17  INTELLIGENT TRANSPORTATION SYSTEMS (ITS)

17.1  General
The Design-Builder shall conduct all Work necessary to meet the requirements for intelligent transportation systems (ITS). The Design-Builder shall design and construct the Work of relocating and modifying the existing ITS elements to generally meet the locations in Exhibit 2-17-A (Preliminary ITS Components Drawing). The scope of ITS Work shall include system planning, design, furnishing, installation, modifying, integration, testing, interim maintenance, and system acceptance of ITS.

17.2  Administrative Requirements

17.2.1  Standards
The Design-Builder shall perform the ITS Work in accordance with the manuals and documents listed in Book 3. In the event of a conflict among the standards set forth in Book 3, the order of precedence shall be as set forth below, unless noted otherwise:

<table>
<thead>
<tr>
<th>Agency</th>
<th>Title</th>
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<tbody>
<tr>
<td>Port</td>
<td>Design Criteria &amp; Standard Plans</td>
</tr>
<tr>
<td>Caltrans</td>
<td><em>California Manual on Uniform Traffic Control Devices (CA MUTCD)</em></td>
</tr>
<tr>
<td>Caltrans</td>
<td>District Electrical Details</td>
</tr>
<tr>
<td>Caltrans</td>
<td>Signal Design Manual</td>
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<tr>
<td>Various</td>
<td>Special Provisions</td>
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<tr>
<td>Caltrans</td>
<td>Standard Specifications*</td>
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<td>Caltrans</td>
<td>Standard Plans</td>
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<tr>
<td>Caltrans</td>
<td><em>Highway Design Manual (HDM)</em></td>
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<tr>
<td>Caltrans</td>
<td>Construction Manual</td>
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<tr>
<td>Caltrans</td>
<td>Plans Preparation Manual (PPM)</td>
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<tr>
<td>AASHTO</td>
<td>Roadside Design Guide</td>
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<tr>
<td>Caltrans</td>
<td>Fiber Optic System Design Guide</td>
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<tr>
<td>Caltrans</td>
<td>Transportation Electrical Equipment Specifications (TEES)</td>
</tr>
<tr>
<td>Caltrans</td>
<td>Ready to List and Construction Contract Award Guide (RTL Guide)</td>
</tr>
<tr>
<td>NFPA</td>
<td>National Electric Code (NEC) Standards</td>
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<tr>
<td>USDOT</td>
<td>National ITS Architecture</td>
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<tr>
<td>NEMA</td>
<td>National Electrical Manufacturers Association (NEMA) Standards</td>
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<tr>
<td>EIA</td>
<td>Electronics Industries Alliance (EIA) Standards</td>
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<tr>
<td>TIA</td>
<td>Telecommunications Industries Association (TIA) Standards</td>
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<tr>
<td>NTCIP</td>
<td>National Transportation Communications for ITS Protocol (NTCIP) Standards</td>
</tr>
<tr>
<td>ITE</td>
<td>Institute of Transportation Engineers (ITE) Standards</td>
</tr>
</tbody>
</table>
EIA/TIA  Fiber Optic Test Procedure (FOTP) Standards
USDA  Rural Utilities Service (RUS) Specifications
Caltrans  *Signal, Lighting and Electrical Systems Design Guide*
Caltrans  *CADD Users Manual*
Caltrans  Director’s Policy and Deputy Directives (Pavement Delineation and Signing)
Various  Remaining standards set forth in Book 3

*Document modified for design-build.*

If the Design-Builder requests Approval to use methods or materials that are not standards, such request shall include comprehensive specifications and provisions associated with the proposed non-standard methods or materials.

The Design-Builder shall utilize the Project-Specific Special Provisions contained in Book 3. State-Furnished Material will be required for the Project for the Department portion of ITS work. An approved list of State Furnished Traffic Monitoring Station controllers will be provided to the Design-Builder.

### 17.2.2 Software Requirements

For security systems, the Design-Builder shall use ITS devices that are compatible with the data requirements of the Port Command and Control Center’s Verint Nextiva surveillance system, Lenel Access Control system, and Proximex control software. For freeway management systems the Design-Builder shall use ITS devices compatible with the Department Los Angeles Regional Transportation Management Center (LARTMC) software. Due to ongoing technology updates, the Design-Builder shall meet with Port and the Department to identify software currently being used and ensure Project conformity. The Design-Builder shall perform the necessary work at the control centers to integrate the Port systems at the Port Command and Control Center and the Department systems at the LARTMC. The software shall also be compatible with the Port Traffic Management Center.

### 17.2.3 Meetings

#### 17.2.3.1 General Meetings

The Design-Builder shall meet at the request of the Port or the Department as necessary, to discuss and resolve matters relating to ITS work during the design and construction stages. The requesting party shall provide the other parties prior notice of such meetings and meeting materials a minimum of five Days before the meeting. The Design-Builder shall prepare and distribute a record of the minutes to the meeting within five Days.

#### 17.2.3.2 Concept Meetings

The Design-Builder shall schedule and participate in ITS concept meetings to present layouts of the existing and proposed ITS system on the Project. The Design-Builder shall be responsible for quantifying and locating affected ITS elements and documenting this for discussion at the meeting(s).

At the ITS concept meeting, the Design-Builder shall present a functional ITS design with hardcopy layouts. The ITS concept meeting shall include proposed approaches for and discussion of the following topic areas and others, as applicable:

- Preliminary plan for maintaining existing ITS during construction, including Automated Traffic Management Information System (ATMIS), Port Incident Management System (PIMS), and the three existing Variable Message Signs (VMS) that are part of the ATMIS
- Fiber-optic cable/conduit location
- Splice vault /pull box locations
- Cabinet locations
• Fiber-optic cable splicing and testing
• Locating ITS elements (conduit, traffic monitoring stations/count stations, video surveillance system (VSS) cameras, variable message signs, and highway advisory radio) and Maintenance Vehicle Pullouts (MVPs)
• Salvaged items
• Component testing (wire tests, loop detector testing)
• Test equipment calibration
• Documentation of temporary ITS elements
• Review ITS systems and operations, including field verification of all legacy ITS systems and elements
• Define and finalize ITS functional, technical, operational, and maintenance requirements
• Finalize goals and parameters of ITS design
• Establish integration requirements
• Develop Acceptance of ITS design
• Address and discuss ITS construction issues

The Design-Builder shall submit the functional ITS design layout and a status set of design drawings five Days prior to the meeting. This meeting shall occur prior to any installation.

17.2.3.3 Pre-testing Meeting
The Design-Builder shall schedule and participate in an ITS pre-testing meeting to present the test plans for ITS elements and fiber-optic cable. The Design-Builder shall be responsible for quantifying and locating affected ITS elements and documenting this for discussion at the meeting(s).

17.2.4 Certification Requirements
All laboratory tests and testing equipment calibration shall be performed at a certified Department, City of Los Angeles, or an equivalent AMRL-accredited facility for the geotechnical tests and equipment calibration required by this section.

17.2.5 Port Responsibilities
Port responsibilities are as follows. The Department may be involved in some or all of these responsibilities at the discretion of the Port:
• Review of documentation and certification of test device calibration (to ANSI specified guidelines which call for annual calibration of test equipment) used to measure the following:
  – Electrical characteristics of power and signal control cables and conductors
  – Insulation characteristics of power and signal control cables and conductors
  – Fiber-optic (F/O) cable test equipment
• Review of other documentation, test results, and submittals, including the following:
  – Specifications
  – Shop drawings
  – Measured and recorded values
• Presence when the following ITS component locations are staked or flagged:
  – F/O cable
  – Splice vaults
  – Pull boxes
  – VSS cameras and poles
17.3 Design Requirements

17.3.1 Preliminary ITS Components Drawing

Exhibit 2-17-A (Preliminary ITS Components Drawing) is included to illustrate the general scope of the ITS Work. The Design-Builder shall have the flexibility to make Project changes without impairing the essential functions and characteristics of the Project, such as safety, traffic operations, durability, desired appearance, maintainability, environmental protection, drainage, and other permitted constraints; provided all Work is in accordance with the Contract Documents.

17.3.2 General Requirements

The Project requires two separate ITS networks. Security elements, active traffic management, and communications for Port business will be integrated into the Port’s command and control center. Traffic monitoring stations and VSS cameras outside of the immediate bridge area will be integrated into the Department Los Angeles Regional Transportation Management Center (LARTMC). Exhibit 2-17-A (Preliminary ITS Components Drawing) shows which ITS elements are connected to which system.

The ITS networks shall provide fiber-optic communications, real-time National Television System Committee (NTSC) video surveillance systems (VSS), operations data collection (loop detection), and motorist information features. The Design-Builder shall provide a complete, operational, and maintainable ITS systems and/or components. These systems and/or components shall be compatible with the in-place legacy system in use at the time of the ITS Concept Meeting. The Design-Builder shall label the ITS devices with the Port and the Department provided naming and numbering convention, respectively. The ITS networks shall meet, at a minimum, the following requirements:

- Expandability
- Consistent cabinet layouts throughout field device locations
- Support stand-alone operation of all field devices using backup software components
- Protection from voltage surges and lightning
- Weather-resistant elements capable of operating in rain and wind conditions and in temperature and humidity ranges encountered in the Project area

The Design-Builder shall use stainless steel mounting hardware (e.g., bolts, nuts, washers, and external hinges) and traffic rated lids on pull boxes, vaults, cabinets, shelters, and other outdoor ITS devices. The Design-Builder shall use only components designed for 20 or more years of industrial use. All material, equipment, and component parts furnished shall be new (within 12 months from date of manufacture), of the latest design and manufacture, in an operable condition at the time of delivery and installation, and compatible with the in-place system.

17.3.2.1 Transportation Management Centers

The Port Command and Control Center serves as the headquarters of the Security Division and Harbor Patrol. The Command and Control Center provides communications services including radio dispatching for the Harbor Patrol as well as operating and monitoring various security systems in the Port. The Command and Control center is a regional resource. It houses emergency management facilities, including a Department Operations Center (DOC) and Joint Regional Intelligence Center (JRIC). All security elements, VSS cameras and active traffic management devices on the bridge, and communications systems for Port business will be integrated into the Command and Control center.

The incident management VSSs, count stations, traffic monitoring systems, and associated controllers and appurtenances shall be monitored and controlled by the LARTMC. The LARTMC’s primary purpose is to
integrate the Department’s District Maintenance Dispatch and Division of Operations with the California Highway Patrol Dispatch into a unified command center. The integration provides the communications and computer infrastructure necessary for coordinated transportation management on freeways during normal commuting periods, as well as during special events and major incidents. The LARTMC serves as a central point for collecting, verifying, processing, and distributing real-time transportation information. Information will be collected using various ITS components, including closed circuit television cameras (video surveillance systems) and traffic monitoring stations/count stations. These ITS elements, as defined in the Exhibit 2-17-A (Preliminary ITS Components Drawing) and herein, shall be integrated into the LARTMC by the Design-Builder.

The Port Command and Control Center is linked to the LARTMC. This communications link is for sharing of data and not primary backhaul of the Department ITS elements. The Design-Builder shall maintain this linkage as directed at the ITS Concept Meeting.

17.3.3 Traffic Monitoring Stations/Count Stations (TMS/CS)

The Design-Builder shall design, furnish, and install traffic monitoring stations/count stations for measuring, at a minimum, vehicular volume and lane occupancy on the freeway and selected ramps. The Design-Builder shall place permanent loop detection in mainline, auxiliary, and ramp lanes as shown in Exhibit 2-17-A (Preliminary ITS Components Drawing). The Design-Builder shall use model 2070 controller assemblies in Model 334 cabinet and not have more than 22 detector inputs per cabinet. Locations on elevated sections of roadway, such as the approach bridges, shall use pre-formed loops or microwave radar technology. The Design-Builder shall furnish and install necessary equipment for all TMS/CSs to make the system fully operational.

TMS/CS design shall include the following requirements:

- When cutting mainline loops, the loop wires for all lanes shall go directly to the pull box in the right shoulder.
- An MVP shall be installed for TMS as shown in Exhibit 2-17-A (Preliminary ITS Components Drawing).
- All loops shall be cut on the final layer of the roadway for verification purposes.
- No detector lead-in cable splices shall be allowed.

17.3.4 Video Surveillance System (VSS)

The Design-Builder shall coordinate and furnish licenses and install VSS hardware devices, mounting brackets, power supplies, servers, workstations, recorders, controls, consoles and other components of the system as specified.

The Design-Builder shall provide outlets, junction boxes, pull boxes, conduit, special boxes, cable, connectors, wiring, and other accessories necessary to complete the system installation.

The Port reserves the right to use equipment, material and services provided as part of this Work prior to Acceptance of the Work, without incurring additional charges and without commencement of the Warranty period.

17.3.4.1 Video Surveillance System (VSS) Camera

The Design-Builder shall furnish and install new VSS hardware at locations shown in Exhibit 2-17-A (Preliminary ITS Components Drawing). VSS hardware shall be placed such that the intersecting arterial, if applicable, is viewable and maintenance access is available.

The Design-Builder shall consult with the Port and the Department on the placement of VSS hardware during the design progress meetings. VSS camera views, accessibility, and maintainability are issues of concern and the Design-Builder shall obtain input from the Port and the Department, respectively for the type of camera, prior to submitting RFC Documents for Approval.
VSS cameras designated as “Port” shall be integrated to the Port Command and Control Center. VSS cameras designated as “Department” shall be integrated to the LARTMC. The two camera systems shall be independent and connected via separate communications systems. To provide the separate communications systems the use of separate fibers within one jacketed cable will not be allowed. The use of separate fiber-optic cables within the same duct bank will be allowed.

The Design-Builder shall provide a VSS system that meets the following requirements:

- New VSS camera equipment operable on leased T1 lines for Department locations
- MVP as applicable (see Exhibit 2-17-A (Preliminary ITS Components Drawing))
- Cabling and connectivity
- Coverage to remotely monitor highway and/or connecting arterial street traffic conditions and confirm messages displayed on changeable message signs within Project area
- Coverage to remotely monitor suspension cables, including Intelligent Video Analytic System (IVAS). Typical IVAS rules that can be applied include:
  1. Establishing a “virtual” perimeter line, or “virtual trip wire”, and monitoring the direction of an object crossing the virtual line.
  2. Establishing a virtual area or zone perimeter and monitoring the direction of an object crossing into or out of the zone.
  3. Establishing a virtual area or zone perimeter and monitoring movement within the zone.
  4. Monitoring proximity to a selected object (or critical asset) within the camera view.
  5. Counting the number of objects (vehicles, persons) within a zone and alerting the operator when it exceeds or falls below a given number.
  6. Discriminating when an object is left behind; as when a person carrying a briefcase or backpack separates from the carried object.
  7. Vehicle or person loitering (stopped within a zone for a given duration). Under this rule, the system does not alert the operator if the object continues to move through the zone.
  8. Distinguishing between vehicles, people and other kinds of objects.
- Coverage to remotely monitor all interior areas, including but not limited to those within anchorages and equipment rooms.
- Inspection walks, traveler docks and other under-bridge areas that require cameras for assessment
- Infrared illuminators of varying types will be used to improve the nighttime performance of cameras in specific areas, and to ensure the performance of cameras in enclosed areas where natural and artificial light cannot reach.
- At a minimum, the Port VSS cameras shall be placed at the following locations:
  - Centerline Main Span Edge of Deck looking north at the channel approach
  - Centerline Main Span Edge of Deck looking south at the channel approach
  - East Main Tower below deck looking west
  - East Main Tower below deck looking east
  - West Main Tower below deck looking west
  - West Main Tower below deck looking east
  - East Main Tower above deck looking west
  - East Main Tower above deck looking east
  - West Main Tower above deck looking west
  - West Main Tower above deck looking east
• Platforms shall be provided for cameras installed at the Main Towers
• Placement shall allow monitoring of ramp queues, where applicable
• Maintenance-free, to the extent possible
• Poles and cameras shall not be placed in the median of the highway
• “Port” VSS system shall be compatible with the current video system in the Port Command and control Center discussed in Section 17.2.2. “Department” VSS system shall be compatible with the regional ATMS and Los Angeles Regional Transportation Management Center
• Lightning and surge protection shall be designed and installed at each site
• Access to the cameras shall be provided for maintenance operations, and the cameras below deck shall be accessible by the traveler system.

The Design-Builder shall prepare a VSS field of view report by making a video of the field review at the proposed location/height of all VSS cameras and taking still pictures at 1X, 5X, and 10X zoom levels. The video shall demonstrate the VSS camera’s ability to zoom in and out and pan up and down. The still pictures shall be combined in a report that describes each site and show the locations on a map or design drawing. The video and report shall be reviewed by the owner of the system (Port or Department) for the location and mounting heights proposed. The Design-Builder shall document this Approval. The VSS camera locations shall be reviewed by Port, the Department, and United States Department of Homeland Security.

Work shall consist of furnishing and installing the following:
• A VSS camera assembly on a standard VSS pole
• VSS camera control circuits and accessories
• VSS wiring, including connectors, composite video cables, connectors and coaxial cables
• Fiber-optic equipment

The VSS camera assembly shall be supplied as a fully-assembled, integrated, tested, and configured single unit from the manufacturer at the camera manufacturer facility and shall be delivered to the Project Site accompanied by a written certification of assembly and configuration from the camera manufacturer. This certification shall serve as the manufacturer documentation that the assembly and configuration of the camera/lens/housing equipment were performed. A sample certification document shall be furnished as part of the materials submittal data. VSS camera assembly communications specifications include the following:
• Serial data communications ports conforming to EIA/TIA-232 and EIA/TIA-422
• Configurable to support NTCIP 1205 - NTCIP objects for VSS camera control
• Via the VSS protocol, the user shall be able to obtain camera position information including tilt angles, pan positions and zoom levels. The information shall be supplied as 0-359° azimuth and -95° to +95° elevation

Before installation and after installation, the Design-Builder shall test to verify that all new VSS camera assembly equipment functions in accordance with the manufacturer's specifications. After installation, new VSS camera equipment shall be tested at each individual location. The Design-Builder shall install and fully adjust the VSS camera assembly with the associated components, power supply, and all necessary cabling and equipment to make the VSS camera assembly completely operational. All VSS camera assembly components shall be fully interchangeable.

17.3.4.2 VSS Poles
The Design-Builder shall furnish and install VSS poles or structure mounts for all the VSS camera sites.

17.3.5 Weigh-in-Motion System (WIM)
The Design-Builder shall furnish and install two permanent WIM stations at the locations shown in Exhibit 2-17-A (Preliminary ITS Components Drawing). WIM stations shall use bending plate sensors, capable of
measuring each side (left, right) of the axle load independently. The WIM stations shall be designed in accordance with the Department Weight-in-Motion Data program. The WIM shall have real time output that sends an alert along with a photo of the overweight vehicle to the LARTMC.

17.3.6 Advisory Systems

17.3.6.1 Variable Speed Advisory System

The Design-Builder shall furnish and install a variable speed advisory system consisting of weather sensors, changeable speed limit signs, and control software. The system shall consist of a series of remotely controlled changeable speed limit signs along the eastbound and westbound approaches and facing both directions on the main span of the new bridge.

The changeable speed limit signs shall be designed in accordance with the California MUTCD Chapter 2B and the system shall be implemented per California Vehicle Code 22355. The changeable panels shall be integrated into the Port communications system and capable of control from the Port Command and Control Center.

A Road Weather Information System (RWIS) shall be integrated into the Port Command and control center. The system shall have an Environmental Sensing Station (ESS) with sensors installed at the roadway level in the main span of the new bridge. At a minimum the ESS shall contain sensors for wind speed, wind direction, temperature, relative humidity, barometric pressure, visibility (fog), precipitation, and pavement temperature.

17.3.7 Automated Traffic Management Information System (ATMIS)

The Design-Builder shall install all new ATMIS elements on the new bridge span and integrate those components into the existing system. The new ATMIS elements shall provide the same performance and functional operations as the existing system. The Port’s existing ATMIS shall remain in operation until which point it will be integrated with the new components; a migration plan detailing the disruption time to existing systems shall be submitted to the Port for Acceptance prior to decommissioning the existing systems. At least 48 hours advance notice shall be given to the Port before any part of the ATMIS is disconnected or otherwise affected by construction.

The Design-Builder shall also be responsible for furnishing and installing a vehicle identification tracking system for security purposes. See Exhibit 2-17-B for specific requirements.

17.3.8 Port Incident Management System (PIMS)

The Design-Builder shall install all new PIMS elements on the new bridge span and integrate those components into the existing system. The new PIMS elements shall provide the same performance and functional operations as the existing system. The Port’s existing PIMS shall remain in operation until which point it will be integrated with the new components; a migration plan detailing the disruption time to existing systems shall be submitted to the Port for Acceptance prior to decommissioning the existing systems. At least 48 hours advance notice shall be given to the Port before any part of the PIMS is disconnected or otherwise affected by construction.

17.3.9 Channel Navigation Systems

The Design-Builder shall furnish and install navigational aids for the shipping channel including wind speed/direction indicators and a platform for National Oceanic and Atmospheric Administration (NOAA) equipment. The Design-Builder shall furnish and install a platform for an air gap sensor; NOAA will furnish and install the sensor. Channel Navigational Aids must be in accordance with United States Coast Guard (USCG) requirements and ultimately approved by the USCG.

A minimum of one wind speed/direction indicator, per FAA Advisory Circular 150/5345-27D for Wind Cone Assemblies, shall be installed on each of the two bridge towers. The wind/direction indicators shall be placed in an open air stream such that structural elements of the bridge do not interfere with their operation.
A National Oceanic and Atmospheric Administration air gap sensor will be installed over the center of the channel by NOAA. The Design-Builders shall install a platform and provide electrical power (120V, 15A) to the sensor location following guidelines in the Air Gap Field Installation Guide. The Design-Builders shall contact the Center for Operational Oceanographic Products and Services of the National Ocean Service (757-842-4424) to coordinate this Work.

17.3.10 Communication Network

The Design-Builders shall furnish and install a communication network with redundant routing capabilities and enough bandwidth to meet the operational requirements. Fiber-optic (F/O) communication system shall be used in this Project. The Design-Builders shall perform the following:

- Design and construct two fiber-optic communications networks, one to serve Port ITS elements on and near the Gerald Desmond Bridge and one to serve the Department ITS elements along the Project corridor.
- Provide Port F/O Communication Network cables which shall include one 72-strand single-mode fiber-optic cable for the security backbone communications and four 12-strand single-mode fiber-optic cables for ITS elements.
- Provide Department F/O Communication Network cables which shall include one 72-strand single-mode fiber-optic cable for TMC intertie, one 36-strand single-mode fiber-optic cable for VSS video, and one 36-strand single-mode fiber-optic cable for data communications.
- Propose solutions to achieve design objectives based on the functional, technical, operational, and maintenance requirements.

The Design-Builders shall not substitute or apply any part or attach any piece of equipment contrary to the manufacturer’s recommendations and standard practices.

17.3.10.1 Fiber-Optic Cable

The Design-Builders shall link the controllers of the traffic monitoring stations/count stations and the Department VSS cameras to the Department communications network. All other elements not defined as “Department” (as shown on Exhibit 2-17-A) shall be linked to the Port communications network. The Design-Builders shall provide the necessary fiber-optic pigtails to controller cabinets and shall terminate the fiber-optic pigtails at the fiber distribution units. The Design-Builders shall minimize the number of transverse crossings of the freeway. The Design-Builders shall place the Department armored fiber-optic trunk cable in conduit. The Design-Builders shall provide armored fiber-optic pigtails between splice vaults/shelters and field device control cabinets.

17.3.10.2 Fiber-Optic Connection Components

17.3.10.2.1 Indoor Patch Cords

For indoor patch cords, the Design-Builders shall meet the following requirements for single-mode fibers:

- Indoor patch cords shall not be armored.
- Single mode patch cord jackets shall be yellow, 3 mm (0.12 inches) outside diameter, have aramid strength members, and yellow boots.
- Patch cord fibers shall have a secondary buffer from 250 µm to 900 µm.
- Patch cords shall be individually constructed.
- Patch cords shall not have factory fusion fiber splices.
- Patch cords shall have ST connectors.
- Boots shall be glued to the patch cord jacket.
17.3.10.2.2 Splice Panel Components
The Design-Builders shall provide splice panels as needed. The splice panels shall meet the following requirements:

- Offer a combination of splicing protections and associated pigtail/fiber storage
- Compatible with a splice wheel or splice deck
- Available in 12, 48 and 72 splice capacities
- Front loaded
- Designed for a 19-inch EIA rack with brackets available to accommodate a 23-inch rack
- Hinged on one side allowing access to both the front and back of the front plate and the interior of the panel
- Provide for 5-inch recess rack mounting
- Provide for easy roll-up of pigtail and buffer tube lengths with bend radius control on the splice wheel

17.3.10.2.3 Patch Panel Components
The Design-Builders shall provide patch panels as needed. The patch panels shall meet the following requirements:

- Allow for single fiber maintenance access with dust covers or caps
- Constructed of high-strength aluminum
- Equipped with metal doors with Plexiglas windows
- Available in 12, 24, 48, 96 and 144 termination capacities
- Front loaded
- Designed for a 19-inch EIA rack with brackets available to accommodate a 23-inch rack
- Hinged on the left front side allowing access to both the front and back of the front plate and the interior of the panel
- Provide for pigtails storage
- Provide for 5-inch recess rack mounting
- Equipped with designation labels

17.3.11 Splice Vault and Communication Pull Box
17.3.11.1 Splice Vault
The Design-Builders shall furnish and install splice vaults as needed on the Project. Splice vaults shall be installed on both ends of the main bridge span over the channel, and adjacent to ITS element cabinets. The splice vault and cover shall be constructed of reinforced Portland cement concrete (PCC) or of non-PCC material. The vault and cover shall have the following physical characteristics:

- Dimension of 60 inches long by 30 inches wide by 30 inches deep.
- The wheel loading of the splice vault cover shall meet or exceed HS-20 load rating
- Cover markings for the Department fiber-optic network shall be labeled "CALTRANS COMMUNICATION" on each cover section. Cover markings for the Port fiber-optic network shall be labeled “POLB COMM” on each cover section. Metal cover shall support a minimum force of 100 lb-force.

17.3.11.2 Communication Pull Box
The Design-Builders shall furnish and install the communication pull box. Communication pull box shall be installed every 750 to 1,000 feet along the length of the fiber-optic line. The communication pull box shall be
a pre-cast polymer concrete structure reinforced with fiberglass. The pre-cast polymer structure shall have the following properties:

- Modulus of elasticity of greater than 1 x 10^6 psi
- Compressive strength of greater than 9,000 psi
- Flexural strength of greater than 3,000 psi
- Impact energy of greater than 30 ft-lb, and tensile strength of at least 800 psi

The communication pull box shall have the following physical characteristics:

- Outside dimensions of 42 inches long by 26 inches wide by 42 inches deep
- An open bottom
- An approximate weight of 212 pounds
- UL listed, Tier 10 rated, underground closure

The steel cover for the Department fiber-optic network shall be labeled "CALTRANS COMMUNICATION" on each cover section. Cover markings for the Port fiber-optic network shall be labeled “POLB COMM” on each cover section. All covers shall have the following features:

- Outside dimensions of 35.625 inches x 24 inches x 3 inches
- Weighs 85 lbs
- Two 0.375-16 UNC stainless steel hex head bolts with washers
- Two 0.5-inch by 4-inch pull slots
- A skid-resistant surface

17.3.11.3 Splice Closures

The Design-BUILDER shall enclose F/O field splices in splice closures with splice organizer trays, brackets, clips, cable ties, seals and sealant. Splice closures shall be suitable for direct burial or pull box applications. The Design-BUILDER shall provide manufacturer’s installation instructions prior to installation of splice closures. Splice closures shall conform to the following specifications:

- Non-filled thermoplastic case
- Rodent proof, water proof, re-enterable and moisture proof
- Expandable from 2 cables per end to 8 cables per end by using adapter plates
- Cable entry ports shall accommodate 10-mm to 25-mm diameter cables
- Multiple grounding straps
- Accommodate up to 8 splice trays
- Suitable for "butt" or "through" cable entry configurations
- Place no stress on finished splices within splice trays

The Design-BUILDER shall utilize metal struts to mount the splice closures to side walls of splice vaults. The Design-BUILDER shall verify the quality of splices prior to sealing splice closures and perform link testing and obtain Approval before sealing splice closures.

17.3.11.4 Splice Trays

Splice trays shall accommodate a minimum of 12 fusion splices and allow a minimum bend radius of 45 mm. The Design-BUILDER shall loop individual fibers one full turn within splice trays to allow for future splicing. Fibers shall be unstressed when located in final position. The Design-BUILDER shall secure buffer tubes near entrances of splice trays. Splice tray covers may be transparent. Splice trays shall conform to the following:

- Accommodate up to 24 fusion splices
• Place no stress on completed splices within the tray
• Stackable with a snap-on hinge cover
• Buffer tubes securable with channel straps
• Accommodate a fusion splice with the addition of an alternative splice holder
• Be labeled after splicing is completed

Only one splice tray may be secured by a bolt through the center of the tray in fiber termination units. Secure multiple trays per the manufacturer's recommendation.

17.3.11.5 Splice Protection
The Design-Builder shall mount all splices on the splice tray. Polyethylene tubes protect the fibers and ethylene vinyl acetate sleeves with stainless steel rods protecting the splices. Vinyl markers shall identify each fiber in the closure.

17.3.12 Wireless Communications
While all devices installed on this contract are to be tied into fiber-optic communications systems, the Design-Builder shall provide mounts for antennas for future use by the Port or third parties that accommodate, at a minimum, the following antennas:

• Four rectangular “panel” antennas on the north side of the bridge, between the two main towers, nominally 2 feet x 5 feet
• Four rectangular “panel” antennas on the south side of the bridge, between the two main towers, nominally 2 feet x 5 feet
• Three pole antennas on the north side of the bridge, between the two main towers, offset from the bridge 6 feet and nominally 10 feet long
• Three pole antennas on the south side of the bridge, between the two main towers, offset from the bridge 6 feet and nominally 10 feet long

17.3.13 Conduit and Electric Service
17.3.13.1 Conduit, Innerduct and Communication Conduit
The Design-Builder shall furnish and install communication (non-metallic) conduit for communication trunk cables, which shall be UL listed. The Design-Builder shall ensure the conduit and conduit splices sustain a pressure of 150 psi. The Design-Builder shall furnish and install conduit systems for power and communication systems that comply with the NEC and the local standards.

Communication (non-metallic) conduit shall be PVC Schedule 40, with the exception of conduit under roadway surfaces. Conduit under roadway surfaces shall be heavy-wall rigid PVC Schedule 80.

Inner ducts shall be installed to provide protection for fiber-optic cables. Separate inner ducts shall be installed for each fiber-optic cable along communication mainlines. Inner ducts shall be smooth or ribbed high-density polyethylene (HDPE) duct. The Design-Builder shall locate communication conduit such that the conduit is at least 10 feet inside the Right of Way line where attainable.

All Port F/O cable shall be installed in a microduct/tube bundle system comprised of 25 tubes suitable for air-blown fiber installation. The bundle shall have one 10-mm tube for the 72-strand backbone and 24 5-mm tubes for 12-strand cables. The tube bundle system shall be suitable for direct burial or be contained inside a communications conduit.

Four 4-inch conduits for future use shall be installed across the new bridge (perpendicular to the traffic flow, from the north face to the south face). These conduits shall extend from the wireless communications cabinets to the north-side and south-side antenna mounts. Pull boxes shall be installed along these conduit runs near each end for access, and these conduits shall be accessible at the wireless communications cabinet pad(s) located on the bridge.
All Department F/O cables shall be armored and installed inside 4-inch conduit with four size 25 inner ducts, one cable per inner duct. Two 4-inch conduits shall be provided for the Department system for communications and one 2-inch conduit for power service.

The Design-Builder shall not place the communication conduit in the bottom of a ditch or near culvert clean-out areas. The Design-Builder shall place communication conduit at the middle of the right shoulder and lay to a depth of not less than 24 inches below grade in asphalt concrete and Portland cement concrete areas, and not less than 30 inches below finished grade in soil area. The Design-Builder shall place a bed of fine soil or sand with a minimum thickness of 2 inches in the trench before placing communication conduit. The Design-Builder shall place a conduit spacer with a minimum thickness of 2 inches between the top of fine soil or sand bed and the bottom of the communication conduit, and between the communication conduits at 5 feet maximum spacing. Clearance between the side of communication conduit and the side of communication conduit trench shall be at least 2 inches.

17.3.13.2 Electrical Service

Unless otherwise specified, the Design-Builder shall provide single-phase 120-volt/240-volt electrical power to each location as necessary. The Design-Builder shall be responsible for the application for electrical service and all costs associated with Utility hook-up charges and components installed by the Utility Owner.

Separate feeder conduits shall be used for Traffic Monitoring Systems (TMS), Video Surveillance System (VSS), and from the service cabinet meter to the load. Large conduits with inner ducts to route the conductors for these separate circuits will not be acceptable.

In addition to electrical circuits required for each location, the Design-Builder shall provide a power feed for future use at the wireless communications cabinet pad(s) located on the bridge. This power feed shall be a minimum of 200 amps at 120/240 volts and terminated in a NEMA 4X lockable power distribution panel with space for at least 12 branch breakers.

17.3.13.3 Wireless Communications Cabinets

The Design-Builder shall furnish and install NEMA 4X cabinets with 19-inch racking on the new bridge span over the channel. Cabinets shall be located in the center of the deck, not normally accessible by motorists or pedestrians, between the two main towers. A minimum 36 inches of front and back access is required. The cabinets shall provide a minimum 210U of rack space for future components. The four spare conduits across the new bridge shall be tied into the wireless communications cabinet pad(s) with sweeps. The new 200A 120/240V power distribution panel shall be accessible to the cabinets for future use by way of conduit sweep(s) into the cabinet pad(s). The Port F/O communication network cables shall be locally accessible to these cabinets. The cabinets shall be permanently mounted on a secure pad and capable of being locked per the Port’s standard keyset. The Design-Builder shall label the cabinets with Port provided naming and numbering conventions.

17.3.13.4 Coordination with Power Utility

The Design-Builder shall coordinate with the Utility for request to shut off or turn on service during construction if needed. Design-Builder shall be responsible for obtaining new or modified electrical service points, including all applications and permits required from the serving Utility Owner. Conductors for service and load shall not be in the same conduit. Electrical service cabinets shall be placed off the freeway. Design-Builder shall be responsible for all electrical Utility costs following any change in loading on an existing meter, or installation of a new meter. This responsibility shall continue until Substantial Completion.

17.4 Construction Requirements

The Design-Builder shall design the ITS system as a whole and receive Approval before installation of any individual field element. The Design-Builder shall make final connections of the newly installed ITS elements to the Port’s existing system. The Department will provide means to connect their TMS and VSS systems to the LARTMC. Three Working Days advanced notification to the Port is required prior to staking locations for ITS devices and the Design-Builder shall obtain Approval prior to start of any work related to
the installation of any ITS devices. Upon completion of installation of all ITS devices, a final walk through is required to ensure functional, continuity and connectivity requirements are met. Confirmation that all newly constructed/installed ITS devices (loops, VSS, and others) and connectivity to the existing ITS systems are working properly is required prior to relief of maintenance.

17.4.1 General Requirements

The Design-Builder shall provide an advance notice to the Port of installation of VSS hardware, cabinets, and equipment. The Design-Builder shall provide x, y, z coordinates on the installed ITS elements and on existing elements where the new elements connect to them:

- Loop detectors (including cut loops and pre-formed loops)
- Pull boxes
- Control cabinets
- VSS camera poles
- Trunk fiber-optic cable
- Fiber-optic pigtails
- Splice vaults/communication pull boxes
- Message signs
- Weight in motion
- Security System elements

17.4.1.1 Allowable Working Hours on the ITS System

ITS elements outside the Right of Way shall not be affected by the Design-Builder and remain operable during construction of the Project. The Design-Builder shall not perform ITS construction on weekdays from 6 a.m. to 9 a.m. or from 3 p.m. to 7 p.m. The Design-Builder shall include taking ITS elements out of service on an active road in the Traffic Management Plan (TMP) submitted for Port Approval. The Design-Builder shall perform all work in a matter ensuring the integrity and proper performance of all ITS elements while working on the existing system. A 48-hour notification is required prior to performing any work on existing/active ITS devices.

17.4.1.2 Repair Parts

The Design-Builder shall have repair parts available during construction for all ITS elements.

17.4.1.3 Materials and Fabrication

The Design-Builder shall round and smooth sharp corners and edges on all ITS elements that are furnished and installed.

17.4.1.4 Locates

The Design-Builder shall be responsible for all underground cables placed by the Project until Final Acceptance of the Project.

17.4.1.5 As-Built Documents

The As-Built Documents shall use the Released for Construction design drawings used for construction with all deviations of components from their original design placements redrawn and shown in their coordinate-correct location. As-Built Documents shall contain standard line styles and component symbols used for ITS design. Construction shall be in accordance with the requirements of the Caltrans Standard Specifications and the Project-Specific Special Provisions.

17.4.2 Video Surveillance System (VSS)

The Design-Builder shall furnish and install the VSS hardware. Notification from the Design-Builder shall be required when the installation of the VSS hardware is complete. The Port and the Department shall work
with the Design-Builder and be present to approve the locations for the VSS pole foundation and the VSS control cabinets in the field before the foundations are placed. Design-Builder shall furnish and install the VSS camera assemblies at each of the VSS hardware locations. All VSS shall be installed behind a protective barrier.

17.4.2.1 Video/Control Cable for Camera
The Design-Builder shall furnish and install the camera video/control/power combination cable not to exceed 750 feet in length from the VSS pole box to the top of the pole as recommended by the VSS manufacturer. The Design-Builder shall provide a flat pull strap within the VSS pole to facilitate installation of the VSS communication/video/power combination cable from the VSS pole box to the top of the pole.

17.4.2 VSS Pole Foundation
The Design-Builder shall furnish and install foundations for VSS poles that comply with Caltrans Standard Plans, Sheet ES-16A.

17.4.2.3 Maintenance Vehicle Pullout Adjacent to VSS Camera Site
The Design-Builder shall construct maintenance vehicle pullouts at the locations shown in Exhibit 2-17-A (Preliminary ITS Components Drawing). The Design-Builder shall locate a 3-foot by 3-foot by 4-inch sidewalk under each VSS pole crank opening and another under each VSS cabinet location.

17.4.3 Loop Detectors for TMS/CS
The Design-Builder must show the loop locations on design layouts. Exact locations for all loop stations shall be determined in the final design phase of the Project.

17.4.3.1 Testing and Setting Up the Loop Detector Installation
The Design-Builder shall set up the loop detector card. The Design-Builder shall be responsible for notifying the Department when the loop and lead-in wire are ready for termination and testing. The Department may witness the termination. Testing shall not take place prior to the ITS pre-testing meeting.

17.4.3.2 Terminating Lead-in Wires in the Cabinet
Detector loop lead-in cables shall be terminated on the compression terminal block in the control cabinet. The Design-Builder shall terminate the loop lead-in cable without any splices.

17.4.4 Weight in Motion System
The Design-Builder shall calibrate the WIM to +/- 5 percent accuracy with a test vehicle of known static weight driven at various highway speeds over the WIM scale. The Department CTWIM software suite shall be used for calibration and acceptance testing.

17.4.5 Communication Network
The Design-Builder shall furnish and install materials and equipment such that ITS communications components are composed of identical sub-components. Identical sub-components shall be defined as components of the same manufacturer, model, and installation configuration. The ITS communications sub-components include the following:

- Fiber-optic cable
- Splice vaults, pull boxes, splice closures, and fiber-optic connection components

All locations containing identical equipment shall be configured and wired in a consistent if not identical manner by the Design-Builder, including internal wiring and harnesses, wiring color codes, labeling terminal block positions, termination strips, power service configuration, and panel and equipment mounting and locations.

17.4.5.1 Proposed and Existing Fiber-optic Cable
For fiber-optic trunk cable installations the Design-Builder shall perform the following:
Exercise caution and excavate by hand or by utilizing a vacuum excavator when exposing an existing F/O cable.

Repair all nicks or abrasions on the jacket of any F/O cable. The Design-Builder shall report all nicks or abrasions prior to making repairs.

The F/O cable bending radius of 20 times the outside diameter of the cable shall not be exceeded while handling and/or rerouting the F/O cable.

17.4.5.2 Damaged Fiber-optic Cable

If the Design-Builder damages F/O cable (existing or new) they shall repair the damaged cable as required below for Department or Port F/O.

17.4.5.2.1 Department F/O Cable

For damaged fiber-optic trunk cable the Design-Builder shall perform the following:

- Repair active F/O cable that is severed or otherwise rendered not useable by Project activities. The Design-Builder shall provide notification as soon as the cable damage is discovered.

- Stock approved splice kits to repair any cable damaged by construction activities

Spliced repairs to damaged F/O cable shall comply with the following:

- Initial emergency repairs to F/O cable shall utilize mechanical splices unless all fibers (severed and not severed) are fusion spliced within 24 hours.

- Splices shall be located within existing splice vaults.

- Splices shall comply with the requirements for F/O cable splicing.

Install new cable between existing terminations or vaults, as appropriate, for cable severed by the Design-Builder’s activities. Nicks or abrasions caused by exposing any cable by hand digging or vacuum excavation shall be sealed with rubber splicing tape. The Design-Builder shall seal nicks that penetrate through the cable jacket to the armor with a cast epoxy kit. The Design-Builder shall use “industry accepted lubricants” referenced in Caltrans Standard Specifications during cable pulling operations. The lubricants shall be compatible with cable insulation materials and shall not deteriorate the cable insulation.

17.4.5.2.2 Port F/O Cable

For damaged fiber-optic cable the Design-Builder shall notify Port security immediately and then perform the following:

- Repair active F/O cable that is severed or otherwise rendered not useable by Project activities. The Design-Builder shall provide notification as soon as the cable damage is discovered.

Spliced repairs to damaged F/O cable shall comply with the following:

- Initial emergency repairs to F/O cable shall utilize mechanical splices unless all fibers (severed and not severed) are fusion spliced within 24 hours.

- Splices shall be located within splice vaults, cabinets, or in splice trays housed in splice closures. Splices shall comply with the requirements for F/O cable splicing. Mean splice loss shall not exceed .07 dB per splice.

Install new cable between existing terminations or vaults, as appropriate, for cable severed by the Design-Builder’s activities. Nicks or abrasions caused by exposing any cable by hand digging or vacuum excavation shall be sealed with rubber splicing tape. The Design-Builder shall seal nicks that penetrate through the cable jacket to the armor with a cast epoxy kit.

17.4.5.3 Armored Fiber-Optic Pigtails

The Design-Builder shall use armored fiber-optic pigtails (twelve strand single mode) designed for outdoor use. The physical design for the cable assembly and the fiber specifications apply to the construction of
armored fiber-optic pigtails: The following requirements apply to the installation of armored fiber-optic pigtails:

- The Design-Builders shall remove the following lengths of outer jacket and armor from the behind the breakout to allow for attaching the sheath grounding unit lead to the cable as close as possible to the cabinet ground buss.
- The Design-Builders shall remove 6 inches of the outer jacket of cable terminating in the local control cabinet for VSS.
- The Design-Builders shall remove 8 feet of the outer jacket of cable terminating in a 334 series cabinet.
- The Design-Builders shall remove 13 feet of the outer jacket of cable terminating in a shelter cabinet.
- The Design-Builders shall bond a sheath grounding unit lead to the armor of the cable (3.28 feet long) and terminate at the ground buss.
- The Design-Builders shall label the cable near its cabinet entry point using white tape with cable name and meter marker.

The Design-Builders shall use caution when handling the breakout portion of the armored pigtails since fiber splices under the breakout are vulnerable to damage from pressure. Within control cabinets inside the patch panel, the Design-Builders shall provide strain relief on the inner jacket of the pigtails, not on the breakout. The Design-Builders shall coil 60 feet of the armored pigtails in the splice vault. Factory terminated indoor pigtails shall be described as follows:

- Secondary buffer from 250 µm to 900 µm.
- One end shall be terminated with ST connectors for single mode.
- The individual 0.118-inch outer jacket shall be labeled with the fiber number (place the fiber number label within 3 inches of the connector).
- The breakouts shall be 4 feet in length.

The Design-Builders shall use Approved fiber-optic pigtails assemblies required by this Section 17.

### 17.4.5.4 Fiber-Optic Cable Installation

The cable installation for both the Port system and the Department system shall conform to Caltrans Standard Specifications and the Contract Documents. The Design-Builders shall calculate the expected tension on fiber-optic trunk cable and pulling strap prior to installing trunk cable in conduit runs. The tension in the cables shall not exceed the manufacturer’s recommendation. The Design-Builders shall distribute the pulling force between the inner strength member and the agamid fibers by securing both to the main pulling device. The Design-Builders shall use a “break-away” type pulling attachment to protect against over stressing cable. The Design-Builders shall not use a cable grip that pulls only on the outer jacket to pull fiber-optic cable. The Design-Builders shall backfill open trench installations of trunk cable and armored pigtails with granular material 6 inches over the cable elevation. Damage to the cable from any source or exceeding the manufacturer’s recommended tensile strength limits or cable-bending radius is cause for the cables to be rejected. The Design-Builders shall ensure a minimum loaded bend radius of 20 times the outside diameter. The Design-Builders shall not use the hand hole as a fiber pull box.

### 17.4.5.4.1 Air-Assisted Fiber-Optic Cable Installation

The Design-Builders shall use air-assisted cable installation methods for all trunk fiber cables installed. Fiber shall be blown from vault to vault or vault to shelter. The Design-Builders shall ensure that the duct system is properly installed with pressure-tight splices by performing the following:

- Sealing one end of the duct and pressurizing the duct using a sealed blowing machine
- Maintaining a 130 psi pressure without a significant loss
- Using care around pressurized ducts
For high-speed air blowing, the Design-Builder shall end-cap the front end of the cable so that it does not hang up in the duct. The Design-Builder shall use proper air seals to fit the outer diameter of the cable being pushed. The Design-Builder shall clean, dry, and prove that the duct is not crushed and properly spliced. The Design-Builder shall prove this by performing the following:

- Blow a hard tight mandrel through the duct to establish the duct is not crushed.
- Blow a tight fitting foam carrier through the duct at a high pressure. The foam shall travel at 100 feet per second.
- If excess water or dirt comes from the duct, repeat the process until minimal water and dirt is extruded.
- Dry the duct with airflow.

For high-speed air machines (no missile), the Design-Builder shall inject the recommended amount of Approved lubricant and spread it with a foam carrier. For piston-type machines, the Design-Builder shall inject the majority of the lubricant in front of the missile with some placed behind the missile. The Design-Builder shall hook the blowing machine to the duct. For push/pull machines, the Design-Builder shall attach the piston to the cable and insert the piston into the duct. For high-speed blowing machines, the Design-Builder shall hand push approximately 100 feet of cable into the duct prior to activating the machine.

17.4.5.5 Fiber-Optic Cable Splicing

The Design-Builder shall splice fiber-optic cable as part of the fiber-optic pigtail termination. The Design-Builder shall only fusion-splice the fiber-optic cable. Cable splices shall only be allowed with the Approval of the Department or Port and only at the location specified and then only when there are no practical alternatives. Splices shall be made only in cabinets and splice vaults using Approved splice closures. The Design-Builder shall strictly follow the fiber-optic cable manufacturer’s methods, recommendations, materials, and techniques for splicing. The Design-Builder’s splicing equipment shall be in good working order, properly calibrated, and meet all industry standards and safety regulations. The cable preparation, closure installation, and splicing shall be accomplished in accordance with industry standards. To minimize mechanical stress and splicing locations, cables shall be trained into final position observing minimum bending radii of the cable of not less than 20 times the diameter of the cable or as per the manufacturer’s requirements, whichever is greater. Cleanliness and freedom from contamination shall be strictly observed with respect to splicing materials and joint construction. Upon completion of the splicing operation, the Design-Builder shall deposit all waste material in suitable containers, remove from the job site, and dispose.

17.4.5.6 Fiber-Optic Connection Components

Fiber-optic connection components may be necessary to connect Project-installed cable to the ITS communications network. The Design-Builder shall follow the requirements of the necessary components in the following sections.

17.4.5.6.1 Indoor Pigtails

Indoor pigtails (twelve single modes) shall be required for field splicing, for connecting armored pigtails, and for connecting to patch panels for fiber splicing and testing at trunk cable termination points.

17.4.5.6.2 ST Fiber Connectors

The ST connector complies with the requirements for single mode fiber connector for this Project.

17.4.5.7 Fiber-Optic Cable Identification Requirements

The Design-Builder shall identify all fiber-optic cable whenever the cable is entering or leaving a vault, housing, or closure and at all terminals. The Design-Builder shall use permanent non-conducting marking tags fastened securely to the cables for identification. The Design-Builder shall use cable designations that consistently conform to the Accepted overall scheme developed to indicate location, circuit, device, cable number, terminal branch, position, etc. Letters and numbers shall be used by the Design-Builder. The outer jackets shall have the surface printed with manufacturer’s identification, date of manufacture, and manufacturer’s part number.
17.4.5.8 Coaxial Cable
The Design-Builder shall not use coaxial cable for networking, other than when the Design-Builder determines it is necessary and receives Port Approval. Coaxial cable is allowed for VSS video feeds.

17.4.6 Splice Vault and Communication Pull Box

17.4.6.1 Splice Vault

The Design-Builder shall place the splice vaults in locations to minimize the number and length of pigtails. However, the location of field devices shall be the controlling factor in vault placement. The Design-Builder shall include in the construction of a splice vault a drainage system, grounding provisions, closure hanger bracket assembly, and a ground rod marker. The splice vault protects the outdoor fiber splice closure and shall meet the following requirements: The vault material shall meet the UL requirements for Tier 10 heavy-duty splice vault. The fiber-optic cables shall sweep up near the vault to meet the conduit entrance to the vault (take care not to exceed the specified minimum bend radius). Clean splice vaults after installation and splicing of cables. Cables shall be coiled onto the F/O hanger brackets within the vault. The Design-Builder shall furnish and install a sheath grounding unit between the splice closure and the ground rod. If re-used, the Design-Builder shall clean existing vaults prior to installing cable.

17.4.6.2 Communication Pull Box

The Design-Builder shall place the communication pull box near the approach panels off each end of the bridge to provide an access point to Traffic Management System conduits placed within the bridge rail. Fiber-optic cable shall have two coil loops within the vault for expansion/contraction purposes. The Design-Builder shall provide a drainage system in the communication pull box to avoid water infiltration into the conduit within the bridge rail.

17.4.6.3 Outdoor Fiber Splice Closure

The Design-Builder shall install sufficient desiccant (packaged silica) in the closure to reduce possible damage from moisture. The Design-Builder shall bond all fiber-optic cable shields in fiber-optic splice vaults to the ground lug of the outdoor fiber splice closure. The Design-Builder shall bond a sheath grounding unit conductor to the ground lug of the splice closure and the other conductor to the outside ground rod. The Design-Builder shall mount the sheath grounding unit to the inner wall of the vault along the upper half. The Design-Builder shall use a ground strap to connect the two grounding posts to electrically tie them together. Non-oxidizing coating shall be applied to all connections. The Design-Builder shall tape the F/O cables together as necessary near the outdoor F/O splice closure and throughout the slack length.

17.4.6.3.1 Mounting Splice Closure in Vault

The Design-Builder shall mount the furnished and installed outdoor fiber splice closure in the splice vault. Mounting of the outdoor fiber splice closure shall require a bracket to be constructed to fit the opening to the splice vault. The bracket shall be constructed so that the bracket and closure cannot fall into the vault. The bracket shall remain long enough to rest on the vault lid ledge. The objective of this bracket shall be to keep the splice closure off the floor of the vault. The Design-Builder shall construct the bracket as follows:

- The main support member shall be placed 1/8 inch under the vault opening and is 1 inch by 1.5 inches variable-length “C” channel and may be perforated with web-centered holes. The length dimension will vary with the diameter of the access cover.
- The ends of the main support member shall have “Z” brackets constructed of 0.1875-inch steel 1.5 inches wide. The “Z” brackets rest on the vault lip for the round access cover.
- The outdoor fiber splice closure shall be hung from the bracket assembly with 0.125-inch stainless-steel cable.

17.4.7 Single Point Grounding

For all electrical and electronic grounding, the Design-Builder shall meet single-point grounding requirements. Single-point grounding means referencing all grounded devices to a single point (one single
piece ground rod) via the shortest and straightest route. The Design-Builder shall collect the devices’ chassis and electrical grounds at a ground buss before connecting them to the earth ground rod. The Design-Builder shall connect the ground busses via conductors that meet the requirements of single point grounding. For single-point grounding, the Design-Builder shall perform the following:

- Ground all equipment to meet the requirements of the manufacturer.
- Route each ground conductor to the ground bus via the straightest route that does not hinder maintenance or installation activities.
- Use a sheath grounding unit to ground the outer shield and armor of the fiber-optic cables in control cabinets to the equipment ground bus.
- Clean each grounding component with 300-grit emery cloth before bonding and apply a mineral-oil-based oxide inhibitor to the bond area.

Provide sheath grounding units for all fiber-optic cable ground locations (cabinets, shelters, and splice vaults). In the fiber-optic splice vault, only one sheath grounding unit is needed between the splice closure and the ground rod. When used in control cabinets and fiber patching shelters, a sheath-grounding unit is used on each fiber-optic cable entering/exiting the cabinet/shelter. The sheath grounding unit shall meet the following requirements:

- Connect to the cable armor
- Provide a low-impedance ground path for high-voltage transients while allowing location and monitoring signals to pass
- Provide test access to the armor
- Automatically reset
- Fail-safe circuitry design
- Hybrid surge suppression circuitry
- Suitable for below-grade use
- No. 6 AWG stranded copper lead wires

17.4.7.1 Ground Rods and Ground Rod Connections

The Design-Builder shall furnish and install ground rods and ground rod connections with the following requirements: The ground rod shall be 15 feet long, one piece, and comply with Caltrans Standard Specifications. An oxide inhibitor shall be applied over bonded connections to ground rods. The oxide inhibitor shall meet the following requirements:

- UL listed
- Provide an airtight seal around the conductor and ground rod
- Applied to the bonded area between the temperatures of -22°C (-30°F) and 149°C (300°F)
- Used on copper conductors
- Prevent oxides from forming
- Mineral-oil based

The Design-Builder shall bond the ground conductor to the ground rod by one of the following three bonding methods:

- Compression
- Exothermic welding — used when grounding VSS poles and VMS structures with lightning braid
- Irreversible compression — used when grounding VSS poles and VMS structures with lightning braid and achieved by using one of the following:
  - Hydraulic press with a connector die
- Solid copper connector with a run for a 5/8-inch ground rod and a tap for the specified ground conductor
- Connectors that can accommodate a conductor range from No. 6 solid copper through 500 Kcmil, pre-filled with an antioxidant compound, and strip-sealed

The Design-Builder may propose other methods and materials for implementing an irreversible compression bond and submit the associated products and procedures of equal quality for Approval.

### 17.4.8 Conduit, Innerduct and Communication Conduit

The Design-Builder shall not direct-bury fiber-optic cable on this Project. The Design-Builder shall install armored fiber-optic cables (fiber-optic outside plant cable) with inner ducts together in conduit for the entire length of the corridor. The Design-Builder shall immediately cap all open ends of installed conduit until cables are installed. Standard bell ends shall be installed on all conduit ends by the Design-Builder to prevent damage to the installed cable.

For communication conduit trenches in asphalt concrete and Portland cement concrete areas, the Design-Builder shall place a plastic sheet with minimum thickness of 0.02 inch and full trench width for the entire trench length and at 1 inch above the top communication conduit. For communication conduit trenches in soil area, the Design-Builder shall place a 4-inch-wide underground warning tape with a message of “CAUTION BURIED CALTRANS FIBER-OPTIC CABLE BELOW – CALL BEFORE DIGGING (323) 259-1922” or “CAUTION BURIED POLB FIBER-OPTIC CABLE BELOW – CALL PORT SECURITY BEFORE DIGGING” based on the type of communications conduit. The tape shall be placed 6 inches below finished grade and at the center of the trench. The Design-Builder shall place the colored slurry cement backfill in the trench to 1.2 inches (asphalt) and 4 inches (concrete) minimum below finished grade for trenches in the existing asphalt and Portland cement concrete pavement area, respectively. For trenches in new or existing soil area, colored slurry cement in the trench shall be filled to 1-inch minimum above the top of communication conduit. Top portion above the colored slurry cement in new or existing soil area shall be filled with structure backfill material in conformance with Section 86-2 of Caltrans Standard Specifications. For trenches in new asphalt or Portland cement concrete pavement areas, colored slurry cement shall be filled to the bottom of new lean concrete base.

Conduit routed along elevated sections or roadway and bridge spans shall be hung under the deck or attached to the bridge railing with a cover to prevent inadvertent damage to conduit. All conduit installed in, on, or below structures shall have adequate expansion joints for the type of conduit.

### 17.4.9 Documentation and Testing

The Design-Builder shall arrange a pre-testing meeting with the Port. This meeting shall occur prior to any testing. The ITS element test plan and fiber-optic cable test plan shall be provided 5 days in advance of the meeting. Testing personnel, including the people that will be performing the field-testing shall be required to attend the meeting. The Design-Builder shall notify the Port prior to fiber-optic (F/O) system testing. The Port may observe each test.

#### 17.4.9.1 ITS Element Test Plan

The Design-Builder shall develop a test plan for each ITS element per the manufacturer, industry, and Port recommendations. The Department has published test reports for several types of devices, available from the LARTMC. For components required on this Contract that fall outside of the pre-developed test plans the Design-Builder shall be responsible for submitting a plan for Approval before testing commences. Test plans shall have, at a minimum:

- Materials required for testing
- Test procedure for each component
- Passing criteria
- Process to follow if test fails
17.4.9.2 ITS Element Testing and Documentation
The Design-Build shall complete and submit the inspection checklists. The Design-Build’s Traffic
Control Manager shall sign off on all forms. Notification by the Design-Build is required when all ITS
elements are installed, integrated, and requirements have been met. Contract work will be accepted after
verifying proper operation of all components. The Design-Build shall submit the proof of performance
(POP) test results per the Approved test plan. The Design-Build shall submit the loop detector test report
within one week after completing installation for loops. The Design-Build shall submit all wiring diagrams
for review and incorporate comments resolved in the wiring diagram. The Design-Build shall submit power
and control cable test results within 7 Days of making final connections.

17.4.9.3 Fiber-Optic Cable Test Plan
The Design-Build shall develop and submit for Approval a Fiber-Optic System Test Plan. The test plan
shall include, at a minimum, Optical Time-Domain Refractometer (OTDR) testing for each segment of fiber-
optic cable. The test plan shall include calculated optical budgets for each segment of fiber so that the test
results can be comparatively evaluated.

17.4.9.4 Fiber-Optic Cable Testing and Documentation
The Design-Build shall submit fiber-optic cable test documentation including calibration and certification
of the fiber-optic cable test equipment as part of the component documentation. The Design-Build shall
follow the format of the Fiber-Optic System Test Plan. The Design-Build shall use the Port’s file naming
convention for all OTDR test files. The Design-Build shall provide all test documentation on a CD. The
Design-Build shall store OTDR files under a directory named by the highway number. These files shall
include the following: actual date of testing, all splice points marked, the “index of refraction” (recorded on
the cable spool by the manufacturer), and file names and notes as described by the Port’s file naming
convention. The Design-Build shall provide OTDR “make and model” information as part of the Project
Documentation Submittal. The Design-Build shall provide a test summary describing the following:

- Final measurements that were out of range.
- Approved changes in specified methods.
- Dates tests were performed by both power meter and OTDR.
- Other special circumstances.

The Design-Build shall provide the Port additional copies of the manufacturer’s reel (spool) test
documentation. The test documentation is shipped with the fiber-optic cable spool.

17.5 Deliverables
Unless otherwise indicated, all deliverables shall be submitted in both electronic format and hardcopy
format. Acceptable electronic formats include Microsoft Word, Microsoft Excel, or Adobe Acrobat (.PDF)
files, unless otherwise indicated. At a minimum, the Design-Build shall submit the following to the Port
and the Department:
### Deliverable | For Acceptance or Approval | Number of Copies | Submittal Schedule | Reference Section
--- | --- | --- | --- | ---
ATMIS Migration Plan | Acceptance | 1 | 1 (PDF) | Prior to decommissioning the existing systems | 17.3.7
PIMS Migration Plan | Acceptance | 1 | 1 (PDF) | Prior to decommissioning the existing systems | 17.3.8
VSS Field of View Report | Approval | 1 | 1 (Video and PDF) | Prior to final design of VSS systems | 17.3.4.1
ITS Element Test Plan | Approval | 1 | 1 (PDF) | Prior to testing | 17.4.9.1
ITS Element Test Documentation | Acceptance | 1 | 1 (PDF) | Prior to Acceptance of ITS Elements | 17.4.9.2
Fiber-optic Test Plan | Approval | 1 | 1 (PDF) | Prior to testing | 17.4.9.3
Fiber-optic Test Documentation | Acceptance | 1 | 1 (PDF) | Prior to Acceptance of Communications System | 17.4.9.4
As-Built Drawings | Acceptance | 1 | 1 (PDF) | Prior to Project Acceptance | 17.4.1.5

#### 17.5.1 Released for Construction (RFC) Documents
RFC Documents shall include the following, at a minimum:
- Title sheet
- Legend of symbols
- Existing ITS elements with Utilities
- Proposed ITS devices with GPS locations
- ITS sample plan symbology
- Typical section view
- Communication schematics and layouts
- Test schematics
- ITS element details and plans
EXHIBIT 2-17-A
Preliminary ITS Components Drawing

This exhibit is provided in electronic format.

<table>
<thead>
<tr>
<th>Exhibit</th>
<th>Title</th>
<th>Electronic File(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exhibit 2-17-A</td>
<td>Preliminary ITS Components Drawing</td>
<td>EXHIBIT 2-17-A-Add4.dgn</td>
</tr>
</tbody>
</table>
EXHIBIT 2-17-B

Automated License Plate Recognition System