal) and shall meet the following requirements:

The remote data radio unit shall be configurable as a master station or remote radio. They shall be capable of operating as a half-duplex or simplex radio and shall support all splits in duplex frequencies. Full network diagnosis shall be available when operating as a master station. The units shall provide high system performance and data integrity through digital signal processing. The data radio units shall have the ability to communicate with any asynchronous protocol without extra software or programming.

MATERIALS / EQUIPMENT

688.02.01 FUNCTIONAL REQUIREMENTS: The remote data radio units shall conform to the following general requirements:

- (a) Supply Voltage: 10.5 VDC to 16.5 VDC.
- (b) Tx Current: 2 amps typical at 5 watts.
- (c) Rx Current: Less than 125 milliamps.
- (d) Sleep Mode: 15 milliamps nominal Humidity: 95 percent at 40° C, non-condensing.
- (e) Temperature Range: -30 to +60° C.
- (f) Data Rate: 9,600 bps (rf).
- (g) Port Speed: 300 to 9,600 bps (rf and data) at 12.5 kHz Channel spacing.
- (h) Bit error rate: BER x .000001.
- (i) Casing: Die cast aluminum.
- (j) Dimensions: 2" by 6" by 8" maximum.
- (k) Weight: 2.5lbs. maximum.
- (l) Operational Modes: Async. – Simplex, half-duplex.
- (m) Data Interface: RS-232, DB-25 Female connector supports: TXD, RXD, RTS, CTS, DCD, RUS, AUX 14. POWER, DSR, and GND.
- (n) Synthesizer Range: 400 kHz sliding window, manually tunable.

- (o) Current Consumption:
 - (1) RF Unit Rx/Standby: 70 milliamps maximum.
 - (2) RF Unit Tx: 1.6amps nominal.
- (p) TX to RX Transition Time: 3 milliseconds RSSI Squelch.

Modem/Diagnostics: The remote data radio units shall conform to the following:

- (a) Modulation: Digital / CPFSK.
- (b) CTS Delay: 0 to 255 millisecond, programmable in 1 millisecond increments.
- (c) PTT Delay: 0 to 255 millisecond, programmable in 1 millisecond increments.

Radio Receiver: The radio receiver shall conform to the following:

- (a) Type: Double conversion superheterodyne.
- (b) Frequency Stability: ± 0.00015 percent (1.5 ppm).
- (c) Adjacent Channel: 60 dB nominal.
- (d) Sensitivity 12 dB Sinad: -117 dBm nominal.
- (e) Spurious Rejection: 80 dB.
- (f) Desensitization: 65 dB at 12.5 kHz and 70 dB at 25 kHz nominal.
- (g) IF Selectivity: 100 dB at adjacent channel.
- (h) Electronic Industry Association (EIA) Inter-modulation: 65 dB.
- (i) RSSI: Negative -112 dBm to -54 dBm.
- (j) Squelch Opening Time: 1.5 milliseconds.
- (k) Audio Outputs:
 - (1) Filtered: -10 dB, 600 ohm unbalanced, adjustable.
 - (2) Unfiltered: 40 mV RMS at 2 kHz Dev.
- (l) Harmonic Distortion: 3 percent maximum.

Radio Transmitter: The radio transmitter shall conform to the following:

- (a) RF Power: Adjustable between 0.5 w and 5w at 13.6 VDC.
- (b) Duty Cycle: Continuous.
- (c) Time Out Timer: Programmable between 1 second and 255 seconds, or OFF.
- (d) Spurious and Harmonics: -55 dBc maximum.
- (e) Hum and Noise: -40 dB between 300 and 3,000 Hz.
- (f) Audio Inputs:

- (1) Filtered: -10 dBm 600 ohms unbalanced, adjusted, at 2 kHz Dev.
- (2) Unfiltered: 245 mV RMS at 2.5 kHz Dev.
- (g) Audio Response:
 - (1) Filtered: Between 1 dB and -3 dB from 5 Hz to 3,000 Hz.
 - (2) Unfiltered: 1 dB and -3 dB from 5 Hz to 4,000 Hz.
- (h) Frequency Stability: ± 0.00015 percent (1.5 ppm).
- (i) Transmitter Attack Time: Less than 1 millisecond to within 100 Hz.
- (j) Carrier Power: Programmable from 0.1 to 5 watts.
- (k) Carrier Power Accuracy: Normal plus or minus 1.5 dB.
- (l) Output Impedance: 50 ohms.

Connectors and Harnesses: All connectors and harnesses shall be furnished with each data radio unit. It is the supplier's responsibility to contact FAST to determine the type of connectors required. The remote data radio unit is for with the FAST system.

Power Requirements: The remote data radio units shall meet all specified requirements when the input power is 120 VAC plus or minus 10 VAC, and 55 Hz plus or minus 5 Hz.

Antennae Requirements: A Yagi type antennae with 9 dB gain shall be provided with each unit. The antennae shall be capable of operation within the 940 to 960 MHz bandwidth.

Software Requirements: All software necessary for the units to be fully functional shall be downloaded into the devices at the factory before shipment.

Compliance to FAST: All equipment supplied shall conform to the requirements of FAST.

METHOD OF MEASUREMENT

688.03.01 MEASUREMENT: The quantity of Remote Data Radio unit shall be measured per each. This item shall include providing and installing the radio unit as shown on the plans.

BASIS OF PAYMENT

688.04.01 PAYMENT: The accepted quantity of Remote Data Radio unit(s) will be paid at the contract unit price bid per each which shall be full compensation for the equipment, measured as provided under Section 688.03.01 "Measurements" as specified and shown on the drawings.

Payment will be made under:

PAY ITEM:	PAY UNIT
Remote Data Radio Unit.....	Each