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ALAMEDA CONTRA COSTA TRANSIT
EAST BAY BUS RAPID TRANSIT
PROJECT

INFRASTRUCTURE
AND
STATION PLATFORMS

Volume III

STATION PLATFORM SPECIFICATIONS
AND
EBMUD SPECIFICATIONS

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October 2015
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PROFESSIONAL LICENSE SEALS

The special provisions contained herein have been prepared by or under the direction of the following Registered Persons.

STATION PLATFORM SPECIFICATIONS

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FILE #
APP #01-115240

AC FLS SS
Date

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DIVISION 3 – STATION PLATFORM SPECIFICATIONS

DIVISION 3.1 - ARCHITECTURAL AND STRUCTURAL SPECIFICATIONS

SECTION 03 10 00

CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. Formwork for cast-in-place concrete, with shoring, bracing and anchorage.
2. Openings for other work.
3. Form accessories.
4. Form stripping.

B. Related Documents: The Contract Documents, as defined in Division 1, Section 01 11 00 - Summary, apply to the Work of this Section. Additional requirements and information necessary to complete the Work of this Section may be found in other documents.

C. Related Sections:

1. Division 3.1, Section 03 20 00 - Concrete Reinforcement: Coordination between formwork and reinforcement.
2. Division 3.1, Section 03 30 00 - Cast-in-Place Concrete: Supply of concrete accessories for placement by this section.

1.2 REFERENCES

A. American Concrete Institute (ACI) Codes and Standards latest editions:

1. ACI 301 - Structural Concrete for Buildings.
2. ACI 318 - Building Code Requirements for Reinforced Concrete.
3. ACI 347 - Recommended Practice For Concrete Formwork.

1.3 SUBMITTALS

A. Division 1, Section 01 33 00 - Submittal Procedures: Procedures for submittals.

1. Product Data: Provide data on void form materials and installation requirements. Submit data on form-coating materials.
2. Shop Drawings: Indicate pertinent dimensions, materials, required installation and removal of bracing, shoring and arrangement of joints and ties.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with ACI 347.

B. Where necessary, design formwork, shoring under direct supervision of a Professional Engineer experienced in design of formwork and licensed in the State of California.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Division 1, Section 01 60 00 - Product Requirements: Transport, handle, store, and protect products.

B. Deliver void forms and installation instructions in manufacturer’s packaging.

C. Store off ground in ventilated and protected manner to prevent deterioration from moisture.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Environmental Impact:

1. Formwork: Reuse forms to greatest extent possible without damaging structural integrity of concrete and without damaging aesthetics of exposed concrete.

PART 2 - PRODUCTS

2.1 WOOD FORMS

A. Forms for Exposed Finish Concrete: Plywood panels, to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings.

1. Plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood," Class I, Exterior Grade or better, mill-oiled and edge-sealed, with each piece bearing legible inspection trademark.

B. Forms for Unexposed Finish Concrete: Plywood, lumber, metal, or other acceptable material. Provide lumber dressed on at least 2 edges and one side for tight fit.

C. Lumber: Construction grade; with grade stamp clearly visible.

2.2 PREFABRICATED FORMS

A. Preformed Steel Forms: Minimum 16 gage, well matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.

B. Void Forms (Carton Forms): Moisture resistant treated paper faces, biodegradable, structurally sufficient to support weight of wet concrete mix until initial set. Thickness indicated on drawings.
2.3 ACCESSORIES

A. Form Ties: Factory-fabricated, removable or snap-off type, metal, of fixed or adjustable length as applicable, with cone ends. Designed to prevent form deflection and to prevent spalling concrete upon removal. Back break dimension, 1-1/2 inch from exposed concrete surface. Provide ties that, when removed, will leave holes not larger than 1 inch diameter in concrete surface.

B. Form Release Agent: 100 percent biodegradable colorless agent which will not stain concrete, or absorb moisture, or impair natural bonding or color characteristics of subsequent coatings intended for use on concrete surfaces. Zero VOC.

1. Envirolux by Conspec, Kansas City, KS, (800) 348-7351 or (913) 287-1700.
2. SMD-10 Soy Form Release by Strategic Market Development (800) 959-1071 or (815) 935-0863.
3. Bio-Form by Leahy-Wolf, Franklin Park, IL, (888) 873-5327 or (847) 455-5710.
4. Division 1, Section 01 60 00 - Product Requirements: Product options and substitutions. Substitutions: Permitted.

C. Corners: Chamfered, wood strip 3/4 x 3/4 inch size; maximum possible lengths.

D. Dovetail Anchor Slot: Galvanized steel, 22 gage thick, foam filled, release tape sealed slots, anchors for securing to concrete formwork.

E. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Sized as required, of sufficient strength and character to maintain formwork in place while placing concrete.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Division 1, Section 01 70 00 – Execution and Closeout Requirements: Verification of existing conditions before starting work.

B. Verification of Conditions: Verify that field measurements, surfaces, and conditions are as required, and ready to receive Work.

1. Verify lines, levels and centers before proceeding with formwork. Ensure that dimensions agree with Drawings.

C. Report in writing to Contracting Officer prevailing conditions that will adversely affect satisfactory execution of the Work of this Section. Do not proceed with Work until unsatisfactory conditions have been corrected.
D. By beginning Work, Contractor accepts conditions and assumes responsibility for correcting unsuitable conditions encountered at no additional cost to United States Postal Service.

3.2 FORMWORK INSTALLATION

A. Install formwork, shoring and bracing to achieve design requirements, in accordance with requirements of ACI 347R.

B. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.

C. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores upon approval by the Professional Engineer responsible for their design.

D. Align joints and make watertight. Furnish in largest available sizes to minimize number of joints and to conform to joint system indicated on Drawings.

E. Obtain approval from the Engineer or Architect before framing openings in structural members which are not indicated on Drawings.

F. Provide chamfer strips on external corners of concrete members, to produce uniform, smooth lines and tight edge joints.

3.3 FORM RELEASE AGENT APPLICATION

A. Apply form release agent on formwork in accordance with manufacturer’s published instructions.

B. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.

C. Do not apply form release agent where concrete surfaces will receive special finishes or applied coverings which are effected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces coated prior to placement of concrete.

3.4 INSERTS, EMBEDDED PARTS, AND OPENINGS

A. Provide formed openings where required for items to be embedded in passing through concrete work.

B. Locate and set in place items which will be cast directly into concrete.

C. Coordinate with work of other sections in forming and placing openings, slots, recesses, sleeves, bolts, anchors, other inserts, and components of other Work.

D. Install accessories in accordance with manufacturer's published instructions, straight, level, and plumb. Ensure items are not disturbed during concrete placement.

E. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.

F. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.
3.5 FORM CLEANING

A. Clean forms as erection proceeds, to remove foreign matter within forms.

B. Clean formed cavities of debris prior to placing concrete.

C. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.

D. During cold weather, remove ice and snow from within forms. Do not use de-icing salts. Do not use water to clean out forms, unless formwork and concrete construction proceed within heated enclosure. Use compressed air or other means to remove foreign matter.

3.6 CONSTRUCTION

A. Site Tolerances:

1. Construct formwork to maintain tolerances required by ACI 301 and ACI 347.

3.7 FIELD QUALITY CONTROL

A. Division 1, Section 01 40 00 - Quality Requirements: Field inspection and testing.

B. Inspect erected formwork, shoring, and bracing to ensure that work is in accordance with formwork design, and that supports, fastenings, wedges, ties, and items are secure.

3.8 FORM REMOVAL

A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.

B. Do not remove shoring without approval from the Professional Engineer responsible for their design.

C. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.

D. Store removed forms in manner that surfaces to be in contact with fresh concrete will not be damaged. Discard damaged forms.

END OF SECTION
SECTION 03 20 00

CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Reinforcing steel bars.
   2. Steel wire mesh.
   3. Reinforcement accessories.

B. Related Documents: The Contract Documents, as defined in Division 1, Section 01 11 00 - Summary, apply to the Work of this Section. Additional requirements and information necessary to complete the Work of this Section may be found in other documents.

C. Related Sections:
   1. Division 3.1, Section 03 10 00 - Concrete Forming and Accessories: Coordination between formwork and reinforcing.
   2. Division 3.1, Section 03 30 00 - Cast-in-Place Concrete: Coordination between concrete placement and reinforcing.

1.2 REFERENCES

A. American Concrete Institute (ACI):
   1. ACI 301 - Structural Concrete for Buildings.
   2. ACI 318 - Building Code Requirements For Reinforced Concrete.
   3. ACI SP-66 - American Concrete Institute - Detailing Manual.

B. American Society for Testing and Materials (ASTM):
   1. ASTM A 184 - Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
   2. ASTM A 706 - Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement.
   3. ASTM A 704 - Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement.

C. American Welding Society (AWS):
   1. AWS D1.4 - Structural Welding Code for Reinforcing Steel.

D. Concrete Reinforcing Steel Institute (CRSI):
   1. CRSI - Manual of Practice.
2. CRSI 63 - Recommended Practice For Placing Reinforcing Bars.

3. CRSI 65 - Recommended Practice For Placing Bar Supports, Specifications and Nomenclature.

1.3 SUBMITTALS

A. Division 1, Section 01 33 00 – Submittal Procedures: Procedures for submittals.

   1. Shop Drawings: Indicate bar sizes, spacings, locations, and quantities of reinforcing steel [and wire fabric, bending and cutting schedules, and supporting and spacing device. Include special reinforcement required for openings through concrete structures.

   2. Assurance/Control Submittals;
      a. Manufacturer’s Certificate: Certify that products meet or exceed specified requirements.
      b. Submit certified copies of mill test report of reinforcement materials analysis.
      c. Welder’s Certificates.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with CRSI 63, 65 and Manual of Practice ACI 301, ACI SP-66, ACI 318, and ASTM A 184.

B. Design reinforcement under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State where the Project is located.

C. Welders’ Certificates: Submit certificate, certifying welders employed on the Work, verifying AWS qualification within the previous 12 months.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

A. Reinforcing Steel: ASTM A706, 60 ksi yield grade; deformed low-alloy steel bars, unfinished.

B. Reinforcing Steel Mat: ASTM A 704, ASTM A 706, 60 ksi yield grade; steel bars or rods, unfinished.

C. Reinforcing Steel Mesh: ASTM A185; 6X6, w 1.4 X w 1.4.

D. Dowels at Construction Joints: 1/4” x 4.5” Diamond Dowels by PNA Construction Technologies or approved equal.

2.2 ACCESSORIES

A. Tie Wire: Minimum 16 gage annealed type.
B. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for strength and support of reinforcement during concrete placement conditions including load bearing pad on bottom to prevent vapor barrier puncture.

C. Special Chairs, Bolsters, Bar Supports, Spacers Adjacent to Weather Exposed Concrete Surfaces: Plastic coated steel type(CRSI, Class 1) or stainless steel protected(CRSI, Class 2); size and shape as required.

2.3 FABRICATION

A. Fabricate concrete reinforcing in accordance with ACI SP-66 and ACI 318.

B. Weld reinforcement in accordance with AWS D1.4.

C. Locate reinforcing splices not indicated on drawings, at point of minimum stress. Review location of splices with Contracting Officer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Division 1, Section 01 70 00 – Execution and Closeout Requirements: Verification of existing conditions before starting work.

B. Verification of Conditions: Verify that field measurements, surfaces, and conditions are as required, and ready to receive Work.

C. Report in writing to Contracting Officer prevailing conditions that will adversely affect satisfactory execution of the Work of this Section. Do not proceed with Work until unsatisfactory conditions have been corrected.

D. By beginning Work, Contractor accepts conditions and assumes responsibility for correcting unsuitable conditions encountered at no additional cost to United States Postal Service.

3.2 PLACEMENT

A. Place, support and secure reinforcement against displacement. Do not deviate from required position.

B. Do not displace or damage vapor barrier.

C. Accommodate placement of formed openings.

D. Maintain concrete cover around reinforcing in accordance with ACI 318.

3.3 FIELD QUALITY CONTROL

A. Division 1, Section 01 40 00 - Quality Requirements: Field inspection.

B. Inspect reinforcing locations, bar types and sizes, wire ties, and welding (if applicable).

END OF SECTION
SECTION 03 30 00  
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Includes all labor, materials and appliances, and perform all operations in connection with the installation of Concrete Work, and all related work incidental to the completion thereof, as shown on the drawings, complete, in strict accordance with the drawings and as specified herein. Section Includes:


2. Finishing of concrete floor slabs and toppings. Concrete liquid surface treatment, sealer, and slip-resistant coatings.

3. Expansion and contraction, control joints in CIP concrete.

4. Concrete curing and protection.

5. Non-shrink grout including installation and forming.

6. Testing related services.

B. Related Documents: The Contract Documents, as defined in Division 1, Section 01 11 00 - Summary, apply to the Work of this Section. Additional requirements and information necessary to complete the Work of this Section may be found in other Documents and References in Section 1.2.

C. Related Sections: Related work specified elsewhere includes but may not be limited to

1. Division 3.1, Section 03 10 00: Concrete Forming and Accessories

2. Division 3.1, Section 03 20 00: Concrete Reinforcement

1.2 REFERENCES

A. American Concrete Institute (ACI) Codes and Standards latest editions:


2. ACI 301, “Specification for Structure /Concrete.”

3. ACI 302.1R, “Guide for Concrete Floor and Slab Construction.”


5. ACI 305, “Hot Weather Concreting.”

6. ACI 306, "Cold Weather Concreting."
7. ACI 311, “Recommended Practice for Concrete Inspection.”
8. ACI 315, "Details and Detailing of Concrete Reinforcement."
9. ACI 318, “Building Code Requirements for Structural Concrete.”
10. ACI 347, "Guide to Formwork for Concrete."

B. American Welding Society (AWS)
1. AWS D1.4, "Structural Welding Code Reinforcing."

C. American Society for Testing and Materials (ASTM).

D. Concrete Reinforcing Steel Institute (CRSI),
1. CRSI "Manual of Standard Practice."

1.3 SUBMITTALS
A. Division 1, Section 01 33 00 - Submittal Procedures: Procedures for submittals.
1. Product Data: Provide data technical, testing, and source for mix design materials and additives, steel reinforcement, joint sealant [,and other products as specified on the drawings.]
2. Shop Drawings: Provide shop drawings for reinforcement, layout, detailing, and placing prior to fabrication, site delivery, and installation.
   a. Mix design submittals. Submit properties of mix design for each class of concrete including, but not limited to the followings:
      (1) Specified compressive strength, $f_c$
(2) Documentation of strength test results of similar concrete mixtures indicating

(3) the standard deviation in accordance with ACI 318

(4) Required average compressive strength, $f_{cr}$

(5) Average compressive strength of proposed mixture(s)

(6) Placement method

(7) Slump or slump flow

(8) Air content

(9) Density

(10) w/cm ratio

(11) Maximum aggregate size

(12) Sources and designations of ingredient materials proposed for use including:

(13) Cementitious Materials

(14) Aggregates

(15) Admixtures

(16) Water

(17) Fibers, color pigments, and other additions


c. Form construction details, including jointing, special formed joints or reveals, location and pattern of form tie placement, and other items that affect exposed concrete visually.

d. Calculations and layout drawings for formwork, shoring and/or reshoring, and other submittals indicated on the drawings. Work shall be prepared and signed and sealed by a Professional Engineer registered in the State of California.

e. Provide technical data of any admixtures used in the mix design.

3. Assurance/Control Submittals:
a. Test Reports: Prepare reports in conformance with Division 1, Section 01 40 00 - Quality Requirements:

b. Submit laboratory test reports for concrete materials and mix designs for each strength and type of concrete proposed for use.

c. Certificates: Manufacturer's certificate that Products meet or exceed specified requirements.

4. Delivery Tickets:

a. Copies of delivery tickets for each load of concrete delivered to site.

b. Indicate on each ticket the exact time that the mix is batched and note the time and quantity of admixtures used in the mix, if any.

c. Mix identification number on ticket shall match number on submitted and approved mix design

d. Submit copies to Testing Laboratory for verification of compliance with placing time.

1.4 QUALITY ASSURANCE

A. Perform work in accordance with the Codes and Standards referenced in Division 1, Section 01 40 00, Part 1.2 of this specification.

1. Provide qualification data for manufacturers and installers.

B. Pre-Installation Conference:

2. Conduct a pre-installation conference prior to commencing Work of this Section.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Division 1, Section 01 60 00 - Product Requirements: Transport, handle, store, and protect Products.

B. Deliver materials in unopened containers with labels identifying contents.

C. Store powdered materials in dry area and in manner to prevent damage. Protect liquid materials from freezing or exceeding maximum storage temperatures set by product manufacturer.

1.6 ENVIRONMENTAL REQUIREMENTS

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with project requirements, manufacturers offering Products which may be incorporated in the Work include the following:
2.2 CONCRETE MATERIALS

A. Portland Cement: ASTM C150 – Type IV supplement with fly ash.

B. Liquid admixtures: The following admixtures are permitted when approved in writing prior to use or are required as specified herein and shall be used in strict accordance with the manufacturer’s specifications or recommendations:

1. Calcium chloride: Conform to ACI 301. The water soluble chloride ion level shall not exceed 0.3 percent by weight of cement.

3. Water-reducing admixtures: Conform to ASTM C494, Type A.
4. Water-reducing accelerate admixtures: Conform to ASTM C494, Type C or E.
5. Water-reducing retard admixtures: Conform to ASTM C494, Type D.
   a. High-range/water-reducing (HRWR) admixtures: Conform to ASTM C494, Type F or G super plasticizers. HRWR admixture shall be used in concrete with a maximum water/cement ratio of 0.50 or less.

C. Fly ash: Conform to ASTM C618. The use of a quality fly ash will be permitted as a cement-reducing admixture (minimum 15 percent and maximum 25 percent) unless otherwise restricted by the engineer. Fly ash used in concrete shall be from a single source and of a single class in combination with Portland cement of a single source and single class unless otherwise approved by the Engineer.

D. Granulated Blast Furnace Slag is an alternative to fly ash and shall conform to ASTM C989 Grade 100 or 120. Granulated blast furnace slag may be used as a substitute for a maximum of 30 percent of Portland cement.

E. Aggregates:
   3. Aggregates shall be from a single source.

F. Water:
   1. Clean, potable, and free of injurious amounts of oil, acid, alkali, organic or other deleterious matter not detrimental to concrete; drinkable.

2.3 GROUT/MORTARS

A. Cement grout: Conform to ASTM C387 “Dry packaged mixtures”.

2.4 CURING/SEALING/HARDENERS

A. Dissipating liquid membrane-forming compounds for curing concrete; Conform to ASTM C309, Type 1. Curing compound shall be compatible with floor sealer or finish used. Low VOC.

B. Method of curing shall be approved by the finish flooring applicator where finishes are indicated.

C. Exterior Sealers: applied to horizontal concrete surfaces permanently exposed to salts, deicer chemicals and moisture, including parking decks. The manufacturer shall provide a five year labor and materials warranty on performance of the sealer. Sealer shall be compatible with the curing compound used.

D. Liquid Densifier/Sealer/Hardener: to be applied on exposed concrete floors cured with dissipating membrane forming curing compound to harden and densify concrete surfaces. Sealers are to be clear, chemically reactive, a waterborne solution of silicate or silicate materials and proprietary components, odorless, and colorless.
2.5 JOINTS AND EMBEDDED ITEMS:

A. Construction and Contraction Joints: Sealant shall be two-part semi-rigid epoxy, and shall have minimum Shore A Hardness of 80 when measured with ASTM D2240.

B. Isolation Joints: Fillers shall consist of 1/8 inch width strips of neoprene, synthetic rubber, or approved substitute, extending the full depth of the slab. Sealant shall be two-part elastomeric type, polyurethane base.

2.6 PROPORTIONING

A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. If laboratory trial batch method is used, use an independent testing facility acceptable to Contracting Officer for preparing and reporting proposed mix designs. The testing facility shall not be the same as used for field quality control testing and inspection unless otherwise acceptable to Contracting Officer.

B. Submit written reports to the testing laboratory of each proposed mix for each class of concrete. Do not begin concrete production until mixes have been reviewed and approved.

C. Concrete types and strengths: Minimum 28 Day Compressive Strength shall be per design requirements but not less than:

1. Foundations, and footings: 3,000 psi.
2. Slab-on-grade: 3,000 psi.
3. All concrete shall be air entrained (ASTM C260).
4. All concrete shall be normal weight.

D. Durability: Conform to ACI 301.

1. All concrete exposed to potentially destructive weathering, such as freezing and thawing, or to de-icer chemicals is to be air-entrained, 2 ± 1 percent.
2. Water-cement ratio: For concrete subject to freezing and thawing or deicer chemicals, the water-cement ratio shall not exceed 0.53 by weight including any water added.

E. Slump: Conform to ACI 301 and to specific project mix requirements.

F. Production of concrete: Conform to ACI 301:

1. Cast-in-place concrete used in the work shall be produced at a single off-site batching plant or may be produced at an on-site batch plant.
2. All concrete shall be proportioned conforming to the approved mix designs and of the materials contained in those approved mixes.
3. Prior to adding a high-range water reducer (super plasticizer), slump shall not exceed the working limit.
4. Ready-mixed and on-site batched concrete shall be batched, mixed, and transported in accordance with ASTM C94.

a. The concrete producer shall furnish duplicate delivery tickets, one for the Contractor and one given to the Owner’s Representative for each batch of concrete. The information provided on the delivery ticket shall include the quantity of materials batched including the amount of free water in the aggregate and any water added onsite. Show the date, time of day batched, and if ready-mixed the time of discharge from the truck. The quantity of water that can be added at the site without exceeding the maximum water-cementitious ratio specified shall be noted on the delivery ticket.

5. For concrete produced on site with a central batch plant, mixing shall be done in an approved batch mixer concrete shall be batched, mixed, and transported in accordance with ASTM C94.

6. Variations in consistency during the discharge of a single batch shall not exceed 1 inch of slump, except that a greater variation will be permitted if the slump of the concrete decreases and no water is added.

7. All other concrete: Conform to ACI 301

8. When improved workability, pumpability, lower water-cement ratio, or high ultimate and/or early strength is required, the HRWR admixture (super plasticizer) may be used.

9. Ensure air content for slabs with steel trowel finish is less than 3.0 percent.

10. No water shall be added to concrete except under the direct awareness of the project inspector.

11. Adjustments to concrete mixes: Mix design adjustments may be requested by Contractor for approval by the Engineer at no additional cost to Contracting Officer. Laboratory test data for revised mix design and strength results must be submitted and accepted before using in work.

2.7 FORMWORK

A. Division 1, Section 03 10 00: Concrete Forming and Accessories

2.8 REINFORCING MATERIALS

A. Division 1, Section 03 20 00: Concrete Reinforcement

PART 3 - EXECUTION

3.1 EXAMINATION

A. Division 1, Section 01 70 00 – Execution and Closeout Requirements: Verification of existing conditions before starting work.

B. Verification of Conditions: Verify that field measurements, surfaces, substrates and conditions are as required, and ready to receive Work.
C. Report in writing to Contracting Officer prevailing conditions that will adversely affect satisfactory execution of the Work of this Section. Do not proceed with Work until unsatisfactory conditions have been corrected.

D. By beginning Work, Contractor accepts conditions and assumes responsibility for correcting unsuitable conditions encountered at no additional cost to the United States Postal Service.

3.2 INSTALLATION - GENERAL

A. Install all cast-in-place concrete work in accordance with ACI 301 except as herein specified.

B. All bearing materials shall be inspected by the Geotechnical Engineer prior to placing concrete. The Geotechnical Engineer specify site preparation requirements and provide recommendations to the Architect/Engineer prior to placing concrete.

C. Immediately before placing concrete, spaces to be occupied by concrete shall be free from standing water, ice, mud, and debris.

D. Concrete shall not be deposited under water or where water in motion may injure the surface finish of the concrete.

E. Forms and the reinforcement shall be thoroughly cleaned of ice and other coatings. Remove surplus form releasing agent from the contact face of forms.

F. Notify all trades concerned and the Owner’s Representative sufficiently in advance of the scheduled time for concrete placement to permit installation of all required work by other trades.

G. Before placing concrete, all required embedded items, including dovetail anchor slots, anchors, inserts, curb angles, metal frames, fixtures, sleeves, drains, stair nosings, accessory devices for Mechanical and Electrical installations shall be properly located, accurately positioned and built into the construction, and maintained securely in place.

H. Build into construction all items furnished by the Owner and other trades. Provide all offsets, pockets, slabs, chases and recesses as job conditions require.

I. Place and properly support reinforcing steel and anchor bolts.

J. The alignment, orientation, spacing, and embedment length of mechanical load transfer devices in slab-on-grade and pavements shall conform to dimensions and tolerances shown on the drawings.

3.3 INSTALLATION - FORMWORK

A. Division 3.1, Section 03 10 00 Concrete Forming and Accessories

B. Construction and Contraction Joints: Conform to ACI 301 and recommendations of ACI 302.1R.

3.4 REINFORCEMENT

A. Placement: Division 3.1, Section 03 20 00 Concrete Reinforcement
### 3.5 METHODS OF PLACEMENT AND PLACING CONCRETE

**A. Placement:** Conform to ACI 301:

1. Concrete shall be placed within 90 minutes after the water has been added to the cement and aggregates. Concrete shall be placed prior to initial concrete set. Do not add water to concrete during delivery or during placement unless there is an allowed added water quantity on the delivery. Added water shall be recorded in the delivery ticket.

2. Placing of concrete will not be permitted during rainfall or when rain appears imminent. If rain should fall subsequent to placement, the concrete shall be completely protected until curing is complete.

3. **Cold-Weather Placement:** Comply with provisions of ACI 306.1 “Standard Specifications for Cold-Weather Concreting” for placement at temperatures below 40 deg F (4 deg C).
   
   a. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.
   
   b. Concrete shall not be placed on frozen ground or placed when the ambient temperature is 40 deg F or less and dropping.
   
   c. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures using vented heaters and insulating blankets.
   
   d. Concrete temperatures shall be maintained above 50 degrees F for the first 7 days of curing.

4. **Hot-Weather Placement:** When hot weather conditions exist that would impair quality and strength of concrete, place concrete complying with ACI 305R “Standard Specification for Hot-Weather Concreting” for placement at temperatures above 90 deg F (32 deg C).
   
   a. Reject any concrete that has a temperature at the point of placement above 90 deg F unless approved otherwise by the Engineer. When air temperatures are between 80 and 90 deg F the maximum mixing and delivery time is reduced to 75 minutes. When air temperatures exceed 90 deg F, the maximum mixing and delivery time is reduced to 60 minutes.
   
   b. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, as acceptable to the Engineer.

**B. Depositing Concrete**

1. Deposit concrete as near its final position as possible to avoid segregation due to rehandling or flowing.

2. The number, type, position, and design of joints shall be approved by the Engineer prior to concrete placement.
3. The concreting shall be carried on at such a rate that the concrete is plastic at all times and flows readily into the spaces between reinforcing bars. No concrete that has partially hardened or been contaminated by foreign materials shall be deposited in the work.

4. When concreting is started, it shall be carried on as a continuous operation until the placing of the section is completed.

5. Except as intercepted by joints, concrete shall be placed in continuous layers.

6. Field records shall be kept of the time and date of the placing of each concrete pour. Locations where concrete test cylinders are made shall also be recorded. Records shall be kept on file at the job until its completion and shall be subject to the inspection of the Owner's Representative at all times.

C. Joints

1. Joints shall be vertical in walls and horizontal in slabs [unless otherwise specified on the drawings].

2. Dowel bars and tie bars shall be inspected

3. Control joints for controlling concrete shrinkage shall be provided in floor slabs, walls, decks, conduits, and channels as shown on the plans or approved by the Engineer.

4. Joint spacing and sawcut depth for slab-on-grade and concrete pavement shall conform to that shown on the pour sequencing plan and/or drawings.
   a. Sawed control (contraction) joints for pavements and slab-on-grade shall be installed as soon as practical so as not to ravel the concrete but less than 12 hours.
   b. Joint spacing shall in feet shall not exceed 2-1/2 times the slab thickness in inches unless otherwise approved by the Engineer.

5. Joints in slabs shall align with joints in adjoining walls unless otherwise approved by the Architect/Engineer or shown in the drawings. Joints shall also line up with architectural reveals and form lines. All corners shall be relieved by cutting joint to adjacent control joint.

6. If there is a delay in casting but prior to concrete initial set, the concrete placed after the delay shall be thoroughly spaded and consolidated at the edge of that previously placed to avoid cold joints.

7. Where placing concrete is interrupted long enough for the concrete to take its initial set, the working face shall be made a construction joint.
   a. Preparation and disposition of unplanned cold joints in walls shall be approved by the Engineer.
   b. For slab-on-grade, pavements, sidewalk, and curb and gutter, concrete shall be removed back to the nearest planned joint and a construction joint installed.
8. Unless otherwise noted on the drawings, where concrete is to be placed against existing concrete, except in the case of expansion joints, the joint face of the existing concrete shall be roughened.

9. Corner sections of walls shall not be placed until the adjoining wall sections have cured at least 14 days.

D. Consolidation

1. All concrete shall be thoroughly consolidated by internal mechanical vibrators during the placing operation and shall be thoroughly worked around the reinforcement and embedded fixtures and into corners of the forms.

2. Consolidation shall be carried on continuously with the placing of concrete.

3. The vibrator shall be kept in nearly a vertical position as practicable. The use of vibrators to shift or drag concrete after deposition will not be permitted. Vibrators shall not be laid horizontally or laid over.

4. Concrete shall not be placed until the previous layer has been vibrated.

5. Unless directed otherwise by the Engineer, the top 2 feet of walls shall be re-vibrated approximately 1 hour after placement of concrete and while a running vibrator will still sink under its own weight into the concrete and liquefy it momentarily.

E. Protection of cast concrete: Conform to ACI 301.

F. Repair of surface defects: Conform to ACI 301.

3.6 FINISHING

A. Finishing of formed surfaces: ACI 301:

1. Tops of forms:
   a. Strike concrete smooth at tops of forms.
   b. Float to texture comparable to formed surfaces.

2. Formed surfaces:
   a. Finished formed surfaces shall conform accurately to the shape, alignment, grades, and sections shown on the drawings or prescribed by the Engineer.
   b. Surfaces shall be free from fins, bulges, ridges, honeycombing, or roughness of any kind and shall present a finished, smooth, continuous hard surface.
   c. Rough form finish at unfinished areas unexposed to public view. Smooth form finish at surfaces exposed to public view.

B. Slabs: Minimum slab surface tolerance must satisfy ACI 301 and ACI 302.1R.
1. Slabs-on-grade:
   a. For exposed slabs, install semi-rigid epoxy sealant in construction and contraction joints after slab has a minimum of 60 days or otherwise approved by the Engineer.
   b. Allowable tolerance for slab on grade surfaces, measured in accordance with ACI 117 shall meet or exceed an overall value of FF35/Fl25, with minimum local value of FF24/FL17.

2. Suspended Floor Slab:

3. Concrete Finishes:
   a. Floor Slabs: Steel trowel finish unless otherwise noted on the plans.
   b. Exposed concrete slabs sealed or sealed and hardened using a liquid compound compatible with the curing method used.
   c. Exterior Concrete Finishes: Unless otherwise noted on the drawings, floors, walkways, and roof finishes shall be sloped a minimum 0.125 inch per foot to drain water. A light steel trowel with broom finish unless otherwise noted on the plans. Apply exterior sealer to surfaces exposed to deicer chemicals that is compatible with the curing method used.
   d. Exposed Ramps, Landings and Stair Treads: A light steel trowel with broom finish unless otherwise noted on the plans. Surfaces shall be sealed or sealed and hardened using a liquid compound compatible with the curing method used.
   e. A heavy broom finish shall be provided on disabled person ramps, utility ramps, and around exterior loading docks.

### 3.7 CURING, PROTECTION, LIQUID HARDNERS AND SEALERS

**A. Temperature, Wind, and Humidity**

1. When concrete slabs and other unformed concrete is placed in warm, dry, dusty, or windy conditions, concrete surfaces shall be protected from rapid drying by use of windbreaks, shading, fogging with properly designed nozzles, or a combination of these measures. Hot weather concreting procedures provided in ACI 305R shall be used when ambient conditions dictate.

2. Cold weather concreting procedures provided in ACI 306R shall be used when ambient conditions dictate.

**B. Curing Compound**

1. All curing methods shall be placed [within two hours] after final finishing. All exposed surfaces of concrete including floor slabs, whether or not they receive a finish flooring, shall be protected from premature drying for a minimum of seven days.
2. Apply the specified curing compound in accordance with manufacturer’s written instructions.

3. When used on an unformed concrete surface, application of the first coat of curing compound shall commence immediately after finishing operations have been completed. When curing compound is used on a formed concrete surface, the surface shall first be moistened with a fine spray of water immediately after the forms have been removed.
   a. Surfaces shall be sprayed uniformly with 2 coats of curing compound. As soon as the first coat has become dry, a second coat shall be applied in the same manner. The direction of application of the second coat shall be perpendicular to the first coat.

4. Curing compound shall not be used on any concrete surface specified to receive additional concrete, coatings, grout, and chemical treatment

C. Protection

1. Freshly placed concrete shall be protected against wash by rain.

2. Dust control shall be provided in the surrounding areas during placement.

3. During the first 2 day period of curing, no traffic on or loading of the floors will be permitted unless otherwise approved by the Engineer.

4. The contractor shall allow no traffic and take precautions to avoid damage to the membrane of the curing compound for a period of not less than 28 days. Damage shall be repaired immediately.

5. Self-supporting structures shall not be loaded in such a way to overstress the concrete.

D. All floor slabs shall be cured using products and methods compatible with selected floor adhesives, toppings, and other finish materials.

E. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer’s written instructions.

F. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete according to manufacturer’s written instruction.

3.8 PATCHING AND REPAIR

A. All repairs of defective areas shall conform to ACI 301. On areas requiring treatment of defects and until such repairs have been completed, only water cure will be permitted

B. At any time prior to final acceptance, concrete found to be defective, damaged, or not in accordance with the specifications shall be repaired or removed and replaced with acceptable concrete.

C. Repair or replace concrete with excessive honeycombing due to improper placement.

1. If approved, a bonding admixture, bonding compound, or epoxy adhesive may be used in accordance with the manufacturer’s preparation and application
recommendations. Comply with ACI 301 and ACI 503.2 for standard specifications for bonding plastic concrete to hardened concrete with a multiple component epoxy adhesive.

2. The repair concrete shall be thoroughly consolidated in place and struck off so as to leave the patch slightly higher than the surrounding surface. The concrete shall be left undisturbed for at least 1 hour to permit initial shrinkage then finished.

3. The patched area shall be kept damp for 7 days.

4. The color of the patch material shall match the color of the surrounding concrete. Repairs shall be made promptly while the base concrete is less than 28 days old.

D. Areas showing excessive defects as determined by the Architect/Engineer shall be removed and replaced.

E. High spots identified in the floor flatness and levelness survey may be removed with bump grinding. Areas to be ground shall not exceed more than 10 percent of any one slab nor more than 5 percent of the total slab-on-grade area.

F. If approved by the Architect/Engineer, concrete slab random cracking may be routed and sealed. Slabs with more than one structural crack or with multiple cracks within a slab shall be removed and replaced. If random cracks are attributed to non-working sawcut control joints, uncracked joints parallel to the cracking shall be filled with a structural epoxy.

G. Interior slab-on-grade subjected to lift truck traffic shall be routed and sealed with a semi-rigid epoxy sealant. Exterior slabs may be routed and sealed with the flexible joint sealant to be installed in pavement joints.

3.9 GROUTING

A. After steel columns have been installed and leveled, grout the space between the bottom of the plate and concrete, using cement grout completely filling the space and forming solid bearing for the column base plate.

3.10 EVALUATION AND ACCEPTANCE OF CONCRETE

A. Comply with ACI 301, ACI 318-Chapter 5 and ACI 311 for compressive strength, slump, and frequency of testing.

B. The frequency of testing indicated in the aforementioned codes and standards shall be increased if concrete fails to meet the acceptance criteria or if deemed by the Engineer to be too variable.

3.11 ACCEPTANCE OF STRUCTURE

A. Comply with ACI 301 and modifications in this section.

B. Completed concrete work, which meets all applicable requirements, will be accepted without qualification.

C. Completed concrete work which fails to meet one or more requirements but which has been repaired to bring it into compliance will be accepted without qualification.
D. Completed concrete work which fails to meet one or more requirements and which cannot be brought into compliance may be accepted or rejected by the Contracting officer. In this event, modifications may be required to assure that remaining work complies with the requirements.

E. The costs of any additional tests or analysis, including additional architectural and engineering services, performed to prove the adequacy of the concrete work, shall be borne by the Contractor without extension of contract time.

3.12 MISCELLANEOUS CONCRETE

A. Curbs: Provide monolithic finish to interior surface of curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

B. Equipment bases and foundations: Provide machine and equipment bases and foundations as shown on drawings. Set anchor bolts for machines and equipment with template at correct elevations, complying with certified diagrams or templates of manufacturer furnishing machines and equipment.

3.13 FIELD QUALITY CONTROL

A. Division 1, Section 01 40 00 - Quality Requirements: Field testing and inspection.

B. Requirements:

1. Provide and maintain an adequate program of quality control for the materials, production methods, and workmanship to assure conformance of all work to the project contract documents.

2. Testing and Evaluation:

   a. Furnish and pay for the services of an independent Testing Laboratory satisfactory to the Contracting Officer. The testing laboratory shall have prime responsibility for review, verification inspection, and testing of the concrete producer's materials, operations, facilities, and quality control procedures and evaluating the results for conformance with these specifications.

   b. In addition to the requirements and duties in ACI 301 the testing laboratory shall provide the following:

      One or more additional test cylinders shall be taken during cold weather concrete placement and cured on the job site under conditions of concrete represented to determine safe form-stripping period.

      Inspect concrete batching, mixing, and delivery operations periodically or as directed by the Contracting Officer.

      Submit to the Contracting Officer and concrete producer, during construction, the results of concrete tests.

   c. The Testing Laboratory shall assess and report floor flatness and levelness in accordance with the requirements of this specification.
d. Field and concrete plant inspections are to be made by a competent representative of the Testing Laboratory during all structural concreting operations including periodic audit and spot check of the Producer's and/or Contractor's quality control procedures to assure proper and adequate control. When it appears that any material furnished fails to fulfill specification requirements, the Testing Laboratory is to report such deficiency immediately to the Contracting Officer and appropriately record it in his report.

e. Concrete Test Samples: Samples for concrete tests shall be taken in accordance with ASTM C 172. Compressive Strength Tests on concrete:

(1) Samples for concrete compressive strength tests of each class of concrete placed each day shall be taken not less than once per day, nor less than once for each 150 yd3 of concrete, nor less than once for each 5000 ft2 surface area for slabs or walls. If the total volume of concrete for a class is such that frequency of testing required is less than five tests, then samples shall be made from at least five randomly selected batches or from each batch if fewer than five batches are used.

(2) Acceptance of concrete shall be based on strength test results of standard cured cylinders in accordance with ASTM C 31 and tested at 28 days in accordance with ASTM C 39. Strength test results are the average of two specimens.

(3) When strength cylinders are made, tests of slump, air content, temperature and density shall be made and recorded with the strength test results.

(4) Strength of each concrete class shall be deemed satisfactory when both of the following criteria are met:

   (a) The average of three consecutive compressive-strength tests equals or exceeds specified compressive strength

   (b) Any individual compressive-strength test result does not fall below specified compressive strength by more than 500 psi.

(5) When compressive strength tests indicate low strength, follow procedure in ACI 318 chapter 5.6.4 Investigation of low-strength test results.

END OF SECTION
SECTION 03 35 00

CONCRETE FINISHING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Repair of surface defects
B. Finishing of formed surfaces, except topping slabs
C. For finishing of topping slabs: Refer to Division 3.1, Section 03 53 00 – Concrete Topping
D. Slabs and flatwork
E. Curing

1.2 RELATED SECTIONS

A. Division 3.1, Section 03 10 00 Concrete Forming and Accessories
B. Division 3.1, Section 03 30 00 Cast-In-Place Concrete
C. Division 3.1, Section 03 53 00 Concrete Topping
D. Division 2.1, Section 201-9.2 Materials

1.3 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. AASHTO M182 Burlap Cloth made from Jute or Kenaf and Cotton Mats
B. American Concrete Institute (ACI):
   1. ACI 117 Standard Specification for Tolerances for Concrete Construction and Materials
   2. ACI 301 Standard Specifications for Structural Concrete
   3. ACI 308 Standard Practice for Curing Concrete
   4. ACI 503.4 Mortars Standard Specification for Repairing Concrete with Epoxy
C. ASTM International (ASTM):
   1. ASTM C33 Standard Specification for Concrete Aggregates
   2. ASTM C150 Standard Specification for Portland Cement
   3. ASTM C171 Standard Specification for Sheet Materials for Curing Concrete
4. ASTM C309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

5. ASTM C881 Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete

6. ASTM E1155 Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers

1.4 SUBMITTALS

A. Submit in accordance with Division 1, Section 013300 – Submittal Procedures.

B. Product Data: Submit manufacturer’s product data for manufactured products.

C. Shop Drawings: Submit drawings, or diagrams to scale, that indicate the location in plan and elevation of all concrete finishes including the location and profiles of construction joints.

D. Samples:
   1. Submit 1/2-pint sample container of aluminum oxide and silicon carbide abrasive grit for review and acceptance where “non-slip finish” is indicated.
   2. Submit samples not less than 12 inches by 12 inches in size and type of sandblast finish, indicating materials and methods used to produce the sandblast finishes. Review by the A/E will be for color and texture only. Approved samples will become the A/E control samples.

1.5 QUALITY ASSURANCE

A. Finishes:
   1. Finishing of formed concrete surfaces shall conform to applicable requirements of ACI 301.
   2. Finishes for slabs and flatwork shall conform to applicable requirements of ACI 301.
   3. Special architectural finishes for formed concrete surfaces shall conform to applicable requirements of ACI 301.

B. Curing: Conform to requirements of ACI 301 and ACI 308, as applicable, and requirements specified in this Section.

C. Site Mock-ups: Provide site mock-ups, at least 3 feet by 4 feet in size, of finishes of formed surfaces in locations and of exposed slab finishes for A/E’s review and acceptance. Provide additional mock-ups as required by the A/E, until the desired finish is obtained. Site mock-up requires acceptance by the A/E before work may proceed.

PART 2 - PRODUCTS

2.1 TOOLS AND EQUIPMENT

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A. Furnish all materials, tools, and equipment, facilities, and services required for performing the required concrete-finishing work.

2.2 REPAIR AND FINISHING MATERIALS

A. Portland Cement: Conform to ASTM 150, Type II, of same brand as used in the work. Furnish white Portland cement where required to produce color matching color of surrounding concrete. For requirements at topping slabs refer to Division 3.1, Section 03 53 00 – Concrete Topping.

B. Aggregate:

1. For Bonding Grout: Conform to ASTM C33, washed clean sand passing a No. 30 sieve.

2. For Patching Mortar: Conform to ASTM C33, washed clean, graded fine aggregate of suitable size for areas to be repaired. Clean coarse aggregate up to size No. 8 may be added for repair of larger pockets and voids.

C. Commercial Patching Mortar: A structural repair mortar may be furnished if appropriate for the use and approval by the A/E.

D. Epoxy Patching Mortar: As specified in ACI 503.4 for Epoxy Mortar.

E. Epoxy Adhesive: Conform to ASTM C881, Type II or Type V, epoxy-based bonding agent.

F. Anti-Slip Abrasive Grit: Virgin grain Aluminum Oxide or Silicon Carbide particles, or a mixture of the two.

G. Admixture for integral color and retarder finish: Reference Division 2.1, 201-9.2.

2.3 CURING MATERIALS

A. Damp Curing Materials:

1. Waterproof Sheet Materials: ASTM C171, waterproof paper with white paper face, polyethylene film pigmented white, or white burlap-polyethylene sheeting.

2. Burlap: AASHTO M182, of class and weight suitable for the use and location. Do not use burlap where concrete is exposed to direct sunlight.

B. Curing Compound: ASTM C309, liquid membrane-forming curing compound, Type 1, Class A or B as appropriate for the use or location.

1. Where concrete surfaces will receive architectural finishes, such as paint or membrane waterproofing, membrane-forming curing compound shall not leave a coating or residue that will impair bond of adhesives, paints, and coatings with concrete.

PART 3 - EXECUTION

3.1 REPAIR OF SURFACE DEFECTS
A. Repair Standards: Repair of surface defects shall conform with applicable requirements of ACI 301. When using epoxy, conform to applicable requirements of ACI 503.4.

B. Surface Defects:

1. Repair of surface defects shall begin immediately after form removal. For repair with epoxy mortar, concrete shall be dry.

2. Surface defects are defined to include: form-tie holes, air voids or pockets, bug holes with a nominal diameter of depth greater than 1/4-inch, honey combed areas, rock pockets, visible construction joints, fins and burrs.

3. Repair of surface defects shall be tightly bonded and shall result in concrete surfaces of uniform color and texture, matching adjacent surfaces, and free of shrinkage cracks.

C. Repair Work:

1. Remove honeycombed and other defective concrete down to sound concrete free of flaw or defect. Saw-cut the edges perpendicular to the surface or slightly undercut. Feathered edges will not be permitted. Dampen the area to be patched and an area at least 6 inches wide surrounding the area to be patched to prevent absorption of water from the patching mortar.

2. Where rock pockets or similar defects or voids expose steel reinforcement, cut out to solid surface behind the reinforcing steel to provide suitable key-lock for patching mortar. Patching mortar shall completely cover and envelope the exposed reinforcing bar.

3. Bond patching mortar to concrete with bonding grout or epoxy adhesive. Bonding grout shall consist of 1 part Portland cement to 1 part No. 30 mech sand, mixed to the consistency of a thick cream, and then well brushed onto the concrete. Bond commercial patching mortar to concrete in accordance with the manufacturer’s instructions.

4. Make the patching mortar of the same materials and of approximately the same proportions as used for the concrete, except omit the coarse aggregate. Use not more than 1 part Portland cement to 2-1/2 parts sand by damp loose volume, and substitute white Portland cement for a portion of the regular gray Portland cement to produce patching mix matching the surrounding concrete in color when dry. Determine the proportion of white Portland cement by trial mixes and test areas prior to repair of actual defective areas.

5. After the surface water has evaporated for the area to be patched, brush the bond coat well into the surface. To permit initial shrinkage, leave the patch undisturbed for at least 1 hour before being finally finished. Keep the patched area damp for 7 days.

6. Finish patch surfaces to match adjacent surrounding texture of concrete. Grind or fill surfaces to produce level and plumb, true planes.

7. For walls exposed in the finish work, patch form tie holes and finish flush with adjacent surface. For holes passing entirely through walls, use a plunger type injection gun or other device designed for this type of use to completely fill the holes.
8. For patching honeycombed areas or rock pockets that are too large and unsatisfactory for mortar patching, cut out to solid surface, key, and pack solid with matching concrete to produce firm bond and flush surface. Match texture of patching to texture of adjacent surfaces where exposed in the finished work.

9. Repair work in exposed locations that does not match the texture, color, appearance, and quality of surrounding surface shall be removed and reinstalled until repair work conforms with the requirements of these Specifications.

10. Remove fins and loose material at surfaces to receive membrane waterproofing. Patch voids and cracks flush with adjacent surfaces.

11. Cure complete repairs in conformance with Article 3.4, Curing, of this Specification Section.

3.2 FINISHING OF FORMED SURFACES

A. Unexposed Surfaces:

1. Form finishes specified in Division 3.1, Section 03 10 00 – Concrete Forming and Accessories and “rough form finish” as specified in ACI 301 are acceptable for concrete that will not be exposed in the completed structure.

2. Provide a “smooth form finish” in conformance with ACI 301 for concrete to receive membrane waterproofing. Concrete to receive membrane waterproofing shall receive a “smooth form finish” in accordance with ACI 301.

B. Sand Blast Finish:

1. Blasting Operations and Requirements:

   a. Apply sandblasted finish to expose concrete surfaces where indicated.

   b. Perform sandblasting at least 72 hours after placement of concrete. Provide uniform matching blasted concrete surfaces by coordinating formwork construction, concrete placement schedule, and formwork removal to ensure that surfaces to be blast finished are blasted at the same age.

   c. Determine type of nozzle, nozzle pressure, and blasting techniques required to match the A/E control samples.

   d. Abrasive blast corners and edge of patterns carefully, using back-up boards, to maintain uniform corner or edge line.

2. Depths of Cut: Use an abrasive grit of proper type and gradation to expose aggregate and surrounding matrix surface to match A/E control samples as follows:

   a. Brush Sandblast Finish: Remove cement matrix to expose face of fine aggregate (no reveal).

   b. Light Sandblast Finish: Expose fine aggregate with occasional exposure of coarse aggregate (maximum 1/16-inch reveal)
c. Medium Sandblast Finish: Generally expose coarse aggregate (3/16-inch to 1/4-inch reveal).

3. Surface Continuity: Perform sandblast finishing in a continuous operation, utilizing the same work crew to maintain continuity of finish on each surface or area of work. Maintain patterns of variances in depths of cuts as indicated on the Plans.


5. Protection and Repair:
   a. Protect adjacent materials and finishes from dust, dirt, and other surface or physical damage during abrasive blast finishing operations. Provide protection as required and remove from site at completion of work.
   b. Repair or replace other work damaged by finishing operations.

6. Clean-up: Maintain control of concrete chips, dust, and debris in each area of work. Clean up and remove such material at the completion of each day of operation. Prevent migration of airborne materials by use of tarpaulins, wind breaks, and similar containing devices.

### 3.3 SLABS AND FLATWORK

A. Placement and Finishing Standards: Slabs and flatwork shall be placed, consolidated, and finished in accordance with applicable requirements of ACI 301. Coordinate with Division 3.1, Section 03 30 00 – Cast-In-Place Concrete, as applicable.

B. Placement:
   1. Monolithically place and finish slabs and flatwork. Strike off and screed slabs to true, plane surfaces at required elevations, and thoroughly compact concrete with vibrators, floats, and tampers to force coarse aggregate below the surface. Finish slab within 4 hours of concrete placement.
   2. Whether indicated or not, in areas where drains occur, slope finished slab to drains. Slope shall be a minimum of 1/8-inch per foot unless indicated otherwise.

C. Slab Finishes: Unless indicated otherwise, slabs and flatwork shall receive the following finishes as indicated:
   1. Broom Finish: Conform to ACI 301. Exact texture and coarseness of the broom finish shall match the approved site mock-up. Provide fine or medium coarse “broom finish” as indicated for exterior sidewalks and paving, exterior ramps, and equipment.
   3. Unspecified Finish: When finish is not indicated or specified, provide finishes as specified in ACI 301.
D. Surface Tolerances:

1. Flat Tolerance: Slabs and flatwork with "troweled finish" and with "nonslip finish."

2. Straightedge Tolerance: Slabs and flatwork with fine "broom finish" or medium coarse "broom finish."


E. Joints:

1. Locate construction, expansion, isolation, and contraction joints as indicated on the Plans and on the approved Shop Drawings. Construction joints shall act as contraction joints. Where additional contraction joints are required to prevent shrinkage cracks, saw-cut these joints. All joints shall be straight and true to line. Do not saw-cut joints less than 12 hours or more than 24 hours after placing concrete.

2. Finish mark-off lines or edges at formed construction and expansion joints with 1/4-inch radius curved edging tool, neat and true to line, uniform throughout.

3.4 CURING

A. Curing Standards: Curing of concrete shall conform with applicable requirements of ACI 301 and ACI 308, except that the duration of the curing period shall be 10 days. Curing with earth, sand, sawdust, straw, and hay will not be permitted.

B. Curing Requirements:

1. Cure concrete with waterproof sheet materials, damp burlap, or curing compounds.

2. Do not use curing compounds on surfaces when the use of these compounds may be detrimental to bonding of concrete, mortar, membrane waterproofing, calking and sealants, adhesives, plaster, paint, or the specified surface finish materials or coatings.

C. Damp Curing:

1. Cure vertical surfaces by keeping forms wet at all times and by leaving the forms in place as long as possible as specified in Division 3.1, Section 03 10 00 – Concrete Forming and Accessories. After removal of forms, keep concrete continuously damp by fog spraying or otherwise washing down the concrete for 10 days after placement. Protect exposed surfaces by covering with sheet materials or burlap kept continuously moist.

2. Cure and protect horizontal surfaces by covering the finished surfaces with waterproof sheet materials or damp burlap, left in place for a minimum of 10 days and kept continuously moist.

3. Fog spray freshly placed slabs until finishing operations commence. Allow no slabs to become dry until finishing operations are complete.
D. Curing Compound: Apply of curing compound in conformance with applicable requirements of ACI 308.

3.5 PROTECTION

A. Protect exposed concrete surfaces, including flatwork, as required to prevent damage from impact or strain.

B. Protect fresh concrete from drying winds, rain, damage, or soiling.

C. Refer to Division 3.1, Section 03 30 00 – Cast-In-Place Concrete for additional requirements.

3.6 TOLERANCES

A. Formed Surfaces: Conform to applicable requirements of ACI 117.

1. Where elastomeric bearing pads are indicated, the level plane upon which the bearing pads are placed shall not vary more than 1/16-inch from a 10-foot straightedge placed in any direction across the area and the area shall extend a minimum of 1 inch beyond the limits of the pads.

2. Finish bearing surfaces of girders on a slope or with a camber on a horizontal and level plane, so that loads are uniformly distributed over the entire surface of the elastomeric bearing pads.

3. The finished plane shall not vary more than 1/8-inch from the elevation indicated.

B. Slabs and Flatwork: Conform to applicable classification requirements of ASTM E1155, as follows:

1. Very Flat Tolerance: F_F 50, F_L 30. True plane with maximum variation of 1/8-inch in 10 feet when measured with a 10-foot straightedge placed anywhere on the slab in any direction.


END OF SECTION
SECTION 03 53 00

CONCRETE TOPPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Formwork
B. Reinforcing Steel
C. Bond Breaker Membrane
D. Joint Fillers and Sealers
E. Portland Cement Concrete
F. Nonslip Aggregate Materials
G. Colored Concrete Hardener and Sealer
H. Concrete Curing Materials

1.2 RELATED SECTIONS

A. Division 3.1, Section 03 10 00 Concrete Forming and Accessories
B. Division 3.1, Section 03 30 00 Cast-In-Place Concrete
C. Division 3.1, Section 03 35 00 Concrete Finishing

1.3 REFERENCES

A. American Concrete Institute (ACI):
   1. ACI 117 Standard specification for Tolerances for Concrete Construction
   2. ACI 301 Standard Specification for Structural Concrete

B. ASTM International (ASTM)(latest revision):
   1. ASTM C494 Standard Specification for Chemical Admixtures for Concrete
   2. ASTM C618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as Mineral Admixture in Portland Cement Concrete
   3. ASTM C979 Standard Specification for Pigments for Integrally Colored Concrete
   4. ASTM C1017 Standard specification for Chemical Admixtures for Use in Producing Flowing Concrete
   5. ASTM D2178 Standard Specification for Asphalt Glass Felt Used in Roofing and Waterproofing

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1.4 SUBMITTALS

A. Submit in accordance with Division 1, Section 01 33 00 – Submittal Procedures.

B. Product Data: Submit manufacturer’s data for nonslip floor ingredients and colored concrete hardener material and sealer.

C. Shop Drawings:
   1. Submit shop drawings that indicate the locations of all joints in concrete slabs, including construction joints, expansion joints, isolation joints, weakened plane joints and contraction joints. Coordinate with the requirements specified in Division 3.1, Section 03 10 00 – Concrete Forming and Accessories.
   2. Submit shop drawings that indicate concrete placement method, sequence, and location.

D. Samples: Submit 1/2-pint sample container of aluminum oxide anti-slip materials for approval. Sample requires approval of the A/E before incorporation into the Work.

1.5 QUALITY ASSURANCE

A. Specialist Applicator/Installer: Topping slabs shall be installed and finished by a skilled and experienced installer specializing in the installation and finishing of architectural concrete slabs. The Contractor shall submit evidence that the slab installer and finisher is approved by the manufacturer of the colored concrete hardener and the nonslip materials.

B. Topping Slab Finish: “Nonslip Finish” in combination with a fine “broom finish” in conformance with applicable requirements of ACI 301.

C. Topping Slab Tolerance: “Flat” tolerance in conformance with requirements of ACI 117.

D. Cold Joints: Cold Joints in concrete will not be permitted unless planned and treated properly as construction joints and submitted for approval as specified under submittals above.

E. Site Mock-Ups: Provide site mock-up, at least 3 feet by 4 feet in size, of exposed slab finish for A/E review and acceptance. Provide additional mock-ups, as required by the A/E, until the desired finish is obtained. Site mock-up requires acceptance of A/E before work may proceed.

F. Manufacturer’s Instructions: Application of the nonslip ingredients and concrete hardener material and finishing of the concrete topping slabs shall be in accordance with the written or printed instructions and recommendations of the manufacturer of nonslip floor ingredients and concrete hardener materials.

G. Manufacturer’s Field Services: The Contractor shall engage the manufacturer of the nonslip floor ingredients and concrete hardener materials to provide field services in accordance with the requirements of Division 1, Section 01 40 00 – Quality Requirements.

PART 2 - PRODUCTS

2.1 TOOLS AND EQUIPMENT
A. The Contractor shall furnish all materials, tools, equipment, facilities, and services as required for performing the required topping slab placement and finish work.

2.2 MATERIALS

A. Formwork: Refer to Division 3.1, Section 03 10 00 – Concrete Forming and Accessories for requirements.

B. Reinforcing Steel: Refer to Division 3.1, Section 03 20 00 – Concrete Reinforcing for requirements.

C. Bond Breaker Membrane: Conform to ASTM D2178 asphalt glass felt, Type III – standard ply sheet.

D. Joint Fillers and Sealers: Refer to Division 3.1, Section 03 10 00 – Concrete Forming and Accessories for requirements.

E. Portland Cement Concrete: Comply with Division 3.1, Section 03 30 00 – Cast-In-place Concrete and the following requirements:

1. Topping slab concrete shall have a minimum compressive strength at 28 days of 4,000 psi. Maximum size of aggregate shall be 1 inch, except that 3/8 inch maximum size aggregate shall be used for locations where congestion and other conditions indicate the need for smaller aggregate. Maximum cement content per cubic yard of concrete shall be six and a half 94-pound sacks.

2. Mix design for topping slab concrete shall include up to ten percent replacement of the cement content with fly ash (ASTM C618) along with a plasticizing admixture in conformance with ASTM C1017, to provide a dense and plastic concrete mix that will trowel more easily with less surface bleeding of water.

F. Nonslip Material: Crushed ceramically bonded or fused aluminum oxide as specified in ACI 301. Provide 25 pounds per 100 square feet as specified. All aggregate particles shall pass a No. 8 U.S. Standard Sieve, and shall be graded from No. 16 to No. 8 mesh.

G. Colored Concrete Hardener and Sealer: For slabs and flatwork to be colored, as indicated on the Plans, provide ready-to-use, dry-shake, mineral oxide color hardener material. Color hardener shall be formulated as a streak-free, powdered, cementitious material containing hard aggregates in conformance with ASTM C494 and ASTM C979. Colors and finishes as indicated below shall be as reviewed and approved by the A/E. Provide color hardener manufacturer’s recommended penetrating sealing materials as applicable to the installation conditions. Hardener and sealer shall be supplied by the same manufacturer.

1. Color and Finish 1: TBD

2. Color and Finish 2: TBD

H. Concrete Curing Materials: Refer to Division 3.1, Section 03 35 00 – Concrete Finishing for requirements.

1. Provide for damp curing only. Curing compound will not be permitted on slabs to receive concrete hardener and sealer.
3.1 INSTALLATION REQUIREMENTS

A. Comply with the requirements of Division 3.1, Section 03 30 00 – Cast-In-Place Concrete and Division 3.1, Section 03 35 00 – Concrete Finishing where applicable to the work of this Section.

3.2 EXAMINATION

A. Inspect forms, structural slab surfaces, waterproof membranes and protection board, reinforcement, and imbedded items. Obtain A/E approval of the inspection results before placing concrete topping slabs. Complete and sign a pour card on the form supplied by the A/E. Obtain A/E countersignature on the card prior to commencing the pour.

3.3 PREPARATION

A. At least 48 hours prior to actual placement of the topping slab, notify the A/E and nonslip and color hardener manufacturer’s representative of the intention to deliver and place concrete.

B. Before placing concrete, broom clean structural slab surfaces and install bond breaker membrane where indicated on the Plans. Lap edges and ends of asphalt glass felt 6 inches. Small dabs of bituminous cement may be used to hold felt sheets in place during subsequent concrete placing procedures.

3.4 PLACING AND FINISHING

A. Placement and Finishing Standards: Concrete topping slabs shall be placed, consolidated, and finished in accordance with applicable requirements of ACI 301.

B. Placement:

1. Topping slabs shall be placed and finished monolithically. Strike off and screed slabs to true, plane surfaces at required elevations, and thoroughly compact concrete with vibrators, floats, and tampers to force coarse aggregate below the surface. Finish slab within 4 hours of concrete placement.

2. Whether indicated or not, in areas where drains occur, slope finished slab to drain. Slope shall be a minimum of 1/8 inch per foot unless indicated otherwise.

C. Finishes:

1. Topping slabs shall receive a “sandblast finish” in combination with a “nonslip finish,” as selected by the A/E from mock-ups prepared by the Contractor, with “flat” tolerance, as specified in ACI 117.

2. Apply finishes in conformance with colored concrete hardener manufacturer’s instructions and recommendations.

3.5 CURING

A. Curing of concrete topping slabs shall conform to applicable requirements of ACI 301, except that duration of the curing period shall be 10 days minimum.

B. Provide damp curing only as specified in Division 3.1, Section 03 35 00 – Concrete Finishing. Curing compounds will not be permitted.
3.6 APPLICATION OF CONCRETE HARDENER

A. Allow slab surfaces to cure and dry a minimum of 28 days before applying color hardener and sealer material. Slab surfaces shall be clean and dry at the time color hardener and sealer material is applied.

3.7 Apply color hardener, non-slip material, and sealer to slab surfaces, after the damp-curing and drying period, in conformance with the colored concrete hardener manufacturer’s application instructions.

3.8 PROTECTION

A. Protect exposed concrete slab surfaces as required to prevent damage from impact or stains.

B. Protect fresh concrete from drying winds, rain, damage, or soiling.

C. Refer to Division 3.1, Section 03 30 00 – Cast-In-Place Concrete for additional requirements.

END OF SECTION
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SECTION 03 62 00

NON-SHRINK GROUTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Cementitious Grout

B. Epoxy Grout

C. Epoxy Adhesive

1.2 RELATED SECTIONS

A. Division 3.1, Section 05 52 00 Metal Railings

1.3 DEFINITION

A. For the purpose of these Specifications, “non-shrink grout” is defined as a high-strength mortar or grout that does not shrink in the plastic state, is dimensionally stable in the hardened state, and bonds permanently to clean metal baseplate and concrete substrate.

1.4 REFERENCES

A. American Concrete Institute (ACI):

1. ACI 503.2 Standard Specification for Bonding Plastic Concrete to Hardened Concrete with a Multi-Component Epoxy Adhesive

B. ASTM International (ASTM):

1. ASTM C109 Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens)


3. ASTM C579 Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes

4. ASTM C827 Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures

5. ASTM C881 Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete


C. U.S. Army Corps of Engineers, Concrete Research Division (CRD):

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1. CRD-C620 Standard Method of Sampling Fresh Grout
2. CRD-C621 Specification for Non-shrink Grout

1.5 SUBMITTALS

A. Submit in accordance with Division 1, Section 01 33 00 – Submittal Procedures.

B. Product Data: Submit manufacturer’s product data and installation instructions.

C. Certification: Submit certificates of compliance or laboratory test reports that indicate the following:
   1. Materials used in the grout are free from metallic components and corrosion-producing elements.
   2. Materials meet specified shrinkage and compressive strength requirements.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Handle grout in the same manner as concrete with regard to temperature and curing as specified in Division 3.1, Section 03 30 00 – Cast-In-Place Concrete and Division 3.1, Section 03 35 00 – Concrete Finishing.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cementitious Grout: Provide non-shrink, non-metallic, non-corrosive grout in conformance with the following requirements:
   2. Grout shall be manufactured specifically for use in supporting heavy loads (loads in excess of 300 pounds per square foot concentrated load or 100 pounds per square foot uniform load). Use grout in compliance with ASTM C1107, Grades A, B, or C, as appropriate for the conditions.
   3. Shrinkage at 28 days: No shrinkage before hardening (0.00 shrinkage when tested in accordance with ASTM C827) and no shrinkage after hardening (0.00 shrinkage when tested in accordance with CRD-C621).
   4. Compressive strength, minimum:
      a. At one day: 1000 psi
      b. At three days: 2500 psi
      c. At seven days: 3500 psi
      d. At 28 days: 5000 psi
   5. Initial setting time, after addition of water: approximately one hour at 70 degrees F.
6. Provide nonsag trowelability or flowability as required for the particular application.

B. Water: Clean and potable, free of impurities detrimental to grout.

C. Epoxy Grout:
   1. Grout shall be manufactured specifically for use in supporting heavy loads.
   2. Shrinkage at 28 days: None (0.00 shrinkage when tested in accordance with ASTM C827 modified procedure) with a minimum effective bearing area (EBA) of 95 percent coverage of the tested base plate.
   3. Compressive strength, minimum: 10,000 psi at seven days, when tested in accordance with ASTM C579.
   4. Initial setting time: Approximately one hour at 70 degrees F.
   5. Provide flowable consistency as required for the particular application.
   6. Epoxy grouts that are volatile and that give off noxious fumes are not acceptable.

D. Epoxy Adhesive: Conform to ASTM C881, Type V, epoxy-based bonding agent.

2.2 MIXING

A. Mix grout ingredients for both cementitious grout and epoxy grout in accordance with the respective manufacturer's mixing instructions and recommendations. Mix grout materials in mechanical mixers designed for this use.

B. Mix grout as close to work area as possible.

2.3 SOURCE QUALITY CONTROL

A. Inspections and Tests: Perform visual inspections, shrinkage tests, and strength tests using a qualified independent testing laboratory, to verify performance requirements of grout. Sampling and testing of grout shall be in conformance with applicable ASTM and CRD requirements.

B. Visual Inspections: Perform visual inspection of the grout mixing and placement to determine and verify that grout consistency, slump, and stiffness are as required and are correct for the location and type of installation.

C. Shrinkage Tests:
   1. Cementitious Grout: Grout shall conform to the following performance requirements:
      a. Expansion: 0.4 percent maximum at 3, 14, and 28 days. Grout shall exhibit no displacement when tested in accordance with ASTM C157.
      b. Shrinkage: None (0.00 shrinkage at 28 days when tested in accordance with ASTM C827 and ASTM C1090). There shall be no vertical volume shrinkage of grout in the plastic or hardened stage at any time.
2. **Epoxy Grout:** Grout shall conform to the following performance requirements:

   a. **Expansion:** Grout shall exhibit no displacement when tested in accordance with ASTM C827 and ASTM C157, modified procedures.

   b. **Shrinkage:** None (0.00 shrinkage when tested in accordance with ASTM C827, modified procedure; specific gravity ball will be changed to approximately 1.0).

   c. **Effective bearing area:** 95 percent minimum coverage of the tested base plate.

D. **Strength Tests:** Compressive strength of grout shall conform to the following requirements:

   1. **Cementitious Grout:** 5,000 psi minimum at 28 days when tested in accordance with ASTM C109.

   2. **Epoxy Grout:** 10,000 psi minimum at 7 days when tested in accordance with ASTM C579.

**PART 3 - EXECUTION**

**3.1 SURFACE PREPARATION**

A. Concrete surfaces to receive grout shall be prepared by chipping, sandblasting, water blasting, or other accepted methods to remove defective concrete, laitance, dirt, oil, grease, and other foreign matter to achieve sound, clean, concrete surfaces. Lightly roughen concrete for bond, but not enough to interfere with proper placement and installation of grout.

B. Cover concrete areas with protective waterproof covering until ready to place grout.

C. Remove foreign matter from steel surfaces to be in contact with grout. Clean contact steel surfaces by wire brushing and wiping to remove all foreign matter and dust.

D. Align and level components to be grouted and maintain final position until grout placement is complete and accepted by the A/E.

E. Install forms for grout around the column base plates and other spaces to be grouted. The tops of these forms shall be one inch above the surfaces to be grouted.

F. Remove protective waterproof covering and clean contaminated surfaces immediately before grouting.

G. Provide air relief holes in large baseplates and in baseplates where underneath obstructions may cause air entrapment.

H. Saturate concrete surfaces with clean water and remove excess water immediately before grouting.

I. Where bonding is not sufficient to achieve the requirements of these specifications, epoxy adhesive may be applied to clean, dry substrate surfaces in accordance with applicable requirements of ACI 503.2
3.2 PLACING GROUT

A. Place grout in accordance with the respective manufacturer’s installation instructions and recommendations. Pour grout from one side only until grout rises at least one inch above the plate on the opposite side of the plate. Strapping and plunging or other recommended methods may be used to force grout to flow under entire area.

B. Trowel edges of grout base tapered at an angle of 60 degrees when measured from the horizontal, or as indicated. Provide dry-pack cementitious grout where additional grout is required for shoulders.

C. Do not remove leveling shims for at least 48 hours after grout has been placed.

D. Where shims have been removed, fill voids with grout, packing the material with a suitable tool for this application.

E. Do not used grout that has begun to set or if more than one hour has elapsed after initial mixing.

3.3 CURING

A. Cementitious grout shall be cured as specified for concrete in Division 3.1, Section 03 35 00 – Concrete Finishing.

B. Epoxy grout shall be cured as recommended by the grout manufacturer.

END OF SECTION
SECTION 05 12 00

STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural steel framing members, support members, with required bracing, welds, and fasteners.

2. Base plates.


B. Related Sections:

1. Division 3.1, Section 03 30 00 – Cast-In Place Concrete: Anchorages cast in concrete. Grouting base plates and bearing plates.

2. Division 3.1, Section 05 50 00 - Metal Fabrications: Steel fabrications affecting structural steel work.

1.2 REFERENCES

A. American Institute of Steel Construction (AISC):


3. AISC - Section 10 - Architecturally Exposed Structural Steel.

B. American Society for Testing and Materials (ASTM):

1. ASTM A36/A36M - Specification for Structural Steel.

2. ASTM A53 - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.


5. ASTM A153 - Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.

6. ASTM A242/A242M - Specification for High-Strength Low-Alloy Structural Steel.
7. ASTM A 307 - Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
10. ASTM A490 - Specification for Heat-Treated Steel Structural 150 ksi Minimum Tensile Strength.
11. ASTM A 500 - Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
12. ASTM A 501 - Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
13. ASTM A514/A514M - Specification for High-Yield Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding.
17. ASTM A572/A572M - Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.

C. American Welding Society (AWS):
1. AWS D1.1 - Structural Welding Code.
2. AWS A2.4 - Symbols for Welding, Brazing, and Nondestructive Examination.

D. Factory Mutual (FM):
1. FM - Roof Assembly Classifications.

E. Underwriters Laboratories, Inc. (UL):
2. UL - Fire Resistance Directory.

F. Steel Structures Painting Council (SSPC):
1. SSPC - Painting Manual.
2. SSPC-Paint 20 Type II - Zinc Rich Primers - Organic.
3. SSPC-Paint 22 - Epoxy Polyamide Paints.
4. SSPC-Paint 25 - Red Iron Oxide, Zinc Oxide, Raw Linseed Oil, and Alkyd Primer.
5. SSPC-SP 2 - Hand Tool Cleaning.
6. SSPC-SP 6 - Commercial Blast Cleaning.

1.3 SUBMITTALS

A. Division 1, Section 01 33 00 - Submittal Procedures: Procedures for submittals.

1. Shop Drawings:
   a. Indicate profiles, sizes, spacing, locations of structural members, openings, attachments, and fasteners.
   b. Connections.
   c. Cambers and loads.
   d. Indicate welded connections with AWS A2.0 welding symbols. Indicate net weld lengths.

2. Assurance/Control Submittals:
   a. Erection Procedure: Submit descriptive data to illustrate structural erection procedure including sequence of erection and temporary staying and bracing.
   b. Field Welding Equipment: Submit descriptive data for field welding equipment including type, voltage, and amperage.
   c. Test Reports: Submit the following reports directly to Contracting Officer from Testing Laboratory, with copy to Contractor. Prepare reports in conformance with Division 1, Section 01 40 00 - Quality Requirements:
      (1) Welding inspection.
      (2) Bolted connection inspection.
   d. Certificates: Certify welders employed on Work, verifying AWS qualification within previous 12 months.
   e. Qualification Documentation: Submit documentation of fabricator and erector experience indicating compliance with specified qualification requirements.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Fabricator: Company specializing in performing the work of this section with minimum 5 years documented experience.

2. Erector:
   a. A company specialized in performing the work of this section with a minimum of 5 years documented experience.
b. A qualified company that participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CASE or CSE.

3. Qualifications for Welding Work: Qualify welding operators in accordance with AWS Standard Qualification Procedures. Provide certification that welders employed in work have satisfactorily passed AWS qualification tests within previous 12 months. If rectification of welders is required, provide without additional cost to Owner.

B. Fabricate structural steel members in accordance with AISC Code of Standard Practice.

C. Perform Work in accordance with AISC Section 10.

D. Design connections not detailed on the Drawings under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in State where Project is located.

E. Survey: Employ a Registered Professional Surveyor registered in State in which Project is located, experienced in survey work, to establish permanent bench marks as shown and as necessary for accurate erection of structural steel. Check elevations of concrete and masonry bearing surfaces, and locations of anchor bolts and similar devices, before erection work proceeds, and report discrepancies to Owner. Do not proceed with erection until corrections have been made, or until compensating adjustments to structural steel work have been agreed upon with Owner.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Division 1, Section 01 60 00 - Product Requirements: Transport, handle, store, and protect Products.

B. Store steel above ground on platforms, skids, or other supports.

C. Protect steel from corrosion.

D. Store packaged materials in their original, unbroken packages or containers.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Structural Steel Shapes, Plates and Bars: ASTM A 36.

B. Structural Tubing: ASTM A 500, Grade B.

1. Square/Rectangular HSS Min Fy= 46 KSI; Round HSS Min Fy= 42 KSI

C. Bolts, Nuts, and Washers: AISC Specification Section 1.4.4.


2. High Strength Bolts: ASTM A 325 or A 490.

3. Anchor Bolts and Nuts: ASTM A 307 Grade A.

D. Welding Materials: AWS D1.1; type required for materials being welded or as indicated on Drawings.

E. Grout: Specified in Division 3.1, Section 03 30 00.


2.2 FABRICATION

A. Fabricate structural steel members in accordance with AISC Code Section 6 and AISC Specification.

B. Connections not detailed on Drawings: Engineer by fabricator, which is subject to review.

C. Fabricator's Responsibility:
   1. Errors of detailing, fabrications, and for correct fitting of structural steel members.
   2. Do not splice structural steel members. Members having splice not indicated on Drawings will be rejected.

D. Continuously seal joined members by continuous welds. Grind exposed welds smooth.

E. Fabricate connections for bolt, nut, and washer connectors.

F. Develop required camber for members.

2.3 FINISH

A. Clean, prepare, and shop prime structural steel members in accordance with SSPC - Painting Manual. Do not paint surfaces in contact with concrete, or surfaces specified to be galvanized.

B. Shop prime structural steel members. Do not prime surfaces that will be field welded, in contact with concrete, and high strength bolted.

2.4 SOURCE QUALITY CONTROL AND TESTS

A. Provide shop testing of structural steel sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Division 1, Section 01 70 00 – Execution and Closeout Requirements: Verification of existing conditions before starting work.

B. Verification of Conditions: Verify that field measurements, surfaces, substrates and conditions are as required, and ready to receive Work.

C. Report in writing to Contracting Officer prevailing conditions that will adversely affect satisfactory execution of the Work of this Section. Do not proceed with Work until unsatisfactory conditions have been corrected.
D. By beginning Work, Contractor accepts conditions and assumes responsibility for correcting unsuitable conditions encountered at no additional cost to the United States Postal Service.

3.2 PREPARATION

A. Supply items required to be cast into concrete or embedded in masonry with setting diagrams to appropriate Sections.

3.3 ERECTION

A. Erect structural steel in accordance with AISC Code, Section 7, and AISC Specification Section 1.25 except as specified herein.

B. Make provision for erection loads, and for sufficient temporary bracing to maintain structure safe, plumb, and in true alignment until completion of erection and installation of permanent bracing.

C. Do not field cut or alter structural members without approval of the Engineer.

D. Field weld components indicated on Drawings.

E. Field connect members with threaded fasteners; torque to required resistance.

F. After erection, prime welds, abrasions, and surfaces not shop painted that are to receive finish painting, except surfaces to be in contact with concrete. Use a primer consistent with shop coat.

G. Anchor Bolts: Install anchor bolts and other connectors required for securing structural steel to foundations and other in-place work. Furnish templates and other devices as necessary for presetting bolts and other anchors to accurate locations.


1. Set loose and attached base plates and bearing plates for structural members on steel wedges or other adjusting devices.

2. Tighten anchor bolts after the supported members have been positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with edge of base or bearing plate prior to grouting.

3. Grout solidly between bearing surfaces and bases of plates immediately after erecting member and before additional load is placed on member. Finish exposed surfaces, protect installed materials, and allow to cure. For proprietary grout materials, comply with manufacturer's installation instructions.

4. Slide bearings: Permanently affixed to member and support, respectively, by welding or bolting as indicated. Align and level member faces to maintain full contact between surfaces before completing installation.

I. High-strength Bolting: Comply with specifications for Structural Joints using ASTM A 325 or A 490 Bolts.
J. Erection Bolts:
   2. On exposed welded construction, remove erection bolts, fill holes with plug welds, and grind smooth at exposed surfaces.

K. Touch-up Painting: Immediately after erection, clean exposed field welds, bolted connections, and abraded areas of shop paint. Apply paint to exposed areas with same material as used for shop painting. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

3.4 CONSTRUCTION

A. Site Tolerances:
   1. Maximum Variation From Plumb: 1/4 inch.

3.5 FIELD QUALITY CONTROL

A. Division 1, Section 01 40 00 - Quality Requirements: Field testing and inspection.

B. Quality Assurance Program:
   1. AISC Code Section 8 and AISC Specification Section 1.26.
   2. AISC Quality Criteria and Inspection Standards, except as specified herein.

C. Welding:
   1. AWS D1.1 Section 6.
   2. Inspectors: AWS Certified in accordance with AWS QCI, Standard for Qualifications and Certification of Welding Inspectors.

END OF SECTION
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SECTION 05 50 00

METAL FABRICATIONS

PART 1 - GENERAL

1.1 - SECTION INCLUDES

A. Steel angles  
B. Bearing devices and plates  
C. Steel bar stock  
D. Steel plate  
E. Steel flange inserts  
F. Steel tubes  
G. Miscellaneous steel clips, angles, brackets, fasteners, and metal accessories required to complete architectural work  
H. Stainless steel sheet, strip, plate, and flat bar  
I. Aluminum and aluminum alloy sheet and plate  
J. Aluminum and aluminum alloy extruded bars, rods, wire, shapes, and tubes  
K. Metal Stair Nosings

1.2 - RELATED SECTIONS

A. Division 3.1, Section 05 12 00 Structural Steel Framing  
B. Division 3.1, Section 05 52 00 Metal Railings  
C. Division 3.1, Section 08 63 00 Metal-Framed Skylights  
D. Division 3.1, Section 08 84 00 Plastic Glazing  
E. Division 3.1, Section 09 96 00 High Performance Coatings  
F. Division 3.1, Section 10 14 00 Signage

1.3 - REFERENCES

A. American Architectural Manufacturers Association (AAMA):  

B. American Society for Testing and Materials (ASTM):  
   1. ASTM A27 Standard Specification for Steel Castings, Carbon, for General Application
2. ASTM A36 Standard Specification for Carbon Structural Steel
5. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
6. ASTM A108 Standard Specification for Steel Bars, Carbon, and Alloy, Cold-Finished
8. ASTM A143 Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
9. ASTM A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
12. ASTM A384 Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
13. ASTM A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
14. ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
15. ASTM A663 Standard Specification for Steel Bars, Carbon, Merchant Quality, Mechanical Properties
16. ASTM A666 Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
17. ASTM A675 Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties
18. ASTM A780 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
19. ASTM A1008 Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy High-Strength Low-Alloy with Improved Formability, and Bake Hardenable
20. ASTM B209 Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate
21. ASTM B221  Specification for Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
22. ASTM D6386  Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting
23. ASTM D7396  Standard Guide for Preparation of New, Continuous Zinc-Coated (Galvanized) Steel Surfaces for Painting

C. American Welding Society (AWS):
   1. D1.1  Structural Welding Code – Steel

D. Steel Structures Painting Council (SSPC):
   1. PA 1  Shop, Field, and Maintenance Painting of Steel
   2. PS 12.00  Guide to Zinc-Rich Coating Systems
   3. SP 1  Surface Preparation – Solvent Cleaning
   4. SP 10  Surface Preparation – Near-White Blast Cleaning

1.4 - SUBMITTALS

A. Submit in accordance with Division 1, Section 01 33 00 – Submittal Procedures.

B. Manufacturer's Data: For manufactured or prefabricated items, submit manufacturer's specifications, load tables, dimension diagrams, anchor details, and installation instructions for products being provided and installed under the work of this Section. Indicate in the transmittal that copies of the installation instructions have been provided to the respective installing subcontractors.

C. Shop Drawings:
   1. Verify measurements and take field dimensions for fitting and proper attachment to related work before producing shop drawings.
   2. Submit shop drawings for the fabrication and erection of assemblies of miscellaneous metalwork, which are not completely defined in the manufacturer's data. Include plans, elevations, and details of sections and connections. Show accessories and anchorage items to be incorporated into the work.
   3. Include setting drawings and templates for location and installation of miscellaneous metal items and anchorage devices.
   4. Do not use drawings prepared by the A/E for shop, fabrication, installation, or erection drawings.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel Plates, Shapes and Bars: Conform to ASTM A36.
B. Steel Plates to be Bent or Cold Formed: Conform to ASTM A283, Grade C.

C. Steel Bars and Bar Size Shapes: Conform to ASTM A663 or ASTM A675.

D. Steel Tubing: Conform to ASTM A500, Grade B.

E. Cold Finished Steel Bars: Conform to ASTM A108, grade as selected by fabricator.

F. Cold Rolled Carbon Steel Sheets: Conform to ASTM A1008.

G. Galvanized Carbon Steel Sheets: Conform to ASTM A653, G 90 zinc coating.


I. Malleable Iron Castings: Conform to ASTM A47, grade as selected by fabricator.

J. Steel Pipe: Conform to ASTM A53, type as selected by fabricator, Grade A, standard weight (Schedule 40), black finish unless galvanized indicated on the Plans.
   
   1. Outside diameter (OD) dimensions referenced on the Plans are nominal dimensions. Select and provide stock from standard Schedule 40 pipes that provides the closest possible match to the OD dimension given.
   
   2. For radius bends in pipes 45-degrees or greater, use the smallest possible standard elbow bends that will prevent buckling, wrinkling, or deformation of the pipe.

K. Primer Paint on Steel: As specified in Division 3.1, Section 09 96 00 – High Performance Coatings. Ensure that shop-applied primers are products of the manufacturer of the finish coat products.
   
   1. Prior to submitting product data for proposed shop primer, verify which intermediate and finish coats have been approved for field coats.

L. Concrete Inserts: Threaded or wedge type, galvanized ferrous castings, malleable iron in conformance with ASTM A47, or cast steel in conformance with ASTM A27. Provide bolts, washers, and shims as required, hot-dip galvanized, in conformance with ASTM A153.

M. Isolator for Metals Causing Electrolytic Action: Asphalt bitumen emulsion.


O. Anchors, Bolts, and Fastenings.
   
   
   
   3. Washers: Round washers, conforming to American Standard B27.2, Type B.
4. Screws: Stainless Steel Phillips head, flush head or countersunk unless noted otherwise in this specification or on the Plans. Refer to Division 3.1, Section 08 84 00 – Plastic Glazing for glazing screws.

P. Stainless Steel Sheet, Strip, Plate, and Flat Bar: Conform to ASTM A666.

Q. Aluminum and Aluminum Alloy Sheet and Plate: Conform to ASTM B209.

R. Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes: Conform to ASTM B221.

S. Aluminum Coatings: In accordance with AAMA 2603.

T. Metal Stair Nosings: Provide two-part stair nosing with replaceable tread (for ease of future replacement). Include a removable insert that is replaced with a screw-down abrasive tread (installed after stairs are complete to minimize damage during construction). Tread shall be full solid type abrasive design. Stair nosing shall have full radius return and single piece with no joint.

1. Manufacturers: Nystrom Two Part Stair Nosing or approved equal.

2. Base nosing to be Type 6063-T5 extruded aluminum.

3. Finish: Natural Aluminum.

4. Color (full solid abrasive tread): uniformly black throughout the filler.

5. Tread Abrasive: Anti-slip abrasive of grain aluminum oxide or silicon-carbide. Binder to be fully-cured epoxy.

6. Width: 3-inch minimum.


2.2 FABRICATION

A. Workmanship: Use materials of the composition, thicknesses and sizes shown on the Plans or, if not shown, of the required size and thickness to provide adequate strength and durability in the finished product for the intended use. Work to the dimensions and details shown on accepted Shop Drawings. Use the type of materials shown or specified for the various components of work.

B. When anchors and other connection members occur in concrete, install these anchors and connection members in the concrete as the work progresses to avoid unnecessary cutting and drilling.

C. Provide templates and patterns. Supervise proper location and installation of built-in items. Where needed to complete and assemble, provide holes and connections for the work of other trades.

D. To the extent possible, shop-fit and assemble work ready for erection. For both shop and field connections, rivet, weld or attach with screws. Countersink and finish flush screws that are exposed.
E. Dissimilar materials: To inhibit galvanic action, corrosion, discoloration, and staining, provide positive insulation to prevent contact between dissimilar metals.

F. Form exposed work true to line and level, with accurate angles, surfaces and straight, sharp edges. Ease exposed edges to a radius of approximately 1/32 inch unless otherwise indicated on the approved Shop Drawings. Form bent metal corners to the smallest radius possible without causing grain separation or otherwise impairing the work.

G. Welding for factory, foundry, and job-site metal fabrications:

1. Weld corners and seams continuously and in accordance with AWS D1.1. At exposed visible connections, grind exposed welds uniform, continuous and smooth with no visible ridges or imperfections flush to match and blend with adjoining surfaces to achieve the highest and best visual appearance. Gaps between welds to be filled with appropriate sealant to appear seamless prior to finishing. Position steel members so that mill marks are not visible or grind smooth.

2. Assemble and weld built-up sections by methods that will maintain alignment of members without warpage.

H. Bolted Connections: Provide bolt type and finish as noted herein and align bolt heads and other connection devices as indicated on the approved Shop Drawings.

I. Form exposed connections with hairline joints that are flush and smooth, using concealed fasteners wherever possible. Where exposed fasteners are used, provide Phillips flathead and countersunk screws or bolts, unless otherwise indicated on the approved Shop Drawings.

J. Provide for anchorage of the type shown on the approved Shop Drawings and coordinate with the supporting structure. Fabricate and space anchoring devices in conformance with the structural engineering requirements and approved Shop Drawings.

K. Cut, reinforce, drill, and tap miscellaneous metalwork items to receive finish hardware or similar items of work, as indicated on the Plans and the approved Shop Drawings.

L. Carefully coordinate the dimensions and requirements of fabricated metalwork with the dimensions and requirements of adjacent assemblies, supported by or abutting metalwork. Bring any discrepancies discovered to the attention of the A/E before proceeding with the work.

2.3 CLEANING AND SHOP PAINTING

A. Shop prime miscellaneous metalwork, except for those members or portions of members to be embedded in concrete, surfaces and edges to be field welded, and galvanized surfaces, unless otherwise indicated on the Plans and the approved Shop Drawings.

B. Prepare and clean substrates in accordance with Division 3.1, Section 09 96 00 – High Performance Coatings, the paint manufacturer's written instructions, and as specified below, for each particular substrate condition:

1. For projections and irregular surfaces, grind smooth or remove. Remove weld accumulations, spatter, and slag.
2. Remove accessories, cover plates and similar items in place and not to be painted, or provide suitable protection from surface preparation and painting operations. Remove such items if necessary for the complete painting of the items and adjacent surfaces. Following completion of painting of each space or area, re-install the removed items using workers skilled in the trades involved.

3. Surfaces to be painted: Clean in accordance with SSPC-SP10 to remove oil and grease before mechanical cleaning. Neutralize welds with a chemical solvent that is compatible with the specified painting system.

4. Mechanically clean and abrade prepared surfaces in accordance with the specifications below. Select abrasive type and size to provide the required level of cleanliness while establishing a surface profile recommended by the paint manufacturer. Use new abrasive material, free of contaminants that would interfere with adhesion of the paint. Vacuum clean abraded surfaces immediately before applying primer, to remove residual dust. Ensure that mechanically cleaned surfaces receive a coating of paint within eight hours or before flash rusting can occur. If flash rusting occurs, re-clean the surface before applying paint.

C. Exterior Applications:

1. After fabrication and immediately before shop painting, clean and prepare surfaces as described above.

2. Clean abrasive blast steel surfaces in conformance with SSPC-SP10.

3. Re-wipe as necessary and vacuum surfaces to remove dust immediately before applying paint.

4. Apply primer as specified below.

D. Primer: Immediately after surface preparation, apply primer according to primer manufacturer’s instructions to provide a dry film thickness of not less than 1.5 mils or thickness specified in Division 3.1, Section 09 96 00 – High Performance Coatings, whichever is greater. Conform to the applicable sections of SSPC-PA1 and SSPC-PS12.00. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

E. Inaccessible Surfaces: For surfaces which are inaccessible after assembly or erection, apply a second coat of primer, at 2.0 to 3.0 mils DFT.

2.4 GALVANIZING

A. For steel and ferrous metal items exposed to moisture including gratings, galvanize after fabrication by the hot-dip process in conformance with ASTM A123. Weight of the zinc coating: Conform to the requirements specified under Weight of Coating in ASTM A123.

B. Safeguarding against steel embrittlement: Conform to ASTM A143.

C. Safeguarding against warpage and distortion of steel members: Conform to ASTM A384.

D. Shop galvanized metalwork requiring field welding that results in the removal of original galvanizing, restore by field galvanizing repair in conformance with ASTM A780.
E. For bolts and screws used for attachment of galvanized items, galvanize in conformance with ASTM A153.

F. For galvanized metal surfaces indicated to be painted, prepare in conformance with ASTM D6386 and ASTM D7396, as applicable.

PART 3 - EXECUTION

3.1 EXAMINATION OF EXISTING CONDITIONS

A. Examine the areas and conditions under which the metal fabrications and miscellaneous metalwork will be installed. Correct conditions detrimental to the proper completion of the work before proceeding.

3.2 PREPARATION

A. Furnish setting drawings, diagrams, templates, instructions and directions for the installation of anchorage metal fabrications, such as concrete inserts, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete construction. Coordinate the delivery of these types of items to the Project site to avoid any delays due to lack of materials.

3.3 INSTALLATION

A. Install metal fabrications and miscellaneous metalwork in conformance with the Plans and the approved Shop Drawings, using mechanics and workers skilled in the installation of the type of work involved.

B. Install metal fabrications and miscellaneous metalwork with accessories furnished by the fabricator as required for complete and finished installations.

C. Fastening to In-Place Construction: Provide anchorage devices and fasteners for securing miscellaneous metalwork items to in-place construction, including threaded fasteners for concrete and masonry inserts, toggle bolts, through bolts, wood screws and other connectors in conformance with structural engineering requirements and approved Shop Drawings.

D. Cutting, Fitting and Placement:

1. Perform cutting, drilling and fitting required for the installation of the metal fabrications and miscellaneous metal items. Set the work accurately in location, alignment and elevation - plumb, level, true and free from rack - measured from established lines and levels. Provide temporary bracing or anchors in formwork for items that are to be built into concrete construction.

2. Fit exposed connections accurately together to form tight hairline joints. Weld connections that are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Grind joints smooth and touch-up with shop paint coat. Do not weld, cut or abrade the surfaces of the exterior units which have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.

E. Field Welding: In accordance with AWS D1.1 and requirements of Division 3.1, Section 05 12 00 – Structural Steel Framing for the procedures of manual shielded metal-arc welding, the appearance and quality of welds made, and the methods used in correcting...
welding work. At exposed connections, grind exposed welds smooth and flush to match and blend with adjoining surfaces to achieve highest and best visual appearance.

F. Install metalwork in conformance with approved Shop Drawings, true and horizontal, perpendicular, or at the required angle. Ensure installation of metalwork is level and square, with angles and edges parallel with related lines of the structure.

3.4 SHEET METAL THICKER THAN 10 GAGE (AS APPLICABLE)

A. Fabricate and install metalwork thicker than 10 gage as a part of the work of this Section. Accurately cut and form with clean sharp corners and edges. Fit to other materials in a tight and secure manner with proper fastenings. Drill or punch holes accurately. Ensure that welded joints conform to the requirements specified in AWS D1.1 under Workmanship.

B. Shop prime or galvanize fabricated work as required to receive finish coats as specified in Division 3.1, Section 09 96 00 – High Performance Coatings. Match finish with adjacent or adjoining work.

3.5 MISCELLANEOUS ANGLES, CLIPS, AND OTHER DEVICES

A. Provide required miscellaneous clips, angles, lintels, and similar loose parts. Fabricate parts from standard structural sections or shapes, to sizes required. For miscellaneous parts that are exposed; grind edges, corners, and rough cuts smooth and free of snags. Shop prime all parts excluding those to be encased in concrete or those that require other specified finishes.

3.6 GALVANIZING REPAIR

A. For galvanized surfaces that have become damaged from welding, handling, or installation, repair immediately after installation with galvanizing repair material in conformance with ASTM A780.

3.7 FIELD PAINTING

A. After installation, prepare exposed painted surfaces, field welds, and other abraded or damaged primed surfaces as required by these Specifications, and touch up with an additional coat of the same primers specified for shop painting. Finish field painting, where required and as specified in Division 3.1, Section 09 96 00 – High Performance Coatings. Visible brush strokes will not be acceptable.

END OF SECTION
SECTION 05 52 00

METAL RAILINGS

PART 1 - GENERAL

1.1 - SECTION INCLUDES

A. Metal Handrails and Railings
B. Steel Pipe
C. Steel Tubes
D. Steel Plate
E. Stainless Steel Handrails and Railings
F. Architectural Fence

1.2 - RELATED SECTIONS

A. Division 3.1, Section 03 30 00 Cast-In-Place Concrete
B. Division 3.1, Section 03 62 00 Non-Shrink Grout
C. Division 3.1, Section 05 12 00 Structural Steel Framing
D. Division 3.1, Section 09 96 00 High-Performance Coatings

1.3 - REFERENCES

A. ASTM International (ASTM):
1. ASTM A36 Standard Specification for Carbon Structural Steel
2. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless
4. ASTM A143 Standard Practice for Safeguarding Against Embrittlement of Hot-dip Galvanized Structural Steel Products and Procedures for Detecting Embrittlement
5. ASTM A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
6. ASTM A269 Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
7. ASTM A307 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod, 60000 PSI Tensile
8. ASTM A312  Standard Specification for Seamless and Welded Austenitic Steel Pipe
9. ASTM A384  Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
10. ASTM A385  Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
12. ASTM 500  Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
14. ASTM A595  Standard Specification for Steel Tubes, Low-Carbon or High Strength Low-Alloy, Tapered for Structural Use
15. ASTM A780  Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
16. ASTM D6386  Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting
17. ASTM D7396  Standard Guide for Preparation of New, Continuous Zinc-Coated (Galvanized) Steel Surfaces for Painting
20. ASTM F837  Standard Specification for Stainless Steel Socket Head Cap Screws
21. ASTM F879  Standard Specification for Stainless Steel Button and Flat Countersunk Head Cap Screws
22. ASTM F880  Specification for Stainless Steel Set Screws

B. National Association of Architectural Metal Manufacturers (NAAMM):
   1. Pipe Railing Systems Manual, including Round Tube
   2. AMP 503 Finishes for Stainless Steel Pipe Railing Manual, including Round Tube

C. Specialty Steel Industry of North America (SSINA): “Designer Handbook” including the following industry standards:
   1. Design Guidelines for the Selection and Use of Stainless Steel
      a. Specifications for Stainless Steel
b. Finishes for Stainless Steel  
c. Fabrication of Stainless Steel  
d. Stainless Steel Fasteners

D. Steel Structures Painting Council (SSPC):

2. SSPC-SP 1 Solvent Cleaning
3. SSPC-SP 3 Power Tool Cleaning
4. SSPC-SP 10 Near-White Blast Cleaning
5. SSPC-SP 11 Power Tool Cleaning to Bare Metal

1.4 SUBMITTALS

A. Submit in accordance with Division 1, Section 01 33 00 – Submittal Procedures.

B. Product Data: Submit manufacturer’s product data for railing system and railing system components, handrails, and handrail brackets. Include corrosion-inhibitive shop coat painting system.

C. Shop Drawings: Submit detailed Shop Drawings of metal handrails, railings and architectural fence, showing sizes, details of fabrication and construction, bends and radii, handrail brackets, locations of hardware, anchors, and accessories, including installation details.

D. Calculations and Details: Submit structural calculations and details for the architectural fence, prepared and signed by a civil or structural engineer currently registered by the State of California.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Metal Handrails: Standard steel pipe, architectural handrail grade, of diameter and sizes indicated. Metal handrails shall be galvanized. Provide terminal safety returns for all stair handrails. Handrail brackets shall be galvanized malleable iron, manufactured for the purpose indicated including anchorage to concrete walls where required. Include all fittings and components, sleeves, hardware, backing plates, and accessories required for complete and finished handrail installations.

B. Steel Pipe: Pipe for railings, pipe supports, and pipe sleeves shall be seamless steel pipe in conformance with ASTM A53, Type S, Grade A, of diameters and sizes indicated on the approved Shop Drawings. Special instructions shall be given to the pipe manufacturer to provide architectural handrail grade pipe.

C. Steel Tubes: Tubes for vertical support of railing shall be seamless steel tube in conformance with ASTM A595, Type S, Grade A, of sizes indicated on the approved Shop Drawings.
D. Steel Tube for Architectural Fence: Tubes for architectural fence fabrication and sleeves shall be hollow structural section in conformance with ASTM A500, Grade C, of sizes indicated on the approved Shop Drawings. Oval top rail may conform to ASTM A500, Grade B or C.

E. Stainless Steel Tube or Pipe: Provide stainless steel tube or pipe, where indicated, conforming to ASTM A269, Grade TP316, or ASTM A312, Grade TP316, of diameters and sizes indicated. Provide tube or pipe with a polished finish similar to NAAMM AMP 503 No 4 finish. Tube or pipe shall receive a final polishing using grit no coarser that 180 grit. Ends shall be closed with matching material, welded, and ground smooth.

1. Handrails: Provide terminal safety returns for all handrails. Handrail brackets shall be stainless steel, wrought or welded, manufactured for the purpose, for anchorage to indicated substrate. Handrail brackets shall comply with applicable code and loading requirements. Finish of brackets shall match handrail finish. Include all fittings and components, sleeves, hardware, backing plates, and accessories as required for complete and finished handrail installations.

F. Railing Corners: Provide one-quarter sphere components for rounding of 90-degree outside railing corners. Weld sphere components into position, and grind and dress work weldments smooth so as to be invisible in the finished work. Plate: Steel plate for anchor plates shall be standard steel plate in conformance with ASTM A36, weldable quality.

G. Welding Rod / Electrodes: Refer to Division 3.1, Section 05 12 00 - Structural Steel Framing for requirements. Provide stainless steel welding electrodes where applicable.

H. Anchors, Fasteners, and Accessories: Provide anchors, fasteners, miscellaneous components, and accessories as required for complete and finished railing installations. Bolts, studs, nuts, and washers shall be in conformance with ASTM A307, A449, and A563, as applicable, and shall be galvanized in accordance with ASTM A153.

1. Expansion Bolts: Where anchors are not included in the concrete construction, provide galvanized expansion type anchors with matching galvanized steel bolts or studs with nuts of sizes indicated or required. Provide washers under all bolt heads and nuts. Expansion bolts will not be permitted for use on concrete curbs or along the edge of concrete or a concrete joint.

2. Stainless Steel Anchors, Fasteners, and Accessories: Provide all required anchors, fasteners, and accessories as required for complete and finished handrails installation. Bolts, studs, and nuts shall conform to ASTM F593, F594, F837, F879, and F880 as applicable for Type 316. Also comply with applicable requirements of SSINA’s "Stainless Steel Fasteners." Anchors and fasteners shall be tamper-resistant where exposed.


4. Stainless Steel Hardware Brackets: Provide manufactured 300 Series stainless steel handrail brackets wit proper anchorage hardware for adjoining construction.

I. Grout: Refer to Division 3.1, Section 03 62 00 – Non-Shrink Grouting for requirements.

J. Paint: Provided corrosion-inhibitive protective primer as specified in this Section under "Cleaning and Painting."
2.2 FABRICATION

A. Metal handrails, railings, and architectural fence shall be fabricated by firms or shops experienced and skilled in the custom fabrication of architectural metal handrails and railings, and shall meet the quality requirements of NAAMM's Pipe Railing Manual.

B. Bends in railings shall be precision-formed to a smooth continuous radius by skilled workers. Work quality and finish shall be true to detail. Butt joints shall have internal pipe sleeve or dowel. Ends shall be closed with similar materials, welded and ground smooth.

C. Steel welded connections shall be made in accordance with applicable welding requirements of Division 3.1, Section 05 12 00 - Structural Steel Framing. Welding shall be performed in the shop unless indicated otherwise. Welded joints of handrails, railings and architectural fence shall be ground and dressed smooth to match adjacent surfaces, so that the shape and profile of the item welded is maintained.

D. Bends in tubes or pipes shall be precision-formed to a smooth continuous radius by skilled workers, true to detail. Butt joints shall have tight-fitting internal pipe sleeve or dowel.

E. Butt joints in metal and stainless steel or tube railing shall not be welded. Instead, railing joints shall have internal, tight-fitting metal or stainless steel sleeves, secured with tamper-resistant, counter-sunk metal or stainless steel fasteners located at the railing bottom. Butt joints in railings shall be precision-manufactured to provide tight hairline joints, slightly eased at edges to eliminate burrs and sharp edges. Provide for expansion and contraction at joints where railings exceed runs of 40 feet in length.

F. Welded connections shall be made in accordance with applicable requirements of Division 3.1, Section 05 12 00 – Structural Steel Framing and Division 3.1, Section 05 50 00 – Metal Fabrications. Welding shall be performed in the shop unless otherwise indicated. Grind and dress smooth welded joints to match adjacent surfaces so that the shape and profile of item welded is maintained and that the weld seam is invisible in the finished work. Frind and polish stainless steel welds to match NAAMM AMP 503 No. 4 finish.

G. Architectural Fence: Welded connections shall be made in accordance with applicable requirements of Division 3.1, Section 05 12 00 – Structural Steel Framing and Division 3.1, Section 05 50 00 – Metal Fabrications. Welding shall be performed in the shop unless otherwise indicated. Grind and dress smooth welded joints to match adjacent surfaces so that the shape and profile of item welded is maintained and that the weld seam is invisible in the finished work.

H. Metal handrails, railing and architectural fence shall be prefabricated and preassembled in the factory or shop as far as practicable to minimized field assembly.

2.3 GALVANIZING

A. Ferrous metal railings, architectural fence and related items shall be galvanized, unless indicated otherwise, after fabrication by the hot-dip process in accordance with ASTM A123 and ASTM A385. Weight of zinc coating shall conform to the requirements specified under “Weight of Coating” in ASTM A123.

B. Safeguarding against steel embrittlement shall be in conformance with applicable requirements of ASTM A143.
C. Safeguarding against warpage and distortion of steel members shall be in conformance with ASTM A384.

D. Shop galvanized metalwork necessitating field welding that in any manner removes original galvanizing shall be restored by galvanizing repair methods in accordance with ASTM A780.

E. Bolts and screws for attachment of galvanized items shall be galvanized in accordance with ASTM A153, or of compatible, non-corrosive material.

2.4 CLEANING AND PAINTING

A. Cleaning and painting shall conform to requirements specified in Division 3.1, Section 05 50 00 – Metal Fabrications, Division 3.1, Section 09 96 00 – High-Performance Coatings, and as specified below.

B. All surfaces of metal handrails, railings and architectural fence shall be cleaned and treated to assure maximum paint adherence prior to application of the shop prime coat in accordance with SSPC-SP 1, SSPC-SP 3, SSPC-SP 10, and SSPC-SP 11 as applicable for the type of substrate, exposure, and application.

C. Ferrous metalwork shall be coated in the shop with a rust-inhibitive metal primer as specified in Division 3.1, Section 05 12 00 – Structural Steel Framing or other approved rust-inhibitive metal primer standard with the railing manufacturer. All surfaces of handrails and railings shall be spray-painted.

D. Where galvanized surfaces are indicated to be painted, comply with the cleaning and painting requirements of Division 3.1, Section 05 50 00 – Metal Fabrications.

E. Coordinate with Division 3.1, Section 09 96 00 – High-Performance Coatings for compatibility of the prime coat and finish coats of paint.

PART 3 - EXECUTION

3.1 INSTALLATION

a. Install metal handrails, railings and architectural fence as indicated on the Plans and the approved Shop Drawings using workers skilled and experienced in the installation of the type of work involved. Install metal handrails, railings and architectural fence in conformance with the methods and requirements of NAAMM’s Pipe Railing Manual, as applicable.

b. Install metal handrails, railings and architectural fence with accessories furnished by the railing fabricator as required for a complete and finished railing installation.

c. Installation of handrails, railings and architectural fence shall be in conformance with approved Shop Drawings, true and horizontal, perpendicular, or at the required angle, level and square, with angles and edges parallel with related lines of the structure.

d. Field welding, where required, shall be in conformance with the requirements of Division 3.1, Section 05 12 00 – Structural Steel Framing.

e. Where railing base plates require grouting, conform with the requirements of Division 3.1, Section 03 62 00 – Non-Shrink Grouting and Division 3.1, Section 05 12 00 – Structural Steel Framing.
f. Where architectural fence posts require grouting, conform with the requirements of Division 3.1, Section 03 62 00 – Non-Shrink Grouting and Division 3.1, Section 05 12 00 – Structural Steel Framing.

3.2 GLAZANIZING REPAIR

A. Galvanized surfaces that have become damaged from welding, handling, or installation shall be repaired immediately after installation with galvanizing repair material in accordance with ASTM A780.

3.3 FIELD PAINTING

A. After installation, exposed painted surfaces, field welds, and other abraded or damaged primed surfaces shall be prepared as required and touched up with an additional coat of the same primers for ferrous and galvanized surfaces as specified for shop painting above.

B. Lightly sand and feather out such damaged surfaces, so that paint touch-up becomes invisible. Spray-paint all touch-up work.

C. Finish field painting is specified in Division 3.1, Section 09 96 00 – High-Performance Coatings.

D. All stainless steelwork, after receiving NAAMM AMP No.4 polished finish, shall receive a final polishing using non-ferrous grit no coarser than 180.

E. Clean all stainless steelwork to remove dirt, dust, oil, and grease, fingerprints, atmospheric and aqueous corrosion and iron contamination, rinsed and then polished. The cleaning method shall be the mildest treatment necessary for the problem.

F. Remove corrosion by scouring light with and abrasive cleaner, rubbing in the direction of the finish grain of the metal.

END OF SECTION
SECTION 08 63 00

METAL-FRAMED SKYLIGHTS

PART 1- GENERAL

1.1 SECTION INCLUDES

A. Framing materials
B. Glazing materials
C. Aluminum finishes

1.2 RELATED SECTIONS

A. Division 3.1, Section 05 12 00 Structural Steel Framing
B. Division 3.1, Section 08 84 00 Plastic Glazing

1.3 REFERENCES

A. Aluminum Association (AA):
   1. System for Designating Aluminum Finishes

B. American Architectural Manufacturers Association (AAMA):

C. ASTM International (ASTM):
   1. ASTM A193 Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Applications
   2. ASTM B221 Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
   5. ASTM E283 Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
   7. ASTM E331 Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference

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8. ASTM E547 Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Cyclic Static Air Pressure Difference

D. American Welding Society (AWS):
   1. AWS D1.2 Structural Welding Code – Aluminum

E. National Association of Architectural Metal Manufacturers (NAAMM):
   1. Metal Finishes Manual for Architectural and Metal Products

F. Steel Structures Painting Council (SSPC):
   1. SSPC-SP 12 Power Tool Cleaning to Bare Metal

1.4 PERFORMANCE REQUIREMENTS

A. General: Provide metal-framed skylights capable of withstanding loads as well as thermal and structural movements indicated in this Section without failure. Failure includes the following:
   1. Deflection exceeding specified limits.
   2. Thermal stresses transferred to other parts of the structure.
   3. Skylight framing members transferring stresses, including those caused by thermal and structural movement, to glazing.
   4. Noise or vibration created by thermal and structural movement and wind.
   5. Weakening of fasteners, attachments, and other components.

B. Deflection of the entire length of framing members in direction normal to glazing plane is limited to 1/175 of clear span.

C. Structural Loads: Provide metal-framed skylights, including anchorage, capable of withstanding the effects of the following design loads when supporting full dead loads:
   1. Roof Loads as follows:
      a. Concentrated Load: 250 pounds applied to framing members at locations that produces the most severe stress or deflection.
      b. Wind Loads: As specified in Section 08 84 00 – Plastic Glazing.

D. Structural Performance: Provide metal-framed skylights, including anchorage, capable of withstanding test pressure as indicated below without material and deflection failures or permanent deformation of structural members exceeding 0.2 percent of span when tested in conformance with ASTM E330.

E. Thermal Movement: Provide metal-framed skylights that allow for thermal movements resulting from the following maximum change (100 degrees F.) in ambient temperatures by preventing buckling, sealant failure, and other detrimental effects.
1. Temperature Change (Range): 100 degrees F.

F. Air Infiltration: Provide metal-framed skylights with maximum air leakage of 0.10/cfm/sq. ft. of surface when tested in conformance with ASTM E283 at a minimum static-air-pressure differential of 6.24 lbs/sq. ft. when glazing at perimeter sill is silicone flush glazed. Maximum air leakage shall be 0.06 at 6.24 lbs/sq. ft. if glazing at perimeter sill capped.

G. Water Penetration: Provide metal-framed skylights that do not evidence water penetration when tested in conformance with ASTM E330 and ASTM E547 at a minimum differential static pressure of 20 percent of positive design wind load, but not less than 12 lbs/sq. ft.

1.5 SUBMITTALS

A. Submit in accordance with Division 1, Section 01 33 00 – Submittal Procedures.

B. Product Data: Submit manufacturer’s product data including construction details, material descriptions, dimensions and profiles of components, and finishes of metal-framed skylights.

C. Shop Drawings: Submit detailed Shop Drawings, sealed and signed by a professional engineer with the qualifications specified below, for metal-framed skylights including plans, elevations, sections, details, and attachments to other Work.

D. Samples for Initial Selection: Manufacturer’s color charts showing full range of colors available for factory-finished aluminum.

E. Samples for Verification: Provide finish sample on pieces of 2 inch by 3 inch aluminum sheets.

F. Installer Certificates: Provide installer certificate signed by the manufacturer that installer complies with the requirements of the manufacturer of the skylight system.

G. Product Test Reports: Provide test reports from a qualified testing agency indicating that skylights are in conformance with tests specified in this Section based on testing of current products specified.

H. Sealant Compatibility and Adhesion Test Reports: Provide from sealant manufacturer test reports indicating that materials forming joint substrates and joint sealant backings have been tested for compatibility and adhesion to sealants. Include sealant manufacturer’s interpretation of test results for sealant performance and recommendations for primers and substrate preparation required for adhesion.

I. Field Test Reports: Not required.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is certified by the manufacturer of the skylight system to be installed and has a minimum of 5 years of experience in the installation of engineered metal-framed skylight systems similar to the system specified in this Section.
B. Professional Engineer Qualifications: A professional engineer, registered in the State of California, who is experienced in providing engineering services for skylight systems similar to the system specified in this Section.

C. Pre-construction Testing: Not required.

D. Pre-construction Sealant Compatibility and Adhesion Testing: Not required.

E. Welding: Provide trained personnel and procedures in conformance with the requirements of AWS D1.2.

1.7 PROJECT CONDITIONS

A. Field Measurements: Where metal-framed skylights are indicated to adjoin and attach to other construction or framing members, verify dimensions of other construction and framing members by field measurements before fabrication and indicated measurements on Shop Drawings. Coordinate fabrications schedule with construction progress to avoid delaying the Work.

   1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating the skylights without field measurements. Coordinate construction to ensure actual dimensions correspond with established dimensions.

1.8 WARRANTY

A. Warranty: Provide written warranty, executed by the metal-framed skylight manufacturer agreeing to repair or replace components of metal-framed skylights that fail in materials or workmanship within the specified warranty period. Failures include:

   1. Structural failure.
   2. Sealant failure.
   3. Failure of systems to meet performance requirements and specified in this Section.
   4. Deterioration of metals, metal finishes, and other materials that comprise or are associated with the metal-framed skylight system.
   5. Water leakage is defined as uncontrolled water appearing on normally exposed interior surfaces of skylights from sources other than condensation resulting from defects in skylight materials or workmanship. Water controlled by flashing and gutters that drained back to exterior and that cannot damage adjacent materials or finishes is not water leakage. Water leakage resulting from improper installation is not part of this warranty.
   6. Warranty Period: 5 years from date of shipment from metal-framed skylight manufacturer.

PART 2- PRODUCTS

1.1 MANUFACTURERS
A. Proprietary Products: Use of manufacturer’s proprietary product names to designate materials and finishes is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer’s material data that indicates compliance with the requirements of Part 1 of this Section.

B. Basis of Design for Metal-Framed Skylights: Wasco Horizon Canopy System aluminum-framed classic extended pyramid skylights as manufactured by:

Wasco Products, Inc.
22 Pioneer Avenue
PO Box 351
Sanford, Maine 04073
Phone: 800-388-0293
Fax: 207-490-5270
Email: sales@wascoproducts.com
Internet: www.wascoproducts.com

1. Product: Wasco Classic System Model C-PYH meeting the following requirements:
   a. Size: As indicated on the Plans.
   b. Pitch: As indicated on the Plans.

2. or Equal.

2.2 FRAMING MATERIALS

A. Framing Members: Extruded aluminum alloy 6063-T5 or T6 in conformance with ASTM B221 with minimum effective thickness of 0.109 inches.

B. Exterior Pressure Caps: Extruded aluminum alloy 6063-T5 or T6 in conformance with ASTM B221 with minimum effective thickness of 0.090 inches.

C. Concealed Flashing: Manufacturer’s standard corrosion-resistant, non-staining, non-bleeding flashing, compatible with adjacent materials. Provide separation between dissimilar metals to prevent corrosion and galvanic action as specified in this Section.

D. Exposed Flashing and Closures: Aluminum sheet alloy and temper of 1100-H4, thickness as required for proper performance as indicated below:

1. Minimum Thickness at Apron Flashings: 0.032 inch.
2. Minimum Thickness at Closures: 0.062 inch.

E. Fasteners and Accessories: Manufacturer’s standard corrosion-resistant, non-staining, non-bleeding fasteners and accessories compatible with adjacent materials. Provide separation between dissimilar metals to prevent corrosion and galvanic action as specified in this Section.

1. Aluminum Retaining Cap Fasteners and Framing Member Fasteners: Conform to ASTM A193 using Series 300 stainless steel screws of type recommended by skylight manufacturer.
2. Connections to Supporting Structure: Series 300 stainless steel.

F. Framing System Sealants: Single-component, non-sag, high performance, non-priming, gun-grade elastomeric polyurethane sealant furnished by the skylight manufacturer.

1. Sealant: Conform to ASTM C920: Type S, Grade NS, Class 25, use T, NT, M, A, G, and O.

2. Sealant shall conform to USDA approval standards.


G. Bituminous Paint: Cold-applied asphalt mastic paint in conformance with SSPC-12, except containing no asbestos, and formulated for 30-mil thickness per coat.

H. Flashing Sealant: Single-component, non-sag, high performance, non-priming, gun-grade elastomeric polyurethane sealant furnished by the skylight manufacturer.

1. Sealant: Conform to ASTM C920: Type S, Grade NS, Class 25, use T, NT, M, A, G, and O.

2. Sealant shall conform to USDA approval standards.


2.3 GLAZING MATERIALS

A. Polycarbonate Glazing: Refer to Division 3.1, Section 08 84 00 – Plastic Glazing.

B. Glazing Gaskets: Manufacturer’s proprietary pressure-glazing gaskets of elastomer type and hardness selected by skylight manufacturer to comply with requirements. Glazing gaskets to be made of extruded thermoplastic elastomer by the skylight manufacturer.

C. Spacers, Edge Blocks, and Setting Blocks: Skylight manufacturer’s standard permanent non-migrating type of elastomer type and hardness as recommended by the manufacturer to comply with requirements of the glazing installation.

D. Glazing Weatherseal Sealant: Neutral-curing silicone sealant recommended by the skylight and sealant manufacturers for the use specified.

1. Sealant shall be capable of withstanding 50 percent movement in both extension and compression (total of 100 percent movement) when tested for adhesion and cohesion under maximum cyclic movement in conformance with ASTM C719.

2. Sealant: Conform to ASTM C920: Type S, Grade NS, Class 25, use NT, A, G, and, as applicable to substrates including other sealants in contact use O.


2.4 FABRICATION

A. Fabricate framing components, as follows:

1. Factory fit and assemble components to greatest extent possible, before finishing.
2. Fabricate components that, when assembled, have accurately fitted joints and ends coped or mitered or produce hairline joints free of burrs and distortion.

3. Fabricate components to drain water passing joints and to drain condensation and moisture occurring or migrating within the skylight system to the exterior.

4. Fabricate components to accommodate expansion, contraction, and field adjustment, and to provide for minimum clearance and shimming at skylight perimeter.

5. Fabricate components to ensure that glazing is thermally and physically isolated from framing members.

6. Form shapes with sharp body profiles, straight and free of defects or deformations, before finishing.

7. Fit and secure joints by heliarc welding.

8. Reinforce members as required to retain fastener threads.

9. Attach retainer bars with gasketed stainless steel fasteners spaced at maximum of 12 inches on center.

10. Weld components before finishing in concealed locations to the greatest extent possible to minimize distortion.

B. Prepare framing to receive anchor and connection devices and fasteners.

C. Factory Glazing: Locate and size extruded elastomeric setting blocks and spacers in conformance with glazing manufacturer's instructions and recommendations.

2.5 ALUMINUM FINISHES

A. General: Comply with NAAMM's “Metal Finishes for Architectural and Metal Products” for recommendations for applying and designating finishes.

B. Use finish designations prefixed by “AA” to ensure compliance with the system established by the Aluminum Association for designating aluminum finishes.

C. Mill Finished Baked Enamel: Conform to AAMA 2604.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions with installer present to verify conformance with requirements for installation tolerances and other conditions affecting skylight performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect metal as follows:
1. Where aluminum will contact dissimilar metals, protect against galvanic action and corrosion by painting contact surfaces with primer or by applying sealant or tape as recommended by the manufacturer for this purpose.

2. Where aluminum will contact concrete or masonry, protect against corrosion by paint contact surfaces with bituminous paint as specified in this Section.

### 3.3 INSTALLATION

**A. General:** Comply with metal-framed skylight manufacturer’s written instructions for protecting, handling, and installing skylight components.

1. Fit frame joints to produce hairline joints free of burrs and distortion.
2. Rigidly secure non-movement joints.
3. Accommodate thermal and mechanical movements.
4. Install framing components to drain water passing joints and to drain condensation and moisture occurring or migrating within the skylight system to the exterior.
5. Coordinate installation of flashings at skylight perimeters to maintain continuity of water barriers.

**B. Erection Tolerances:** Install skylight components true in plane, accurately aligned, and without warp or rack. Adjust framing in conformance with the following tolerances:

1. Variation from Plane: Limit variation from plane or location shown on the approved Shop Drawings to 1/8 inch in 10 feet and 1/4 inch over total length.
2. Alignment: Where surfaces abut in line and at corners, and where surfaces are separated by less than 3 inches, limit offset from true alignment to less than 1/32 inch; otherwise limit offset from true alignment to 1/8 inch.

**C. Field Glazing:** Locate and size extruded elastomeric setting blocks and spacers in compliance with the glazing manufacturer’s recommendations.

**D. Install secondary sealant weatherseal in compliance with sealant manufacturer’s written instructions to provide weatherproof seals.**

### 3.4 CLEANING

**A. Clean skylights, inside and outside, immediately after sealants have cured in compliance with the manufacturer’s written instructions and recommendations.**

1. Remove temporary protective coverings and strippable coatings from prefinished metal surfaces and glazing material. Remove labels and markings from all components.

**B. Remove excess sealant in accordance with sealant manufacturer’s written instructions.**

**C. Final and subsequent cleaning is by others, following skylight manufacturer’s and glazing manufacturer’s written instructions.**

END OF SECTION
SECTION 08 84 00

PLASTIC GLAZING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Mar and UV-resistant polycarbonate plastic glazing at canopy roof panels, wall panels, and windscreens.

B. Accessories and materials for installation of plastic glazing.

C. Vandal-resistant film.

1.2 RELATED SECTIONS

A. Division 3.1, Section 05 50 00 Metal Fabrications

B. Division 3.1, Section 08 63 00 Metal-Framed Skylights

1.3 REFERENCES

A. American National Standards Institute (ANSI):


B. ASTM International (ASTM):

   2. ASTM D635 Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position

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9. ASTM D2843 Standard Test Method for Density of Smoke from the Burning or Decomposition of Plastics


13. ASTM E313 Standard Practice for Calculating Yellowness and Whiteness Indices from Instrumentally Measured Color Coordinates


15. ASTM G154 Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials

C. Bombardier SMP 800-C: Toxic Gas Generation


1.4 SYSTEM DESCRIPTION

A. Design requirements for installed plastic glazing systems:

1. Windload Resistance: Applicable uniform and unbalanced positive and negative wind pressure corresponding to Exposure C, 70 mph wind velocity, importance factor 1.00

2. Uplift resistance: Provided by plastic glazing supplier.

3. Air infiltration: (not applicable)

4. Water infiltration: (not applicable)

5. Flammability rating: CC1

B. Performance requirements for plastic glazing: Conforming to the requirements of 16 CFR 1201, ANSI Z97.1, and the following:

1. Weather resistance, when tested for 3500 hours in accordance with ASTM G154.
   a. Light transmission: Change not to exceed 2 percent.
   b. YI: Change not to exceed a delta of 2.
   c. Percent haze: Change not to exceed 3 percent.

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d. Coating Integrity: Intact after testing period.

2. Abrasion resistance after 500 hours QUV weathering, when tested for 100 cycles with 500-gram CS10F wheel in accordance with ASTM D1044: Change in haze 5.0 percent maximum.

3. Coefficient of expansion, when tested in accordance with ASTM D696: 3.75 X 10-5 inch/degree C.

4. Modulus of elasticity, when tested in accordance with D790: 340,000 pounds per square inch.

5. Flexural strength, when tested in accordance with D790: 13,500 pounds per square inch.

6. Impact resistance, when tested in accordance with Drop Dart Impact Test: 200 foot-pounds for 1/4-inch sheet.

7. Deflection temperature, when tested in accordance with ASTM D648: 270 degrees F. at 264 pounds per square inch.

8. Flammability, when tested in accordance with ASTM D635: CC1 Flame Rated.

9. Self Ignition temperature, when tested in accordance with ASTM D1929: Greater than 1000 degrees Fahrenheit.

10. Smoke density, when tested in accordance with ASTM D2843: Maximum 75.

11. Allowable continuous service temperature: Maximum 180 degrees Fahrenheit.


1.5 SUBMITTALS

A. Submit in accordance with Division 1, Section 01 33 00 – Submittal Procedures.

B. Product Data: Submit manufacturer’s descriptive literature for each glazing type specified, including documentation for code compliance and performance compliance as required in these Specifications. Include descriptive literature for recommended installation accessories and glazing techniques.

C. Samples Submittals:

1. Verification samples: Four (4) samples, 6-inches square (minimum size), representing actual color and finish of products to be installed.

2. Security screw fasteners.

D. Quality Control Submittals:

1. Design Data: System analysis by manufacturer verifying conformance of plastic glazing assemblies to specified design requirements. Include details of glazing edge engagement and allowance for anticipated thermal movements.
2. Manufacturer’s Qualifications: Documentation of specified manufacturer’s qualifications as required under “Quality Assurance” of this Section.

E. Closeout Submittals

1. Operation and maintenance data: Printed instructions on recommended cleaning and maintenance materials and methods.

1.6 QUALITY ASSURANCE

A. Manufacturer’s Qualifications:

1. Minimum 5 years experience producing plastic glazing products.

2. Minimum 5 years in-house coating experience.

3. Minimum 5 years completed projects on which manufacturer has supplied plastic glazing, similar in type and scope to this project. Each completed project to be minimum of 5 years old.

B. Mock-up: Provide full-scale mock-up of water diverter and plastic glazing panel as shown on the Plans for testing of water diversion performance. Mock-up may be constructed with materials other than the polycarbonate specified in this Section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store products of this section with manufacturer’s protective film intact.

B. Maintain storage area in accordance with plastic glazing manufacturer’s instructions until installation of products.

C. Do not slide, drag, or drop polycarbonate sheets.

1.8 WARRANTY

A. Manufacturer’s Warranty: 10 years warranty against breakage, yellowing or loss of light transmission, abrasion, and coating delamination.

1.9 EXTRA MATERIALS

A. Provide 1 additional vertical glazing panel of each size appropriately labeled and securely packaged for storage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Proprietary Products: Use of manufacturer’s proprietary product names to designate materials and finishes is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer’s material data that indicates compliance with the requirements of Part 1 of this Section.

B. Basis of Design for Polycarbonate Sheets:
2.2 MATERIALS

A. Vertical glazed surfaces: Solid polycarbonate sheets as manufactured by Sheffield Plastics with UV, abrasion-resistant, and graffiti-resistant hardcoat surface treatment both sides.

1. Sheet thickness: 0.375 inches.

2. Color: Clear A00

3. Light Transmission: 100 percent in accordance with ASTM D1003.

B. Horizontal (roof) surfaces: Solid polycarbonate sheets as manufactured by Sheffield Plastics with UV, abrasion-resistant, and graffiti-resistant hardcoat surface treatment both sides - smooth one side and textured one side.

1. Sheet thickness: 0.375 inches.

2. Color: Clear A00

3. Light Transmission: 100 percent in accordance with ASTM D1003
B. Vandal Resistant Film: “Scotchguard” Multi-layer protective film as manufactured by 3M Industrial Adhesives and Tape Division.

1. Layers per sheet: 4
2. Size: As indicated on the Plans. (Maximum Size: 72 inches by 60 inches)
3. Adhesion to Polycarbonate: 28 oz/in.
4. Clarity: 96 percent.
6. Haze Percentage: 3 percent.

2.3 ACCESSORIES

A. Neoprene “U” gaskets and blocks.

B. Glazing tape: 3M VHB Tape 4947, black double-coated conformable pressure sensitive acrylic foam tape, thickness: 0.045 inches.

C. Supply installation accessories specified in plastic glazing manufacturer’s instructions for indicated installation conditions.

D. Attachment: Countersunk galvanized or stainless steel security screws, painted to match steel finish coat as specified in Division 3.1, Section 09 96 00 – High Performance Coatings. Use coating system for screws that is compatible with screw finish.

E. Sealants: As specified by the polycarbonate sheet manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify prepared openings are in accordance with recommendations of polycarbonate sheet manufacturer.

B. Verify openings are correctly sized and within tolerances.

C. Verify surface of glazing channels and recesses are clean, free of obstructions and ready to receive plastic sheet material.

3.2 PREPARATION

A. Clean contact surface with compatible solvent and wipe dry.

B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.

C. Measure openings: determine recommended edge engagement and expansion allowance.

D. Cut sheets to exact size required with clean edges free of notches.
3.3  ERECTION / INSTALLATION / APPLICATION

A.  Install glazing in accordance with instructions of polycarbonate sheet manufacturer. Use only glazing accessories approved by sheet manufacturer.

B.  Immediately prior to installation, expose sheet edges only by removing protective masking to sufficiently facilitate installation in framing members.

C.  Install polycarbonate sheets. At roof, install textured side down.

D.  After completion of all installation operations and immediately prior to cleaning, remove remainder of protective masking form both sides of sheet. Do not expose masking to sunlight for an extended period of time.

3.4  CLEANING

A.  Clean polycarbonate sheet in accordance with instructions of polycarbonate sheet manufacturer. Use only procedures and cleaning agents approved by the glazing manufacturer.

B.  Clean surfaces generally as follows:
   1.  Rinse with lukewarm water.
   2.  Wash with mild soap and lukewarm water.
   3.  Use soft cloth or sponge and gently wash to loosen dirt and grim.
   4.  Repeat rinse. Dry with soft cloth until dry and spotless.
   5.  Scrubbing and use of squeegees is not permitted.

3.5  PROTECTION OF INSTALLED PRODUCTS

A.  Do not remove strippable protective coating from installed glazing until Substantial Completion. If masking is removed, tape polyethylene or other approved covering to framing members to protect polycarbonate sheets from damage.

B.  Clean glazing in accordance with plastic glazing manufacturer’s instructions. Scrubbing glazed surfaces, or using squeegees on glazing surfaces is not permitted.

3.6  INSTALLATION OF VANDAL-RESISTANT FILM

A.  After complete installation and cleaning of polycarbonate glazing material, install 3 layers of vandal-resistant film on both sides of the polycarbonate glazing using methods, tools, and solutions in conformance with film manufacturer’s instructions and recommendations.

END OF SECTION
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SECTION 09 96 00

HIGH PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Specifications for finishing and applying factory and field finish painting work as indicated on the Plans and as listed below:

1. Coating system for exposed steel.

2. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming, and finish coats specified in other Sections of these Specifications.

B. Items not included in this Section:

1. Paints and coatings for site furniture, see Division 3.1, Section 12 93 00 – Site Furnishings.

2. Factory-prefinished items as specified in other Sections. Coordinate shop primed coating with field finishes.

3. Painting specified elsewhere and included in respective Sections, including shop priming.

C. Paint exposed surfaces, except where this Section indicates that the surface of material is not to be painted or is to remain natural. If an item or a surface is not specifically mentioned, paint the item or surface the same as similar adjacent materials or surfaces. If color is not indicated, the A/E will select the color.

D. Do not paint prefinished items, concealed surfaces, finished metal materials, operating parts, and labels.

1.2 RELATED SECTIONS

A. Division 3.1, Section 05 12 00 Structural Steel Framing

B. Division 3.1, Section 05 50 00 Metal Fabrications

C. Division 3.1, Section 05 52 00 Metal Railings

D. Division 3.1, Section 10 14 00 Signage

1.3 REFERENCES

A. ASTM International (ASTM) (latest revision):

1. ASTM D16 Standard terminology for Paint, Related Coatings, Materials, and Applications

2. ASTM D6386 Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting

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B. The Society for Protective Coatings (SSPC):

1. SSPC-SP 1 - Solvent Cleaning
2. SSPC-SP 7 - Brush-Off Blast Cleaning
3. SSPC-SP10 - Near White Metal Blast Cleaning

1.4 DEFINITIONS

A. “Paint” as used in these specifications means all coating system materials, including primers, emulsions, enamels, stains, sealers, fillers, and other applied materials whether used as prime, intermediate, or finish coats. A “paint system” is defined to be all coats of all materials applied to any given material or substrate.

B. Standard Coating terms defined in ASTM D16 apply to this Section.

C. Full gloss refers to a high-sheen finish with a gloss range of more than 70 when measured at a 60-degree meter.

D. Shop Priming: Unless otherwise specified, shop priming of ferrous metal items is included under various Division 3.1, Sections of 05 12 00 - Structural Steel Framing and Division 3.1, Section 05 50 00 – Metal Fabrications.

E. Pre-Finished Items: Unless otherwise indicated, do not include painting when factory finishing or installer finishing is specified for these items.

F. DFT: Dry Film Thickness, MDFT: Minimum Dry Film Thickness

1.5 SUBMITTALS

A. Submit in accordance with Division 1, Section 01 33 00 – Submittal Procedures.

B. Product Data

1. Submit manufacturer’s technical information, including paint label analysis and application instructions, for each material proposed to be used.

C. Samples

1. Using materials conforming to the requirements of the Plans and these Specifications, prepare and submit 6-inch by 6-inch samples of each color and paint finish. Submit 4 samples of each color.

2. Sample Panels: Finish and fully paint one complete surface area on the Project, for each finish material and color scheme called for on the Plans and these Specifications. Obtain the approval of A/E for conformance to the color and finish. All subsequent work on the Project shall be of the same or higher standard of quality as the approved area.

D. Quality Control Submittals

1. Applicator’s Qualifications: Documentation of specified applicator’s qualifications as required under “Quality Assurance” of this Section.
1.6 QUALITY ASSURANCE

A. Single Source Responsibility:
   1. To the maximum extent practicable, select a single manufacturer to provide all materials required by this Section, using additional manufacturers to provide systems not offered by the selected principal manufacturer. If more than one quality of a product is available, use material of highest quality.
   2. For each individual system:
      a. Provide primer and undercoat paint produced by same manufacturer as finish coat.
      b. Use only thinners approved by coating manufacturer, and use only within recommended limits.

B. Coordinate factory applied finishes for compatibility with specified field finishes.

C. Unsuitability of Specified Products:
   1. Claims concerning unsuitability of any material specified (or inability to satisfactorily produce the Work) will not be considered, unless such claim is made in writing to the A/E before the Work is started.

D. Applicator:
   1. Firm with not less than 5 years of successful experience in painting work similar in scope to work of this Project.

E. Field Quality Control:
   1. Request review by the A/E for color, texture, and workmanship.
   2. Selected texture and colors shall be modified, if requested by the A/E, to achieve the desired results in conformance with the Plans and these Specifications.
   3. Use acceptable samples as the Project standard for each color and texture.

F. Regulatory Requirements:
   1. Paints and coatings shall comply with the latest regulations of the State of California Air Resources Board and the local air quality district applicable to the geographic area where the project is located.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling, and Unloading
   1. Deliver paint materials to the job site in their original, unopened containers bearing the following information: manufacturer and material, stock number and date of manufacture, contents by volume for major pigments and vehicle constituents, thinning and application instructions, color name and number, and VOC content.
2. Materials that are potentially hazardous to human life shall be noticeably labeled, identifying the potential hazard and emergency treatment procedures.

3. Perform allowable field mixing, cleaning of painting equipment, and other related work in a separate paint preparation facility.

B. Storage and Protection

1. Store paint materials and equipment in a separate enclosed facility provided specifically for such storage. The storage facility shall conform to requirements of applicable jurisdictional agencies. Do not store materials or equipment in any portion of any structures or enclosures being constructed as part of the Work of this Project.

2. Storage environment shall comply with manufacturer’s specifications. If no specifications are provided, store materials at ambient temperature of 45 degrees Fahrenheit minimum and 90 degrees F. maximum, in a well ventilated area.


4. Take all precautionary measures to prevent fire and health hazards.

1.8 PROJECT / SITE CONDITIONS

A. Comply with coating manufacturer’s recommendations for environmental conditions under which paint and paint systems shall be applied. Do not apply paint products while the surface to receive the paint or coating material is subject to rain, fog, mist, extreme humidity exceeding 85%, or surface temperatures less than recommended by coating manufacturer. Ensure proper, at least 6 air changes per hour, ventilation during painting and curing operations.

B. Remove from the job site on a daily basis, empty containers, rags, and other debris of the work of this Section. Ensure that storage is neat, clean, and orderly.

C. Contractor shall be fully responsible for the controlling of over-spray and work environment during the application of all field applied paints. Follow manufacturer’s recommendations for field spray applied coatings. Protect adjacent surfaces and in-place construction during field applied spray application. Do not spray apply paint in moderate or high wind conditions. Contacto shall control over-spray and protect adjacent properties including pavement, buildings, structures, vehicles, landscape, and furnishings while applying paint in the field.

D. Apply paint only with a minimum of 50 foot-candles light provided at all surfaces.

E. Provide barriers during painting and curing operations.

1.9 SEQUENCING

A. Submit and obtain approval of finish system for steel early in project to ensure sufficient time to submit primer under Division 3.1, Section 05 12 00 – Structural Steel Framing that is coordinated with finish coats specified in this Section.

PART 2 - PRODUCTS

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2.1 ACCEPTABLE MANUFACTURERS

A. Proprietary Products: Use of manufacturer’s proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer’s material data and certificates of performance for proposed substitutions.

B. Products of the following manufacturers, or approved equal:

1. Tnemec Company Incorporated
   6800 Corporate Drive
   Kansas City, MO 64120-1372
   800-863-6321

C. Primers, intermediate, and finish coats in each paint system shall be the products of the same manufacturer, including any thinners or coloring agents.

2.2 MATERIALS

A. Provide undercoat paint produced by the same manufacturer as the finish coats. Use thinners approved by the paint manufacturer, and use only to recommended limits.

B. Use primers and undercoats that are suitable for each surface to be covered and that are compatible with the finish coat required.

C. Use products of the same manufacturer for succeeding coats where shop primed materials are to be finish painted and prime coat materials are by a different manufacturer than the finish coat materials. Confirm compatibility of the primers with the manufacturer of the finish coat paints.

D. Materials for undercoats and finish coats of paint shall be ready-mixed and shall not be changed, except for thinning of undercoats (when required), reinforcing or coloring, any of which shall be in conformance with the recommendations of the manufacturer.

E. Dry Film Thickness (DFT) and Minimum dry film thicknesses (MDFT), in mils, and the number of coats required to obtain that thickness shall be in conformance with the recommendations of the paint manufacturer of each system.

2.3 ACCEPTABLE PAINT SYSTEMS FOR EXTERIOR FERROUS METALS

A. Tnemec System:

1. Coordinate with Division 3.1, Sections of 05 12 00 - Structural Steel Framing and Division 3.1, Section 05 50 00 – Metal Fabrications of these Specifications for surface preparation and shop priming.

2. Surface Preparation: Conform to SSPC-SP10, Near White Blast Cleaning.

3. Shop Prime: One coat, Tnemec Series 90-97 Tnemec-Zinc at 2.0 to 3.5 mils MDFT.

4. On-site Intermediate Coat: One coat, Tnemec Series V69 Epoxoline at 3.0-5.0 mils MDFT
5. On-site Finish Coat: One coat, Tnemec Series1080 Endura-Shield Waterborne Acrylic Polyurethane at 3.0 to 5.0 mils MDFT. Multiple coats may be required to achieve the specified finish color.

6. Finish: Gloss

7. Color of Finish Coat: TBD

B. Or equal systems.

2.4 ACCEPTABLE PAINT SYSTEMS FOR GALVANIZED METALS

A. Tnemec System

1. On-site Undercoat Coat: One coat, Tnemec Series V69 Epoxoline at 2.5 to 3.0 mils DFT. Color to be the same color as the finish coat.

2. On-site Finish Coat: One coat, Tnemec Series1080 Endura-Shield Waterborne Acrylic Polyurethane at 2.0 to 3.0 mils DFT. Multiple coats may be required to achieve the specified finish color.

3. Finish: Gloss

4. Color of Finish Coat: TBD.

B. Or equal systems.

1. Proprietary Products: Use of manufacturer’s proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer’s material data and certificates of performance for proposed substitutions.
A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible, because of size, weight, configuration, or obstruction; provide surface-applied protection before surface preparation and painting.

1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.

2. Remove any surface-applied protection.

B. Cleaning: Before applying paint or other surface treatments, clean substrates of substances that could impair bond of the various coatings. Remove oil and grease before cleaning.

1. Schedule cleaning and painting, so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

C. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.

1. Provide barrier coats over incompatible primers or remove and reprime.

2. Ferrous Metals: Clean ungalvanized ferrous-metal surfaces that have not been shop coated and remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with SSPC's recommendations.
   a. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
   b. Clean according to manufacturer's instructions. Touch up bare areas and shop-applied prime coats that have been damaged.

3. Galvanized Surfaces: Clean all surfaces in compliance with SSPC-SP1 (Solvent Cleaning) using non-petroleum based solvents, and abrasive sweep blasting in compliance with SSPC-SP7 (Brush-off Blast Cleaning and ASTM D6386, Section 5.4.1. Provide a profile of 1.0 to 1.5 mils. Galvanized surfaces with non-should be free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated for coil stock by mechanical methods.

D. Material Preparation: Mix and prepare paint material according to manufacturer’s written instructions.

1. Maintain containers used in mixing and applying a paint in a clean condition, free of foreign materials and residue.

2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.

3. For thinner requirements, refer to Article entitled “Quality Assurance” under “Single Source Responsibility” these Specifications.

3.3 APPLICATION
A. General: Apply paint in accordance with manufacturer’s written instructions. Use applicators and techniques best suited for substrate and type of material being applied.

1. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.

2. Provide finish coats that are compatible with primers used.

3. Extend coatings into exposed surfaces, as required, to maintain system integrity and provide desired protection.

4. For galvanized metal, verify with manufacturer the appropriate surface preparation instructions.

B. Scheduling Painting Application:Apply first coat to surfaces that have been cleaned, pre-treated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

1. The number of coats and film thickness required are the same regardless of application method. Do not apply succeeding coats until previous coat has cured as recommended by the manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer’s written instructions, sand between each application.

2. Omit primer over metal surfaces that have been shop primed and touched up painted.

3. If undercoats, stains, or other conditions show through final coat of paint; apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure that edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of adjacent flat surfaces.

4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried, feels firm to the touch, and does not deform or feel sticky under moderate thumb pressure; and until application of another coat of paint does not cause the preceding coat to lift or lose adhesion.

C. Application Procedures: Apply paints and coatings by spraying equipment, brush, roller, or other applicators according to manufacturer’s written instructions.

D. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer’s recommended spreading rate to achieve dry film thickness indicated. Provide total dry film thickness of the entire system as recommended by manufacturer.

E. Electrical Work: Paint any, non-prefinished exposed conduit and electrical boxes to match adjacent metal work.

F. Prime Coats: Before applying finish coats, apply a prime coat as recommended by manufacturer to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in the first coat appears to ensure a finish coat with no burn-through or other defects due to insufficient sealing.

G. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness,
spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surfaces imperfections will not be acceptable.

H. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not in compliance with requirements.

3.4 CLEANING

A. Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from Project site.

1. After completing painting Work, clean glazed and paint-spattered surfaces. Remove spattered paint without scratching or damaging the affected surface or adjacent surfaces.

3.5 PROTECTION

A. Protect work of other trades, whether receiving paint or not, against damage from painting. Correct damage by cleaning, repairing, or replacing; and repainting as required by the A/E.

B. Provide "Wet Paint" signs to protect newly painted surfaces. After completing painting operations, remove temporary protective wrappings provided by the painting contractor or by others to protect their work.

1. After work of other trades is complete, touchup and restore damaged or defaced surfaces resulting from the painting Work.

END OF SECTION
SECTION 09 96 33

GRAFFITI-RESISTANT COATINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Graffiti-resistant coatings

1.2 RELATED SECTIONS

A. Division 3.1, Section 08 84 00 – Plastic Glazing: For vandal resistant film on polycarbonate

B. Division 3.1, Section 32 17 26 – Tactile Warning Surfacing

1.3 SUBMITTALS

A. Submit in accordance with Division 1, Section 01 33 00 – Submittal Procedures.

B. Manufacturer’s Data: Submit manufacturer’s product data, including analysis of coatings, performance, and application instructions. Include manufacturer’s recommended graffiti-removal procedures and products.

C. Samples: Submit samples of graffiti-resistant coating applied to 8 inch by 10 inch samples of each type of concrete finish specified for the Project.

1.4 QUALITY ASSURANCE

A. VOC Regulations: Graffiti-resistant coating shall comply with the Bay Area Air Quality Management District regulations governing permissible content of volatile organic compounds (VOC).

B. Manufacturer’s Qualifications: Graffiti-resistant coatings shall be furnished by a manufacturer specializing in the manufacture of graffiti-resistant coatings.

C. Applicator’s Qualifications: Graffiti-resistant coatings shall be applied by a licensed applicator approved by the manufacturer furnishing the materials.

D. Coating Manufacturer’s Representative and Approval Service:

1. The Contractor shall make arrangements with the coating manufacturer to provide on-site consultation and inspection services to ensure the proper applications and completion of the graffiti-resistant coatings system.

2. The coating manufacturer’s representative shall be present at the time any phase of the work is started. Graffiti-resistant coatings shall be applied only over surfaces previously approved by the coating manufacturer’s representative.

3. Contractor shall provide the graffiti-resistant coating manufacturer’s representative’s approval of coating applications to the A/E.

1.5 MOCK-UP
A. Before beginning application of the coating system, provide sample mock-up applications, measuring 3 feet by 4 feet, at conspicuous locations, on each different substrate. Also provide a mock-up of pre-cast concrete walking deterrent dome, as specified in Division 3.1, Section 32 17 26 – Tactile Warning Surfacing, with coating system applied. Coordinate mock-up location with the A/E for review and testing.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the project site in new, unopened containers with the following information:

1. Manufacturer’s Name.
2. Product Data.
3. Application Instructions.

B. Store materials and equipment in a properly ventilated, designated storage space. Temperature of storage area shall not be less than 45 degrees F and shall not exceed 90 degrees F.

1.7 ENVIRONMENTAL CONDITIONS

A. Apply coatings only when the temperature of surfaces to receive coatings and surrounding air temperatures are between 50 degrees and 90 degrees F, unless otherwise permitted by the coating manufacturer’s printed instructions.

B. Do not apply coatings during periods of fog, mist, and rain, or when rain is imminent.

PART 2 - PRODUCTS

2.1 GRAFFITI-RESISTANT COATINGS

A. Graffiti-resistant coatings, base or prime coat and finish coats, shall be two-component, polymer-based, non-sacrificial product. The finished coating shall be stable, colorless, transparent, low sheen (satin or flat), water soluble product.

B. Coatings shall be weather and rain resistant, abrasive resistant, peel resistant, ultra-violet light resistant, non-yellowing, and shall permit vapor relief.

C. Graffiti-resistant coatings shall be capable of having all types of paints and graffiti materials completely removed without damaging the uncoated surfaces to which they are applied. Coatings that require re-application in areas that have been repeatedly cleaned will be acceptable. Re-application shall not require removal of coating.

D. Products required to remove graffiti from the coating shall be non-toxic and shall comply with the herein applicable VOC regulations. Removal of graffiti shall cause no damage or change in appearance of the treated surface.

E. Coatings shall be products manufactured specifically for protection of surfaces against graffiti vandalism. Products require review and approval by the A/E before they may be purchased for use in the work of this Section.

PART 3 - EXECUTION
3.1 CONDITION OF SUBSTRATE

A. Examine the areas and conditions under which the graffiti-resistant coating work is to be performed.

B. Do not apply coating system over surface contaminants such as dust, dirt, oils, and loose substrate.

C. Verify that pH of concrete substrate is within coating manufacturer’s requirements using a test method acceptable to coating manufacturer. Any action required to ensure pH of substrate is acceptable, including delaying application until substrate has further cured, shall be the responsibility of the Contractor.

3.2 COATINGS PREPARATION AND MIXING

A. Prepare and mix materials in accordance with the coating manufacturer’s instructions and recommendations.

B. Remove any skins that form on surface of material prior to moving containers, mixing, or applying.

C. Stir materials before application to produce a mixture of uniform density, and stir as necessary to maintain uniform density during the application process. Do not stir surface film into material. Remove film and, if necessary, strain material before applying.

3.3 APPLICATION

A. Prepare surfaces and apply coatings in accordance with the coating manufacturer’s instructions and recommendations. Apply coatings in thickness and sequence of coats as recommended by the coating manufacturer.

END OF SECTION
SECTION 10 14 00
SIGNAGE

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Specifications of materials for and installation of Station and Off-Platform Wayfinding signage and graphics:

1. Cast Aluminum
2. Aluminum Sheet and Plate
3. Bolts, studs, and nuts
4. Steel Plate
5. Etched Zinc Plate with Grade II Braille and 1/32” Raised Letters
6. Pole Mount Ring Bracket
7. Steel Sign Posts
8. Finishes
9. Dimensional metal copy

1.2 RELATED SECTIONS

A. Division 3.1, Section 05 50 00 Metal Fabrications (for metals and associated accessories not specified in this Section but required to complete signage assemblies as well as for galvanizing of steel sign poles)

B. Division 3.1, Section 09 96 00 High Performance Coatings

C. Division 3.1, Section 12 93 00 Site Furnishings (for Visual Messaging System (VMS)

D. Division 2.1, Section 316 Off-Platform Wayfinding Signage

E. Division 2.2, Section 56-8 Off-Platform Wayfinding Signage

1.3 REFERENCE STANDARDS

A. American Architectural Manufacturers Association (AAMA):


B. ASTM International (ASTM):

1. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
3. ASTM A153  Standard Specification for Zinc-Coating (Hot-Dip) on Iron and Steel Hardware
5. ASTM B209  Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate
7. ASTM D4956  Standard Specification for Retroreflective Sheeting for Traffic Control

C. American with Disabilities Act (ADA)
D. California Code of Regulations (CCR):
   1. CCR Title 24, Part 2, California Building Code
E. Society for Protective Coatings (SSPC):
   1. SSPC SP6/NACE No.3 Commercial Blast Cleaning
F. Metropolitan Transportation Commission (MTC) Regional Transit Wayfinding Guidelines and Standards, 2012

1.4 DESIGN REQUIREMENTS

A. Seismic Design: Seismic design shall be based on the Structural Criteria indicated on the Drawings.
B. Wind Load: As indicated on the Drawings.
C. Installation accessibility: Provide for removal and easy installation of the sign face and graphics by maintenance crews.
D. Expansion/Contraction: Provide for expansion and contraction of the sign face, without bowing, warping, or exposure of light leaks, to a range of ambient temperatures from 120 degrees F to 0 degrees F.
E. Joint Design: Design and fabricate so that joints will remain true and tight under conditions of expansion and contraction of the faces.

1.5 SUBMITTALS

A. Submit in accordance with Division 1, Section 01 33 00 – Submittal Procedures.
B. Product Data: Submit manufacturer's technical data and maintenance instructions for each type of sign specified, including sign poles, mounting hardware, and retroreflective sheeting, digital printing ink.

C. Shop Drawings: Submit for approval by the Engineer fully detailed Shop Drawings of all sign components, fittings, parts, and installation procedures showing layout, jointing, and complete anchoring and supporting systems for the various applications and mounting details. Shop Drawings shall indicate sizes, thickness, finishes of materials, and shall include methods of attachment for anchoring, expansion, and sealing.

1. Show sign mounting heights according to the clearances indicated on the Drawings, locations of supports, and accessories.

2. Submit half-size laser print-outs of the layout of each sign face for approval by the Engineer. Layout shall reflect the location-specific message, type face, graphic elements for each sign face.

3. Along with the Shop Drawings, the Contractor shall submit a description of the method for executing the Work for each type of sign.

4. Sign fabrication shall not commence until the Shop Drawings have been approved by the Engineer.

D. Samples: Submit samples of color and finish of exposed materials, mounting assemblies, and accessories required for signs. Review of samples by the Engineer will be for color and texture only. When requested, furnish full-size samples of sign materials. Submit samples for approval by the Engineer of the following materials and assemblies prior to proceeding with the work:

1. Paint showing color and texture (minimum 8-inch by 10-inch plate).

2. Galvanized surfaces (minimum 4-inch by 4-inch plate).

E. Braille/raised Letter Signs:

1. Full size sample for plaque and copy in colors specified.

2. Sample will not be returned for use in Project.

F. Calculations and Details: Submit structural calculations and details, prepared and signed by a civil or structural engineer currently registered by the State of California. Indicate capacity of signage assemblies to withstand wind load and seismic requirements for all applicable mounting conditions.

G. Fabricators’ Experience: As specified under “Quality Assurance” in this Section, submit list of installations and other substantiating data that demonstrate each fabricator’s experience in the type of signage work required for the Work of this Project.

H. Contract close out:

1. Furnish appropriate checklist for aiding in reordering after Date of Substantial Completion. Maintain computer schedule program for a minimum of five years for ordering new or replacement signage.

2. Maintenance data and cleaning requirements for exterior surfaces.

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1.6 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the most current applicable provisions in ADA Accessibility Guidelines and the current California Building Code. In case of conflicting requirements, California Building Code prevails.

B. For each separate sign assembly, obtain these signs or parts from a single manufacturer. Parts or components may be from differing sources, but the part or component shall be the same throughout the Project even when installed on various types of signs.

C. Fabricator Qualifications:
   1. Minimum five years experience in the fabrication of signage of the types specified for this Project.

D. Powder-Coating Applicator Qualifications: A firm experienced in successfully applying powder coatings of type specified and employing competent control personnel to conduct continuing, effective quality control program to ensure compliance with the requirements of these specifications.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials in accordance with Division 1, Section 01 60 00 – Product Requirements and manufacturer’s instructions. Store in dry, secure location, protected against direct sunlight and excessive heat.

1.8 SEQUENCING AND SCHEDULING

A. Coordinate with other trades to assure proper and adequate provision in work of those trades for interface with the work of this specification. Coordinate schedules for installation of the work of this specification with schedules for other installations, to provide orderly progress of the total construction sequence.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum Sheeting (all C- and CU-type Signs):
   1. Aluminum Sheet and Plate: ASTM B209, alloy and temper recommended by aluminum producer and finisher for type of use and finish specified with at least the strength and durability properties of Alloy 5005-H32.
   2. Aluminum sheeting must be pretreated for corrosion resistance under ASTM B449. The surface of the aluminum sheeting must be cleaned, deoxidized, and coated with a light, tightly adherent chromate conversion coating free of powdery residue. The conversion coating must be Class 2 with a weight from 10 milligrams per square foot to 35 milligrams per square foot and an average weight of 25 milligrams per square foot. After the cleaning and coating process, protect the aluminum sheeting from exposure to grease, oils, dust, and contaminants.
   3. Aluminum sheeting must be free of buckles, warps, dents, cockles, burrs, and defects resulting from fabrication.
B. Retroreflective Sheeting (all C- and CU-type Signs):

1. Retroreflective sheeting used for background and legend must comply with ASTM D4956, such as Super Engineer Grade T-2000 manufactured by Avery Dennison, or equal.

2. Type II retroreflective sheeting must have Class 1, 2, 3, or 4 adhesive backing. The adhesive backing must be pressure sensitive and fungus resistant.

C. Process Colors and Film (all C- and CU-type Signs):

1. The type of material used for screened-process colors, nonreflective, opaque, black film, and protective overlay film must be the type recommended by the retroreflective sheeting manufacturer.

2. The fabricator must perform all patterns, layouts, and set-ups necessary for the digital printing process.

3. The completed surface of the printed sign must be flat and smooth.

4. The coefficient of retroreflection for reverse-screened-process colors used on white retroreflective sheeting must be not less than 70 percent of the coefficient of retroreflection specified in ASTM D4956 for the corresponding colored retroreflective sheeting.

5. Colors and nonreflective, opaque, black film or ink used in a digital printing process must have equivalent outdoor weatherability characteristics as the retroreflective sheeting specified in ASTM D4956. Nonreflective, opaque, black film must be an acrylic material compatible with and recommended by the retroreflective sheeting manufacturer. If a digital printing process is used, the ink applied to the retroreflective sheeting must be compatible with and recommended by the retroreflective sheeting manufacturer.

6. The retroreflective sheeting shall permit color processing with compatible transparent and opaque process inks as approved by the sheeting manufacturer.

7. Colors: As indicated on the drawings and per the MTC Transit Wayfinding Guidelines and Standards.

D. Anti-Graffiti Overlay Film (all C- and CU-type Signs):

1. Applied to both sides – Avery Dennison OL-1000 Premium Anti-Graffiti Film, or equal.

E. Steel Plate: See Division 3.1, Section 05 50 00 – Metal Fabrications for requirements.

F. Zinc Plate: Zinc plate compliant with ASTM B949 and suitable for etching of Grade II Braille and 1/32” Raised Letters and of dimensions indicated on the Drawings.

G. Bolts, Studs, and Nuts: See Division 3.1, Section 05 50 00 – Metal Fabrications for requirements.

H. Steel Pole (standalone poles): Shall confirm to ASTM A53, Type S, Grade B.
I. Perforated Steel Pole and Anchor Assembly: “Telespar” as manufactured by Tyco Electrical & Metal Products, or equal. Pole shall be 1 3/4-inch by 1 ¾-inch, 14 gauge perforated steel, conforming to ASTM A1011, Grade 50. Holes shall be 7/16-inch pre-punched holes on 1-inch centers. Determine pole length based on sign clearances indicated on the Drawings. Anchor Assembly: Heavy Duty Anchor sized to manufacturer’s recommendations and designed for foundation-less, direct embedment in concrete pavement using a drive cap and sledge, with a pneumatic hammer or by means of self-contained power equipment.

J. Perforated Steel Pole Sign Mounting Hardware: As specified on Drawings and per manufacturer’s recommendations.

K. Pole Mount Ring Brackets: As manufactured by Seton Sign Post and Accessories, or equal:
   1. Metal bracket assembly sets designed to fit 4 inch to 12 inch diameter poles.
   2. Each set shall contain two straps and hardware required to mount 1 sign.
   3. Strap or band width: 9/16 inch.

2.2 FINISHES

A. Painted Aluminum: Paint or Powder Coat, at fabricator’s option:
   1. Paint finish: Acrylic polyurethane.
   2. Powder Coat finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer’s written instructions for cleaning, conversion coating, and applying and baking finish.

B. Tactile Signs:
   1. Factory applied baked-on-acrylic polyurethane enamel, semigloss, UV inhibited.
   2. Colors: As indicated on the Drawings.

C. Galvanized and Painted Steel Sign Posts:
   1. Galvanizing: See Division 3.1, Section 05 50 00 – Metal Fabrications for requirements.
   2. Paint: See Division 3.1, Section 09 96 00 – High Performance Coatings. Color and Sheen: As indicated on the Drawings (TBD): Color and sheen shall match the canopy structure.

2.3 DIMENSIONAL METAL COPY (Station Name Sign Letters): Cast Aluminum. Paint all surfaces with two part polyurethane as specified under “Finishes” in this Specification Section.

2.4 TACTILE SIGNAGE: Text etched into zinc plate surface using a chemical etc process to produce raised numbers and letters with corresponding Grade II and pictograms on zinc sign, raised a minimum of 1/32 inch, embossed domed California grade 2 Braille minimum of 1/40 inch. Epoxy powder coat. Color: black

2.5 GENERAL FABRICATION
A. All exposed surfaces shall be true, square, and free from warping, bending, blemishes and scratches. All joints and seams in the exposed cladding shall be precise and tight fitting with no light leaks. Any exposed edges shall be painted to match the color and texture of the exposed face. All vertical and horizontal joints in the sign faces shall be true, tight, and unnoticeable. Location and frequency of joints shall be as indicated.

B. All exposed fasteners and anchors shall be painted to match adjacent surfaces.

C. All letters and pictograms shall be formed sharp and clean with no edge buildup, bleeding or burrs.

D. Weld aluminum to the applicable requirements of Division 3.1, Section 05 12 00 Structural Steel Framing Metal Welding. Comply with AWS standards for recommended practices in shop welding. Provide welds behind finished surfaces without discoloration or discoloration of exposed side. Where exposed, joints shall be ground and dressed smooth to match adjacent surfaces, so that the shape and profile of the item welded is maintained. Clean exposed welded surfaces of welding flux and dress exposed and contact surfaces.

E. Mill joints to tight, hairline fit. Form exposed joints to exclude water penetration.

F. Conceal fasteners if possible; otherwise install fasteners in inconspicuous locations.

G. Shop assemble units and apply finishes and graphics in compliance with manufacturer's standards and approved shop drawings.

H. Retroreflective Sheeting:
   1. Retroreflective sheeting must be applied to sign panels at the fabrication plant under the retroreflective sheeting manufacturer's instructions without appreciable stretching, tearing, and damage.
   2. The orientation of the legend must comply with the retroreflective sheeting manufacturer's instructions.
   3. The retroreflective sheeting on a sign panel with a minor dimension of 48 inches or less must be a single, contiguous sheet without splices except for the splices produced during the manufacturing process of the retroreflective sheeting. A sign panel with a minor dimension greater than 48 inches may have 1 horizontal splice in the retroreflective sheeting other than the splices produced during the manufacturing process of the retroreflective sheeting.
   4. Unless the retroreflective sheeting manufacturer's instructions require a different method, splices in the retroreflective sheeting must overlap by a minimum of 1 inch. The retroreflective sheeting on either side of a splice must not exhibit a color difference under incident and reflected light.

2.6 ACCESSORIES

A. Provide coatings, neoprene gaskets or tape to dissimilar materials to prevent galvanic action.

B. Use of adhesive anchors is prohibited.

2.7 PAINTING
A. Apply paint evenly without pinholes, scratches, peeling, or application marks.

B. Touch up and finish damaged surfaces of signs to match adjoining surfaces after erection of signs is complete.

2.8 SIGN INSPECTION: Signs are subject to inspection by the Engineer at the sign fabricator's plant before shipment. Notify the Engineer at least 72 hours before the time the signs will be ready for inspection.

PART 3 - EXECUTION

3.1 EXAMINATION: Examine the substrates and conditions under which the signs and poles are to be installed and verify that all Work is complete for proper installation of the signs and poles.

A. Verification of conditions:

1. Examine poles, substrates and other conditions under which the work is to be performed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with installation until unsatisfactory conditions have been corrected.

2. Verify that substrates are stable and capable of supporting the weight of signage units.

3. Verify that substrates have been adequately prepared for secure anchorage of signage units.

4. Beginning work indicates acceptance of conditions.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Protect surrounding finishes and fixtures from damage by work of this Section.

3.3 INSTALLATION

a. Install sign units and components at the locations indicated on the Plans and approved Shop Drawings, securely anchored and mount signs using methods described and in compliance with manufacturer's written instructions. Verify clearance, anchorage method, and final location for each sign before installation.

b. Install level, plumb, and at height indicated on the Plans and approved Shop Drawings with sign surfaces free of distortion and other defects in appearance. Repair or replace damaged units as determined by the Engineer.

3.4 CLEANING AND PROTECTION

A. Clean exposed surfaces in accordance with manufacturer's instructions.

END OF SECTION
SECTION 12 93 00

SITE FURNISHINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Recycling / Litter Receptacles
B. Benches
C. Map Cases:
   1. Surface mounted
   2. Freestanding
D. Bicycle Racks
E. This Section includes specifications for the following items to be furnished by the District and installed by the Contractor:
   1. Variable Message System (VMS)

1.2 SUBMITTALS

A. Submit in accordance with Division 1, Section 01 33 00 – Submittal Procedures.
B. Materials list, along with manufacturer’s recommended method of installation.
C. Shop Drawings – Contractor Supplied and Installed Items:
   1. Submit Shop Drawings for the fabrication and installation of items listed and assemblies. Include plans, elevations, and details of sections and connections. Show accessories and anchorage items to be incorporated in the Work.
   2. Do not use drawings prepared by the A/E for shop, fabrication, or installation drawings.
D. Shop Drawings, Product Data, Samples, and Warranties – AC Transit (District) Supplied and Contractor Installed Items:
   1. District will arrange for and deliver District-reviewed Shop Drawings, product data, and samples to Contractor.
   2. Contractor shall review District-reviewed shop drawings, product data, and samples.
   3. Coordinate with Shop Drawings for bus shelters.
   4. District will arrange for manufacturer’s warranties, inspections, and service.
E. Manuals: Provide manuals with installation, operation, and maintenance information in compliance with the closeout requirements of Division 1, Section 01 70 00 – Execution and Close-out Requirements

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F. Color Schedule for each individual item specified herein including quantities of items in each color and samples in a minimum 3-inch by 5-inch size.

G. Documentation certifying that the fabricators, suppliers and or subcontractors received and reviewed a complete copy of these Specifications and all layout plans and furniture item details as indicated on the Plans, prior to preparing submittals. All submittals received prior to receipt of certification will be returned “Not Reviewed,” requiring resubmittal.

H. Submit two gallons of touch-up paint for each color and type of finish for District maintenance purposes.

1.3 DELIVERY, STORAGE, HANDLING, AND STOCKPILING

A. For items supplied by the District: Contractor shall receive and unload products at site. Inspect for completeness and damage jointly with District. The District will submit claims for transportation damage and replace damaged, defective, or deficient items. Contractor shall repair to the satisfaction of the A/E or replace items damaged after receipt.

B. Comply with Division 1, Section 01 60 00 – Product Requirements.

C. Protect dissimilar metals subject to galvanic action and corrosion from contact with each other and from other surfaces that cause corrosion of metal.

D. Protect surfaces of plastic from damage, including scratching, from point of manufacture through acceptance.

E. Protect the condition and finish of all site furnishings during storage and installation. Furnishings damaged shall be repaired or replaced at Contractor’s expense, subject to the direction of the A/E or District.

F. Extra stock shall be packaged by manufacturer for storage. All items to be shipped, unloaded and stockpiled at the time and location determined by the District.

G. All items shall be handled, shipped, unloaded and stockpiled or stacked per each item manufacturer’s recommendations.

H. All items shall be clearly marked with the following: Identification of item contained; Contractor’s name, telephone and contact person; Contract number; shipping date; number of pieces; customer’s name, telephone and contact person; and delivery address.

PART 2 - PRODUCTS

2.1 ACCEPTABLE PRODUCTS AND MANUFACTURERS

A. Recycling / Litter Receptacle. Provide one (1) per shelter unit, six (6) total:

1. Urban Renaissance Receptacle as manufactured by:

   Forms + Surfaces
   30 Pine Street
   Pittsburgh, PA 15223
   phone: 800-451-0410
   fax: 412-781-7840
email: sales@forms-surfaces.com  
website: www.forms-surfaces.com  
Rep: Michael Risso, 925-890-4623  

a. Part # 970270-001 Rev  
b. SF, SLURB-36R, URB, 36G, SO, RCYL, CUST  
c. Product: Forms + Surfaces Urban Recycling Receptacle  
d. Size/Style: 36 Gallon, Side Opening, with Recycling Attachment  
e. Material: 16 gage Stainless Steel with Spun Aluminum Top  
f. Pattern: Custom Solid Cylinder with Vertical Bars as indicated on the Shop Drawings  
g. Details: Slam Lock with approved Key to be provided by Others  
h. Finish: Anti-graffiti Texture Powdercoat  
i. Color: Verify with A/E  
j. Liner: 32-gallon Galvanized Steel  
k. Mounting: Surface Mount  

B. Benches:  

1. Transit Seating as manufactured by:  

Forms+Surfaces  
30 Pine Street  
Pittsburgh, PA 15223  
phone: 800-451-0410  
fax: 412-781-7840  
email: sales@forms-surfaces.com  
website: www.forms-surfaces.com  

a. Type: Single-sided backed bench, angled seat with armrests  
b. Dimensions (6 foot with 3 armrests):  

1) Overall: 74.4” long x 16.5” deep x 31.4” high  
2) Seat: 72” long x 13” deep x 18” high (19.8” at back of seat)  
c. Dimensions (4 foot with 2 armrests):  

1) Overall: 50.4” long x 16.5” deep x 31.4” high  
2) Seat: 48” long x 13” deep x 18” high (19.8” at back of seat)  
d. Materials:
1) Bench Legs: 3” diameter tubular stainless steel.

2) End Castings: Cast stainless steel.

3) Seats and Backrests: Stainless steel sheet with 1/2 diameter perforations.

4) Armrests: Formed from 1.5” stainless steel bar.

e. Finishes:

1) Bench Legs: Radial satin finish.

2) End Castings: Bead-blasted finish.

3) Seats and Backrest: Satin finish.

4) Armrests: Satin finish.

2. Benches to be permanently secured to platform. Surface mount with 6” diameter base plates using threaded anchors. Provide installation hardware.

C. Map Case: See Plans for both free-standing and windscreen mounting conditions.

1. Manufactured by:

Tolar Manufacturing Company
258 Mariah Circle
Corona, CA 92879
800-339-6165

a. San Pablo Corridor Schedule Holder

b. 44-1/2 inches high by 40-1/2 inches wide

D. Bicycle Racks: In compliance with City of Oakland “Bicycle Parking Rack Guidelines”:

1. City of Oakland single standard bicycle “U” rack with the following requirements:

a. Square inverted U-shaped steel tube supported at two points.

b. Unpainted, hot-dipped galvanized finish.

c. Minimum dimensions: 18 inches wide (as measured from outside of tube) by 32 inches high.

d. Flange-mounted minimum 3/8-inch thick galvanized steel base plate: 5 inches by 6 inches.

2. Contact Information:

a. City of Oakland Bicycle and Pedestrian Facilities Coordinator:

Phone: 510-238-3983
Email: bikeped@oaklandnet.com

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2.2 PRODUCTS SUPPLIED BY AC TRANSIT AND INSTALLED BY CONTRACTOR:

A. Variable Message Sign (VMS):
   1. Electrical sign complete with all illuminations and electronics as specified by the District.
   2. Color and Finish: Standard or custom color as selected by the District.

2.3 MATERIALS

A. General: Materials for site furnishing items shall be of the size and finish as indicated on the Plans and as specified in this Section.

B. Materials for extra stock items are to be identical to the site furnishing items as shown on the Plans and as specified in this Section.

C. Miscellaneous Metal, Bolts, Nuts and Fasteners: As specified in Division 3.1, Section 05 50 00 – Metal Fabrications. All exposed fasteners shall be vandal-resistant and shall be flush, counter-sunk, or plugged.

D. Electrical Conduits: As specified in Division 3.2 – Communication and Electrical Specifications.

2.4 QUALITY ASSURANCE

A. General: Engage a single manufacturer to ensure undivided responsibility for each specific furnishing element. The manufacturer shall be able to demonstrate at least five years successful experience in fabrication and installation of similar work.

B. Tolerances shall be within plus or minus 1/8 inch for dimensions less than 6 feet and within plus or minus 1/4 inch for dimensions over 6 feet.

C. Obtain and execute manufacturer’s recommendations for packaging, stacking, and storing extra stock site furnishings.

2.5 FABRICATION

A. General:
   1. Fit and assemble site furnishings at the shop to the greatest extent possible. Fabricate in sizes as large as practicable to keep field assembly to a minimum. Disassemble only as required for shipment and erection.
   2. Provide miscellaneous metal items required for completion of the Work, even though not specifically shown or specified.
   3. Conceal connections where possible; otherwise provide vandal proof connections and fasteners.
   4. Workmanship and finish shall be in accordance with printed directions, and specifications of associations, trades and manufacturers indicated for all items and work involved. Finish work shall be firm, well anchored in true alignment, and properly squared, with smooth clean uniform appearance; without waves, distortions, holes, marks, cracks, stains or discolorations. Joints shall be close-
fitting with neat fits, well scribed. Finish work shall have no exposed unsightly anchors or fastenings and shall present no hazardous, unfinished or unsafe protrusions, offsets, burrs, raw edges, or sharp corners. All work shall have provisions for expansion and contraction or shrinkage as necessary to prevent cracks, buckling and warping.

5. Defective component parts that are warped, bowed, dented, abraded including broken members and glass with edge damage, shall not be delivered to the Project site. Members damaged during fabrication, handling, or storage and prior to final acceptance shall be removed and replaced.

A. Structural Steel Welding: As specified in Division 3.1, Section 05 12 00 – Structural Steel Framing.

B. Finish and Color: Manufacturer’s standard finish in standard or custom color as selected by the District.

C. Reinforce points of support of anchorage at mechanical joints and points of attachment for other work as necessary.

1. Where fasteners anchor into aluminum less than 0.125 inch thick, use non-corrosive, press-in splined grommet nuts or other types of reinforcement using fastener threads.

2. Separate dissimilar metals with bituminous paint or performed separators to prevent galvanic action and corrosion.

D. Map Case

1. Shop assemble Map Case as instructed by Tolar Manufacturing.

PART 3 - EXECUTION

3.1 INSPECTION

A. Inspection: Prior to commencement of work, carefully inspect installed work of other trades and verify that such work is correct and complete. All unsatisfactory conditions must be corrected prior to commencement of work.

3.2 INSTALLATION

A. General:

1. Install furnishings as shown on the Plans, on the approved Shop Drawings, and as directed by these Specifications, in compliance with the manufacturer’s specifications and recommendations.

2. Install products furnished by the District including electrical hook-up and testing.

3. Do not install defective component parts that are warped, bowed, dented, abraded including broken members and glass with edge damage. Remove and replace members damaged during installation and prior to final acceptance.

4. Install site furnishings plumb, level, and square in true alignment and firmly anchored. Verify specific furnishing orientations prior to installation.
5. Line up furnishings straight along indicated centerlines.

6. Install concealed gaskets, sealants, and fillers to be watertight or sealed.

B. Erection Tolerances:

1. Variations from plumb, level, or dimensioned angle shall be limited to 1/8 inch maximum deviation in a 10-foot vertical or angular run, or in a 10-foot horizontal run.

2. Variations from location, including plumb and level, shall be limited to 1/8 inch maximum change in deviation for a 10-foot run in any direction.

3. Offsets in the end-to-end and edge-to-edge alignments of adjoining and consecutive members forming planes, continuous runs, and profiles shall be limited to the following:
   a. 1/16-inch maximum offset in flush alignment including those separated two inches or less by a reveal or protrusion in plane of wall.
   b. 1/8-inch maximum offset in flush alignment including those separated by a reveal or protrusion of more than 2 inches in width.

C. Verification of Conformance to the Requirements of the Contract Documents:

1. Verify the following:
   a. Bolts, nuts and other connections for proper fit and tightness.
   b. Components for proper alignment, fit and tolerances.
   c. Finishes for damage. Replace damaged components at no cost to the District.

D. Assembly and Anchorage:

1. Anchor component parts securely in place by bolting, welding, or other permanent mechanical attachment systems.

2. Secure component parts to the structure with non-staining and non-corrosive shims, anchors, fasteners, spacers and fillers. Provide erection equipment that will not mar or stain finished surfaces and that will not damage the component parts in any way.

3. Grind cut edges of metal smooth on exposed edges, and refinish to match factory finish.

E. Recycling / Litter Receptacles: Install receptacles at locations indicated on the Plans. Attach receptacles securely to platform surface material. Follow manufacturer’s installation specifications to prevent damage. Protect from damage before and after installation.

F. Benches:

1. Assemble benches as in accordance with manufacturer’s specifications.
2. Take precautions to prevent damage during assembly.

3. Verify that substrates are stable and capable of supporting the weight of bench assemblies.

4. Verify that substrates have been adequately prepared to securely anchor those items that will be surface mounted.

5. Permanently mount benches to platform in accordance with manufacturer’s specifications and installation instructions at locations identified on the Plans.

6. Install benches in conformance with applicable accessibility guidelines and code requirements.

G. Map Cases: Install at locations indicated on the Plans. All fasteners shall be concealed wherever possible. Fasteners shall be appropriate for installation.

H. Bicycle Racks: Install on flat, uncracked concrete in compliance with:
   2. California Building Code of Regulations Title 24
   3. Americans with Disabilities Act

I. Variable Message Sign (VMS):
   1. Install in accordance with manufacturer’s instructions.
   2. For electrical requirements see Division 3.2 - Communication and Electrical Specifications

END OF SECTION
SECTION 32 17 26

TACTILE WARNING SURFACING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Detectable warning surface tiles
B. Detectable directional tiles
C. Black coated urethane cement strip material and finish
D. Walking deterrent domes

1.2 RELATED SECTIONS

A. Division 3.1, Section 09 96 33 – Graffiti-Resistant Coatings

1.3 REFERENCE STANDARDS

A. American National Standards Institute (ANSI):
   1. ANSI A117.1 Standard for Buildings and Facilities Providing Accessibility and Usability for Physically Handicapped People

B. ASTM International (ASTM):
   1. ASTM C293 Test Method for Flexural Strength of Concrete (Using Simple Beam with Center-Point Loading)
   2. ASTM C551 Specification for Asbestos-Cement Fiberboard Insulating Panels
   3. ASTM C1028 Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method
   4. ASTM D543 Test Method for Resistance of Plastics to Chemical Reagents
   5. ASTM D570 Test Method for Water Absorption of Plastics
   6. ASTM D638 Test Method for Tensile Properties of Plastics
   7. ASTM D695 Test Method for Compressive Properties of Rigid Plastic
   8. ASTM D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulation Materials
   10. ASTM D2486 Test Method for Scrub Resistance of Interior Latex Flat Wall Paints
   11. ASTM D3359 Test Methods for Measuring Adhesion by Tape Test
12. ASTM D4060 Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser


14. ASTM D5420 Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of A Striker Impacted by a Falling Weight (Gardner Impact)

15. ASTM E84 Test Method for Surface Burning Characteristics of Building Materials

16. ASTM G26 Practice of Operating Light-Exposure Apparatus (Xenon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials

C. California Building Code, 2013, California Code of Regulations (CCR):

1. CCR Title24, Part 2, California Building Code, Chapter 11B – Accessibility to Public Buildings, Public Accommodations, Commercial Buildings and Public Housing

D. Federal Standards (FED-STD):

1. FED-STD-595C Colors Used in Government Procurement

1.4 SUBMITTALS

A. General: Refer to Contract Specifications Division 3.1, Section 01 33 00 – Submittal Procedures.

B. Product Data: Submit manufacturer's product data and installation instructions for all specified products, including connection materials, devices, fasteners, accessories, and adhesives. Include maintenance and cleaning instructions for the tile.

C. Samples: Submit full-size samples of the detectable warning surface tiles, detectable directional tiles, detectable door indicator tiles, detectable guide strip, black warning stripe material, and walking deterrent dome in each color specified for the A/E's approval. Samples shall match the A/E's control samples.

D. Installer's Qualifications: Submit evidence of the tactile warning surfacing material manufacturer's approval of the qualifications and experience of the proposed installer.

E. Provide Shop Drawings for products specified showing fabrication details; surface profile; fastener locations; plans of placement including joints, and material to be used as well as outlining installation materials and procedures. Do not use drawings prepared by A/E for shop, fabrication, or installation drawings.

F. Material Test Reports: Submit test reports from qualified independent testing laboratory indicating that materials proposed for use meet the properties specified and are in compliance with applicable codes and requirements.

1.5 QUALITY ASSURANCE
A. Single Source Responsibility: Provide tactile warning surfacing products and accessories as produced by a single manufacturer. Provide black stripe material and finish products as produced by a single manufacturer. This requirement does not apply to the manufacturers of walking deterrent domes.

B. Installer’s Qualifications: Engage an experienced installer certified in writing by tactile warning surfacing manufacturer as qualified to perform the installation and including verification that the installer has successfully completed installations similar in material, design, and scope to that indicated for the Contract. Contractor shall ensure that manufacturer’s representative be present at all times during installation.

C. Americans with Disabilities Act (ADA): Products must comply with CBC 2013. Chapter 11B.

D. Vitrified Polymer Composite (VPC) tiles shall be an epoxy polymer composition with an ultra-violet resistant coating employing aluminum oxide particles in the truncated domes:

1. Tile Dimensions: Various sizes shall be as shown on the Plans. Tiles shall be formed with holes for anchors as required for proper installation.

2. Water Absorption of Tile, when tested in conformance with ASTM D570, not to exceed 0.35%.

3. Slip Resistance of Tile, when tested in conformance with ASTM C1028, the combined wet/dry static coefficient of friction not to be less than 0.80.

4. Compressive Strength of tile, when tested in conformance with ASTM D695, not to be less than 18,000 psi.

5. Tensile Strength of Tile, when tested in conformance with ASTM D638, not to be less than 10,000 psi.

6. Flexural Strength of Tile, when tested in conformance with ASTM C293, not to be less than 24,000 psi.

7. Gardner Impact to geometry “GE” of the standard, when tested in conformance with ASTM D5420, to have a mean failure energy expressed as a function of specimen thickness of not less than 450 in-lbf/in. A failure is noted if a hairline fracture is visible in the specimen.

8. Chemical Stain Resistance of Tile, when tested in conformance with ASTM D543, to withstand without discoloration or staining acid, urine, calcium chloride, stamp pad ink, gum, and red aerosol paint.

9. Abrasive Wear of Tile when tested by BYK Gardner Tester ASTM D2486 with reciprocating linear motion of 37 plus or minus cycles per minute over a 10-inch travel. The abrasive medium, a 40-grit Norton Metallite sand paper, fixed and leveled to a holder. The combined mass of the sled, weight and wood block is 3.2 pounds. Average wear depth shall not exceed 0.030 after 1000 abrasion cycles measured on the top surface of the dome representing the average of three measurement locations per sample.

10. Fire Resistance, when tested in conformance with ASTM E84, flame spread shall be less than 25.
11. Accelerated Weathering of Tile, when tested in conformance with ASTM G26 for 2000 hours, shall exhibit no deterioration, fading or chalking of surface of tile.

E. Polymeric Concrete and/or epoxy resin properties shall meet or exceed the following test criteria:

1. Tensile Strength of Resin: greater than 7,000 psi in conformance with ASTM D638.

2. Modulus of Elasticity of Resin: greater than 4,000 psi in conformance with ASTM D638.

3. Bond Strength of Polymeric Concrete: greater than 8,000 psi in conformance with ASTM C551.

F. Sealant for joint between tiles and joint between tiles and concrete: Cured material shall be not less than 80 Shore A hardness and compatible with platform edge tile and opposite joint edge material.

G. Colors shall be yellow conforming to Federal Color No. 33538, and black, conforming to Federal Color No. 37038. Colors shall be homogeneous throughout the tile.

1.6 DELIVERY, STORAGE AND HANDLING

A. Tiles shall be suitably packaged or crated to prevent damage in shipment or handling. Finished surfaces shall be protected by sturdy wrappings, and tile type shall be identified by part number.

B. Tiles shall be delivered to location at building site for storage prior to installation.

1.7 ENVIRONMENTAL CONDITIONS: Maintain minimum temperature of 40 degrees F in spaces to receive tiles for at least 48 hours prior to installations, during installation, and for not less than 48 hours after installation. Store tiles in spaces where they will be installed for at least 48 hours before beginning installation. Subsequently, maintain minimum temperature of 40 degrees F in areas where work is completed.

1.8 EXTRA STOCK: Furnish new materials from same manufactured lot as materials installed and enclosed in protective packaging with appropriate identification. Furnish not less than 2 percent of the supplied materials for each type, color and pattern installed.

1.9 GUARANTEE: In addition to the Guaranty of Work requirements in General Conditions, tiles shall be guaranteed in writing for a period of five years from date of final substantial completion. The guarantee shall include defective work, breakage, deformation, fading and chalking of finishes, and loosening of tiles, and shall cover the cost of labor and materials for repair or replacement.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Proprietary Products: Use of manufacturer’s proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer’s material data and certificates of performance for proposed substitutions.
2.2 MATERIALS

A. Materials and properties for the following are described under “Quality Assurance” of these Specifications.

1. Detectable warning surface tiles

2. Detectable directional tiles

B. For installation of detectable warning surface tiles, detectable directional tiles, detectable door indicator tiles, and detectable guide strip provide:

1. Galvanized steel expansion anchors with approximately 1-1/8 inches of embedment shall be positioned in the molded recess of the tile and concealed with a VPC concealed cap.

2. Heavy duty elastomeric polyurethane adhesive as manufactured by Boiardi, Mapei, Bostik, or equal.

C. Black coated urethane cement strip material: Self-leveling flowable urethane cement mortar that meets or exceeds the following requirements:

1. Physical Properties:
   a. Solids % volume (mix) 100
   b. Shelf life 1 year

2. Technical Data
   a. Tack Free over concrete @72 degrees F. 8 hours
   b. Foot Traffic over concrete @72 degrees F. 12 hours
   c. Wheel Traffic 48 hours
   d. Pot Life (Gel Time) 150gm @ 72 degrees F. 5-10 minutes
   e. Adhesion to Concrete ASTM 4541 concrete fails
   f. Tensile Strength, psi ASTM D638 850
   g. Compressive Strength ASTM D695 >5,000

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h. Flexural Strength, psi 
   ASTM D790  900
i. Hardness Shore D
   ASTM D2240  85
j. Reducer/Clean Up 
   solvent

3. Basis of Design:
   a. Westcoat EC Temper-Crete 3/16 inch Quartz.

D. Black coated urethane cement strip finish: Two component polyurethane non-yellowing high gloss finish coat to be applied over black warning stripe material:

1. Physical Properties:
   a. Weight/gallon (mix)  9.0
   b. Gloss @ 60 degrees  109
   c. Solids %weight (mix)  100
   d. Solids %volume (mix)  100
   e. Viscosity cPs (mix)  475
   f. Viscosity KU (mix)  68
   g. VOC gm/l  0
   h. Shelf Life  1 year
   i. Color  1

2. Technical Data (clear):
   a. Tack Free over concrete @72 degrees F.  1.25 hours
   b. Foot Traffic over concrete @72 degrees F.  5 hours
   c. Foot Traffic-sealed surface @72 degrees F.  6.25 hours
   d. Wheel Traffic  72 hours
   e. Pot Life (Gel Time) 150gm @ 72 degrees F.  0.5 hours
   f. Heat Resistance (max0  220 degrees F.
   g. Adhesion to Concrete 
      ASTM D3359  5
   h. Impact Resistance in-lbs direct/reverse  >250 psi (concrete fails)
   i. Hardness Shore D
      ASTM D2240  85
   j. Pencil Hardness 
      3H

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k. Reducer and Clean Up acetone

l. Abrasion Resistance ASTM D4060 36 mgs


4. Basis of Design:
   a. Westcoat EC-100 Polyurea Topcoat.

E. Walking Deterrent Domes:
   1. Material: Pre-cast, pre-drilled architectural concrete dome in size and shape as indicated on the Plans:
      b. Pre-drill each dome to receive one dowel.
   2. Attachment: Pre-cast, pre-drilled concrete dome to be mounted on epoxy set galvanized steel dowel in size and length as indicated on the Plans.
   3. Adhesive: Concrete bondage adhesive.
   4. Graffiti-Resistant Coating: Apply graffiti-resistant coating as specified in Division 3.1, Section 09 96 33 – Graffiti-Resistant Coatings.

PART 3 - EXECUTION

3.1 INSTALLATION OF VPC TILES

A. Comply with applicable requirements of the tile manufacturer’s installation instructions.

B. Tiles shall have a structural epoxy polymer concrete fill and epoxy coated rebar system installed by the tile manufacturer.

C. Layout tiles and joints to fit spacing between expansion joints in concrete slab, and ends of platform, with tiles manufactured to fit the tapered 8-foot end of the platform edge.

D. Place plastic shims on substrate to coincide with leading edge corners of tile to set tile flush with adjacent surface.

E. Set first tile over shims and non-shrink leveling grout and make final adjustment to the shims.

F. Drill four 1/4-inch diameter holes as indicated on the Plans in the pre-determined tile recess and vacuum clean.

G. Set expansion anchors checking that torque of 20-25 foot pounds is achieved.

H. Place plastic shim on substrate to coincide with leading edge corner of second tile to be placed.
I. Set second tile over shims non-shrink leveling grout and make final adjustments to the shim. Repeat the aforementioned steps for a continuous installation of tiles.

J. Return to the start of tile installation to complete the finish operations.

K. Mechanically abrade, vacuum clean and solvent wipe four concealed cap recesses.

L. Apply urethane sealant/adhesive into cap well to cover fastener then set concealed cap with mallet.

M. Vacuum clean, mechanically abrade and solvent wipe leading edge groove between tile and adjacent concrete surface.

N. Place 3/8-inch diameter foam rope at bottom of leading edge groove.

O. Tape off each side of leading edge groove in preparation for the self leveling urethane sealant.

P. Pour self leveling urethane sealant in groove filling flush to top of joint then remove the tape prior to curing.

Q. Inspect and clean the tile after allowing the self leveling sealant to cure undisturbed or protected for 48 hours.

R. Maintain expansion and contraction joints in platforms and any other reference markers or opening that may be required to be left exposed.

3.2 INSTALLATION OF BLACK COATED URETHANE CEMENT STRIP MATERIAL AND FINISH:

A. Examination of substrate:
   1. Verify that concrete is even, clean, dry, and free of grease, paint, oil, dust, curing agents, or any foreign material that will prevent proper adhesion. Verify that concrete has cured for a minimum of 28 days concrete and is at least 2500 psi, porous, and able to absorb water.

B. Install strip and pigmented epoxy finish in accordance with manufacturer's instructions.

3.3 INSTALLATION OF WALKING DETERRENT DOMES:

A. Install pre-cast, pre-drilled concrete domes on galvanized steel dowels as indicated on the Plans and adhere dome to prepared curb with concrete bondage adhesive.

3.4 CLEANING AND PROTECTING

A. Protect tiles, warning stripe, and concrete domes against damage during construction period. Comply with tile manufacturer's specifications.

END OF SECTION
DIVISION 3.2 – COMMUNICATION AND ELECTRICAL SPECIFICATIONS

SECTION 01 43 20

COMMUNICATIONS SYSTEM ASSURANCE

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The Communications System is a certifiable item requiring safety certification by ACT. This Section includes the requirements for the Contractor to develop and implement an overall System Assurance Program Plan (SAPP) encompassing system safety and security, and reliability engineering.

B. The SAPP shall describe and provide means for evaluating system safety, security, and reliability of newly installed equipment.

C. The requirements of this Section shall apply to Contractor and all its subcontractors’ functions during all phases of the Work, including design, construction, installation, testing, pre-revenue operations, in-service support, warranty, retrofits and field modifications.

D. The Contractor shall be responsible for verifying that the Communications Systems meet the highest achievable level of system assurance, that they are designed and constructed in compliance with all applicable, codes, ACT’s safety requirements, and industry standards and in accordance with the results of a detailed hazards analysis.

E. Incorporate hazard analyses performed into Contractor’s process for the identification, analysis and resolution of safety hazards and security vulnerabilities, in accordance with the General Requirements. All Contractor-provided subsystems and equipment shall be designed using the principles of Crime Prevention Through Environmental Design (CPTED) in accordance with the requirements of ACT’s Safety and Security Program Plan (SSecPP).

F. The Contractor shall participate as a member of the Security Committee and the Safety and Security Certification Review Committee (SSCRC) to ensure that the equipment is safe to operate and is not subject to vandalism or damage.

1.2 RELATED WORK

A. Division 1, Section 01 33 00, Submittal Procedures

B. Division 3.2, Section 01 45 23, Communications Commissioning and Testing

C. Division 3.2, Section 01 45 25, Communications Spare Parts and Test Equipment

D. Division 3.2, Section 01 78 23, Communications Operations and Maintenance Manuals

E. Division 3.2, Section 27 13 10, Carrier Transmission System

1.3 Acronyms and Definitions

OCTOBER 2015
ACT – Alameda-Contra Costa Transit
APTA - American Public Transportation Association
BRT – Bus Rapid Transit
COOP – Continuity of Operations
CPTED – Crime Prevention Through Environmental Design
EB – East Bay
EMI – Electromagnetic Interference
FMEA - Failure Modes and Effects Analysis
IEEE – Institute of Electrical and Electronic Engineers
MIL – Military
MTBF - Mean Time Between Failures
OHA - Operating Hazard Analysis
O&M – Operations and Maintenance
PMTBF – Predicted Mean Time Between Failures
SAPP – Systems Assurance Program Plan
SSCRC – Safety and Security Certification Review Committee
SSecPP – Safety and Security Program Plan
SSMP – System and Safety Management Plan

1.2 REFERENCED STANDARDS

A. Military [MIL]
F. MIL STD-470A – Maintainability Program Requirements (for Systems and Equipment).
G. MIL-STD-721, Definition of Terms for Reliability and Maintainability
H. Institute of Electrical and Electronic Engineers (IEEE)

J. American Public Transportation Associate (APTA) Glossary of Reliability, Availability and Maintainability Terminology for Rail Rapid Transit

K. AC Transit – Continuity of Operations (COOP) Plan

L. AC Transit East Bay BRT (EB BRT) System and Safety Management Plan (SSMP)

1.3 SUBMITTALS

A. System Assurance Program Plan (SAPP, CDRL 01830-01): Submit an SAPP. Clearly segregate the plan to identify specific Communications Systems elements and requirements for Reliability Analysis for the equipment installed as part of this contract.

B. Monthly System Safety, Security and Reliability Progress Reports (CDRL 01830-02): Submit monthly system safety, security and reliability progress reports. Include the status of system activities based upon the approved milestone chart.

C. Communications System Reliability Plan (CDRL 01830-03): Submit a Reliability Plan for the Communications System subsystems and equipment. Include in the plan, the methods to be employed to demonstrate how reliability requirements will be verified. Upon approval of this plan, include it in the SAPP specified herein. This plan shall be applicable to CCTV equipment (network video recorder, camera, head-end server, workstations), Public Address equipment (VOIP Audio Device, amplifiers, speakers, microphone, noise sensing controller, head-end server, workstations), core switch, station switch, and SCADA RTU.

D. Maintenance Plan (CDRL 01830-04): Submit a Maintenance Plan three months prior to Revenue Service. This plan will become part of the Operations and Maintenance Manual (O&M). It includes, but is not limited to preventive maintenance analysis, corrective maintenance analysis.


PART 2 - PRODUCTS

2.1 GENERAL

A. System Assurance Program Plan (SAPP): The Contractor shall develop an overall comprehensive SAPP for evaluating the system designs with regard to system safety, and reliability with the objective of prescribing corrective action in a timely and cost-effective manner. Include the process for hazard identification, analysis and resolution and the process for identification of unreliability. The SAPP shall:

1. Include specific sections describing the plans and processes for system reliability.

2. Include procedures to perform the specific tasks necessary to meet system reliability requirements.

3. Identify the responsibilities and functions of personnel directly associated with, and responsible for, systems assurance policies and implementation of the program. Describe the systems assurance organization. Identify and formally
document authority delegated to the systems assurance organization and the relationship between that organization and all other organizational components.

4. Address the interface requirements between the systems provided in this Contract, and other ACT system elements and subsystems. Element interfaces shall include Communications, Station Facilities, Station Power, and the Operating and Maintenance environment. Interface requirements shall include, but not be limited to, hardware, man/machine interfaces, operations, maintenance, training, rules and procedures.

5. Describe the rationale for meeting criteria to achieve a high degree of reliability. Include project phases of design, manufacturing, procurement, installation, testing, and pre-revenue operations. Identify adherence to and implementation of sound safety as applicable, reliability in design, manufacturing, and operation; effective control of human factors; and implementation of effective maintenance and repair schedules.

6. Provide a description of safety and reliability failure data collection systems. Address the provisions for a closed loop data collection system for collecting, analyzing, and recording all failures that occur during in-plant tests and those that occur at installation or test sites prior to acceptance. The analysis and recording of failures shall differentiate between those due to design or workmanship and those due to other causes such as error in handling, transporting, storing, installing, and operating the equipment. The failure reporting system shall include provisions to ensure that problems are detected and investigated, and that effective corrective actions are taken on a timely basis to reduce or prevent repetition of the failures.

7. Other SSAP topics shall include:
   a. System safety, as applicable and reliability test procedures.
   b. System safety, reliability milestone charts.
   c. Communications Systems Reliability plan, including Reliability Block Diagram, Predicted Mean Time Between Failures (PMTBF) and MTBF in the field, on equipment installed as part of this Contract.

8. Tasks: Task listing and time phasing of each task.


B. Safety Procedures: Procedures to accomplish the system safety tasks if applicable, including provisions to:
   1. Correct system safety deficiencies noted during the design phase as soon as possible, but not later than system design acceptance.
   2. Evaluate system design and design changes.

C. Implementation: Implement safety changes, if applicable which are initiated by the Contractor and approved by ACT.
D. Safety Plan Data Collection System: If applicable, use a data collection and feedback system to establish requirements for redesign, design changes, and corrective actions. During the Reliability Demonstration portion of the program, integrate this system with the failure data collection system specified under the reliability requirements herein. Use a follow-up procedure to verify results of completed action as follows:

1. During the early phases of system development, the data shall include hazards identified during various analyses. Submit the data as part of the monthly progress reports of the SAPP to ACT to inform of problems in design and hardware development, and to facilitate early remedial action.

2. In the latter stages of system development, and during installation, indicate appropriate corrective actions, and verify the requirements and results of corrective action taken.

2.2 RELIABILITY TEST REPORTS

A. Prepare and submit monthly reports to identify the status of system safety, reliability, and activities performed throughout the performance of this Contract, including the performance of test activities specified in Division 3.2, Section 01 45 23 - Communications Commissioning and Testing.

B. In the event of a test failure or “reject” decision, within 15 working days, analyze the cause of the deficiency and make recommendations for corrective action, if the failure or “reject” decision was as a result of a system component failure. After approval, implement the recommendations within 30 working days, and then repeat the test.

C. Prepare and submit as part of each report, data which shall initially indicate predicted MTBF values and, as data becomes available after the commencement of the Reliability Demonstration Plan (described herein), the actual values.

D. Prepare and submit an Operating Hazard Analysis (OHA).

E. Failure Modes and Effects Analysis (FMEA): Identify potential system weaknesses, critical items, and unsafe failure modes.

F. Quantitative analysis such as fault tree or logic network, if required because of unresolved potential hazards, in a format selected by the Contractor and approved by ACT.

2.3 RELIABILITY/MAINTAINABILITY

A. Prepare a detailed Reliability Plan. Upon approval of this plan, include this plan in the SAPP. This plan shall include:

1. Task listing and time phasing for each task.

2. Organization and responsibilities of key personnel.

3. Techniques for allocation of quantitative requirements to lower level functional elements.

4. Interfaces between reliability and other closely related programs, if applicable, and support to efforts such as:
a. Logistic support and maintenance planning.

b. Design.

c. Quality assurance and quality control.

d. Standardization.

e. Systems engineering.

f. Personnel subsystem program (training and personnel resources).

5. Methods for assuring that all reliability efforts are consistent with overall system requirements.

6. Provision for source selection, first article inspection, and surveillance of subcontractors’ reliability activities.

7. Procedures and controls, including piece part selection and screening, manufacturing process controls, procurement controls, and test procedures, to be utilized during production to ensure achievement of reliability requirements.

8. Provisions to evaluate design changes for possible effects upon subsystem and functional level requirements and goals.

B. Reliability Analysis: Perform reliability analysis up to the point of interface with other subsystems or assemblies:

1. Develop reliability block diagrams that show each equipment element that is essential to the successful performance of each system/subsystem, including element interrelationships. Revise block diagrams to keep current with design iterations.

2. Develop a reliability model consisting of reliability block diagrams and probability of success equations. The model shall show the relationships required for system success. Revise the model to keep current with design iterations.

3. Obtain reliability prediction, including predicted mean time between failures (PMTBFs) from the equipment suppliers. Conduct the predictions in accordance with established techniques, such as: MIL-HDBK 217E, MIL-STD 756B, or properly documented and verifiable field failure data.

4. Identify actions taken and specific features designed in by the Contractor to mitigate the effect of the failures. Document all assumptions made during the analysis.

C. Communications Reliability/Availability Requirements

1. New communications ring shall provide availability as specified in Division 3.2, Division 3.2, Section 27 13 10 Carrier Transmission System.

2. The reliability requirements for the new equipment shall be 99.9%. Each make and model of equipment provided shall have an MTBF better than (greater
than) at least 49 percent of all equipment (make/model) available in the commercial marketplace meeting both of the following criteria:

a. That equipment provides essentially equivalent functionality.

b. That equipment is ranked in the top five for domestic market share (measured by sales dollars) for equipment providing essentially equivalent functionality.

D. Reliability Demonstration Plans: Provide a plan for formal demonstration of achieved reliability for the Communications systems and equipment as part of the Reliability Plan. Identify the means for obtaining reliability data.

E. Maintenance Concept: Develop a Maintenance Concept which is consistent with the overall Maintenance Concept, taking the following into considerations:

1. Provisions for early fault detection and rapid fault isolation to the proper service level to minimize costs and MTTR.

2. Provisions for simplification of fault detection, isolation, and repair so as to minimize the skill levels and training requirements for maintenance personnel.


4. Provisions for reduction of the complexity of the maintenance, design-dictated maintenance activities and related costs, maintenance down-time and effects on system operation, maintenance costs, potential for maintenance error and man/machine interface problems.

5. Provisions to evaluate operational and design changes for possible effects upon maintainability requirements.

6. The Maintenance Concept shall define the repair, corrective, and preventive maintenance program plans, policies, and support requirements for all equipment supplied under this Contract. It shall:

   a. Minimize each level of maintenance consistent with these technical specifications requirements and system reliability goals.

   b. Recommend policies and practices which ensure that, at the time of a failure, qualified maintenance personnel will be promptly notified and will have the necessary documentation, tools, test equipment, and spare parts to affect the repair in a minimum of time.

7. The Maintenance Concept shall develop recommendations for:

   a. Depth and frequency of maintenance requirements at each level.

   b. Facilities required.

   c. Support equipment and tools required.

   d. Skill levels and numbers of personnel required.

   e. Subsystem, component, and piece part repair policy.
f. Detailed fault isolation and troubleshooting procedures, diagnostic equipment, and special test equipment.

8. Maintenance Assumptions:

a. Troubleshooting and repair will be done by a high school graduate who has had two years of relevant qualifying technical school training and two years of experience; has attended the training programs and has all maintenance manuals, as specified in Division 3.2, Section 01 78 23 – Communications Operations and Maintenance Manuals, and has use of the test equipment recommended by the Contractor.

b. Spare parts recommended by the Contractor will be available, as specified in Division 3.2, Section 01 45 25 – Communications Spare Parts and Test Equipment.

c. Perform maintenance at three discrete levels; on-line, off-line, and bench:

(1) On-line maintenance is that performed on an in-place and operational equipment element. Test points or built-in indicators shall facilitate identification of interfaces with other system elements. On-line maintenance shall not disrupt service. Online maintenance shall also include software or remote troubleshooting tools.

(2) Off-line maintenance is that performed on in-place but out-of-service equipment elements.

(3) Bench maintenance is that which is performed on out-of-place and service equipment elements. This maintenance is to be performed in a shop area where standard test equipment and fixtures are available. Test equipment and procedures shall allow maintenance to the lowest pluggable component part level.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The System Assurance Program Plan (SAPP) shall be developed and implemented to:

1. Minimize the severity and probability of occurrence of hazardous conditions.

2. Provide a high degree of reliability.

3. Minimize downtime during maintenance and malfunctions.

B. The SAPP shall satisfy the systems assurance requirements through the design, construction, and installation and testing phases of the contract.

C. The SAPP shall assure that the Communications Systems achieve the highest level of safety, as applicable and consistent with the Contract Specifications.
D. Applicability: The systems assurance requirements shall apply to Contractor and its subcontractor functions during all phases of the work as applicable and defined in the Contract Specifications.

E. Program Plans: Implement and maintain the various aspects of the program, including: system safety, security, reliability and maintainability program plans, during all phases of the Contract, as specified, and as applicable.

F. Plan and Procedure Review: Review the Test Program Plan and all test procedures to ensure that:

1. Testing will be carried out in a safe manner.
2. Any additional hazard, introduced by testing procedures, instrumentation, and test hardware, is properly identified and minimized.
3. Safety objectives are achieved and maintained.

G. Design Reviews: Design reviews shall be conducted in accordance with the requirements of Division 1, Section 013300 – Submittal Procedures. Applicable aspects of reliability, maintainability, EMI suppression techniques, availability, integrity of operation, and operation in the event of failure shall be covered in each of the design review packages

### 3.2 RELIABILITY DEMONSTRATION TESTS

A. Test Duration: The reliability demonstration tests shall be initiated during the pre-revenue test period and shall be completed in 90 calendar days.

B. Minimum Acceptable MTBF: Refer to specified MTBF requirement herein for each subsystem.

C. Accept/Reject Criteria: Accept/reject criteria shall be as specified in the test documentation described in Division 3.2, Section 014523, Communications Commissioning and Testing. All decisions to accept or reject equipment shall be based upon actual operational experience. The test logs shall be analyzed on a weekly basis and summarized on a monthly basis to provide:

1. Total accumulated operating time per equipment type.
2. Total accumulated chargeable failures per equipment type with details of each failure.

D. Test Personnel: Identify all ACT special facilities and personnel required to support the testing program.

E. Test Logs: Maintain logs of all equipment test performance. Hours shall be calculated cumulatively for all equipment under test. Failures shall be compiled from the Failure Report forms. The logs shall be maintained for the test period, and contain the following information for each incident:

1. Identification of the equipment, including nomenclature, serial number, manufacturer’s part number, and location.
2. Operating time of each system, including each shutdown and its cause.
3. Date and time of each incident.

4. Failure indication.

5. Identification of the failed article.

6. Classification of the incident (relevant independent failure or dependent failure).

7. Corrective maintenance or operational procedures required to restore the system to operation.

8. Failures occurring during the various tests shall be recorded on Failure Report form provided by the Contractor and approved by ACT.

9. Consequences of Accept-Reject Decisions: An MTBF accept decision shall terminate the respective test. Document and submit the results as provided herein. In the event of an MTBF reject decision, document and submit the results and then, within 15 working days, analyze the cause of the deficiency and prepare recommendations for corrective action. After approval, implement the recommendations within 30 working days and then repeat the test of the rejected part of the system. In the event of a second reject decision or failure of ACT to approve recommended action, terminate the test until the corrective action is implemented.

F. Records Management: Maintain documentation of systems assurance throughout the design, and make it available for examination by ACT.

3.3 MAINTENANCE OF SYSTEMS PRIOR TO ACCEPTANCE

A. Perform and provide documentation of preventive maintenance on completed portions of the Work, until accepted by ACT.

END OF SECTION
SECTION 01 45 23

COMMUNICATIONS COMMISSIONING AND TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Description: This Section includes:
   1. Requirements for the testing and inspections to be performed for the Communications Systems.
   2. Testing criteria.
   3. Requirements for test planning, performance, and recording of test data and results.
   4. Requirements for pre- and post-revenue operations support.

1.2 SCOPE

A. Prior to deploying any equipment, component, software, or system, and after the installation of all equipment, components, software, and systems supplied under this Contract, the Contractor shall assure their proper operation. The Inspection & Test Plan shall provide details of the tests for the EB BRT system.

B. System-specific test procedures and data sheets shall be submitted for the systems to be installed by the Contractor. Once approved by ACT, they shall be executed in the order required by the test plan and individual test procedures. Each test procedure shall include the test objective, test description, test prerequisites, acceptance/rejection criteria, resources required and estimation of test duration. Test procedures shall be supplied by the BRT Contractor to reflect the tests that are specified herein.

C. During testing, data sheets shall be used to track the progress of the test with check off lists, pass/fail designators, discrepancy lists, and other test results indicated in the appropriate places as described herein.

D. Test reports consist of completed data sheets. Copies of these data sheets shall be submitted to ACT for approval within fifteen (15) days of completion of each test as detailed herein.

1.3 RELATED WORK

A. Coordinate the work of this Section with all other Sections of this Specification and in particular the following Sections:
   1. Division 1, Section 01 32 00, Construction Progress Schedules
   2. Division 1, Section 01 40 00, Quality Requirements
   3. Division 3.2, Section 01 91 40, System Safety & Certification
   4. Division 3.2, Section 27 51 10, Closed Circuit Television System (CCTV)
5. Division 3.2, Section 27 53 50, Fare Collection System

1.2 SUBMITTALS

A. Inspection & Test Plan (CDRL 01814-01): Submit a comprehensive Inspection & Test Plan encompassing the Communications portions of the project as detailed herein.

B. Detailed Test Schedule: Submit a detailed test schedule, showing all factory and field tests, with the Construction Schedule and updated on a monthly basis, in accordance with the requirements of Division 1, Section 01 32 00 – Construction Progress Schedules.

C. Test Procedures (CDRL 01814-06): Submit detailed procedures for each test, for factory, field and system integration testing, as specified in the approved Inspection & Test Plan (CDRL 01814-01) and as detailed in the System s Test Plan.

D. First Article Inspection (FAI) Procedures (CDRL 01814-02): Submit procedures for each FAI specified.

E. Communications System Test Reports and Inspection Records (CDRL 01814-03): Submit reports and records for each completed test.

F. System Integration Test Report (CDRL 01814-04): Submit reports for each completed integration test.

G. Qualification Test Data (CDRL 01814-05): Submit reports, records and data for each completed qualification test.

PART 2 - PRODUCTS

2.1 INSPECTION & TEST PLAN

A. General: The Contractor shall provide a detailed Inspection & Test Plan that address how the testing and inspection of all equipment provided in this Contract will be implemented on a location by location basis, and as an overall integrated system as detailed herein.

B. The Plan shall identify all factory and field test activities necessary to demonstrate compliance with the requirements of the Contract. The tests specified below shall be included as a part of the progressive levels of integrated testing as defined in the Systems Test Plan. Such activities shall include, at minimum:

1. First Article Inspection (FAI),

2. Subsystem Factory Testing,

3. Factory Acceptance Testing (FAT),

4. Site (Field) Acceptance Testing (SAT),

C. FTA Requirements: Address additional requirements in accordance with the requirements of Division 1, Section 01 40 00 – Quality Requirements.
D. Test Sequencing: The plan shall identify the inspection activities, grouping of tests into test activities, and shall show the relative sequence of each test activity. Include a line diagram. An inspection and testing schedule shall be also included with each activity.

E. Inspection Activities: The test plan shall identify inspection activities to be performed after the equipment is installed in the field but prior to conducting testing. The inspection activities shall be part of the Inspection and Test Plan. The Contractor shall provide details of subsystem, system, and hardware to be inspected prior to commencing testing.

F. Test Activities: The plan shall identify a proposed list of all test procedures, and for each test activity, include:

1. The organization/team performing each test.
2. The organization/team witnessing each test.
3. The location of each test activity.
4. The estimated elapsed calendar time to perform the tests.
5. Resources and facilities required, including any ACT-furnished resources and facilities.
6. Any elements proposed to be shown to meet requirements through means other than Contractor testing (e.g., through means such as manufacturer's certification, analysis, inspection).
7. Dependencies on completion of other testing activities.
8. Temporary or staged activities to facilitate project staging.

G. Test Personnel: Identify the test organization, including assigned responsibilities. Qualified personnel shall be available for test planning, scheduling, performance, analyses, and reporting efforts. The description of organizational responsibilities shall include:

1. Preparation of test plans.
2. Test procedures and reports.
3. Recording of test data.
4. Reporting and resolution of test failures and anomalies.
5. Coordination of each identified test effort.
6. Quality assurance and control.

### 2.2 TEST PROCEDURES

A. Format, and content, and logistics of Test Procedures are defined herein the Systems Test Plan.
B. For each integrated test identified herein, the Contractor shall submit Test Procedures for ACT review and approval 30 Working Days before execution of the test.

C. Test Procedures shall define all test segments to be performed and include a description of the purpose and objectives of each test and test segment.

D. All requirements from the Contract Documents shall be tested and tracked in a Test Procedure.

E. The Contractor shall develop Integration Test Procedures which shall define the environment in which the tests shall be executed. Integration Test Procedures shall be derived from the functional requirements of the Specification and shall include the following:

1. Unique test title, number, issue date, and revision number and date;

2. Name of the function or equipment to be tested;

3. The purpose of the tests, including reference to the corresponding test plan test area; requirements and functions covered by the procedures; specified design and performance requirements, and cases and conditions tested by the procedures;

4. References to requirements that are being tested;

5. Descriptions of test objectives;

6. Test or inspection prerequisites (e.g., sequence of testing);

7. Personnel required to conduct the test or inspection;

8. Test or inspection software required;

9. Test or inspection tools/equipment including equipment’s last calibration date where applicable;

10. Special preparations and/or preventive maintenance required before test or inspection;

11. Identification of test location;

12. Estimated duration of each test;

13. Each procedure shall include space to record the serial numbers of the equipment tested and the version numbers of the software tested;

14. Description of test environment, including use of simulators, test equipment and test data;

15. Description of the techniques and scenarios to be used to simulate system field inputs and controlled equipment;

16. Test forms used for test setup and for recording test results;

17. Method(s) for resolving testing or inspection deficiencies;
18. Signatures block(s) (who conducted, who witnessed);

19. Step-by-Step description of each test segment, including inputs and user actions for each test step;

20. The expected results for each test segment, including pass/fail criteria.

### 2.3 INSPECTION AND TEST REPORTS

**A. General:** Reports and records (together referred to as "results") of each test and each inspection, including each FAI, shall be submitted for ACT review and approval within 10 Working Days of FA. The original results shall contain the original forms filled out by the persons performing the inspection/tests, and original signatures. Forms shall be filled out in ink. Errors shall be crossed out with a single line and initialed by the person making the correction. Each set of inspection/test results shall be accompanied by a cover letter signed by the Project Manager or his/her Designee.

**B. Content:** Each set of results shall include the following information:

1. The completed, signed, set of procedures used.
2. The completed, signed, set of forms used.
3. Name/number of the test procedures executed;
4. Identification of the system, equipment or component tested;
5. Date, time, and location of the test;
6. Personnel in attendance;
7. Identification of the lead tester;
8. Status of the test (e.g. passed, failed, suspended);
9. Name/signature of the person who conducted the test;
10. If the Integration Test Report indicates a non-passing status (e.g. failed, suspended), the test report shall also include the following:
    a. Information indicating the reason for the non-passing status;
11. Date and time for when the test shall be rerun. A summary of the inspection/test. For inspection/test of components, equipment and assemblies, include: quantity inspected/tested, quantity that failed the inspection/test, quantities that failed one or more individual procedures. A summary table showing the serial number or lot number of each unit inspected/tested and the outcome for that unit shall be included;
12. All required data and reference drawing explanations to permit evaluation of test report without the necessity of securing this information from other sources.
C. Reporting of Variance: A variance report shall be prepared each time a deviation from the Specifications is detected during the test process. The reports shall include a complete description of the problem, including:

1. A sequential identifying number assigned to the variance.
2. The date and time the variance was first discovered.
3. References to the Specifications and/or the test procedure, including test name and test procedure step.
4. A description of the test conditions at the time the problem was detected and a full description of the deviation.
5. Identification of Contractor and ACT representative.
6. The assignment of each variance to one of three classes, depending on the effects of the variance, as follows:
   a. Class 1 - Testing will stop for immediate evaluation and correction by the Contractor.
   b. Class 2 - Testing will continue and the variance will be corrected at the end of the current session or day.
   c. Class 3 - Testing will continue and the variance will be corrected and tested prior to next test/shipment as applicable.
7. Variance reports shall be available to ACT at all times and shall be submitted by the Contractor to ACT at the start of the availability test. The Contractor shall maintain and periodically distribute a variance summary that lists for each variance the variance number, a brief description of the variance, its class, and its current status.

D. Disposition of Variances: The Contractor shall document all actions taken to correct variances on the report. Sufficient information shall be provided to enable ACT to determine the need for and extent of retesting, the need for testing interactions of the correction with any previously tested hardware and software, and the need for updating appropriate documentation. A variance or discrepancy shall be deemed resolved only when all retesting has been performed to the satisfaction of the ACT, and after Contractor and ACT acknowledge correction of the variance on the report.

1. Enact a Variance Tracking Program as detailed herein.

E. Inspection

1. ACT shall be allowed access to the Contractor’s facilities during system manufacturing and testing. The Contractor shall provide office facilities, equipment, and documentation necessary to complete all inspections and to verify that the system or equipment is being fabricated and maintained in accordance with the Specifications.
2. ACT shall be allowed to review and verify the functional implementation and functional logic of system software only confidentially at the Contractor’s
facilities. No test plan, procedures, and reports are required to support software functional logic review.

3. ACT shall be allowed to inspect the Contractor’s hardware and software quality assurance standards, procedures, and records. Documents identified in the software quality assurance plan will be inspected to verify that the Contractor has performed the required quality assurance activities.

4. The inspection rights described above shall not apply to Contractor’s subcontractors supplying standard computer or peripheral equipment and third-party software products. However, inspection rights shall apply to subcontractors that are developing new software or hardware for inclusion in the system or equipment being provided.

PART 3 - EXECUTION

3.1 WITNESSING AND INSPECTION

A. Witnessing: The Contractor shall permit the ACT designated representatives to participate in all inspections and to witness all construction and tests, both in manufacturer’s plants and at the construction site. ACT has the right to reject any completed material, equipment, or installation that does not conform to these technical specifications, and shall have access to all work at the construction site at any time during working hours. Where requirements for testing, witnessing and inspection activities are present elsewhere, the requirements specified in this section shall be augmented by those additional requirements. ACT reserves the right to:

1. Inspect test records (including variance reports) at any time before signing off on said records.

2. Inspect the Contractor’s inspection and test facilities, activities and records at any time.

3. Perform additional testing, beyond that specified herein if shown a sufficient cause to do so.

B. Test Facilities: All facilities for tests and inspection at manufacturers’ plants and at the construction site shall be provided by the Contractor at its expense.

C. Notification

1. Notice shall be given to ACT for each planned test or inspection (or group of test activities, per the approved Inspection & Test Plan), 2 calendar weeks prior to an event in a manufacturer’s plant and 2 working days prior to a construction site event.

2. The Contractor shall notify and coordinate all testing that involves the Operations Control Center (OCC) with ACT prior to the start of any activity.

D. Waive: ACT retains the right to waive the requirement for any test and to decline to participate in any inspection, or witness any test. This does not relieve the Contractor in any way from the requirement that it provide working, functional, and reliable systems in accordance with these technical specifications.
E. Variance Reporting: The Contractor shall maintain a Variance Tracking Program for recording all problems, faults, and defects determined from testing.

F. Rejected Work: Any rejected material, equipment, or installation shall be replaced or reworked and shall be subject to re-inspection by ACT. In the event of repetitive rejections, ACT shall have the right to stop manufacture or installation of the affected item until a technical resolution of the problem is presented to and accepted by ACT.

G. The Contractor shall:

1. Be responsible for planning, conducting and documenting all inspections and tests required by these technical specifications, as well as any additional tests to show conformance with Contract requirements.

2. Perform re-testing, at no additional cost to ACT, for any portion of the system that does not successfully pass all tests.

3. Furnish all measurement and test equipment and any other materials, equipment and personnel needed to perform the tests. The testing related equipment shall be returned to the Contractor upon completing the testing.

   a. The Contractor shall be responsible for the costs of its personnel and any special equipment required to conduct all required tests until all tests are successfully completed, and to complete the required documentation. When any portion (e.g., equipment, subsystems or location-specific system subsets) do not initially meet the requirements of these technical specifications, the Contractor shall be responsible for the necessary corrections, including the cost of re-testing to prove compliance.

   b. Measurement and test equipment shall be calibrated at an interval defined in the approved Contractor’s Quality Assurance Program Plan. Calibration shall be certified by a recognized testing facility. Tests conducted with equipment not certified as calibrated within the approved time period prior to those tests shall not be valid and shall be conducted again.

   c. Measurement and test equipment and any other materials and equipment need to perform on-site tests shall be available at the test site and “ready for use” in advance of the scheduled test.

4. Be fully responsible for the replacement of all equipment damaged as a result of the Contractor tests, and shall bear all associated costs.

5. Maintain comprehensive records of all tests.

6. Provide test records and reports for all tests (including both successful and unsuccessful tests) to ACT for approval.

H. Additional Testing: ACT may require that the Contractor perform additional testing, beyond that specified herein, of any equipment, material or subsystem in order to determine conformance with the Contract requirements. Such testing will be paid for by ACT, unless either of the following is true, in which case the Contractor shall not receive any additional compensation for performing the tests:
1. Conformance with Contract requirements of that equipment, material, or subsystem has not yet been proven by tests (as evidenced through test records provided to ACT).

2. That additional testing shows that the equipment, material or subsystem did not comply with these technical specifications.

3.2 FIRST ARTICLE INSPECTIONS (FAI)

A. General

1. First Article Inspections (FAI) performed by the Contractor shall include those for all custom-built and custom-assembled equipment. FAI's may also be conducted if any equipment in the opinion of Contractor is considered to be key equipment. Key equipment is defined as vital or not off the shelf equipment.

2. Each FAI shall be conducted at the earliest possible time in the manufacturing stage.

3. The Contractor shall notify ACT at least 21 calendar days prior to each FAI so ACT may be present if they so choose.

4. ACT may perform a FAI on any subsystem and/or component. For those subsystems and/or components where ACT performs an FAI:

   a. ACT reserves the right to review and approve the acceptability of the level of workmanship and of operating and maintenance safety observed.

   b. The following, applicable to the subject subsystem/component, shall be available at the time of the FAI:

      (1) Approved drawings and other design documentation.

      (2) Subsystem/component parts list.

      (3) Manufacturing and quality assurance inspection records.

      (4) Test records.

      (5) Tools and staff to make measurements.

      (6) Tools and staff to remove covers and perform limited disassembly.

      (7) Documentation of applicable workmanship standards, practices and procedures.

5. The Contractor’s project Quality Assurance Manager, or that individual’s approved designated representative, shall witness and document each FAI to help ensure conformance to workmanship standards, to help ensure applicable requirements are met, and to verify conformance with the Contractor’s design documentation.
B. Purpose: The purpose of each FAI shall be to:

1. Determine, based on inspection, measurement, and basic operation, whether the mechanical aspects and electrical levels of the unit under inspection are consistent with approved drawings and other design documentation. If not, the subject unit shall be replaced and the FAI repeated.

2. Determine whether an acceptable level of workmanship is present in the initial copy of the subject subsystem or component. If not, the subject subsystem/component shall be replaced and the FAI repeated.

3. Determine whether an acceptable level of operating and maintenance safety is provided in the initial copy of the subject unit. If not, the subject unit shall be replaced and the FAI repeated.

C. Required Inspections: First Article Inspections performed by the Contractor shall include those for:

1. Communications equipment for a station cabinet.
2. CCTV equipment, including head-end servers.
3. Public Address equipment, including head-end servers.
4. Fare Collection equipment.
5. SCADA equipment.
6. CTS network switches.
7. OCC workstations and monitors.

3.3 INSTALLATION INSPECTION AND TEST

A. Pre-Installation: Pre-Installation inspection shall include inspection for:

1. Missing components and parts.
2. Correct serial numbers.
3. Damage to equipment.
4. Incorrectly supplied equipment

B. Post-Installation: All installed equipment shall undergo as a minimum, inspections for:

1. Conformance to standards, methods, and quality.
2. Correct location, positioning, mounting, orientation, and labeling.
3. Damage to equipment.
4. Missing components and parts.
5. Correct and secure external connections.
6. Correct and secure routing of cable and wires.
7. Correct and secure internal connections.
8. Correct and secure wire terminations.
10. Proper grounding.
11. Correct labeling of all wires, cables and connectors.

3.4 SUBSYSTEM FACTORY TEST

A. Factory tests shall include the static pre-test of equipment and wiring verification, after the manufacturer’s equipment is powered on and verified for correct functionality.

B. Factory tests shall make sure that the software or logic contains the required functions and proper operations.

C. Factory Testing shall be performed for the following subsystems:
   1. Carrier Transmission System (CTS),
   2. SCADA System,
   3. CCTV System, including head-end servers.
   4. Public Address equipment, including head-end servers.
   5. CTS network switches.
   6. OCC workstations and monitors.

D. The Factory Tests shall verify that all subsystems work as specified and shall include the following steps:
   1. Physical inspection of equipment being tested (including model and item numbers, identification labels, etc.).
   2. Static pre-test of each equipment rack (subsystem stand-alone, wiring verification).
   3. Interconnection of racks as would be configured in the field.
   4. Pre-testing of systems in field configuration.
   5. Perform factory tests with racks and sites interconnected and configured as they would be in the field, with a simulated site-by-site testing methodology.

E. The Contractor shall notify ACT of the date of Factory Acceptance Tests in advance. ACT shall reserve its right to attend or have PMC attend on its behalf.
3.5 FACTORY ACCEPTANCE TEST (FAT)

A. General

1. Factory acceptance tests shall be conducted in compliance with approved plans and procedures and shall be performed prior to shipment to the installation location.

2. Respective factory testing for equipment, for an assembly, for a subsystem, or for a location shall be successfully completed prior to shipping to ACT that equipment, any equipment for that subsystem, or any equipment for that location. Approval of test data shall be required prior to shipping to the field.

3. Factory testing for equipment, for an assembly, for a subsystem, or for a location shall occur only after:
   a. The corresponding Final Design Review submittal package for that equipment, subsystem, or location subsystem has been approved.
   b. Quality assurance and quality control procedures and activities have been completed per the approved Quality Assurance Program Plan.
   c. The corresponding test procedures have been approved.

B. Factory Test Commencement/Successful Termination

1. Factory tests shall begin only after the following criteria have been met:
   a. The design of the equipment has been approved by ACT,
   b. Specific test procedures and data sheets to be used for factory testing have been approved by ACT,
   c. Current, up-to-date copies of all approved design drawings pertaining to the system or equipment being tested are made available to all test attendees.

2. This test phase shall be deemed to have been successfully completed when:
   a. All discrepancies have been fixed and re-tested.

C. Communications Subsystem Proof of Concept Testing: The Contractor shall inspect and test each item that is a part of each communication subsystem to be provided under the contract. The following inspection and tests shall be included:

1. Receiving inspection of all parts and assemblies received for assembly into a rack, cabinet, or building.

2. Each completed component and assembly shall be tested to confirm conformity to this specification and the manufacturer’s published specifications.

D. Carrier Transmission System FAT

1. A subsystem level test of the CTS shall be performed by the Contractor. Prior to start of the formal CTS test the node equipment and the Network
Management System shall be tested to manufacturer’s published specifications and functionality to confirm satisfactory operation.

2. Loopback function performs as specified as a result of a single fiber optic cable cut, loss of both cables at a site, a node failure. Repeat test for each node.

3. Verify that the CIR and EIR data rates are being provided for each virtual path so configured. Ethernet testing shall verify bandwidth, latency, loss, jitter, and packet/frame handling.

4. Demonstrate that after a node failure, the “node reboots and automatically restores all services.

5. Testing shall include:
   a. Ethernet communications verification (Ping test),
   b. IP Address and VLAN mapping verification,
   c. Network performance test.

E. SCADA FAT

1. Test Initiation: The following conditions shall be satisfied before starting any test:
   a. All database, displays, and report definitions shall be saved to archived media so that the SCADA system database, displays, and reports can be recreated if necessary.
   b. All source code libraries shall be saved to archived media so that the SCADA system software can be regenerated if necessary.

2. Functional Performance Test: The functional performance test shall completely verify all features of the installed SCADA system hardware equipment and software. This test shall be conducted using a hardware configuration that simulates the field configuration. The functional performance test shall include, at a minimum:
   a. Inspection of all equipment for conformance to drawings and satisfactory construction and appearance.
   b. Demonstration of proper functioning of software, including test cases with normal and exception data.
   c. Simulation of local and remote input noise and transient conditions.
   d. Simulation of PLC I/O inputs to suitable indicators.
   e. Simulation of PLC and data link communication errors and channel failures.
f. Demonstration of all features of the database, display and report generator, and other system maintenance diagnostic software functions.

g. Verification of all screen animation functions.

3. Testing shall include:

a. Simulation of field data inputs being entered into the Central Database,

b. Controls initiated by the server are transmitted to the simulated field device,

c. Verification of field bit map programmed matches latest documentation.

F. CCTV System FAT

1. A complete set of tests shall be performed on the CCTV to verify the manufactures specifications for the equipment, compatibility between equipment and to demonstrate conformance to each of the specification requirements of Division 3.2, Section 27 51 10 – Closed Circuit Television System (CCTV).

2. As a minimum the system level test for both subsystems shall include:

a. End to end test demonstration with display, recording, and playback as specified.

b. Demonstration of digital PTZ control and recording of delay between command and action of the PTZ cameras.

c. Alarm trigger the digital PTZ camera preset position

d. Control of devices and displays via the workstations.

e. Demonstration of the camera management features and the editing/updating involved in adding additional equipment (e.g., cameras and NVR). Testing shall include:

   (1) Connectivity to each camera,

   (2) Proper recording by CCTV Network Video Recorder (NVR),

   (3) Interface testing with a video display,

   (4) Interface to Ticket Vending Machine (TVM).

G. Logging Recorder: Verify the recorder operates in conformance with the manufacturer’s specifications.

3.6 GENERAL FIELD TESTING

A. General
1. Perform approved installation, subsystem and system tests to demonstrate installation meets these specifications and the approved design prior to any operational testing of systems or subsystems.

2. Perform tests to ensure proper and safe operation of systems and subsystems to prove the adequacy and acceptability of installation specified herein. Perform tests so each system and subsystem is sequenced through its operations, including imposition of simulated conditions to prove that the installation complies with specified fail-safe requirements.

B. Equipment Testing: The following types of equipment field tests shall be performed for all installed equipment:

1. Basic operation of the equipment.
2. Functional and performance testing.
3. All external interfaces (electrical, and functional).
4. Operation in the presence of equipment and communications failures.
5. Operation in the presence of power failure and restart.
6. Correct functioning and performance in the presence of actual electrical noise within the limits of tolerance for that equipment.
7. Maintainability, including tests for maintenance safety.
8. Tests for proper end-to-end operation.
9. Tests to confirm the installed subsystem meets performance requirements.
10. Tests to confirm the installed equipment and subsystem meets requirements for fault monitoring, reporting, and management.
11. Validation of all data used to configure or operate the subsystem.

3.7 SITE ACCEPTANCE TESTING (SAT)

A. Site Acceptance Test (SAT) Commencement/Successful Termination

1. Site Acceptance Testing shall begin only after the following criteria have been met:
   a. Successfully performed and ACT approved Factory Acceptance Tests and General Field Tests,
   b. All FAT discrepancies are accounted for,
   c. All discrepancies have been fixed.

2. The Site Acceptance Test shall be deemed to have been successfully completed when:
a. All discrepancies have been fixed and re-tested, or a plan is in place to address them that has been agreed to by ACT.

B. Fiber Optic Cable Tests

1. All fibers shall be 100 percent attenuation tested in the field before pulling the fiber optic cable in place to assure no damage was incurred in shipment.

2. Each optical fiber in the cable shall be tested from one end with an OTDR compatible with wavelength and fiber type. Testing shall check for continuity, length, anomalies, and approximate attenuation. Each measurement shall be recorded with color, location and type of fiber measured. If the tested loss exceeds the loss from the manufacturer's test data the Contractor shall reject the cable.

3. Upon completion of installation and termination of fiber optic cable, a visual inspection shall be made of all portions of the installation, recording all defects noted.

4. Upon completion of installation and termination of fiber optic cable, all fibers within each cable shall be tested as terminated on each fiber distribution panel.

5. The Contractor shall notify ACT in writing at least 2 weeks in advance of testing so that ACT may be present for all tests.

6. Tests shall include but not be limited to the following:
   a. Cable length.
   b. Propagation delay.
   c. Optical loss.
   d. OTDR.

7. OTDR: Test shall be performed on all spliced circuits and unused fibers using the OTDR. Tests shall be conducted for both directions of transmission. All OTDR tests shall be made with an OTDR approved by the Contractor, at both the 1310 and 1550 nanometer wavelengths.

8. OTDR Test Results: Test results shall include:
   a. Hard copies, labeled, and identified.
   b. Electronic copies on compact disk (CD), labeled, and identified.
   c. All OTDR test results, known as a trace, (hard copy and electronic file) shall identify, for each fiber tested, the following fields/requirements at a minimum:
      (1) The trace itself, with a launch transition not to exceed 6 dB.
      (2) Cursor.
(3) Marker.
(4) Distance between cursor and marker.
(5) Total Loss.
(6) Total Attenuation in dB/km for the bi-directional test.
(7) Event
(8) Cable ID.
(9) Fiber ID.
(10) Manufacturer’s Reel ID or Serial number.
(11) OTDR Location.
(12) End of Fiber Location.
(13) Operator/Technician Name or ID number.
(14) Date and Time test was performed.
(15) Test Wavelength.
(16) Test Pulse Width.
(17) Scale.

C. Copper Cable Tests

1. Installed Field Tests: Testing of installed outside plant copper communications cable shall be performed before and after installation, and after complete termination of the cable.

2. Testing shall be performed on the copper conductors, as terminated on the terminal block, patch panel, or other termination points.

3. Tests shall include, but not be limited to, the following:
   a. Attenuation at 1000Hz, 150 kHz, and 772 kHz, between terminations.
   b. Conductor to conductor resistance.
   c. Insulation resistance:
      (1) Prior to the test, disconnect power sources, direct connection to ground circuits, and any equipment that may be damaged by the voltages of the test instrument unless connection incorporates an isolation link.
      (2) Connection to ground for the test shall be the most convenient previously verified low resistance connection to ground available.
Test all wire and cable installed at the job site for insulation resistance between the conductor and ground, using a direct resistance reading instrument having a self-contained or generating test voltage of 500 to 1000 VDC.

Minimum insulation resistance to ground for circuits shall be 100 megohms. Wires and cable shall be replaced when insulation resistances are below these values. Actual resistance readings shall be recorded on test forms and submitted as project documentation.

D. Communication System Power Supply Test

1. The Uninterruptible Power Supply (UPS) equipment shall be tested to the manufactures specifications upon installation at each site to verify no damage during shipment. The UPS tests shall be performed prior to connection to other communication equipment using a load approximately equal to the site load.

2. The UPS Field Inspection and Tests:

   a. Inspection of installation and cable labeling at each site.

   b. Test of the ground buses at each site to ensure the resistance between each bus and the single point ground is not greater than 5 ohms.

   c. The Contractor shall test the UPS equipment at each site and submit the inspection report and test data to ACT for approval.

   d. Once the inspection certification has been approved for each site, system testing shall address at minimum:

      (1) Proper operation under normal conditions.

      (2) Simulation of commercial power failure and return of power after a short interval (i.e. 15 min.)

      (3) Proper operation with the batteries disconnected.

      (4) The following shall be recorded for each of the above tests

         (a) Voltage regulation over load range (i.e. with and without commercial power)

         (b) Dynamic response for a step change from 50% to 100%

         (c) Alarm indications and contact

         (d) Harmonic distortion

         (e) Battery capacity and recharge time

E. Carrier Transmission System (CTS) SAT
1. The CTS equipment shall be tested to the manufactures specifications upon installation at each site to verify no damage during shipment.

2. The CTS shall be tested as a subsystem upon completion of the installation.

3. Field Inspection and Tests:
   a. Inspection of installation and cable labeling at each site
   b. The Contractor shall test the CTS equipment at each site and submit the inspection report and test data to ACT for approval.
   c. Once the inspection certification has been approved for each site, system testing shall address at minimum:
      (1) Each new equipment shall be end to end tested to confirm functionality.
      (2) Functionality of the Ethernet Switch/Router shall be verified, display and logging of simulated alarms, access and password protection.
      (3) Local and remote access of each node.

4. Testing shall include:
   a. Ethernet communications verification (Ping test),
   b. IP Address and VLAN mapping verification,
   c. Synchronized NTP time service.

F. Closed Circuit Television (CCTV) SAT

1. The CCTV equipment shall be tested to the manufactures specifications upon installation at each site to verify that it is not damaged during shipment.

2. The CCTV equipment shall be tested for data transmission via the CTS upon completion of the installation at each site.

3. Field Inspection and Tests:
   a. Inspection of equipment installation and cable labeling at each site.
      (1) The Contractor shall test all the new equipment at each site and submit the inspection report and test data to ACT for approval.
      (2) Each camera shall be end to end tested to confirm functionality. The test shall include:
          (a) Quality of picture from all cameras.
          (b) PTZ functionality of all major components.
(c) User Interface.

(d) Verify camera has correct (intended) field of view as shown in Shop Drawings.

(e) Video Recording, of all incoming live video.

(3) Functionality of the Camera Management Software modules shall be verified. This shall include communications via the Ethernet Switch/router, display and recording of site activity and shall include all analytic application testing and verification.

4. Testing shall include:
   a. Connectivity to each camera,
   b. Proper recording by CCTV Network Video Recorder (NVR),
   c. Interface testing with a video display,
   d. Interface to SCADA.

G. SCADA SAT

1. Field tests shall be performed to verify that the equipment for SCADA system has been properly installed and to demonstrate that it satisfies all performance, and functional requirements while communicating with field devices under actual service conditions. Field tests shall include:
   a. A complete system inspection, including proper installation, grounding, cabling work in conformance to plans and drawings.
   b. Diagnostics on SCADA system hardware.
   c. A subset of functional performance test to confirm the operation of SCADA system functions, such as data acquisition and user interface.
   d. Network communications and SCADA connections to other systems shall be operational.
   e. Point-to-point verifications from the SCADA system to the field devices.

2. Field Integration Test
   a. The field integration test shall occur after all of the communication equipment has been installed at all of the sites. The tests shall be an expanded version of the Communication System Integration Test demonstrating the interoperability of all of the communication systems.
   b. The test procedures shall be those used for the Communication System Integration Test expanded to incorporate all of the equipment and sites.
3. Testing shall include:
   a. Simulation of field data inputs being entered into the system database,
   b. Controls initiated by the server are transmitted to the field device and server,
   c. Perform end-to-end testing of SCADA I/O points using a workstation at the OCC connected to each SCADA PLC,
   d. Use site specific SCADA I/O lists to document the results of each point test.

H. Fare Collection System SAT
   1. Testing shall include:
      a. TVM connectivity and fare collection,
      b. Interface to SCADA System.
   2. Reference Division 3.2, Section 27 53 50, Fare Collection System, for further specification of the FCS SAT.

3.8 SYSTEM INTEGRATION TESTING

A. System Integration Testing encompasses all tests performed to demonstrate that various subsystems perform together as an operating system. The proper operation and performance of all subsystem features and functions are exercised during integration testing. Integration Testing shall only start after successful completion of installation tests, factory tests, field, and site tests.

B. System integration tests for the EB BRT system shall be performed in accordance with ACT-approved, test plans and procedures, with an accompanying check list/test witness sign-off sheets as per the Systems Test Plan.

C. System Integration Testing Requirements
   1. The Contractor shall develop an Integration Test Plan that describes how testing shall be managed during Integration Testing.
   2. The Contractor shall develop Test Procedures and Test Reports for each Integration Test to be performed.
   3. The Contractor shall perform and verify proper execution of all test procedures for each Integration Test prior to notifying ACT that the test is ready to be witnessed.
   4. The Contractor shall develop an integrated testing schedule, manage its implementation, and coordinate changes with the Construction Manager.
   5. The Contractor shall conduct all tests in accordance with the final approved Test Procedures.
6. The Contractor shall furnish fully qualified test personnel and materials necessary to perform tests, record data, and prepare reports.

7. Should any equipment fail to meet the Specification requirements, the Contractor shall make all necessary corrections and perform all additional tests required to prove compliance at no additional cost. The Contractor shall re-inspect or retest all equipment and/or software functions affected when modifications, repairs, or replacements are required.

8. After completion of the Integration Test, the Contractor shall remove all test equipment, software tools, and temporary facilities and restore all systems to full operational status.

9. The Contractor shall supply all the test equipment, tools, hardware, documentation, data, and other items necessary to conduct tests in accordance with Contract Drawings and Specifications.

10. The Contractor shall maintain records documenting that equipment or systems have passed inspection or test within ACT-approved acceptance-testing criteria, and provide these to ACT.

D. Systems Integration Testing Plan

1. The Contractor shall develop a Systems Integration Test Plan that follows an orderly and logical sequence to describe how the Contractor shall verify the adequacy of the system to meet all technical and performance requirements. The Integration Test Plan shall provide a list of tests to be performed, and shall include at a minimum:

   a. Overview of the plan for conducting all tests;

   b. Definition of all phases of testing;

   c. Relationships between each phase;

   d. Regression test strategy to be implemented as part of each test phase;

   e. Identification of the test documentation to be developed and used for each phase;

   f. A description of the Contractor’s integrated testing organization, including identification and a description of the qualifications of the Contractor’s Integrated Testing Manager;

   g. The identification of and description of the responsibilities of the Contractor, other Contracts and/or for implementing the Integration Test Plan;

   h. The description of the responsibilities of individuals assigned by the Contractor to administer and implement the Integration Testing Plan, and the responsibilities and skill levels of individuals assigned to conduct the integrated tests;
i. Criteria to be used to develop Test Procedures, including the types of testing necessary to be performed and the conditions to be tested (including all abnormal or error conditions) shall be described in the Integration Test Plan;

j. Criteria to be applied to determine successful completion of each phase and the method to be used to measure completion;

k. Sample forms and reports to be used during each test;

l. Risk identification, control, and management;

m. Variance Tracking Program to track all discrepancies discovered during testing and to track correction of all such discrepancies;

n. Methodology to assure that all functionality, user operations, performance, normal and abnormal or perturbed conditions are completely and successfully tested.

o. The overall Integration Test program schedule, and estimated duration for each integrated test:

(1) The test schedules shall define the sequencing of test procedures;

(2) The test schedules shall define dependencies and/or restrictions on the execution of test procedures;

(3) The test schedules shall include the scheduling of test equipment and test personnel including Contractor and ACT witnesses;

(4) Test Reports shall be updated and submitted on a weekly basis to include the following:

(a) Document the status of the tests that have been executed during the prior week;

(b) Identify tests to be executed in the upcoming week;

(c) Identify the associated test procedures to be run.

p. Responsibilities (Contractor and/or other parties) for testing.

3.9 PRE-REVENUE OPERATIONS SUPPORT

A. Technical Support

1. Following installation, testing, and commissioning, ACT plans to operate the EB BRT system in non-revenue, shake down mode to ascertain equipment performance for buses and related system components. An additional purpose of the pre-revenue operations phase is to assure that operators, maintainers, bus Traffic Controllers, and supervisory staff gain familiarity with the equipment and subsystems they will be using. As part of this effort, the
Contractor shall provide support personnel as required to accomplish the following functions:

a. User training for Operating Staff and BRT Instructors.

b. Troubleshooting/Repair Training for BRT System Maintainers.

2. During this phase of the work, the Contractor shall also provide on-call maintenance services as required to assure continued operation of all newly installed Communications equipment.

3. The Contractor shall maintain sufficient, skilled and experienced personnel within the Oakland Metropolitan area to respond to on-site call outs within 4 hours of a request from ACT.

B. Documentation: At the start of this phase of the work, the Contractor shall provide ACT with all as-built drawings, instruction manuals, operating manuals, and related documentation. Manuals, drawings, and documentation shall include:

1. All Communications cable pair and fiber assignments and channel unit assignment.

2. An updated list of all maintenance work, including equipment module/PC board replacements/cable repairs/and other trouble shooting work required to maintain system operation since completion of the Systems Integration Tests.


C. Manpower: For the purpose of planning and providing manpower required to support pre-revenue operations, the Contractor shall assume:

1. One (1) communications Engineer and one (1) senior field technician for a period of 2 months.

2. For tests at OCC, one (1) Communications CCS software Engineer shall be provided.

3. Project Engineer for a period of 3 months.

4. Support personnel shall be on-call at all times.

5. Support personnel shall be pre-approved by ACT.

3.10 POST-REVENUE OPERATIONS SUPPORT

A. Technical Support: The final phase of the contract shall be to provide technical support to ACT after the system has been placed into revenue service. The Contractor shall provide on-call maintenance support to ACT that may be beyond the expertise of ACT maintenance staff capabilities shall require the Contractor's assistance on an on-call basis.

1. The Contractor shall maintain sufficient, skilled and experienced personnel within the Oakland Metropolitan area to respond to on-site calls within 8 hours of a request from ACT.
2. Pre-approval is required by ACT.

B. Manpower: For the purpose of planning and providing manpower required to support post-revenue operations, the Contractor shall assume:

1. One (1) communications Engineer and one (1) senior field technician for a period of 1 month.

2. Support personnel shall be on-call at all times.

3. Support personnel shall be pre-approved by ACT.

3.11 COMMISSIONING

A. General: Upon successful completion of System Integration Tests and Safety Certification (described below), the operation of the individual subsystems and the combined, integrated system shall be phased over for ACT use. This Commissioning process, once completed, shall be coincident with ACT’s acceptance of the materials, equipment, goods, and services provided by the Contractor. The Contractor shall prepare a system checklist, delineating all work performed, including design approvals, test completion reports, as-built drawings and manuals, spare parts records, training reports, and related materials reflecting the status of the entire signal and communications systems.

B. Safety Certification: A Safety Certification program shall be implemented as specified in Division 3.2, Section 01 91 40– System Safety and Security.

END OF SECTION
SECTION 01 45 25

COMMUNICATIONS SPARE PARTS AND TEST EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Description:

1. This Section identifies the requirements for providing spare parts and test equipment to maintain the Communications Systems for two years after the date of acceptance of the work by ACT.

2. This Section also identifies the requirements for providing spare parts to maintain the systems or equipment provided at stations and operator facilities.

1.2 SUBMITTALS

A. Spare Parts Tools and Test Equipment Lists (CDRL 01790-01): Submit a comprehensive list of spare parts, tools and test equipment hardware and software necessary for ACT to maintain the Communications and station/operator facilities. Provide separate lists for Communications and station/operator facilities. Include any spare parts, tools and test equipment identified in the individual sections of these Technical Specifications.

B. Recommended Consumables Lists (CDRL 01790-02): Submit a recommended list of consumable material necessary for ACT to maintain the Communications System and station/operator facilities.

C. Laptop Computer Tablet Product Data (CDRL 01790-03): Submit product data for the Communications laptop computers, tablets, and all supporting hardware and software for Communications System diagnostics and maintenance.

D. Spare Parts, Equipment, and Tools Inventories (CDRL 01790-04): Submit inventories of spare parts, test equipment, and tools once delivered.

1.3 SPARE PARTS FOR WARRANTY REPAIRS

A. Spare parts provided to ACT for support of revenue operations shall not be used by the Contractor or its subcontractors for warranty repairs and warranty parts replacements, unless pre-approved by ACT in writing. Parts required for use by the Contractor and its subcontractors to provide warranty support are considered the responsibility of the Contractor and its subcontractors. ACT shall not be responsible for receiving or storing any parts for warranty support. In the event that spare parts, tools, or test equipment are used in the course of satisfying warranty procedures, replace such item, in kind, within 30 calendar days, at no cost to ACT.

B. At the end of the warranty period, ACT may consider a negotiated price for purchase of all parts stocked by the Contractor for warranty support.

1.4 RELATED WORK

A. Division 3.2, Section 27 00 10, Basic Communications Technical Requirements

1.5 REPLACEMENT PARTS
A. The Contractor shall not utilize parts which are in the process of being phased out. Such parts shall include discontinued parts and parts that are known to be soon discontinued.

1.6 PACKAGING

A. All spare parts, maintenance materials, keys, special tools, and test equipment shall be securely packaged in boxes, with the boxes clearly labeled as to the contents. Such labeling shall include: location and description of the equipment and the item, complete listing of all items in the box, and the quantity of each item included in the box.

B. Cable shall be delivered on reels.

C. Comply with the requirements as specified in Division 3.2, Section 27 00 10 Basic Communications Technical Requirements.

1.7 DELIVERY

A. Deliver spare parts, maintenance materials, keys, special tools, and test equipment to the warehouse location or locations specified in the Contract Documents prior to the date of Substantial Completion. Provide unloading service at the designated storage location for all delivered products.

B. Prepare formal receipts for all such delivered products, and have them signed by the authorized Agency’s representative at the location. A copy of all such receipts shall be submitted to ACT for information and record.

C. Comply with the requirements as specified in Division 3.2, Section 27 00 10 Basic Communications Technical Requirements.

1.8 STORAGE

A. Spare parts, maintenance materials, keys, special tools, and test equipment may be stored temporarily at the site of the Work in suitable storage facilities until time to deliver these products to the locations designated by ACT.

B. Comply with the requirements as specified in Division 3.2, Section 27 00 10 Basic Communications Technical Requirements.

PART 2 - PRODUCTS

2.1 SPARE PARTS

A. General

1. Spare parts shall be identical to the equivalent installed item and shall meet all requirements of the appropriate sections of these Technical Specifications.

2. All items shall be complete and ready for installation, and required programming and configuration for use; other than wire and cable necessary for connection to external equipment.

B. Spare Parts Tools and Test Equipment Lists: Spare parts and materials lists shall include the following information for each part:

1. Description.
2. Quantity.

3. Unit Price.

4. Supplier/Manufacturer.

5. Name and address of supplier or manufacturer.

6. Supplier’s/Manufacturer’s part number.

7. Supplier’s/Manufacturer’s lead-time.

8. Assignment (type of assembly).


10. Lead time for re-order.

11. Frequency and reasons for replacement based on records.

12. Each part of component identified as being part of next larger assembly or sub-assembly.

13. Spare parts shall be grouped by equipment/subsystem/section category. Replacement parts common to more than one category shall be cross-referenced and indexed, however, only the total required quantity shall be provided. Such common parts shall have only one part number. A brief description of the reason for the inclusion and/or for quantities of the items on the list shall be provided.


15. Contract number.

16. If material requires a Material Safety Data Sheet (MSDS) sheet, that sheet shall be provided at time of delivery.

C. Required Spare Parts: Provide spare parts as detailed in the Spare Parts Tools and Test Equipment Lists necessary to maintain the Communications Systems, and equipment used at the stations and operator facilities, down to the Lowest Level Replaceable Unit (LLRU). The quantity of spare parts listed shall be 10 percent (minimum quantity of one) of the total used on the project, unless otherwise specified.

1. For Communications, furnish each type of equipment used including:

   a. CCTV Camera.

   b. CCTV Network Video recorder (NVR).

   c. LAN switches.

   d. Fiber Optic Interface Modules (All Types Used).
e. Public Address (PA) amplifier.
f. PA VOIP Audio Device.
g. PA Ambient Noise Controller.
h. PA Ambient Noise Microphone.
i. PA speaker.
j. Servers.
k. Workstations.
l. Monitors.
m. Protector Blocks.
n. Cable of each type.
o. PLCs.

2. For station cabinet and operator facilities, furnish each type of equipment used including, but not limited to:
   a. Cabinet air conditioner
   b. Lighting System components
   c. Electrical System components (e.g., panelboards, low voltage circuit breakers).
   d. Station UPS with all electronic assemblies
   e. Wiring devices
   f. Grounding material

3. Contractor shall provide a corrosion control kit that includes spare gaskets, primer paint, touch up paint, steel wool, sandpaper, and materials to keep the site equipment free of corrosion.

D. Recommended Consumable Materials: Provide a Recommended Consumables List of recommended consumable material required to maintain the communications systems, and the cabinet and operator facilities.

### 2.2 TEST EQUIPMENT AND TOOLS

A. Provide the following lists:

1. Spare Parts Tools and Test Equipment Lists as described herein.

2. Communications System Test Equipment and Tools: List and furnish the tools and test equipment necessary to maintain the system for 2 years. As a minimum the list shall include:
a. Crash Kit: A mobile kit (suitcase) of manufacture recommended spare parts necessary for rapid restoration of an optical node. The contractor shall supply these kits with all components included such that for any single contingency or failure within an optical CTS node, the kit will contain the required spare parts for restoration of service.

3. Laptop Computers: Provide 2 laptop computers for performing system maintenance and diagnostics on the Communications Systems provided.

4. Communications: All necessary software for connecting to the CTS, CCTV, SCADA, Fare Collection Systems and performing system maintenance and diagnostics at the station platforms or the Control Center. The laptops supplied to ACT shall be new at the time of delivery and shall not be used by the Contractor in the performance of the Contract. The laptops shall be turned over to ACT and shall be available for training and use by ACT prior to integrated testing.

5. Additional Licenses: In addition to that being loaded on the laptops being provided in this section, provide 3 additional licenses for all Communications software.

2.3 LOCKS AND KEYS

A. Padlocks

1. Padlocks and door locks (or other means of security) for cabinets, junction boxes and all other enclosures shall be the responsibility of the Contractor until acceptance by ACT. For locks exposed to the environment, provide a rubber cap that covers the key hole to prevent the entry of dirt and dust.

2. Upon acceptance, the Contractor shall rekey locks to match AC Transit’s keys.

3. Keying shall be compatible with AC Transit’s existing keying system.

B. The type of locks and door locks provided for equipment provided shall be coordinated with AC Transit.

PART 3 - EXECUTION

Not Used

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. Description: This Section includes the requirements for Contractor-provided manuals to provide ACT staff with the knowledge to operate, maintain, train, and expand the Communications Systems.

1.2 SUBMITTALS

A. Manual Lists and Outlines: Submit a listing of manufacturer’s standard product manuals for proposed equipment. Custom manuals, submit Custom Manual Synopsis (CDRL 01785-01) - a manual outline for each manual that defines the proposed formats (e.g., for pages, paragraphs, lists, and flow charts), fonts and types, terminology, general manual and chapter organization, guidelines for including manufacturer materials, guidelines for referencing other materials, and methods for highlighting, presenting illustrations and drawings, and depicting procedures.

B. Approved Communications System Manuals (CDRL 01785-02): Submit five hard copies and two electronic copies (CD-ROM) of each approved manufacturer’s product manual.

C. Manual Update Notification (CDRL 01785-03): Submit a letter indicating that all suppliers have been notified in writing that they are to provide ACT updated operation and maintenance data, service bulletins, and other information pertinent to the equipment as they become available. Include a list of all relevant suppliers, including their addresses and phone numbers, on the Manual Update Notification letter, or provide a copy of each letter sent to each supplier. The development of manuals shall include updating in conjunction with the approval and return of the designs from the Contractor’s responsible engineer. Any revisions to documents contained in previously approved manuals shall be submitted to ACT for approval, equal in quantity to the number of manuals supplied.

PART 2 - PRODUCTS

2.1 COMMUNICATIONS SYSTEM MANUALS

A. Manufacturer’s Operation and Maintenance (O&M) manuals shall be provided for each of the following:

1. Each make and model of equipment;
2. Each make and model revision of System Software;
3. Each make, model revision of utility software (e.g., compiler and editor); and
4. Each make and model of test equipment, including options provided in the equipment.

B. Manufacturer’s Standard Manuals
1. Programmer’s manuals shall be provided for PLC equipment, and shall include use of the programmers test set. These manuals shall allow ACT to fully program, debug, test, and update all PLC software.

2. Programmer’s manuals shall be provided for microprocessor-based Communications System components such as the Ethernet Switches, CCTV, SCADA processors, PA head-end servers & workstations, and similar equipment that is different from what is currently being used, unless complete programming instructions are already included in customized manuals. These manuals shall allow ACT to fully program, debug, test, and update all software.

3. Maintenance manuals shall be provided for new software. Manuals for all software based systems shall include volumes specifically addressing operations, administration, and maintenance procedures.

PART 3 - EXECUTION

Not Used

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. Description - this Section includes:

1. Requirements for Contractor-provided training to provide ACT staff with the knowledge needed to operate and maintain the Communications and Fare Collection Systems.

   a. Reference Division 3.2, Section 27 53 50, Fare Collection, for training requirements specific to Fare Collection Systems.

1.2 SUBMITTALS

A. Training Plan (CDRL 01820-01): Submit a complete plan for providing training described herein. Provide separate sections in the plan for each discipline (communications, fare collection and facilities maintenance). Provide cross-references between sections for common elements and interfaces between systems. Include two electronic copies of each plan.

B. Draft Training Course Descriptions (CDRL 01820-02): Submit a draft description for each course, including workbooks, to be provided.

C. Final Training Course Descriptions (CDRL 01820-03): Submit a final draft of the course, including workbooks, descriptions to be utilized for training.

D. Approved Training Course Descriptions (CDRL 01820-04): In addition to the 15 copies to be provided for each training class, submit 20 copies of the final approved course descriptions, including workbooks, to be utilized for future training by ACT. Include two electronic copies of each approved course.

E. Training Class Video Recordings (CDRL 01820-05): Submit three copies of each training class in electronic format.

PART 2 - PRODUCTS

2.1 GENERAL

A. General Formatting Requirements

1. Size: 8-1/2 inches x 11 inches for write-up.

2. 11 inches x 17 inches for all drawings.


4. Text: Printed or typewritten, and based on the font and format approved by ACT.

5. Drawings: 11 inches by 17 inches shall be “Z” folded to open out clear of the main text, show the drawing title block. Larger drawings are acceptable, provided they are folded to fit into a pocket inside the rear cover of the
6. Bindings: Conceal the binding mechanism inside the manual. 3-ring, vinyl-covered (D binders are acceptable), maximum size 3”, subject to ACT approval. Include pocket folders on the inside covers for folded information. Provide see-through covers on the front and spine of each binder to insert cover and identification in both.

B. Soft Copy: Provide all training material (training plan, course descriptions, Instructor's Manual, student tests, student workbooks) in electronic format (CD-ROM). All Training Documents shall be produced in Microsoft Office and the final document shall be copied to the CD-ROM. Additionally, the Training Documents shall be converted to PDF format using the latest version of Adobe Acrobat and it shall include full book marks keyed and hyper-linked to the Table of Contents. The CD-ROM shall contain all material contained in the hard copies provided, including photographs, drawings, and diagrams, and shall allow ACT to modify and upgrade the manual (including text, tables, and embedded drawings) using standard software tools using the laptop computers provided in this Contract. Accurate, non-editable graphics will be accepted, provided the specific graphic(s) is pre-approved by ACT. However, ACT requires all information (e.g., text, graphics) be provided in electronic format. Should an individual manufacturer's manual and/or training information not be provided to the Contractor in electronic format, the Contractor shall scan the information to PDF format. ACT reserves the right to modify the manual using an Adobe graphic editor. If any of the information provided is copyrighted, the holder of the copyright shall provide a copyright release of the document to ACT for their internal use.

C. Video Recording: The first training session of each type of training shall be video recorded by the Contractor and the Contractor shall provide ACT with a copy of the recordings in electronic format for their future use. Videos shall be professional grade, providing a clear view of material being trained with quality audio. Provide the first training video to ACT for approval. If, in the opinion of ACT, the recording is of poor quality – in content, audio, or video – re-perform the class and submit a new video. Subsequent videos shall not be performed until the first session has been approved.

2.2 TRAINING PLAN

A. General: Training Plan shall include:

1. A proposed schedule for each class.

2. Resumes of personnel proposed to be instructors for each class.

3. A statement of purpose of the training for each course.

4. A course syllabus for each course.

5. An overview of the hands-on experience to be included as part of each course, and a list of the equipment, tools and test equipment, manuals, and other materials to be utilized as student training aides and instructor aids.

6. A description of the pre-requisite knowledge for each course. The Contractor may assume each student has at least an AA degree, or has graduated from a technical school, or worked in a similar role to that intended for the student.

2.3 TRAINING COURSES - GENERAL
A. Software Training: Operator training shall be supplied for all delivered software systems. Training shall also be provided for any system hardware that is user configurable or for software that is capable of being user configurable. Training shall include all manuals, slides, instructor materials and software (except standard applications such as Word and Acrobat) necessary to execute the training and deliverables shall be provided that will facilitate the ability of ACT to perform their own training programs.

B. Course Descriptions: Provide course descriptions for each training course that includes, at a minimum, the following information:

1. A detailed outline of the material to be covered in the course and the duration, in hours, of the training for each major subject area within the course.
2. Copies of the visual aides, manuals, as-built documentation, and other printed materials to be used during the course.
3. Description of all other training aids, materials, tools and equipment.
4. Detailed descriptions of the procedures to be performed by students during hands-on training.
5. Specific pass/fail criteria for the course, including a sample test or assessment sheet, and a statement of the knowledge and skills students should possess at the conclusion of the course.
6. Description of Instructor materials. ACT shall be provided with all Instructor materials at the conclusion of Training.
7. Description of ACT-provided facility requirements and estimated time of use.

C. Course Workbooks: Provide a student workbook for each student in each training course. Include questionnaires and tests for the students.

D. Instructor: Classes shall be conducted by instructors provided by the Contractor. For each class, the instructor shall have previously conducted a class of similar subject matter and scope, and shall be proficient in use of the tools, equipment, and instructor aids. Class instructors shall be fully fluent in conversational English.

E. Students: Unless otherwise specified, each class will have approximately 15 students per class. In addition to those students, ACT may authorize up to three additional persons to observe any or all training sessions.

F. Materials

1. Course materials (e.g., manuals, class hand-outs, tools, equipment, video recordings, computer-based software, Instructor materials) shall be provided for each class, and shall be reusable (where practical), and shall become the property of ACT.
2. Information for each course period shall define the objective of the course period; the instruction environment, tools, course materials; procedure-level use of course materials, tools, other instruction aids; alternative training approaches (to cater where materials are not producing the level of training intended); and methods and criteria to assess/determine student progress and proficiency. Information shall include instructions on use of course materials, tools, equipment and other instruction aids.
G. Location: Training will be held at an ACT location. ACT will provide necessary seating, lighting, and related facilities.

H. Emphasis: Courses shall emphasize hands-on training, using System equipment, tools, test equipment, and documented procedures, as applicable. Equipment and instruction aids shall be used to illustrate information and procedures in corresponding O&M manuals.

I. Maintenance Course Goals: Maintenance training shall provide maintenance personnel with the knowledge and skills required to:

1. Gain a thorough understanding of the operation of the system, subsystem, and equipment.

2. Gain an understanding of the technology, architecture, and specific configuration.

3. Gain familiarity with the specific components and their role.

4. Gain familiarity with drawings and other design and installation documentation.

5. Gain familiarity with and use procedures in the corresponding maintenance manuals.

6. Be adept at using all tools, test equipment and built-in diagnostics and monitors.

7. Be adept at performing preventative maintenance.

8. Be adept at performing first level maintenance (to the Field Replaceable Unit), including:
   a. Using Systems facilities, tools and test equipment to efficiently recognize problems, troubleshoot equipment in the field, isolate the problem, and determine units which have failed or are operating incorrectly.
   b. Removing failed or incorrectly operating equipment from service safely and with minimal impact on continued operation of the Systems.
   c. Capturing and recording supporting diagnostic data to help further troubleshooting of computer controlled equipment.
   d. Planning and implementing temporary workarounds.
   e. Ensuring candidate replacement units are operating correctly, and have correct settings.
   f. Installing replacement units safely and correctly, checking that the replacement unit is operating correctly, and introducing the replacement unit into the operating System with minimal impact on the operation of the System.

9. Be adept at performing shop maintenance (to the Lowest Level Replaceable Unit), including:
a. Using Systems facilities, tools and test equipment to efficiently isolate the problem within the subject Field Replaceable Unit (FRU), troubleshoot, and determine which replaceable unit has failed or is operating incorrectly.

b. Removing replaceable units from the Field Replaceable Units.

c. Capturing and recording diagnostic data.

d. Coordinating with manufacturer’s support staff and information centers as needed, including actions such as downloading, installing and testing new firmware.

e. Rebuilding, configuring and verifying correct operation of higher level replaceable units, up through and including Field Replaceable Units.

J. Completion

1. Training classes shall be repeated if in the opinion of ACT the training provided is inadequate and does not meet the goals of the training course and the requirements of these technical specifications. Success or failure of class participants on the tests or assessment sheets specified elsewhere in this section shall be factored into the ACT determination of whether training goals have been met.

2. Each type of training shall be completed prior to the need for ACT staff to perform the functions associated with that training.

K. Training Schedule: Schedule is to accommodate ACT’s operation and maintenance of the installed systems and equipment. Training shall not start until the training program, lesson plans, and all required material have been approved, and all required copies have been received by ACT. Unless otherwise specified, each training class longer than 8 hours shall be held on consecutive days, excluding weekends and holidays. Classes shall be provided no later than 30 days prior to pre-revenue service operations date. Coordinate the schedule with ACT.

PART 3 - EXECUTION

3.1 ONSITE TRAINING

A. General: ACT reserves the right to train its operations and maintenance staff during installation and testing work performed by the Contractor during the performance of the Contract, to the extent possible, as long as it does not interfere with the Work of the Contract.

B. Schedule: Coordinate with ACT during the installation and testing phase of the Contract as to what equipment being installed or tested in which the Contractor will permit ACT to participate in order to obtain advanced training.

3.2 COMMUNICATION COURSE - MAINTENANCE AND OPERATIONS

A. General

1. Class length: 40 hours, minimum.

2. Number of classes: 2.
3. Each class may have up to 15 students.

B. Topics: Course Content shall include review of the following procedures necessary for system operations:

1. SCADA System
   a. RTU setting and test procedures, and;
   b. RTU replacement.

2. UPS Systems
   a. Battery capacity checks and battery preventative maintenance procedures.
   b. Battery replacement techniques.

3. Carrier Transmission System
   a. Switch configuration and provisioning.
   b. Core router configuration and provisioning.
   c. Any software provided.

4. CCTV System
   a. Adding cameras to stations.
   b. Network Video Recorder (NBR) setup and configuration.
   c. Any software provided.

5. PA System
   a. Making live and recorded PA announcements.
   b. Any software provided.

C. Course Goals: This course shall be conducted for Communications System Maintenance Technicians to familiarize them with maintenance, trouble shooting, preventative maintenance, and adjustment procedures necessary to assure full time system operation.

### 3.3 AUTOMATED FARE COLLECTION

A. Provide training for the Fare Collection System as specified in Division 3.2, Section 27 53 50, Fare Collection.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. Section identifies aspects of System Safety and Security Program that Owner considers as essential requirements for this Project. Contractor shall implement and maintain existing System Safety/Security Certification Management Plan in compliance with ACT Safety and Security Management Plan and FTA requirements.

1.2 RELATED DOCUMENTS

A. The following list is provided for convenience and is not intended to exclude or supersede any portion of the Contract Documents.

2. 100 percent Preliminary Engineering Design Submittal.

1.3 DOCUMENTATION

A. Safety and Security Certification Plan: AC Transit Project: Safety and Security Certification Program shall be implemented by Contractor during final design, construction/procurement/installation, and startup and integration testing of Project.

B. Safety and Security Management Plan: Owner has prepared the ACT EB BRT Safety and Security Management Plan (SSMP). Plan addresses overall requirements for the Project's Safety and Security Management Program and defines responsibilities of Owner, and Contractor for the implementation of this Program. Plan also references the construction safety program that shall be implemented by Contractor during construction and testing of Project.

1.4 SUBMITTALS

A. Submittal of update to Safety/Security Certifiable Items List (CIL), Construction Specification Conformance Checklists and Systems Integration Test checklists for review and acceptance by Owner to be concurrent with scheduled milestones for construction, procurement, installation, Dynamic Testing Readiness, and startup and integrated testing of Project.

B. Submittal of the Final Construction/Procurement/Installation Report.

C. Submittal of the Final Startup and Integrated Testing Report.

PART 2 - PRODUCTS

2.1 SAFETY AND SECURITY CERTIFICATION PLAN (SSCP)

A. Contractor shall be responsible for the SSCP during construction, manufacturing, installation and testing of Project. Contractor shall maintain, revise, and update this plan as necessary during course of Work in compliance with overall requirements of FTA and SSMP. Contractor shall develop and implement procedures and instructions that are necessary to implement requirements of SCMP during the Work.

B. Contractor shall assign, subject to Owner's approval, an experienced and qualified Safety and Security Manager to implement the Contractor's Project Safety and Security Certification Program and to participate as a member and activities coordinator of the Project's Safety and Security Certification Review Committee (SSCRC) which will be chaired by the Owner.

PART 3 - EXECUTION

3.1 FINAL DESIGN, CONSTRUCTION, MANUFACTURING, INSTALLATION AND TESTING

A. During course of the Work, Contractor shall implement the safety and security-related activities as specified by SSCP. These include but are not limited to the following major activities:

1. Update and maintain the Safety/Security Certification Items List (CIL).

2. Verify and document for each CIL item that construction/procurement/installation complies with Design through completion of the Construction/Procurement/Installation Conformance Checklist concurrent with construction schedule milestones. Issue final report.

3. Verify and document for each CIL item that all design and construction/procurement/installation and testing certifications are complete to support Dynamic Testing Readiness.

4. Verify and document for each CIL item that startup and integrated test results comply with design/safety/security requirements through completion of the Startup and Integrated Testing Conformance Checklist concurrent with startup and integrated testing schedule milestones. Issue final report.


7. Assist Owner in Final Certification activities AC Transit and California Public Utility Commission (CPUC)

8. Assist in training of O&M personnel, updating O&M and security-related plans and procedures, and assist in the conduct of operational readiness reviews.

END OF SECTION
SECTION 26 00 10

GENERAL PROVISION FOR ELECTRICAL WORK

PART 1 - GENERAL

1.1 SUMMARY

A. This Section covers and applies to all work specified in Division 26.

B. Coordinate all work in this Division with related trades.

C. Work Included: Materials, equipment, fabrication, installation and tests for fully operational and safe systems, including all necessary materials, appurtenances and features whether specified or shown on Plans or not, in conformity with applicable codes and authorities having jurisdiction for the following:

1. Electrical work specified in all Sections within Division 3.2 of these Specifications, including, but not limited to:

   A. Primary underground service ducts and conduit from the point of serving agency connection to the metering section.

   B. Lighting and power distribution facilities, including busways, main switchboard with metering, panelboards with feeders, branch circuit wiring, connections to outlets, and wiring devices.

   C. Light poles, lighting fixtures and lamps.

   D. Motor and other power consuming equipment connections from distribution apparatus to equipment.

   E. Conduits for all low voltage systems.

   F. Electrical grounding system.

   G. Excavation, backfilling and compacting for the Electrical Work.

   H. Cutting and patching for the Electrical Work.

   I. Adjustment and testing of the Electrical Work.

2. Principal item includes:

   A. Division 3.2, Section 09 96 00 – High Performance Coatings

   B. Division 3.2, Section 26 00 15 – Basic Electrical Materials and Methods

   C. Division 3.2, Section 26 05 26 – Grounding and Bonding

   D. Division 3.2, Section 26 05 48 – Seismic Controls for Electrical Work

   E. Division 3.2, Section 26 05 53 – Electrical Identification

   F. Division 3.2, Section 26 05 31 – Manholes and Pullboxes
G. Division 3.2, Section 26 05 32 – Conductors and Cable
H. Division 3.2, Section 26 05 33 – Raceways and Boxes
I. Division 3.2, Section 26 05 83 – Wiring Devices
J. Division 3.2, Section 26 43 00 – Surge Protection
K. Division 3.2, Section 26 05 20 – Grounding System
L. Division 3.2, Section 26 05 43 – Underground Conduit
M. Division 3.2, Section 26 56 00 – Exterior Luminaries

1.2 REFERENCE STANDARDS

A. Published codes, specifications standards, tests or recommended methods of trade, industry or governmental organizations, or local utilities apply to Work in this Division where cited below:

1. ANSI – American National Standards Institute.
3. CBM – Certified Ballast Manufacturers.
4. AEIC – Association of Edison Illuminating Companies.
5. ETL – Electrical Testing Laboratories.
6. FAA – Federal Aviation Administration.
8. ICEA – Insulated Cable Engineers Association.
9. IEEE – Institute of Electrical and Electronics Engineers.
10. IES – Illuminating Engineering Society.
12. CEC – California Electrical Code (CEC-2013)
13. NEMA – National Electrical Manufacturer’s Association.
15. OSHA – Occupational Safety and Health Act.
17. UL – Underwriters’ Laboratories Inc.
19. State of California, Cal. OSHA.
20. Local Building Department.
21. Local Fire Department.
22. Local Electrical Utility.
23. American Disability Act - ADA

B. In addition to complying with all other legal requirements, comply with current provisions of governing Codes and Regulations in effect during the progress of the Work, and with the following:

1. Plans and Specification requirements shall govern where they exceed Code and Regulation requirements.
2. Where requirements between governing Codes and Regulations vary, the more restrictive provision shall apply.
3. Nothing contained in Contract Documents shall be construed as authority or permission to disregard or violate legal requirements.

1.3 QUALITY ASSURANCE

A. All equipment and accessories to be the product of a manufacturer regularly engaged in its manufacture.
B. Supply all equipment and accessories new, free from defects and listed by Underwriters’ Laboratories, Inc. or bearing its label.
C. Supply all equipment and accessories in compliance with the applicable standards listed in Article 1.2 of this Section and with all applicable national, state and local codes.
D. All items of a given type shall be the products of the same manufacturer.

1.4 SUBMITTALS

Refer to Division 1, Section 01 33 00, Submittal Procedures for submittal requirements and procedures. Refer to the individual Sections of Division 3.2 for the submittals required.

A. Corrections or comments made on the Submittals during review do not relieve the Contractor from compliance with requirements of the Plans and Specifications. Submittal checking by the ACT is only for review of general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. The Contractor is responsible for:

1. Confirming and correlating all quantities and dimensions.
2. Selecting fabrication processes and techniques of construction.
3. Coordinating his work with all other trades.
4. Performing his work in a safe and satisfactory manner.
1.5 DESCRIPTION OF CONTRACT DOCUMENTS

A. Specifications:

1. Specifications, in general, describe quality and character of materials and equipment.

2. Specifications are of simplified form and include incomplete sentences.

3. Words or phrases such as "The Contractor shall," "shall be," "furnish," provide," "a," "an," "the," and "all" etc. have been omitted for brevity.

B. Plans:

1. Electrical layouts are generally diagrammatic and, although size and location of equipment is drawn to scale wherever possible, Contractor shall make use of all data in Contract Documents and verify this information at Work site.

2. Locations of items on the Plans may be distorted for purposes of clearness and legibility. Actual locations of architectural and communication items are shown on architectural and communication Plans.

3. Outlets shall be located as shown on the Contract Documents.

4. Manufacturers' Drawings and instructions shall be followed in all cases where the makers of devices and equipment furnish directions, where details are not shown on the Plans, or where described in the Specifications.

5. Work installed in a manner contrary to that shown in the contract documents shall be removed and reinstalled when so directed by the ACT, at no additional cost. Discrepancies and questionable points shall be immediately reported to the ACT for clarification.

C. If any part of Specifications or Plans appears unclear or contradictory, apply to ACT for his interpretation and decision as early as possible, including during bidding period. Do not proceed with such Work without ACT's decision.

1.6 DEFINITIONS

A. "Furnish" or "Provide": To supply, install and connect complete and ready for safe and regular operation of particular work referred to unless specifically otherwise noted.

B. "Install": To erect, mount and connect complete with related accessories.

C. "Supply": To purchase, procure, acquire and deliver complete with related accessories.

D. "Work": Labor, materials, equipment, apparatus, controls, accessories and other items required for proper and complete installation.

E. "Wiring": Raceway, fittings, wire, boxes and related items.

F. "Concealed": Embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces or in enclosures.
G. "Exposed": Not installed underground or "concealed" as defined above.

H. "Indicated" "Shown" or "Noted": As indicated, shown or noted on Plans or Specifications.

I. "Equal": Equal in quality, workmanship, materials, weight, size, design and efficiency of specified product, conforming to "Manufacturers".

J. "Reviewed," "Satisfactory," "Accepted," or "Directed": As reviewed, satisfactory, accepted or directed by or to ACT.

K. "Control Devices": Automatic sensing and switching devices such as thermostats, pressure, float, electro pneumatic switches and electrodes controlling operation of equipment.

1.7 UTILITY CONNECTIONS

A. Finalize electrical service arrangements including verification of locations and details with the Serving Agency.

B. In addition to the requirements shown on the Plans and stated herein, the Work shall comply with the following:

   1. Construction Standards and Service Requirements of the respective utilities including any supplementary Plans issued by the utilities.

   2. Be subjected to inspection approval of these utilities.

C. Electrical service facilities shall consist of furnishing and installing concrete encased primary conduits, transformer vault appurtenances and secondary service in accordance with the arrangement, details, and locations shown on the Plans and described herein.

1.8 ELECTRICAL SYSTEM CHARACTERISTICS

A. Service: 120/240 volts, 1 phase, 3 wire with grounded neutral unless otherwise specified.

B. LED lighting: 120 volts.

C. Motors 1/2 horsepower and above: 240 volts, 1 phase, unless specifically indicated otherwise.

D. Fractional horsepower motors less than 1/2 horsepower: 120 volts single phase.

E. Lighting and receptacles will be supplied at 120 volts or 125/250V.

F. All electrical equipment shall be designed to withstand maximum available fault current established.

1.9 JOB CONDITIONS

A. Examine all Plans and Specifications in a manner to be fully cognizant of all work required under this Division.
B. Adjoining work of other Divisions shall be examined for interferences and conditions affecting this Division.

C. Examine site related work and surfaces before starting work of any Section.
   1. Prepare review drawings showing proposed rearrangement of work to meet project conditions, including changes to work specified in other Sections.
   2. Perform any required removal, repair or replacement of this Work caused by unsuitable conditions at no additional cost to Agency.

1.10 MOUNTING HEIGHTS

A. Mounting heights of devices and equipment shown on the lighting fixture schedule shall govern. In the absence of such indications, the centerline heights of devices above the finished floor shall be confirmed with ACT before installation.

1.11 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Ship equipment in original packages, to prevent damaging or entrance of foreign matter.

B. Handle and ship in accordance with manufacturer's recommendations.

C. Provide protective coverings during construction.

D. Replace at no expense to Agency, equipment or material damaged during storage or handling.

E. Tag all items with weatherproof tag, identifying equipment by name and purchase order number.

F. Include packing and shipping lists.

G. Special requirements as specified in individual sections.

1.12 SEISMIC RESTRAINTS

A. Provide seismic restraints per California Building Code (CBC). Design and provide restraints to prevent permanent displacement in any direction caused by lateral motion, overturning or uplift. Submit calculations and details to ACT for approval.

B. Lighting fixtures shall be supported from structural as required by local codes or local authorities.

C. Requirements:
   1. Seismic: Design Category E, or as required by CBC.
   2. Major equipment including:
      A. Main switchboards.
      B. Floor mounted distribution panels.
3. Other equipment and apparatus:
   A. Panelboards.
   B. Busways.
   C. Starters, including those furnished under other sections.
   D. Lighting fixtures.
   E. Life safety related enclosures and devices.

D. Equipment: If required to be restrained, the equipment itself must be designed to withstand the required seismic force criteria, including its internal design, components and frame; and must have suitable structural elements to which restraining attachments may be fastened.

E. Rigidly supported equipment: Restrain per SMACNA guidelines where applicable; where not applicable restrain similarly and as recommended by manufacturer of equipment.

F. Design:
   1. Prepare designs, including arrangements, sizes and model numbers indicated or referenced in applicable standards.
   2. Where designs, etc., are neither indicated nor referenced, prepare such designs, together with supporting calculations prepared by a duly licensed engineer registered in the State.

1.13 PROTECTION OF MATERIALS

A. Protect from damage, water, dust, etc., material, equipment and apparatus provided under this Division, both in storage and installed, until final acceptance.

B. Arrange with Agency for storage facilities for materials and equipment.

C. Material, equipment or apparatus damaged because of improper storage or protection will be rejected.
   1. Remove from site and provide new, duplicate, material equipment or apparatus in replacement of that rejected.

D. Protect premises and work of other Divisions from damage arising out of installation of work of this Division.
   1. Repair or replace, as directed by ACT, materials and parts of premises which become damaged as result of installation of Work of this Division.
   2. Remove replaced parts from premises.
1.14 REVIEW OF CONSTRUCTION

A. Work may be reviewed at any time by ACT. Corrections shall be made to any work, material or equipment found to be deficient or defective at no additional cost to Agency.

1.15 SCHEDULE OF WORK

A. Arrange with Agency schedule for Work in each area.

B. Unless otherwise directed by Agency perform work during normal working hours.

1.16 PERMITS, LICENSES, AND INSPECTIONS

A. Permits and Licenses:

1. Secure required permits and licenses including payments of all charges and fees.

B. Inspections:

1. Obtain certificates of final inspection approval from authorities having jurisdiction.

2. Obtain inspections during the Work as required to allow timely progress of these and other trades.

1.17 GUARANTEE

A. Guarantee all materials, equipment, apparatus and workmanship to be free of defective materials and faulty workmanship for period of one year from date of filing of final acceptance. Unless extended guarantee periods are specified in individual sections.

B. Provide new materials, equipment, apparatus and labor to replace that determined by ACT to be defective or faulty.

C. This guarantee also applies to services such as Instructions, Adjusting, Testing, Noise, etc.

D. Equipment manufacturers shall include extended warranty to give full coverage during warranty period, unless longer period is specified.

1.18 PRELIMINARY OPERATION

A. Any portion of the system or equipment shall be placed in operation at the request of the Agency prior to the final completion and acceptance of the Work. Such operation shall be under the direct supervision of the Contractor, but the expense thereof will be paid separately and distinct from any money paid on account of the Contract. Contractor shall correct all deficiencies and provide all rework as necessary at his expense.

B. Preliminary operation or payment thereof shall not be construed as acceptance of any part of the Work.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. When specific names are not stated, only the best available quality of material or equipment shall be submitted for review and used in the installation.

B. Named materials shall comply with the specifications. Where the phrase "equal to" or words of similar intent are used in reference to material or equipment, the product is specified as to type and construction only and equivalent products may be submitted for review.

C. Where names of selected manufacturers and certain types of material are shown or specified without the use of the above phraseology, the Contractor shall base his proposal and work on use of the selected products and only such products shall be submitted for review.

2.2 MATERIALS AND EQUIPMENT

A. Nameplates:

1. Screwed on engraved white laminated plastic sheet with 3/4 in. black lettering.

2. Inscription: Subject to review, indicating equipment and voltage.

3. Provide nameplates for the following:

   A. Disconnect switches.

   B. Individually mounted circuit breakers.

   C. Panels.

   D. Cabinets.

   E. Switchboards.

B. Inserts and Supports:

1. Inserts: Steel, slotted type, factory painted.

   A. Single rod: Equal to Anvil Fig. 281.

   B. Multi rod: Equal to Fee Mason Series 9000 with end caps and closure strips.

   C. Clip form nails flush with inserts.

   D. Maximum loading: 75 percent of rating.

2. Supports from building construction: Inserts, beam clamps, fishplates, cantilever brackets or other means. Submit for review.

3. Where building construction is inadequate: Provide additional framing. Submit for review.
C. Guards and Railings:

1. Furnish guards and railings as required by Authorities having jurisdiction.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Layout and installation of electrical work shall be coordinated with the overall construction schedule and work schedules of various trades, to prevent delay in completion of the Project.

1. Complete Plans and Specifications for the entire project will be available at the Work site.

2. It shall be obligatory to thoroughly check these Plans before organizing the electrical work schedule, or installing material and equipment.

B. Dimensions and information regarding accurate locations of equipment, and structural limitations and finish shall be coordinated and verified with other Division of Work. Be prepared to promptly furnish dimensions and information regarding electrical Work to other trades and cooperate with them to secure harmony and the best progress of the Project.

C. The Plans do not show offsets, bends, and special fittings, or junction or pull boxes necessary to meet job conditions. These items shall be provided as required at no additional cost to the Agency.

D. Accessibility and Clearance:

1. Electrical equipment, outlets, junction and pull boxes shall be installed in accessible locations, avoiding obstructions, preserving headroom, and keeping openings and passageways clear.

2. Minor adjustments in the locations of equipment shall be made where necessary, providing such adjustments do not adversely affect functioning of the equipment.

E. Scaffolds and staging for installation of electrical work shall be provided under the work of this Division.

3.2 STRUCTURAL FITTINGS

A. Furnish and install the necessary sleeves, inserts, hangers, anchor bolts, and related structural items. Install at the proper time.

B. Openings have been indicated on the Architectural and Structural Plans. Should any additional openings or holes be required, the same shall be supplied at no additional cost to the Agency.

C. Location: At a time in advance of the Work, verify openings shown on the Architectural and Structural Plans.
D. If the Work of this Section requires modification of the Architectural or Structural plans, furnish new instructions as to requirements for these openings. Submit for review and coordination to ACT.

E. Sleeves shall be supplied for electrical conduits passing through walls or slabs and shall be placed before concrete is poured.

F. Equipment supports for electrical work shall be fastened to the structure by inserts, anchor bolts, bolting to drilled and tapped structural members, or by welding to the structure.

   1. Welding shall be done by the electric arc method with fully competent welders. Supporting members shall be shop coated with a suitable primer.

   2. Surfaces damaged by installation of supports shall be touched up with primer to match shop coat. Any drilling of structural members shall be approved by ACT.

G. Flashing:

   1. Wherever conduits pass through the roof or outer walls, base flashing and counterflashing shall be provided.

   2. Such flashing shall be properly installed by skilled workmen, and shall include grouting, mastic or tar application, or other means to insure a permanent, waterproof, neat and workmanlike installation.

H. Anchor bolts and inserts shall be galvanized and of adequate size and strength for installation of electrical work and shall be placed in forms before concrete is poured.

I. Cutting and patching:

   1. All additional cutting, patching and reinforcement of construction of building, subject to review by the ACT, shall be performed under this Section.

   2. Refer to appropriate Division for requirements.

3.3 WEATHERPROOF EQUIPMENT

A. Electrical devices or equipment located in damp, semi exposed areas shall be weather resistant. Enclosure shall comply with NEMA Type 3R requirements.

B. Surface mounted outlet boxes shall be cast metal with threaded hubs. Pull or junction boxes shall be cast metal with bolted and gasketed covers.

C. Outlet box covers shall be of a suitable weatherproof type with gaskets, packing glands, weatherproof doors, or other required means to prevent entry of moisture.

D. Lighting fixtures shall be installed with suitable gasket, and UL labeled for location.

E. Exterior air conditioned cabinets shall be sealed 4x type.
3.4 COOPERATION WITH OTHERS

A. The Work has been shown in locations suited to accommodate the work of others. Interferences between the Work of various trades shall be promptly reported to the ACT for adjustment and clarification.

B. Electrical Work installed in a manner that interferes with the work of another trade shall be removed and reinstalled at no additional cost to the Agency.

3.5 EXCAVATION AND BACKFILL

A. Excavation and Backfill required for electrical work shall be done in accordance with the requirements of the Division describing EXCAVATING AND BACKFILLING.

B. Pits and trenches shall be the minimum size required. Shoring and bracing shall be provided as required.

C. Provide necessary guard rails, barriers and warning lights. Work shall be scheduled in a manner that excavations shall be open for a minimum period.

3.6 HOUSEKEEPING PADS AND FOUNDATIONS

A. Furnish required dimensional Plans and specify locations. Minimum height of housekeeping pads shall be 6 inches.

B. Furnish anchor bolts and sleeves, and verify accuracy of installation.

C. Provide for:
   1. Switchboards.
   2. Light Pole Foundation.
   3. Other items as noted.

3.7 PAINTING

A. Paint and coatings for electrical work shall meet the requirements of Division 3.2, Section 09 96 00 – High Performance and Coatings.
   1. Best grade for exterior substrates as noted.
   2. Deliver in original sealed containers.
   3. Apply in accordance with manufacturer’s instructions.
   4. Colors: As selected.

B. Galvanized iron primer: Panel and pull boxes, after fabrication.

C. Hot dipped galvanized or dipped in zinc chromate: Outlet boxes, junction boxes, conduit hangers, rods inserts and supports.

D. Zinc chromate with finish to match surroundings: Marred surfaces of steel equipment and raceways.
E. Field applied zinc chromate prime coat: Steel or iron work.

F. Do not paint over required labels, equipment identification, rating plates, or other data plates.

3.8 CLEANING

A. Brush and clean work prior to concealing, painting and acceptance. Perform in stages if directed.

B. Painted exposed work soiled or damaged: Clean and repair to match adjoining work before final acceptance.

C. Remove debris from inside and outside of material and equipment.

3.9 IDENTIFICATION OF CIRCUITS AND EQUIPMENT

A. Tags shall be attached to feeder wiring in conduits at every point where runs are broken or terminated. Tag pull wires in empty conduits.

1. Circuit, phase, and function shall be indicated. Tags may be made of pressure sensitive plastic or embossed self attached stainless steel, brass ribbon or engraved laminated plastic.

2. Branch circuit wiring shall be tagged with numbered adhesive strip.

B. Cardholders and cards shall be provided for circuit identification in panelboards. Cardholders shall consist of a metal frame permanently attached to the inside of panel door, with clear plastic cover for directory card.

1. List of circuits shall be typewritten on card. Circuit description shall include name or number of circuit, area, and connected load.

C. Junction and Pull boxes shall have covers stenciled with box number when shown on the Plans, or circuit numbers according to panel schedules. Data shall be lettered in a conspicuous manner with a color contrasting to finish.

D. Switchplates shall be suitably engraved with a legend showing function or areas served when required by Codes or shown on the Plans.

3.10 CONNECTIONS TO EQUIPMENT

A. Connections to equipment furnished under other Divisions or by Agency shall be part of the electrical work.

1. Work shall include wiring for equipment without factory fabricated wiring; connection to motors when the motor is supplied as a separate unit; and connections only for equipment furnished with factory installed internal wiring, except as further limited by the Plans and other portions of the specifications.

2. Work shall include furnishing suitable outlets, disconnecting devices, starters, pushbutton stations, selector switches, conduit, junction boxes, wire and wiring devices necessary for complete electrical installation.
3. Devices and equipment furnished shall be of the same type used elsewhere on the project or as specified herein. Location and electrical requirements of such equipment shall be verified in advance with the Contractor or manufacturer furnishing the equipment.

B. Equipment specified under other Divisions for installation and/or connection under Work of this Division will be delivered to the installation location by the Contractor furnishing the equipment.

C. Equipment furnished under other Divisions, and requiring electrical connection under this Division will be set in place by Contractor furnishing the equipment.

D. Suitability and connection of equipment specified under other Divisions shall be determined in advance of installation. Immediate notice shall be given to the affected parties of damage, unsuitability, or lack of parts. No connection shall be made until satisfactory resolution of the deficiencies has been accomplished.

3.11 ADJUSTMENTS AND TESTS

A. Wiring shall be tested for continuity, short circuits, and improper grounds. Insulation resistances shall comply with values stated in the applicable Electrical Code.

B. Devices and equipment shall be checked for correct functional performance in accordance with apparatus ratings, operating sequence and Code requirements.

C. All motors shall be checked and adjusted for correct direction of rotation.

D. Loading of circuits and feeders in panelboards shall be checked and balanced.

E. Repair or replace defective work or equipment, at no cost to Agency.

F. The entire electrical installation shall be tested, adjustments made, and defects corrected.

PART 4 - MEASUREMENTS & PAYMENT

4.1 MEASUREMENT

A. No separate measurement will be made for the Work of this Section.

4.2 PAYMENT

A. No separate payment will be made for the Work of this Section since its cost is incidental to other payment items.

END OF SECTION
SECTION 26 00 15

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section consists of basic electrical materials and methods to be used by the Contractor in furnishing and installing electrical work described by the Contract Documents.

1.2 SUMMARY

A. This Section includes the following:
   1. Supporting devices for electrical components.
   2. Cutting and patching for electrical construction.
   3. Touchup painting.

1.3 RELATED WORK

A. Coordinate the work of this Section with all other Sections of this Specification and in particular the following Sections:
   1. Division 3.2, Section 26 00 10, General Provision for Electrical Work
   2. Division 3.2, Section 26 05 26, Grounding and Bonding
   3. Division 3.2, Section 26 05 48, Seismic Controls for Electrical Work
   4. Division 3.2, Section 26 05 53, Electrical Identification
   5. Division 3.2, Section 26 05 31, Manholes and Pullboxes
   6. Division 3.2, Section 26 05 32, Conductors and Cables
   7. Division 3.2, Section 26 05 33, Raceways and Boxes
   8. Division 3.2, Section 26 05 83, Wiring Devices
   9. Division 3.2, Section 26 43 00, Surge Protection
   10. Division 3.2, Section 26 05 20, Grounding System
   11. Division 3.2, Section 26 05 43, Underground Conduit
   12. Division 3.2, Section 26 56 00, Exterior Lighting
   13. Division 3.2, Section 27 53 50, Fare Collection System

1.4 DEFINITIONS

A. GRS: Galvanized Rigid Steel Conduit.
B. LFMC: Liquidtight flexible metal conduit.
C. LFNC: Liquidtight flexible nonmetal conduit.
D. RNC: Rigid nonmetallic conduit.

1.5 SUBMITTALS
A. Submit the following in accordance with Division 1, Section 01 33 00, Submittals and the approved Schedule of Shop Drawing and Sample Submittals:
   1. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.6 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. Comply with NFPA 70.

1.7 COORDINATION
A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.
   1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.
B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.
C. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.

PART 2 - PRODUCTS
2.1 SUPPORTING DEVICES
A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.
B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.
C. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.
D. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.
E. Expansion Anchors: Carbon-steel wedge or sleeve type.
F. **Toggle Bolts:** All-steel springhead type, corrosion-protective coating.

G. **Powder-Driven Threaded Studs:** Heat-treated steel, galvanized.

### 2.2 ELECTRICAL IDENTIFICATION

A. **Identification Devices:** A single type of identification product for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.

B. **Raceway and Cable Labels:** Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and minimum length of color field for each raceway and cable size.

1. **Type:** Preprinted, flexible, self-adhesive, vinyl. Legend is overlaminated with a clear, weather- and chemical-resistant coating.

2. **Color:** Black letters on orange background.

3. **Legend:** Indicates voltage.

C. **Underground Warning Tape:** Permanent, bright-colored, continuous-printed, vinyl tape with the following features:

1. Not less than 6 inches wide by 4 mils thick.

2. Compounded for permanent direct-burial service.

3. Embedded continuous metallic strip or core.

4. Printed legend that indicates type of underground line.

D. **Tape Markers for Wire:** Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.

E. **Color-Coding Cable Ties:** Type 6/6 nylon, self-locking type. Colors to suit coding scheme.

F. **Engraved-Plastic Labels, Signs, and Instruction Plates:** Engraving stock, melamine plastic laminate punched or drilled for mechanical fasteners 1/16-inch minimum thickness for signs up to 20 sq. in. and 1/8-inch minimum thickness for larger sizes. Engraved legend in black letters on white background.

G. **Interior Warning and Caution Signs:** Comply with 29 CFR, Chapter XVII, Part 1910.145. Preprinted, aluminum, baked-enamel-finish signs, punched or drilled for mechanical fasteners, with colors, legend, and size appropriate to the application.

H. **Exterior Warning and Caution Signs:** Comply with 29 CFR, Chapter XVII, Part 1910.145. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch, galvanized-steel backing, with colors, legend, and size appropriate to the application. 1/4-inch grommets in corners for mounting.

I. **Fasteners for Nameplates and Signs:** Self-tapping, stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.
2.3 TOUCHUP PAINT

A. For Equipment: Equipment manufacturer’s paint selected to match installed equipment finish.

B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

PART 3 - EXECUTION

3.1 ELECTRICAL EQUIPMENT INSTALLATION

A. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

B. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.

C. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 WIRING INSTALLATION

A. Install splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

B. Install wiring at outlets with at least 12 inches of slack conductor at each outlet.

C. Connect outlet and component connections to wiring systems and to ground. Tighten electrical connectors and terminals, according to manufacturer’s published torque-tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 486A.

3.3 ELECTRICAL SUPPORTING DEVICE APPLICATION

A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.

B. Dry Locations: Steel materials.

C. Support Clamps for PVC Raceways: Click-type clamp system.

D. Selection of Supports: Comply with manufacturer’s written instructions.

E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb design load.

3.4 SUPPORT INSTALLATION

A. Install support devices to securely and permanently fasten and support electrical components.

B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.
C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.

D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.

E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.

F. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.

G. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.

H. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:

1. Wood: Fasten with wood screws or screw-type nails.

2. Masonry: Toggle bolts on hollow masonry units and expansion anchors on solid masonry units.

3. New Concrete: Concrete inserts with machine screws and bolts.

4. Existing Concrete: Expansion anchors.

5. Steel: Welded threaded studs or spring-tension clamps on steel.

   a. Field Welding: Comply with AWS D1.1.

6. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.

7. Light Steel: Sheet-metal screws.

8. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

3.5 IDENTIFICATION MATERIALS AND DEVICES

A. Install at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations indicated in the Contract Documents or required by codes and standards. Use consistent designations throughout Project.

C. Install continuous underground plastic markers during trench backfilling, for exterior underground power, control, signal, and communication lines located directly above power and communication lines. Locate 6 to 8 inches below finished grade. If width
of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches, overall, use a single line marker.

D. Color-code 208/120-V system secondary service, feeder, and branch-circuit conductors throughout the secondary electrical system as follows:

1. Phase A: Black.
2. Phase B: Red.
3. Phase C: Blue.

E. Color-code 480/277-V system secondary service, feeder, and branch-circuit conductors throughout the secondary electrical system as follows:

1. Phase A: Yellow.
2. Phase B: Brown.
3. Phase C: Orange.

F. Color-code 240/120-V system secondary service, feeder, and branch-circuit conductors throughout the secondary electrical system as follows:

1. Leg A: Black.
2. Leg B: Red.

G. Install warning, caution, and instruction signs where required to comply with 29 CFR, Chapter XVII, Part 1910.145, and where needed to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.

H. Install engraved-laminated emergency-operating signs with white letters on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

3.6 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved to restore integrity of the original structure.
3.7 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work, including the following:

1. Raceways.
2. Building wire and connectors.
4. Electrical identification.
5. Concrete bases.
6. Cutting and patching for electrical construction.
7. Touchup painting.

3.8 REFINISHING AND TOUCHUP PAINTING

A. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.

B. Follow paint manufacturer’s written instructions for surface preparation and for timing and application of successive coats.

C. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

D. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.9 CLEANING AND PROTECTION

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION
SECTION 26 05 20

GROUNDING SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install grounding system and equipment as indicated in plans and specified, including: Service and equipment, Service drops, underground distribution and outdoor enclosures.

B. Related Sections:

1. Division 1, Section 01 33 00, Submittal Procedures
2. Division 3.2, Section 26 00 10, General Provisions for Electrical Work
3. Division 3.2, Section 26 00 15, Basic Electrical Material and Methods
4. Division 3.2, Section 26 05 26, Grounding and Bonding
5. Division 3.2, Section 26 05 32, Conductors and Cable
6. Division 3.2, Section 26 43 00, Surge Protection

1.2 SYSTEM DESCRIPTION

A. Ground all neutral conductors, conduit systems, cabinets, equipment, motor frames, device plates, etc., in accordance with NEC and applicable codes.

B. In non-metallic conduits, maintain continuity of equipment grounding system by conductor installed and connected by an acceptable method.

1.3 SUBMITTALS

A. Submit all product data for review and approval (CDRL 16450-01) in accordance with Division 1, Section 01 33 00, Submittal Procedures.

B. Submit all test reports for approval and as-built records. (CDRL 16450-02).

PART 2 - PRODUCTS

2.1 MATERIALS

A. Copper Conductor, 98 percent conductivity, Class B stranding, Type TW insulation for:

1. Service: Size per CEC, Table 250-190, conductor in rigid metallic conduit.
2. Metallic raceway continuity: No. 6 AWG.

B. Ground Clamps: Bronze, solderless type with bronze screws, suitable to receiving noted conductors.

C. Ground Rods: Copperweld, suitable for adding multiple sections, minimum 10 long feet by 3/4 inch diameter.
D. Ground Rod Inspection and Test Wells: As required for ground rods that are not installed within equipment cabinets, lighting poles, or structural columns, provide ground well to allow access for inspection and testing of the ground system. Well shall be minimum 10” diameter with vandal-resistant covers. Well and cover shall be solid, suitable for traffic loads in street locations, and suitable for 350 lb loads on sidewalk areas.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Service and Equipment:
   1. Ground neutral bus to ground bus at ends and ground bus to:
      a. Driven ground rods.

B. Underground Distribution:
   1. Ground:
      a. Interrupted metallic raceways with ground conductors connected to metallic raceway at each end.
   2. Provide vertically driven ground rods with tops 2 feet below finished grade, unless otherwise noted.

3.2 TESTS

A. For ground continuity at:
   1. Switchboards.
   2. Panelboards.

B. Ground Resistance Test.
   1. Conduct ground grid to earth tests prior to tie into system at sufficient points throughout the grid system to assure a measured resistance of 2 ohms or less to ground.
   2. Conduct the tests under the following conditions:
      a. After the installed ground grid is backfilled and compacted.
      b. Dry weather, not less than 48 hours after rainfall.
   3. Test instrument: Null balance type, Biddle Megger Earth Tester or approved equal.
   4. Compile all resistance readings and calculations and prepare as a report and submit to the ACT after the tests are conducted.

C. Provide written certification of compliance.
PART 4 - MEASUREMENTS & PAYMENT

4.1 MEASUREMENT

A. No separate measurement will be made for the Work of this Section.

4.2 PAYMENT

A. No separate payment will be made for the Work of this Section since its cost is incidental to other payment items.

END OF SECTION
SECTION 26 05 26
GROUNDING AND BONDING

PART 1 - GENERAL

1.1 DESCRIPTION
This Section consists of the Contractor furnishing all materials, labor and equipment necessary and incidental to furnishing and installing grounding and bonding.

1.2 SUMMARY
This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

1.3 RELATED DOCUMENTS
Coordinate the work of this Section with all other Sections of this Specification and in particular the following Sections:

A. Division 1, Section 01 33 00, Submittal Procedures
B. Division 3.2, Section 26 00 10, General Provision for Electrical Work
C. Division 3.2, Section 26 00 15, Basic Electrical Materials and Methods
D. Division 3.2, Section 26 05 32, Conductors and Cables
E. Division 3.2, Section 26 05 33, Raceways and Boxes
F. Division 3.2, Section 26 43 00, Surge Protection
G. Division 3.2, Section 26 05 20, Grounding System
H. Division 3.2, Section 26 05 43, Underground Conduit
I. Division 3.2, Section 26 56 00, Exterior Lighting
J. Division 3.2, Section 27 53 50, Fare Collection System

1.4 SUBMITTALS
Submit the following in accordance with Division 1, Section 01 33 00, Submittals and the approved Schedule of Shop Drawing and Sample Submittals:

A. Product Data (CDRL 16060-01): For ground rods and each type of other product indicated.
B. Qualification Data (CDRL 16060-02): For firms and persons specified in "Quality Assurance" Article.
C. Field Test Reports (CDRL 16060-03): Submit written test reports to include the following:
1. Test procedures used.

2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.

1. Testing Agency’s Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1. Comply with UL 467.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Grounding Conductors, Cables, Connectors, and Rods:
   a. Apache Grounding/Erico Inc.
   b. Boggs, Inc.
   c. Chance/Hubbell.
   d. Copperweld Corp.
   e. Dossert Corp.
   g. Framatome Connectors/Burndy Electrical.
   h. Galvan Industries, Inc.
   i. Harger Lightning Protection, Inc.
   j. Hastings Fiber Glass Products, Inc.
   k. Heary Brothers Lightning Protection Co.
   l. Ideal Industries, Inc.
m.  ILSCO.


o.  Korns:  C. C. Korns Co.; Division of Robroy Industries.

p.  Lightning Master Corp.

q.  Lyncole XIT Grounding.

r.  O-Z/Gedney Co.; a business of the EGS Electrical Group.

s.  Raco, Inc.; Division of Hubbell.

t.  Robbins Lightning, Inc.


v.  Superior Grounding Systems, Inc.

w.  Thomas & Betts, Electrical.

2.2 GROUNDING CONDUCTORS

A.  For insulated conductors, comply with Division 3.2, Section 26 05 32 "Conductors and Cables."

B.  Equipment Grounding Conductors: Insulated with green-colored insulation.

C.  Grounding Electrode Conductors: Stranded cable.

D.  Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

E.  Bare Copper Conductors: Comply with the following:


F.  Copper Bonding Conductors: As follows:

   1.  System grounding conductors shall be minimum of 4/0 AWG copper, unless otherwise indicated, and shall be continuous with no joints or splices.

   2.  Insulated stranded ground cable: UL83, Conductors No. 6 AWG and smaller shall have green-colored insulation. Conductors larger than 6 AWG shall be bare or have green-colored insulation or marked with green-colored tape or adhesive labels at each end and at every point where the conductor is accessible.

   3.  Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

G. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.

2.3 CONNECTOR PRODUCTS

A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.

C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

2.4 GROUNDING ELECTRODES

A. Ground Rods: Refer to Division 3.2, Section 25 05 20, Paragraph 2.1.

PART 3 - EXECUTION

3.1 APPLICATION

A. In raceways, use insulated equipment grounding conductors.

B. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells.

C. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

D. Ground Rod Clamps at Test Wells: Use bolted pressure clamps with at least two bolts.

3.2 EQUIPMENT GROUNDING CONDUCTORS

A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. Install equipment grounding conductors in all feeders and circuits.

C. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

D. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.3 INSTALLATION

A. Ground Rods: Install at locations indicated.
1. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.

B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

C. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

D. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

3.4 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvancically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.

2. Make connections with clean, bare metal at points of contact.


5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and ground rods.

Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

### 3.5 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified testing agency to perform the following field quality-control testing:

1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.

2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests, by the fall-of-potential method according to IEEE 81.

3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

   a. Equipment Rated 500 kVA and Less: 10 ohms.

4. Excessive Ground Resistance: If resistance to ground exceeds specified values, Add two additional ground rods spaced at 10 feet from each other.

### 3.6 GRADING AND PLANTING

A. Restore surface features at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Maintain restored surfaces. Restore disturbed paving as indicated.

END OF SECTION
SECTION 26 05 31

MANHOLES AND HANDHOLES

PART 1 - GENERAL

1.1 SUMMARY

A. Manholes and handholes consists of furnishing transportation, labor, materials, and equipment to furnish and install manholes and handholes. Provide precast concrete manholes and handholes for power and telephone cabling and equipment. The design for precast concrete manholes shall be accomplished by the Contractor.

B. Precast concrete manholes and handholes are to be provided for installation and pulling cables, changes in direction of ductbanks and cabling, and terminating and splicing cabling. Precast concrete manholes are, in general, over 48 inch x 48 inch x 48 inch with manhole lid rings and risers and cast iron manhole lids. Precast concrete manholes are intended for personnel entry during installation and maintenance of cabling and wiring systems.

C. Precast concrete handholes include miscellaneous handholes, junction boxes, pullboxes, and termination points for power, communication, and signal wiring. Their interior dimensions are up to a nominal 48 inch x 48 inch x 48 inch, with fixed covers, but without manhole rings or steel handhole lids. Provide where shown on the drawings.

1.2 REFERENCES

A. American Concrete Institute (ACI)

B. City Of Oakland Electrical Code

C. Caltrans Standard Specifications

1.3 SUBMITTALS

A. Submit shop drawings and calculations, sealed by a currently licensed Structural Engineer in the State of California, for all precast concrete manholes.

1. Submit fully dimensioned shop drawings for all precast concrete items showing weights, steel reinforcing, openings, blockouts, and accessory items such as pulling irons, ladders, manhole risers, covers, hatches, and sumps (CDRL 16118-01).

2. Submit structural calculations for all precast concrete items as follows (CDRL 16118-02):

   a. Submit structural calculations for all loads including traffic, soil pressure, and live loads.

   b. Submit buoyancy calculations based on water table at five (5) feet below grade. All products shall have a buoyancy safety factor of 1.5 minimum.
1.4 QUALITY ASSURANCE

A. Precast concrete manholes shall be fabricated by a supplier regularly engaged in design, fabrication, and installation of concrete products for electrical power wiring.

1.5 RELATED WORK

A. Coordinate the work of this Section with all other Sections of this Specification and in particular the following Sections:

1. Division 3.2, Section 26 00 10, General Provision for Electrical Work
2. Division 3.2, Section 26 00 15, Basic Electrical Materials and Methods
3. Division 3.2, Section 26 05 43, Underground Conduit

PART 2 - PRODUCTS

2.1 PRECAST CONCRETE MANHOLES

A. Provide precast concrete manholes for power cabling, sized and located where indicated on the drawings. Manholes shall be integrally formed walls and floor with cover, base unit with risers and cover, or panel construction with base, walls and cover(s), depending on size.

B. Manholes shall be designed and constructed to accommodate the following load criteria: Vehicular loading shall be 100 kips wheel plus 25 percent impact on a 2'-0" by 2'-6" wheel imprint area, wheels 6'-0" apart on centers, unless noted otherwise for installations in terminals.

C. Each manhole shall have ladders with extendable ladder safety posts, as manufactured by Bilco Ladderup, O’Keefe, Milcor or approved equal, and three (3) cast-in-place steel channels on each side wall for cable racking and support.

D. All cables routed through manholes shall be securely fastened to the walls, so as to support the weight of the cables and to provide separation between circuits. Where circuits of different voltage ratings occupy the same manhole, comply with code requirements for permanently and effectively separating the conductors of the various systems.

E. Manholes shall be steel reinforced precast concrete with integrally formed base and walls.

1. Provide with pulling irons, 1 in each corner.

2. Provide with 30” diameter cast iron or ductile iron manhole ring and 30” diameter cast iron cover, rated for load criteria shown on drawings. Covers shall be bolted down with stainless steel bolts, nuts and washers.
F. Manholes shall be manufactured by Utility Vault, Brooks Jensen or approved equal.

G. Manholes shall have a sump and drain in the floor fitted with a removable grate that is flush with the floor of the manhole so as to result in a uniform smooth walking surface.

H. Where the drawings call for a manhole to include a check valve, install a Zurn 4 inch backwater valve, model Z-1099, or approved equal.

2.2 PRECAST CONCRETE HANDHOLES

A. Provide precast concrete handholes sized and located where indicated on the drawings.

B. Handholes shall be designed and constructed to accommodate the load criteria shown on the drawings. Cover must not fail and must not deflect more than 1/4 inch when a vertical force of 1,500 lb is applied through a ½-by-3-by-6-inch steel plate to a non-concrete cover on pullbox. Handhole as specified in Caltrans Standard Specifications section 86-2.06.

C. Provide integrally formed floors and walls. Provide watertight seal using keyed cover and neoprene or butyl sealing strip with mastic backing.

D. Provide cutouts or blockouts for ductbank and conduit entry, or at Contractor’s option, field cut openings for ductbanks and conduits.

E. Handholes shall be manufactured by Utility Vault, Brooks, or approved equal.

PART 3 - EXECUTION

3.1 SECURING SITE WORK

A. The Contractor alone is solely responsible for securing all electrical site work with adequate barriers, warning indicators, and shoring.

3.2 EXCAVATIONS

A. Excavations shall be as required for installation intended or as shown on the drawings.

B. The Excavation bottom shall be free of debris and graded smooth.

3.3 BACKFILL AND COMPACTION

A. Backfill around vaults to be free of debris larger than 2 inches in all directions to 1 foot from vault.

B. Bedding for manholes shall be 12 inches of ¾” A Crushed Rock.

C. All other backfill and compaction shall be in conformance with TRENCHING AND BACKFILLING Section.

3.4 MANHOLES

A. Seal all joints of all conduits or ductbanks that enter or leave manholes to ensure water tightness.
B. All cables routed through manholes shall be securely fastened to the walls, so as to support the weight of the cables and to provide separation between circuits. Where circuits of different voltage ratings occupy the same manhole, comply with code requirements for permanently and effectively separating the conductors of the various systems.

C. All lift points and all joints between precast elements shall be thoroughly wetted and then completely filled with mortar, smoothed, and sealed both inside and out, to ensure water tightness.

D. In precast sections where steel loops have been provided in lieu of lift holes, remove loops flush with the inside wall surface. No short cutoff protrusions will be permitted. If concrete spalling occurs as a result of the loop removal, restore the spalled area with mortar to a uniformly smooth surface.

END OF SECTION
SECTION 26 05 32

CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 DESCRIPTION

This Section consists of the Contractor furnishing all materials, labor and equipment necessary and incidental to furnishing and installing conductors and cables.

1.2 SUMMARY

This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.3 RELATED WORK

Coordinate the work of this Section with all other Sections of this Specification and in particular the following Sections:

A. Division 3.2, Section 26 00 10, General Provisions for Electrical Work
B. Division 3.2, Section 26 00 15, Basic Electric Materials and Methods
C. Division 3.2, Section 26 05 26, Grounding and Bonding
D. Division 3.2, Section 26 05 53, Electrical Identification
E. Division 3.2, Section 26 05 33, Raceways and Boxes
F. Division 3.2, Section 26 05 83, Wiring Devices
G. Division 3.2, Section 26 43 00, Surge Protection
H. Division 3.2, Section 26 05 20, Grounding System
I. Division 3.2, Section 26 05 43, Underground Conduit
J. Division 3.2, Section 26 56 00, Exterior Lighting
K. Division 3.2, Section 27 53 50, Fare Collection System

1.4 SUBMITTALS

Submit the following in accordance with Division 1, Section 01 33 00, Submittals and the approved Schedule of Shop Drawing and Sample Submittals:

A. Product Data (CDRL-16120-01): For each type of product indicated.
B. Qualification Data (CDRL-16120-02): For testing agency.
C. Field Quality-Control Test Reports (CDRL-16120-03): From a qualified testing and inspecting agency engaged by Contractor.
1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.

1. Testing Agency’s Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 CONDUCTORS AND CABLES

A. Manufacturers:

2. General Cable Corporation.

B. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.

C. Conductor Material: Copper complying with NEMA WC 5 or 7; stranded conductor or solid conductor for No. 10 AWG and smaller, stranded for No. 8 AWG and larger.

D. Conductor Insulation Types: Type THHN-THWN complying with NEMA WC 5 or 7, unless noted otherwise in plans.

2.3 CONNECTORS AND SPLICES

A. Manufacturers:

1. AFC Cable Systems, Inc.
2. AMP Incorporated/Tyco International.
3. Hubbell/Anderson.
4. O-Z/Gedney; EGS Electrical Group LLC.
5. 3M Company; Electrical Products Division.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR AND INSULATION APPLICATIONS

A. Service Entrance: Type THHN-THWN, single conductors in raceway.
B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.
C. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
D. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspace: Type XHHN, single conductors in raceway.
E. Exposed Branch Circuits, including in Crawlspace: Type THHN-THWN, single conductors in raceway.
F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
G. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.

3.2 INSTALLATION

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
E. Support cables according to Division 3.2, Section 26 00 15 - "Basic Electrical Materials and Methods."
F. Seal around cables penetrating fire-rated elements.
G. Identify and color-code conductors and cables according to Division 3.2, Section 26 00 15 - "Basic Electrical Materials and Methods"
3.3 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

3.4 FIELD QUALITY CONTROL

A. Testing: Engage a qualified testing agency to perform the following field quality-control testing:

B. Testing: Perform the following field quality-control testing:

1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.

2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.

C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.

2. Test results that comply with requirements.

3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION
SECTION 26 05 33

RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 DESCRIPTION

This section consists of the contractor furnishing all materials, labor and equipment necessary and incidental to furnishing and installing raceways and boxes.

1.2 SUMMARY

This section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.3 RELATED WORK

Coordinate the work of this Section with all other Sections of this Specification and in particular the following Sections:

A. Division 3.2, Section 26 00 10, General Provisions for Electrical Work
B. Division 3.2, Section 26 05 26, Grounding and Bonding
C. Division 3.2, Section 26 05 48, Seismic Controls For Electrical Work
D. Division 3.2, Section 26 05 32, Conductors and Cables
E. Division 3.2, Section 26 05 83, Wiring Devices
F. Division 3.2, Section 26 05 43, Underground Conduits
G. Division 3.2, Section 26 56 00, Exterior Lighting
H. Division 3.2, Section 27 53 50, Fare Collection System

1.4 DEFINITIONS

A. GRS: Galvanized Rigid Steel Conduit
B. LFMC: Liquidtight flexible metal conduit.
C. LFNC: Liquidtight flexible nonmetallic conduit.
D. RNC: Rigid nonmetallic conduit.

1.5 SUBMITTALS

A. Submit the following in accordance with Division 1, Section 01 33 00, Submittals and the approved Schedule of Shop Drawing and Sample Submittals:

B. Product Data (CDRL 16130-1): For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 METAL CONDUIT AND TUBING

A. Manufacturer:

1. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Anamet Electrical, Inc.; Anaconda Metal Hose.
4. Electri-Flex Co.
5. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
7. O-Z Gedney; Unit of General Signal.
8. Wheatland Tube Co.

B. Galvanized Rigid Steel Conduit: ANSI C80.1.


D. Fittings: Compression type.

E. LFMC: Flexible steel conduit with PVC jacket.

F. Fittings: NEMA FB 1; compatible with conduit and tubing materials.

2.3 NONMETALLIC CONDUIT AND TUBING

A. Manufacturers:

2. Anamet Electrical, Inc.; Anaconda Metal Hose.
3. Arnco Corp.
4. Cantex Inc.
7. ElecSYS, Inc.
8. Electri-Flex Co.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT/Cole-Flex.
11. RACO; Division of Hubbell, Inc.
12. Spiralduct, Inc./AFC Cable Systems, Inc.

B. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.
C. RNC Fittings: NEMA TC 3; match to conduit or tubing type and material.
D. LFNC: UL 1660.

2.4 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers:
1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. Emerson/General Signal; Appleton Electric Company.
3. Erickson Electrical Equipment Co.
6. O-Z/Gedney; Unit of General Signal.
7. RACO; Division of Hubbell, Inc.
10. Spring City Electrical Manufacturing Co.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.
D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
E. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
F. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
G. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
H. Cabinets: NEMA type as indicated, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage.

2.5 FACTORY FINISHES

A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard paint applied to factory-assembled surface raceways, enclosures, and cabinets before shipping.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors:

1. Exposed: Galvanized Rigid Steel.
2. Concealed: Galvanized Rigid Steel.
3. Underground, Single Run: RNC.
4. Underground, Grouped: RNC.
5. Galvanized rigid steel (GRS) conduit and fittings shall be installed in all outdoor above ground areas. Minimum conduit size: 3/4-inch.
6. Non-metallic rigid conduit shall be used for underground feeders, service feeders, and under concrete slabs on grade. Minimum conduit size: 1-inch for branch circuit feeders and 2-inch for service feeders.
7. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
8. Boxes and Enclosures: NEMA 250, Type as indicated.

B. Raceway Fittings: Compatible with raceways and suitable for use and location.
   1. Galvanized Rigid Steel Conduit: Use threaded hot dip galvanized rigid steel conduit fittings. Feraloy, aluminum or threadless fittings are not acceptable.
   2. PVC Externally Coated, RNC Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.

C. Do not install aluminum conduits embedded in or in contact with concrete.

3.2 INSTALLATION

A. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

B. Complete raceway installation before starting conductor installation.

C. Support raceways as specified in Division 3.2, Section 26 00 15 - "Basic Electrical Materials and Methods."

D. Install temporary closures to prevent foreign matter from entering raceways.

E. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.

F. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
   1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.

H. Raceways Embedded in Slabs: Install in middle 1/3 of slab thickness where practical and leave at least 2 inches of concrete cover.
   1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
   2. Space raceways laterally to prevent voids in concrete.
   3. Run conduit larger than 1-inch trade size parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
   4. Change from nonmetallic tubing to galvanized rigid steel conduit before rising above the floor.

I. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
1. Run parallel or banked raceways together on common supports.

2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

J. Join raceways with fittings designed and approved for that purpose and make joints tight.

1. Use insulating bushings to protect conductors.

K. Tighten threadless fittings with suitable tools. Set screws are not acceptable.

L. Terminations:

1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.

2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

M. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

N. Raceways, 2-Inch Trade Size and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.

O. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.

2. Where otherwise required by NFPA 70.

P. For underground conduit installation see Division 3.2, Section 26 05 43, Underground Conduits.

Q. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.

R. Flexible Connections: Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission,
or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.

S. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.

T. Set floor boxes level and flush with finished floor surface.

U. Set floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.4 CLEANING

A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION
SECTION 26 05 43

UNDERGROUND CONDUITS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The work of this Section consists of furnishing and installing underground PVC and rigid steel conduits as shown on the Drawings and specified herein.

1.2 RELATED WORK

A. Coordinate the work of this Section with all other Sections of this Specification and in particular the following Sections:

1. Division 3.2, Section 26 00 10, General Provision for Electrical Work
2. Division 3.2, Section 26 00 15, Basic Electrical Materials and Methods
3. Division 3.2, Section 26 05 26, Grounding and Bonding
4. Division 3.2, Section 26 05 31, Manholes and Handholes
5. Division 3.2, Section 26 05 32, Conductors and Cables
6. Division 3.2, Section 26 05 33, Raceways and Boxes

1.3 REFERENCE STANDARDS

A. Comply with the provisions of all applicable Local, State and Federal codes, specifications, standards and recommended practices.

1.4 SUBMITTALS:

A. Submit the following in accordance with Division 1, Section 01 33 00, Submittals and the approved Schedule of Shop Drawing and Sample Submittals:

1. Product Data (CDRL 16471-01): For surface underground conduits.
2. Certification (CDRL 16471-02): Submit manufacturer’s certification that the conduit and other materials are in compliance with this Specification.

1.5 QUALITY ASSURANCE

A. Work shall comply with applicable requirements of latest NEMA, NEC and UL Standards pertaining to raceways. Products provided shall be UL listed and labeled.

PART 2 - PRODUCTS

2.1 GENERAL

A. Materials used shall be as follows unless otherwise specified or noted on the Drawings.
1. PVC Conduit: UL listed, Type EPC-40-PVC conforming to NEMA TC-2 and UL-G651 with fittings conforming to NEMA TC-3.

2. Fittings:
   a. For PVC conduit, where conduits enter manholes, provide terminal adapters and flat washers to provide waterproof termination.
   b. All elbows and risers shall be rigid steel.

3. Rigid Steel Conduit: ANSI C80.1

4. Fittings:
   a. For rigid steel conduits, where conduits enter manholes, provide conduit bells and factory type long sweep 90 degree elbows.
   b. All elbows and risers shall be PVC (40 mil) wrapped through concrete.


6. Spacers: Manufactured fitted duct spaces made of high-density polyethylene.

7. Provide watertight plugs to plug conduits.

### 2.2 BEDDING

A. Bedding for conduit shall be sand bedding as specified in Construction Methods; Division 2.1, Section 306-1.2, except where concrete encased per 3.2 below.

### 2.3 WARNING TAPE

A. Warning tape shall be as specified in Division 3.2, Section 26 00 15, Part 2.2.C underground warning tape.

### PART 3 - EXECUTION

#### 3.1 GENERAL

A. Electrical raceways shall be installed where indicated in accordance with the manufacturer's written instructions, applicable requirements of NEC and NECA "Standard of Installation", and complying with recognized industry practices.

#### 3.2 INSTALLATION OF ELECTRICAL RACEWAYS

A. Underground installation shall conform to NEMA TCB 2, ANSI C 2 and NFPA 70, except as otherwise specified or indicated.

B. Cover: Conduit shall be installed with a minimum of 2 feet 6 inches of cover below finished grade.

C. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes, to drain in both directions.
D. Changes in direction of runs exceeding a total of 10 degrees, either vertical or horizontal, shall be accomplished by long sweep bends having a minimum radius of curvature of 25 inches, unless otherwise indicated; sweep bends may be made up of one or more curved or straight sections or combinations thereof. Manufactured bends shall have a minimum radius of 36 inches. Select sweep radius based on cable manufacturer’s requirements. Trenches shall be excavated along straight lines from structure-to-structure before conduits are laid or structure constructed so the elevation can be adjusted, if necessary, to avoid unseen obstruction.

E. Separators shall be located at a maximum center-to-center spacing of 4 feet. The joints of the conduits shall be staggered by rows and layers to provide a bank line having the maximum strength. During construction, partially completed bank lines shall be protected from the entrance of debris such as mud, sand, and dirt by means of suitable conduit plugs. As each section of a bank line is completed from structure-to-structure, and in the presence of the Commission, a testing mandrel not less than 12 inches long with a diameter 1/4 inch less than the size of the conduit shall be drawn through each conduit, after which, a brush having the diameter of the conduit and having stiff bristles, shall be drawn through until the conduit is clear of all particles of earth, sand, and gravel; conduit plugs shall then be immediately installed.

F. Conduit installed in a common trench with other utilities shall be 6 inches clear of other utilities and a minimum of 3 inches between like services.

G. Provide one 1/4 inch polypropylene drag line in each conduit including 3 feet of spare at each end.

H. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.

2. Grout end bells into structure walls from both sides to provide watertight entrances.

I. Conduit shall extend 10 feet beyond each end manhole and shall be plugged with watertight plugs. Provide stakes at grade, marked with survey flagging showing elevation and type of utility.

J. Conduit install under road shall have a minimum depth of 18”.

K. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

END OF SECTION
SECTION 26 05 48

SEISMIC CONTROLS FOR ELECTRICAL WORK

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section consists of the Contractor furnishing all materials, labor and equipment necessary and incidental to furnishing and installing seismic controls for electrical work.

1.2 SUMMARY

A. This Section includes seismic restraints and other earthquake-damage-reduction measures for electrical components. It complements optional seismic construction requirements in the various electrical component Sections.

1.3 RELATED WORK

A. Coordinate the work of this Section with all other Sections of this Specification and in particular the following Sections:

1. Division 3.2, Section 26 00 10, General Provision for Electrical Work
2. Division 3.2, Section 26 00 15, Basic Electrical Materials and Methods
3. Division 3.2, Section 26 05 33, Raceways and Boxes
4. Division 3.2, Section 26 56 00, Exterior Lighting

1.4 DEFINITIONS

A. CBC: California Building Code.

B. Seismic Restraint: A fixed device (a seismic brace, an anchor bolt or stud, or a fastening assembly) used to prevent vertical or horizontal movement, or both vertical and horizontal movement, of an electrical system component during an earthquake.

C. Mobile Structural Element: A part of the building structure such as a slab, floor structure, roof structure, or wall that may move independent of other mobile structural elements during an earthquake.

1.5 SUBMITTALS

A. Submittals and the approved Schedule of Shop Drawing and Sample Submittals (CDRL 16071-01):

1. Product Data: Illustrate and indicate types, styles, materials, strength, fastening provisions, and finish for each type and size of seismic restraint component used.

   a. Anchor Bolts and Studs: Tabulate types and sizes, complete with report numbers and rated strength in tension and shear as evaluated by ICBO Evaluation Service or the equivalent local approving agency.
B. Shop Drawings (CDRL 16071-02): For anchorage and bracing not defined by details and charts on Drawings. Indicate materials, and show designs and calculations signed and sealed by a professional engineer registered in the State of California.

1. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.

2. Details: Detail fabrication and arrangement. Detail attachment of restraints to both structural and restrained items. Show attachment locations, methods, and spacings, identifying components and listing their strengths. Indicate direction and value of forces transmitted to the structure during seismic events.

3. Preapproval and Evaluation Documentation: By an agency approved by authorities having jurisdiction, showing maximum ratings of restraints and the basis for approval (tests or calculations).

C. Product Certificates (CDRL 16071-03): Signed by manufacturers of seismic restraints certifying that products furnished comply with requirements.

1.6 QUALITY ASSURANCE

A. Comply with seismic restraint requirements in CBC, unless requirements in this Section are more stringent.

1.7 PROJECT CONDITIONS

A. Project Seismic Zone: Design Category E

1.8 COORDINATION

A. Coordinate layout and installation of seismic bracing with building structural system and architectural features, and with mechanical, fire-protection, electrical, and other building features in the vicinity.

B. Coordinate concrete bases with building structural system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amber/Booth Company, Inc.
2. B-Line Systems, Inc.
3. Erico, Inc.
4. GS Metals Corp.
5. Loos & Company, Inc.
6. Mason Industries, Inc.
2.2 MATERIALS

A. Use the following materials for restraints:
   1. Indoor Dry Locations: Steel, zinc plated.
   2. Outdoors and Damp Locations: Galvanized steel.

2.3 ANCHORAGE AND STRUCTURAL ATTACHMENT COMPONENTS

A. Strength: Defined in reports by ICBO Evaluation Service or another agency acceptable to authorities having jurisdiction.

B. Structural Safety Factor: Strength in tension and shear of components used shall be at least two times the maximum seismic forces to which they will be subjected.
   1. Concrete and Masonry Anchor Bolts and Studs: Steel-expansion wedge type.

C. Concrete Inserts: Steel-channel type.

D. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.

E. Welding Lugs: Comply with MSS SP-69, Type 57.

F. Beam Clamps for Steel Beams and Joists: Double sided. Single-sided type is not acceptable.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install seismic restraints according to applicable codes and regulations and as approved by authorities having jurisdiction, unless more stringent requirements are indicated.

3.2 STRUCTURAL ATTACHMENTS

A. Use bolted connections with steel brackets, slotted channel, and slotted-channel fittings to spread structural loads and reduce stresses.

B. Attachments to New Concrete: Bolt to channel-type concrete inserts or use expansion anchors.

C. Attachments to Existing Concrete: Use expansion anchors.

D. Holes for Expansion Anchors in Concrete: Drill at locations and to depths that avoid reinforcing bars.

E. Attachments to Solid Concrete Masonry Unit Walls: Use expansion anchors.
F. Attachments to Hollow Walls: Bolt to slotted steel channels fastened to wall with toggle bolts.

G. Attachments to Wood Structural Members: Install bolts through members.

H. Attachments to Steel: Bolt to clamps on flanges of beams or on upper truss chords of bar joists.

3.3 ELECTRICAL EQUIPMENT ANCHORAGE

A. Anchor rigidly to a single mobile structural element or to a concrete base that is structurally tied to a single mobile structural element.

B. Anchor panelboards, motor controls, transformers, transfer switches and distribution units as follows:
   1. Size concrete bases so expansion anchors will be a minimum of 10 bolt diameters from the edge of the concrete base.
   2. Bushings for Floor-Mounted Equipment Anchors: Install to allow for resilient media between anchor bolt or stud and mounting hole in concrete.
   3. Anchor Bolt Bushing Assemblies for Wall-Mounted Equipment: Install to allow for resilient media where equipment or equipment-mounting channels are attached to wall.
   4. Torque bolts and nuts on studs to values recommended by equipment manufacturer.

3.4 SEISMIC BRACING INSTALLATION

A. Expansion and Contraction: Install to allow for thermal movement of braced components.

B. Cable Braces: Install with maximum cable slack recommended by manufacturer.

C. Attachment to Structure: If specific attachment is not indicated, anchor bracing to the structure at flanges of beams, upper truss chords of bar joists, or at concrete members.

3.5 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Make flexible connections in raceways, cables, wireways, cable trays, and busways where they cross expansion and seismic control joints, where adjacent sections or branches are supported by different structural elements, and where they terminate at electrical equipment anchored to a different mobile structural element from the one supporting them.

END OF SECTION
SECTION 26 05 53

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY
A. This Section specifies equipment, wire and conduit identification.

1.2 RELATED DOCUMENTS
A. Drawings and general provisions of contract, including General and Special Conditions and Division 1 Specification sections, apply to this section.

1.3 SUBMITTALS
A. Division 1, Section 01 33 00 – Submittal Procedures: Submittal procedure
B. Product Data (CDRL 16075-01):
   1. Submit manufacturer’s catalog literature for each product required.
   2. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.
C. Manufacturer’s Installation Instructions (CRDL 16075-02): Indicate installation instructions, special procedures, and installation.

1.4 RELATED WORK
A. Division 3.2, Section 26 00 10, Basic Electrical Requirements
B. Division 3.2, Section 26 00 15, Raceways and Boxes
C. Division 3.2, Section 26 05 32, Conductors and Cable

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION
A. After finish painting is completed, the Contractor shall provide white with black core laminated phenolic nameplates with 3/8 inch lettering etched through the outer covering. Each nameplate shall be fastened with stainless steel screws to each piece of equipment, in a way that will not void the NEMA rating for the enclosure.
   1. All major electrical equipment shall be identified which shall include motor starters, disconnect switches, panelboards, transfer switches, transformers etc.
   2. Disconnect switches serving feeders and overcurrent protective devices mounted in a switchboard shall also be identified.
B. Embossed self-adhering plastic tape labels will not be accepted.
2.2 WIRE IDENTIFICATION

A. Cable/wire markers shall be installed on both ends of all conductors.

B. All wire and feeder cables shall be labeled with wire markers in all junction boxes, pull boxes, control panels, motor control centers, panelboards, switchboards, etc.

C. Wire and cable markers shall be self adhesive, self laminating mechanically printed with a clear protective laminating over wrap or mechanically printed with a clear protective laminating over wrap or mechanically printed heat shrink tubing. Cable and wire markers shall be approved by ACT and shall be attached to all cables where entering or leaving the conduit run. The cable designation and circuit use shall appear on the tag.

D. Acceptable manufacturers shall be Brady, Panduit, 3-M, Thomas and Betts, or approved equal.

PART 3 - EXECUTION

3.1 EQUIPMENT IDENTIFICATION

A. Each nameplate shall include the equipment designation as shown on the Drawings, as approved by ACT, and other information as required in the Specifications.

B. The Contractor shall provide the following identification markings on each individually mounted circuit breaker, disconnect switch, contactor, and motor starter:

1. Feeder name, number, voltage and phase.
2. Item of equipment controlled.

C. The Contractor shall provide the following identification markings on each motor and other utilization equipment, except lighting fixtures:

1. Equipment tag designation.
2. Feeder number
3. Voltage and phase.

D. The Contractor shall provide the following identification markings on each transformer:

1. Equipment tag designation.
2. Feeder number
3. Voltage and phase.
4. Name of lighting and/or power panels supplied by the secondary of the transformer.

E. The Contractor shall provide a typewritten directory of circuits in lighting and power panels and provide panel identification in black alkyd paint stenciled inscriptions on the inside of the door, directly above the centerline of directory frame, or on vertical and horizontal centerline of doors without directory frames.
F. The Contractor shall provide on device plates for local toggle switches, toggle switch type manual starters, pilot lights, and other electrical items whose function is not readily apparent, engraved suitable inscriptions on laminated phenolic nameplates describing the equipment controlled or indicated.

G. Each nameplate shall be fastened with a minimum of two self tapping stainless steel screws. This shall not change the NEMA rating of the enclosure.

H. The Contractor shall provide the following alkyd paint stenciled inscription markings on the outside face and on the inside face of each feeder splice box, feeder junction box, and feeder pull box cover plate:

1. Designation shown on the Drawings.
2. Feeder name.
3. Feeder number.
4. Voltage and phase.

3.2 CONDUIT, WIRE, CABLE AND BUS IDENTIFICATION

A. Each wire and each cable shall be labeled at terminals and at all accessible points in equipment, panelboards, manholes, handholes, and pull boxes. Labels shall be self-sticking wire markers.

B. Each cable run shall be assigned a circuit number and shall be recorded on a cable schedule showing from, to, purpose, number of conductors and length.

C. Cable/wire wire markers shall be the wrap-around self-adhesive type, with factory or mechanical printed numbers, letters and symbols which shall be used to identify all feeders, mains and branch circuit conductors.

D. All conductors shall be tagged in cabinets at the time wires are pulled in and tested and markers shall not be removed for any reason.

E. Phase identification letters, in readily visible locations, shall be stamped into the main bus bars of switchboards and panelboards.
PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Furnished and installing weatherproof wiring devices as indicated on plans and this section.

1.2 SUBMITTALS

A. Submit the following product data (CDRL 16140-1) for review and approval in accordance with Division 1, Section 01 33 00, Submittal Procedures.

1. Receptacles.
2. Light Switches, Toggle Switches
3. Device plates.
5. Time switches.
6. Photoelectric relays.
7. Lighting contactors.
8. Terminal blocks.

1.3 RELATED WORK

A. Coordinate the work of this Section with all other Sections of this Specification and in particular the following Sections:

1. Division 3.2, Section 26 00 10, General Provision for Electrical Work
2. Division 3.2, Section 26 00 15, Basic Electrical Materials and Methods
3. Division 3.2, Section 26 05 33, Raceways and Boxes

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.
PART 2 - PRODUCTS

2.1 MATERIALS

A. Receptacles shall be UL listed to Federal Specification WC596.
   1. Convenience outlets for general use shall be commercial specification, duplex, 3 wire, 20 ampere, 125 volt, NEMA 5-20 R grounding type.
   2. Ground fault circuit interrupters shall be heavy duty, feed through, duplex type rated 20 ampere, 125 volt, incorporating solid state ground fault sensing and signaling, 5 mA trip level.

B. Lighting switches and toggle switches shall be UL listed to Federal Specification WS896.
   1. Single pole switches shall be rated 20 amperes, 120 volts AC.

C. Switch and receptacle wall plates.
   1. Plates shall be manufactured by the device manufacturer.
   2. In unfinished areas, plates shall be of the type designed for use with the particular boxes.
   3. Wet-Location, weatherproof, gasketed, lockable spring type covers shall be provided for weatherproof receptacles. Weatherproof covers shall meet NEMA 250, complying with type 3R weather-resistant.

D. Circuit Breaker: Comply with UL 489
   1. Thermal-Magnetic Circuit Breakers plug-in type with interrupting capacity to comply with available fault currents.
   2. Features and Accessories:
      a. Electrical relay that will indicate loss of power.
      b. Alarm Switch Contact with "b" contacts which closes when circuit breaker is tripped.
      c. Auxiliary Switch contacts that indicate if the breaker is in the ON or OFF position.

E. Time Switches: Comply with UL 917
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Contact Configuration: SPST.
   3. Contact Rating: 40-A resistive load, 120-V ac.
   4. Circuitry: Allows connection of a photoelectric relay as a substitute for the on-off function of a program.
5. For exterior lighting: Programmable astronomical timeclock with, ON at sunset, OFF at sunrise, feature.

6. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of 16 hours.

F. Outdoor Photo-electric Relay: Comply with UL 773A.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Contact Relays: Single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay. Relays shall have directional lens in front of photocell to prevent fixed light sources to cause turnoff.
   3. Exterior photocell as indicated on plans.
   4. Relay with locking-type receptacle shall comply with NEMA C136.10.

G. Lighting Contactors: Electrically operated and mechanically held lighting contactor, complying with NEMA ICS 2 and UL 508.
   1. Enclosure: Comply with NEMA 250.
   2. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

H. Terminal Blocks: Comply with UL 94:
   1. Terminal blocks shall be spring terminal, feed through, rated for 600 volt and 30 ampere.

2.2 MANUFACTURERS

A. Local Wall Switches, Receptacles, Device Plate and Pilot Lights:
   1. Hubbell
   2. Leviton
   3. Or approved equal

B. Circuit Breaker:
   1. Schneider Electric
   2. Square D
   3. Or approved equal

C. Time Switches:
   1. Intermatic, Inc.
2. Tork.
3. Or approved equal

D. Photoelectric Relay:
   1. Intermatic, Inc.
   2. Tork.
   3. Or approved equal.

E. Lighting Contactors:
   1. ASCO Power Technologies.
   2. General Electric Company.
   3. Schneider Electric.
   4. Or approved equal

F. Terminal Blocks:
   1. Schneider Electric
   2. Bussman by Eaton
   3. GE Industrial
   4. Or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with the California Electrical Code.
B. Install devices plumb and level.
C. Install switches with OFF position down.
D. Install receptacles with grounding pole on top or right-hand side.
E. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.
F. Provide suitable outlet box for each device with device plate or ganged devices with multi device plate.
G. Provide cast metal "FS" box for exterior or moist locations.
H. Each device: minimum rating suited to load and circuit characteristics.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. Surge protection consists of furnishing labor, equipment, materials, and incidentals necessary to provide surge protection at all panelboard locations and other related Work complete, as indicated on the Drawings and as specified. Section includes: Related Sections:

1. Service entrance surge protection
2. Electrical equipment and raceway grounding and bonding.

B. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.

1.2 RELATED WORK

A. Division 3.2, Section 26 00 10, General Provisions for Electrical Work
B. Division 3.2, Section 26 00 15, Basic Electrical Materials and Methods
C. Division 3.2, Section 26 05 26, Grounding and Bonding
D. Division 3.2, Section 26 05 32, Conductors and Cables
E. Division 3.2, Section 26 05 20, Grounding System

1.3 REFERENCES

A. California Electrical Code
B. ANSI – American National Standards Institute:
   1. ANSI C62.41 – Recommended practice on surge voltage in low voltage power circuit.
C. Underwriters Laboratories, Incorporated (UL):
   1. UL 497A – Secondary Protectors for Communication Circuits
   2. UL 1449 – Standard for Safety for Surge Protective Devices
   3. UL 1283 – Electromagnetic Interference Filters

1.4 SUBMITTALS

A. See Division 1, Section 01 33 00 – Submittals, for submittal procedures.
B. Product Data (CDRL 16280-01): Indicated surge protective device and connectors.

C. Shop Drawings (CDRL 16280-02): Indicate surge protective device and connectors.

D. Test Reports (CDRL 16280-03): Submit manufacturer’s UL certified test and nameplate data for each surge protective device(s).

1.5 QUALITY ASSURANCE

A. UL Compliance and Labeling

1. For power and signal circuits, surge protective device shall comply with UL 1449 and UL 1283 as an electromagnetic interference filter. Provide units which shall be listed and labeled by UL.

2. For telephone circuit protection, surge protective device shall comply with UL 497A.


PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Surge protective devices shall be products of one of the following manufacturers.

1. Square – D Schneider Electric

2. Advanced Protection Technologies

3. Cutler-Hammer Clipper Power System

2.2 DESIGN REQUIREMENTS

A. All surge protective devices (SPD) or transient voltage surge suppressors (TVSS) for power circuits, provided under this section, shall be the product of a single manufacturer and shall be of modular construction designed for field replacement.

B. SPD shall be capable of performance at ambient temperature between -40 and 60 degrees C, at relative humidity ranging from 0% to 95%, and at altitudes ranging from sea level to 12,000 feet.

C. SPD shall be protected by a circuit breaker or fused to disconnect the suppressor from the electronic source should the processor fail. The fusing shall allow full surge handling capabilities and to afford safety protection from thermal overloads and short circuits.

D. Design SPD for the specific type and voltage of the electrical service. Single-phase and 3-phase wye-configured systems shall have L-N, L-G, and N-G protection.

E. Power filter: The SPD shall include a high frequency extended range power filter and shall be UL 1283 listed as an electromagnetic interference filter.
PART 3 - EXECUTION

3.1  INSTALLATION

A. Surge Protectors shall be installed as close as practical to the electrical panel or dedicated electronic equipment to be protected. The SPD shall be close connected to the panel in a position near the panel board neutral bus bar or positioned so that the overall lead length will be minimal.

B. The Surge Protector shall be installed in a manner consistent with proper and acceptable industry wiring practice. SPD connection leads shall be as short and straight as possible while avoiding sharp bends.

C. Surge Protectors provided with terminals shall be wired with stranded conductor size permitted within rating of lugs. Minimum wire size shall be 10 AWG conductors.

D. The Surge Protector shall be installed with a means for disconnecting the device for servicing via an integral fused or a dedicated three-pole 15 amp minimum circuit breaker.

E. Surge Protective Devices shall be provided at locations and equipment indicated on the drawings and panel schedules.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. Exterior lighting consists of furnishing design, transportation, labor, materials and equipment to manufacture, transport, and install exterior lighting including, but not limited to:

1. Exterior luminaires with LED lamp technology.
2. Poles and accessories for support of luminaires.

1.2 REFERENCES

A. American Standards Institute (ASI)
B. Certified Ballast Manufacturers (CBM)
C. City of Oakland Electrical Code
D. Electrical Testing Laboratory (ETL)
E. National Electrical Manufacturers Association (NEMA)
F. InterNational Electrical Testing Association (NETA)
G. Institute of Electrical and Electronics Engineers (IEEE)
H. State of California - Title 24 (T24)
I. Underwriters Laboratories, Incorporated (UL)

1.3 SUBMITTALS

A. Product Data (CDRL 16521-01): For each luminaire, arranged in the order of lighting unit designation. Include data on features, accessories, finishes, and the following:

1. Physical description of fixture, including dimensions and verification of indicated parameters.
2. Luminaire dimensions, effective projected area, details of attaching luminaires, accessories, and installation and construction details.
3. Photometric data, in IESNA format, based on certified results of laboratory tests of each luminaire type, outfitted with lamps, LED arrays, drivers and accessories identical to those indicated for the luminaire as applied in the Project. Luminaire materials.
4. LED power supplies.
5. Types of lamps and LED’s, including manufacturer, wattage, and Color Rendering Index (CRI) and color temperature in degrees Kelvin (K), and seismic performance.

B. Shop Drawings for pole (CDRL 16521-02):
   1. Include data on construction details, profiles, EPA, cable entrances, materials, dimensions, weight, rated design load, and ultimate strength of individual components.
   2. Include finishes for lighting poles and luminaire-supporting devices.
   3. Anchor bolts.

C. Wiring Diagrams (CDRL 16521-03): Power, signal, and control wiring.

D. Coordination Drawings (CDRL 16521-04): Mounting and connection details, drawn to scale, for exterior luminaires with requirements specified for lighting poles and standards.

E. Source quality-control test reports (CDRL 16521-05).

F. Field quality-control test reports (CDRL 16521-06).

G. Operation and Maintenance Data (CDRL 16521-07): For luminaires to include in maintenance manuals.

H. Warranties (CDRL 16521-08): Special Warranties specified in this section.

1.4 RELATED WORK

A. Coordinate the work of this Section with all other Sections of this Specification and in particular the following Sections:
   1. Division 3.2, Section 26 00 10, General Provision for Electrical Work
   2. Division 3.2, Section 26 00 15, Basic Electrical Materials and Methods
   3. Division 3.2, Section 26 05 26, Grounding and Bonding
   4. Division 3.2, Section 26 05 48, Seismic Controls For Electrical Work
   5. Division 3.2, Section 26 05 33, Raceways and Boxes

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to the City of Oakland, and marked for intended use.

B. FMG Compliance: Fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.

D. Comply with NFPA 70.
E. Comply with ANSI/NEMA C136.31, Vibration Level 2.

1.6 COORDINATION

A. Coordinate exterior luminaires with mounting and wind load requirements specified for lighting poles and standards.

1.7 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace luminaires or components of luminaires, lamps and poles that fail in materials or workmanship; corrode; or fade, stain, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Luminaires: 5 years from date of Substantial Completion.
   a. Warranty Period for Metal Corrosion: 5 years from date of Substantial Completion.
   b. Warranty Period for Color Retention: 5 years from date of Substantial Completion.
   c. Warranty Period for LED arrays/drivers: Five years from date of Substantial Completion.

2. Warranty Period for Pole: 5 years from date of Substantial Completion.
   a. Warranty Period for Metal Corrosion: 5 years from date of Substantial Completion.
   b. Warranty Period for Color Retention: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRES, GENERAL

A. Complying with UL 1598 and listed for installation in wet locations.

B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Optical assemblies: full cutoff with zero uplight, “dark sky” compliant. LED assemblies shall comply with BUG rating system.

J. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
   1. White Surfaces: 85 percent.
   2. Specular Surfaces: 83 percent.
   3. Diffusing Specular Surfaces: 75 percent.

K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

L. Seismic Performance: Luminares shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. The term “withstand” means “the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational after the seismic event. Luminares and lamps shall be labeled vibration and shock resistant, per ANSI/NEMA 136.31, Level 2 (3.0 G).

2.2 EXTERIOR LUMINA IRES

A. Luminaire types called out on Drawings are for performance definition; alternate types which provide the same lighting level will be considered when submitted for review.

2.3 LED DRIVERS AND ARRAYS

A. Drivers shall accept 120 through 480 volts, 50/60 Hz.

B. The housing shall have an integral thermal management system with extruded aluminum radiation fins and lateral airways.

C. Comply with IES LM-79-08, LM80-08 and LM-90-08 Approved Methods.

D. CRI 80 or higher, and color temperature of 3000°K.

2.4 COMPLY WITH IES LM-79-08, LM80-08 AND LM-90-08 APPROVED METHODS. FACTORY FINISHES

A. Field Painting Finish: Manufacturer’s standard prime-coat finish ready for field painting.
B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match process and color of pole or support materials.

C. Factory-Painted Finish for Steel Luminaires: Comply with NAAMM's Metal Finishes Manual for Architectural and Metal Products for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, Solvent Cleaning, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, White Metal Blast Cleaning, or SSPC-SP 8, Pickling.

2. Interior Surfaces: Apply one coat of bituminous paint on interior of pole, or otherwise treat to prevent corrosion.

3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
   a. Color: As selected by ACT from manufacturer's full range.


1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hardcoat wax.

3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611, Voluntary Specification for Architectural Anodized Aluminum.

4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 millimeter or thicker) complying with AAMA 611.
   a. Color: As selected by ACT from manufacturer's full range.

5. Gold Anodic Finish: AA-M32C22A43 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, impregnated color coating 0.018 millimeter or thicker) complying with AAMA 611.

2.5 METAL POLES

A. Manufacturers:
1. Beacon

2. Or approval equal.

B. Provide poles designed for wind loading of 100 miles per hour determined in accordance with AASHTO LTS while supporting luminaires and all other appurtenances indicated. Provide effective projected areas of luminaires and appurtenances used in calculations specific to the actual products provided on each pole. Provide anchor type bases designed for use with underground supply conductors. Provide an oval-shaped handhole having a minimum clear opening of 2.5 by 5 inches. Secure handhole cover with stainless steel captive screws. Provide metal poles with an internal grounding connection accessible from the handhole near the bottom of each pole. Do not install scratched, stained, chipped, or dented poles.

C. Fasteners: Stainless steel, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.

1. Materials: Compatible with poles and standards as well as to substrates to which poles and standards are fastened and shall not cause galvanic action at contact points.


D. Material and Finish: Provide aluminum poles with a bronze finish, manufactured of corrosion resistant aluminum alloys conforming to AASHTO LTS for Alloy 6063-T6 or Alloy 6005-T5 for wrought alloys and Alloy 356-T4 (3,5) for cast alloys.

2.6 SOURCE QUALITY CONTROL

A. Provide services of a qualified, independent testing and inspecting agency to factory test luminaires with ballasts and lamps; certify results for isofootcandle curves, zonal lumen, average and minimum ratios, and electrical and energy-efficiency data for ballasts.

B. Factory test fixtures with ballasts and lamps; certify results for isofootcandle curves, zonal lumen, average and minimum ratios, and electrical and energy-efficiency data for ballasts.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lamps in each fixture.

B. Luminaire Attachment: Fasten to indicated structural supports.

C. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.
3.2 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Replace all burned out or inoperative lamps or LED arrays at the end of Construction.

C. Tests and Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):

1. IESNA LM-72.

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION
SECTION 27 00 10

BASIC COMMUNICATIONS TECHNICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes:

1. General requirements for supply and handling of materials and equipment.
2. General system wide requirements.
3. Electromagnetic Interference (EMI)/Electromagnetic Compatibility (EMC) design requirements.
4. Environmental design requirements.
5. General requirements for providing a configuration editor for software based systems.

1.2 SUBMITTALS

A. Completed Equipment List (CDRL 20010-01): Submit an Equipment List for all major types of equipment to be used and for which requests for payment will be made during the Contract.

PART 2 - PRODUCTS

2.1 PRODUCT LISTING

A. Prepare a schedule, in a form acceptable to ACT, listing proposed products (by generic names) required for the Work. For each product, show the product names. The list of products is not a substitute for required submittals, acceptance of products, or a means for submitting substitutions to products specified.

B. Content: Upon approval of the form, provide the Completed Equipment List, a comprehensive list of the major components to be used in the Communications Systems. At a minimum, the lists shall include:

1. All equipment listed in the List of Materials, to be submitted per requirements of these Specifications.
2. Proposed product options or substitutions, if required, shall be later supported in writing, in accordance with the requirements of these Specifications.
3. Communications – the Completed Equipment List shall contain entries for each of the following equipment categories, plus any other equipment proposed for use:
   a. Communications rack (each type);
   b. Servers (each type);
   c. Workstations (each type);
d. CCTV cameras;
e. CCTV Network Video Recorder (NVR);
f. Public Address speakers;
g. PA amplifiers, VOIP Audio Device, ambient noise controller, ambient noise microphone;
h. Fiber Optic Interface Modules (each type);
i. Application Server (each type);
j. Protector Blocks;
k. Copper cable and wire;
l. Fiber optic cable;
m. Fiber optic cable splice and encapsulation kits;
n. Ethernet switches;
o. Routers;
p. Intrusion detection components, including door contacts;
q. Programmable Logic Controllers (PLC);
r. Uninterruptible Power Supplies (UPS).

PART 3 - EXECUTION

3.1 PROCEDURES FOR SELECTING PRODUCTS

A. General: The specified requirements for individual products indicated in the Contract are multiple in nature and may include generic, descriptive, proprietary, performance, compliance with standards, compliance with codes, conformance with graphic details and other similar forms of requirements. In addition to the requirements herein, provide requests for product substitutions and options per requirements of these specifications.

1. Provide products and designs conforming to all specified requirements unless otherwise requested in writing. Any other product will be considered only if requested as substitution and approved in accordance with these Specifications.

2. Contractor's Options: Where an option, or choice, is indicated, provide either one or another of the options. The choice of an option is the Contractor's. Where submittals are required, state which option has been chosen. An option is not a consideration of whether a product or method will be provided, but of which among several indicated products or methods will be provided.

3. Equivalent Materials and Equipment: Whenever a material or article is specified or described by using the name of a proprietary product or the name of a particular manufacturer or vendor, the specific item mentioned is understood as establishing type, function, dimension, appearance and quality.
desired.

a. Substitutions by Approved Manufacturers. Substituted items must provide equal or better performance, similar size and configuration, and be constructed of equal or better quality of materials, as determined by ACT.

b. No substitution will be ordered or installed without ACT’s prior written acceptance.

B. Compatibility: Verify that equipment and installation supplied under other contracts, but required for the Work in this Contract, are compatible.

C. Supervision: Supply necessary supervision and coordination information to accommodate the installation of equipment.

D. Procedures: Contractor’s options for selecting products are limited by the specified requirements and governing regulations. Following are some of the various selection procedures for specified requirements:

1. Qualities or Performance Requirements: Provide products that comply with the specific qualities indicated, and which are recommended or certified in writing by manufacturer for the specific use indicated. General performance of a product is implied where product is specified for specific performances (e.g., where the term “similar in design” is used).

2. Prescriptive Requirements: Provide products produced in accordance with the prescriptive requirements, using the specified ingredients and components, and complying with the specified requirements for mixing, fabricating, curing, and finishing, testing and similar operations.

3. Standards, Codes and Regulations: Provide products that comply with the specified standards, codes and regulations and with the other requirements.

4. “Or Equal”: Where named products or sources are accompanied by the term "or equal" or other language of similar effect, provide one of the specified products, or submit a request for substitution for a product not named, which Contractor judges to be of equal or better quality. ACT reserves the right to be final arbiter of an “equal or better quality” determination.

5. Visual Matching: Where matching an established sample is required, ACT will make final judgment of whether a product proposed by Contractor matches the sample satisfactorily.

6. Non-Conforming Products: Use of any product not conforming to specified requirements may only be approved by means of a request for substitution as specified elsewhere.

### 3.2 PRODUCT REQUIREMENTS

A. Equipment and Material Acceptability

1. Standard Products: All equipment design shall be standard products of manufacturers regularly engaged in the production of such equipment and material, and shall be subject to all contractual design and approval requirements, as indicated. Standard products which are essentially equal or
2. New Products: The equipment shall be new, and shall be the manufacturer's current model and revision level, whenever such models and revisions meet the Specification requirements at the time of installation.

3. Material Substitution: The Contractor shall identify and use current model equipment, giving preference to the manufacturer's recommended replacement model when equipment and material, previously identified in approved submittals, has been discontinued or is no longer current.

4. Material Acceptance: The award of this Contract does not imply ACT's approval of any or all of the manufacturer's equipment or materials identified in the Contract Documents.
   a. The Contractor is responsible for furnishing a completely functional system as defined herein.
   b. Acceptance will be given by ACT only after all work is complete and the system has been tested, as described within these technical specifications.

B. Material Lifetime: The equipment provided under this Contract shall be consistent with systems having an expected lifetime as industry practice for each system and subsystem.
   a. Subsystem designs and products shall be chosen which can continue to support ACT bus operation while the subsystems are extended to support bus rapid transit (BRT) growth during the expected lifetime.
   b. Subsystems, assemblies, and subassemblies shall be able to incorporate replacement spare parts for the expected lifetime.
   c. All internal interfaces (e.g., subsystem to subsystem and between all major elements within subsystems) shall be comprehensively documented in drawings to help replacement of portions of the system during the expected lifetime.

C. Availability of Products
   a. All products provided shall be available for a period of not less than 2 years after the completion of the Contract.
   b. The Contractor shall notify ACT if any product is known to be discontinued by the supplier during the project.

3.3 MANUFACTURERS' INSTRUCTIONS

A. General: When the Contract Documents require that installation of work comply with manufacturers' instructions, obtain and distribute copies of such instructions to parties involved in the installation. Maintain one set at the site until installation is complete.

B. Handling: Handle, install, connect, clean, condition and adjust products in strict compliance with the instructions and specified requirements. Should job conditions or specified requirements conflict with the manufacturers' instructions, notify ACT for further direction. Do not proceed with work without clear instruction and direction.
C. Performance: Perform the Work in accordance with the manufacturer's instructions. Do not omit any steps unless specifically modified or exempted by the Contract Documents.

D. Verification: Verify with the manufacturer all information regarding scheduling, delivery, and preparation necessary for installation.

3.4 SYSTEMWIDE REQUIREMENTS

A. Design the data and voice Communication Systems to provide CCTV, SCADA, Intrusion and all other required communications links and apparatus, as required for this project.

B. New Products: Provide products and components for this Contract of new manufactured and designed for the application to which they are proposed. Used or remanufactured products or components shall not be accepted.

C. Product Updates: Any modifications or upgrades to solid-state equipment provided by Contractor or its suppliers shall also be made to equipment already delivered. Notification of the upgrade is typically in the form of an Engineering Safety Bulletin (ESB) from the manufacturer that contains recommended instructions for repair or replacement. Product updates shall not apply to typical Product Improvement Announcements (PIAs) that accompany the release of a later version of a product or product executive software should this occur after equipment has been delivered. Determination of whether or not these upgrades are installed shall be to the discretion of the Contractor.

D. Commercially Available: Provide electronic and electrical components and materials that are commercially available from at least two sources, whenever possible. Assembly shall be performed at the point of manufacturing.

3.5 OPERATING ENVIRONMENT CONDITIONS FOR COMMUNICATIONS EQUIPMENT

A. The following operating environmental conditions shall be used as design criteria guidelines and shall be considered as operational requirements for the communications equipment, unless otherwise specified for specific components:

1. Outdoor Temperature and Solar Load
   a. Minimum ambient air temperature external to equipment: 14 degrees F
   b. Maximum ambient air temperature external to equipment: 120 degrees F
   c. Maximum solar radiation: 275 Btu/hr/ft2
   d. Maximum daily temperature range: 50 degrees F

2. Precipitation
   a. Maximum rainfall rate is five (5) inches/hr and this rate may occur simultaneously with wind
   b. Measurable quantities of ice do not occur frequently
3.6 ELECTROMAGNETIC INTERFERENCE/ELECTROMAGNETIC COMPATIBILITY

A. The Contractor shall be responsible for EMI/EMC issues related the newly installed equipment for the EB BRT.

B. Methods and Equipment: Employ design techniques, construction methods, and whatever equipment is required to prevent interference caused by external and internal sources from affecting the proper operation of the equipment and systems specified herein. To contain EMI emissions wherever possible, the suppression of transients shall be at the source of the transient. The following design requirements shall be included:

1. Coordinate frequencies and provide necessary balancing, filtering, shielding, modulating techniques, and isolation to maintain signal to noise above limits required to operate all equipment installed under this Contract. Shielding, isolating, balancing, and grounding shall be used to reduce the undesirable effect of interference.

2. Employ electrostatic and magnetic shielding methods to minimize the effect of stray signals and transient voltages on interconnecting cables.

3. Physically separate interconnecting power and signal cables, whenever possible.

4. Incorporate suppressors across inductive devices to minimize switching transients.

5. Shield equipment design and enclosures from any effects resulting from the operation of cellular telephones, including when said telephones are operated in the vicinity of the equipment and on the passenger platforms.

3.7 OPERATIONAL REQUIREMENTS

A. Graceful Degradation of Service: The design shall provide for graceful degradation of service as a result of component failures. The design shall minimize the impact to service for each component failure. Techniques for achieving this shall include:

1. No shared functions between modules except between two modules when necessary to meet requirements for specified requirements.

2. Circuit logic designed and organized as far as possible to minimize effects of failures.

3.8 USER INTERFACES

A. General: Where specified in the individual sections of these specifications, user interfaces shall require selecting information through the use of a mouse, keyboard or similar device. All user interfaces shall be subject to approval by ACT.

END OF SECTION
SECTION 27 01 00

OPERATIONS CONTROL CENTER

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes:

1. A description of the circumstances of the EB BRT project concerning Operations Control Center (OCC) hardware and software. The OCC EB BRT workstation hardware and software shall be provided by the Contractor. The Contractor shall integrate EB BRT OCC system into the OCC environment that is being provided by others.

2. A description of the components that shall be provided by the Contractor for the OCC workstations, including the ACT-sponsored OCC Relocation project contractor and the ACT-sponsored CAD/AVL project contractor.

1.2 RELATED WORK

A. Division 1, Section 01 33 00, Submittal Procedures

B. Division 3.2, Section 27 22 10, Communications Servers, Workstations, and Video Monitoring System

C. Division 3.2, Section 27 51 10, Closed Circuit Television System (CCTV)

D. Division 3.2, Section 27 51 16, Public Address System

E. Division 3.2, Section 27 53 50, Fare Collection System

F. Division 3.2, Section 34 42 36, Supervisory Control and Data Acquisition

1.3 SUBMITTALS

A. External Contractor Coordination Report: Contractor shall submit a monthly report detailing coordination with the OCC Relocation and CAD/AVL projects as specified herein. CDRL-270100-1

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.1 CONTRACTOR COORDINATION WITH OCC RELOCATION AND CAD/AVL PROJECT

A. Contractor shall be obligated to work with ACT-sponsored OCC Relocation project (herein "OCC Relocation") contractor and the ACT-sponsored CAD/AVL project (herein "CAD/AVL") contractor as necessary to ensure that Contractor workstations and OCC Relocation furniture and equipment, in addition to CAD/AVL KVM (keyboard – video – mouse) hardware are compatible and suitable for Contractor to meet all BRT requirements as specified in the Contract Documents.
1. BRT Contractor/OCC Relocation/CAD-AVL coordination shall involve at least one face-to-face meeting with each external contractor to discuss logistics of the Contractor using OCC Relocation-provided and CAD/AVL-provided workstation components and furniture.

2. The Contractor shall establish an official communications mechanism with the OCC Relocation and CAD/AVL contractors, either written or verbal.

3. Contractor shall maintain a log of all communications with the OCC Relocation and CAD/AVL contractors.

4. Contractor shall submit a monthly External Contractor Coordination Report (CDRL-270100-1) to ACT that details communications with the OCC Relocation and CAD/AVL contractors and tracks resultant design decisions and action items.

5. All issues of coordination shall be discussed and documented as they arise. Initial coordination issues to be managed shall include:
   a. Coordination of CAD/AVL KVM hardware on the dispatcher console desktops for hosting Contractor workstation computers.
   b. Coordination of OCC Relocation hardware for all equipment racks and cabinets in the OCC Server room for housing of Contractor communications and server equipment.
   c. Coordination of OCC Relocation hardware for providing all primary and backup (UPS) power for all Contractor hardware.

3.2 ACT-PROVIDED OCC WORKSTATION CONSOLE HARDWARE

A. ACT will provide hardware and furniture for use by the BRT Contractor as specified in this Section. The physical areas of particular concern to this Section include the Operations Control Center (OCC) within the Central Maintenance Facility (CMF). Areas within the OCC where BRT shall provide Work include:
   1. The OCC Dispatcher Area within the OCC.
   2. The BRT Video Command Room within the OCC.
   3. The OCC Server Room within the OCC.

B. General: the hardware described below to be located in the OCC will be provided by CAD/AVL.
   1. CAD/AVL will provide up to eight (8) KVM connections for BRT workstations within the OCC Dispatcher Area.

C. General: the hardware described below to be located in the OCC will be provided by OCC Relocation.
   1. OCC Relocation will provide up to eight (8) dispatcher workstation computers within the OCC Dispatcher Area.
   2. OCC Relocation will provide all required operator console workstation furniture within the OCC Dispatcher Area to house all dispatcher positions.
3. OCC Relocation will provide all required operator console workstation furniture within the BRT Video Command Room to house all video positions.

4. OCC Relocation will provide all necessary AC power within the OCC Dispatcher Area, BRT Video Command Room, and OCC Server Room necessary to power all BRT equipment.

5. OCC Relocation will provide all necessary UPS backup power within the OCC Dispatcher Area, BRT Video Command Room, and OCC Server Room necessary to power all BRT equipment in the event of power loss.

6. OCC Relocation will provide all necessary equipment racks and cabinets within the OCC Server Room to support all supplied BRT server and communications equipment as defined in the Contract Documents.

D. The Contractor shall confer with the OCC Relocation contractor as necessary in order to ensure that the equipment racks and cabinets supplied by OCC Relocation in the OCC Server Room sufficiently support all Contractor BRT hardware that shall be placed in that room.

E. Specifications for all hardware that is being provided by OCC Relocation and CAD/AVL will be provided by the ACT upon Contractor request.

### 3.3 BRT CONTRACTOR-SUPPLIED OCC WORKSTATION CONSOLE HARDWARE

A. The Contractor shall supply one workstation computer for use as the Video Monitoring System Workstation within the BRT Video Command Room.

B. The Contractor shall provide eight (8) dispatcher workstation computers for use as BRT Workstations within the OCC Dispatcher Area.

C. The Contractor shall provide two (2) dispatcher workstation computers for future use as BRT Workstations as spares.

D. The Contractor shall supply one workstation computer for use as the Engineering Workstation within the Server Room at the General Office (GO).


### 3.4 OCC WORKSTATION CONSOLE SOFTWARE

A. The Contractor shall provide all software to be executed on the BRT Workstations, Video Monitoring System Workstation, and the Engineering Workstation at the OCC.

B. The Contractor shall implement a “client-server” style software architecture. Major components of the Contractor software suite, including any necessary database stores, will be contained and will execute on software installed on the Contractor-supplied servers in the OCC Server Room.

1. Reference Division 3.2, Section 27 22 10 Communications Servers, Workstations, and Video Monitoring System for more information regarding required servers.

C. The Contractor shall install all client software as necessary on the workstations in the OCC in order to support all required BRT functions as specified in the Contract.
Documents includes:

1. Software to support the operator functions for Closed Circuit Television System (CCTV).
   a. Reference Division 3.2, Section 27 51 10 Closed Circuit Television System (CCTV) for additional specification of CCTV.

2. Software to support the operator functions for Supervisory Control and Data Acquisition (SCADA).
   a. Reference Division 3.2, Section 34 42 36 Supervisory Control and Data Acquisition for additional specification of SCADA.

3. Software to support the operator functions for Public Address System (PA).
   a. Reference Division 3.2, Section 27 51 16 Public Address System for additional specification of PA.

4. Software to support the operator functions for Fare Collection System.
   a. Reference Division 3.2, Section 27 53 50 Fare Collection System for additional specification of fare collection.

5. Software to support connection of the dispatcher workstation computers to the Carrier Transmission System (CTS).
   a. Reference Division 3.2, Section 27 13 10 Carrier Transmission System for additional specification of communications requirements.

D. The Contractor’s BRT software shall be configured such that a failure of any single component including but not limited to a workstation computer, one-half of the redundant CTS, or server will not affect any other component in the system.

E. The Contractor shall provide software support for up to ten (10) client seats to be installed on the BRT Workstations.

1. The Contractor shall note that software support of up to ten (10) client seats does not necessarily mean that the Contractor will provide a maximum of ten licenses, but rather as many software licenses for all required products in order to support the specified ten (10) client operator positions.

2. The Contractor BRT software shall be furnished for each client BRT Workstation and shall be installed by Contractor and licensed in perpetuity to ACT.

F. Software, including all system software, middleware, application software, database software, software utilities, and tools shall be provided. The software shall be developed, configured, and fully tested for all requirements specified in this Specification and Contract Drawings.

G. The software package provided for BRT operations shall be service-proven bus or transit control software. Software that has been in service for no less than two years in no fewer than two other comparable transit or bus environments shall be considered service proven bus or transit control software.
H. Interfaces to and between various manufacturers’ software packages shall be provided through industry standard APIs. All software shall be constructed with modular device driver interfaces, and shall employ standard I/O system, operating system, file system, and database management system calls to facilitate migration to new versions of system software.

END OF SECTION
SECTION 27 13 10

CARRIER TRANSMISSION SYSTEM (CTS)

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The Work of this Section consists of the requirements for providing a Carrier Transmission System (CTS), its associated hardware, interface equipment and other materials required throughout the EB BRT alignment, at the EB BRT Operations Control Center (OCC) located at the Central Maintenance Facility (CMF), and at the ACT General Office (GO).

B. The Work shall include design, installation, supply, testing, and in-service performance verification of system hardware and any associated software.

C. The Contractor shall coordinate with the ACT (Alameda Contra Costa Transit District) to ensure that no additional ACT Contracts shall affect the design of the CTS.

D. The Contractor shall coordinate with the ACT to ensure proper and timely installation of all the CTS equipment.

E. The Contractor shall coordinate with the ACT to ensure proper and timely integration of all the CTS elements.

1.2 RELATED WORK

A. Division 1, Section 01 33 00, Submittal Procedures

B. Division 3.2, Section 01 43 20, Communications System Assurance

C. Division 3.2, Section 01 45 23, Communications Commissioning and Testing

D. Division 3.2, Section 01 91 30, Training

E. Division 3.2, Section 27 01 00, Operations Control Center

F. Division 3.2, Section 27 51 10, Closed Circuit Television System

G. Division 3.2, Section 27 51 16, Public Address System

H. Division 3.2, Section 27 53 50, Fare Collection System

I. Division 3.2, Section 34 42 36, Supervisory Control and Data Acquisition System

1.3 ACRONYMS AND DEFINITIONS

A. ACT - Alameda Contra Costa Transit District

B. BRT – Bus Rapid Transit

C. OCC – Operations Central Control

D. CCTV – Closed Circuit Television
E. CMF – Central Maintenance Facility
F. CIC – Communications Interface Cabinets
G. CID – Clipper Interface Device
H. CoS – Class of Service
I. CTS – Carrier Transmission System
J. DHCP – Dynamic Host Configuration Protocol
K. EB – East Bay
L. EIC – Electrical Interface Cabinet
M. EIGRP – Enhanced Interior Gateway Routing Protocol
N. GB – Gigabyte
O. GO – General Office
P. IEEE – Institute of Electrical and Electronic Engineers
Q. IP – Internet Protocol
R. LAN – Local Area Network
S. MAC – Media Access Control
T. MEF – Metro Ethernet Forum
U. MPLS – Multiple Protocol Label Switching
V. MTBF – Mean Time Between Failures
W. MTTR – Mean Time To Repair
X. NMS – Network Management System
Y. NOS – Network Operating System
Z. PA – Public Address
AA. QoS – Quality of Service
BB. REP – Resilient Ethernet Protocol
CC. RFC – Request For Comments
DD. SCADA - Supervisory Control and Data Acquisition
EE. SM – Single Mode
FF. TVM – Ticket Vending Machine
GG. UL - Underwriters Laboratories

HH. UPS - Uninterrupted Power Supply

II. VLAN – Virtual Local Area Network

JJ. VMS – Variable Message Sign

KK. VOIP – Voice Over IP

LL. VPN – Virtual Private Network

MM. WPA – Wi-Fi Protected Access

1.4 REFERENCED STANDARDS

A. Bellcore

1. TR-TSY-000020 – Generic Requirement for Optical Fiber and Optical Cables.

2. GR-63-CORE – Earthquake Environments (Zone 4) and Office Vibration Environments.

B. Institute of Electrical and Electronic Engineers (IEEE)

1. IEEE 802 – Overview and Architecture.

2. IEEE 802.1b – LAN/MAN Management.

3. IEEE 802.1d – Media Access Control Bridges.

4. IEEE 802.1f – Common Definitions and Procedures.

5. IEEE 802.1g – Remote Media Access Control Bridging.

6. IEEE 802.1q – Virtual Bridged Local Area Networks.

7. IEEE 802.1p – Quality of Service/Class of Service Protocol for Traffic Prioritization.


9. IEEE 802.3af – Power Over Ethernet.

10. IEEE 803.2ae – 10 Gigabit Ethernet.

11. IEEE 803.3u – Fast Ethernet.

12. IEEE 803.3z – Gigabit Ethernet.

C. Metro Ethernet Forum [MEF]

1. All applicable MEF Carrier Ethernet technical specifications.

D. RFC (Request For Comments) Editor
1. RFC 2961 - RSVP Refresh Overhead Reduction.

1.5 SUBMITTALS

A. Provide all submittals in accordance with the requirements of Division 1, Section 01 33 00 Submittal Procedures

B. Carrier Transmission System Product Data: Submit CTS product data, including, but not limited to manufacturer’s product descriptions, product specifications, catalog cuts, arrangement plans, system diagrams, installation plans, wiring/interconnection diagrams and shop drawings in CDRL-20090-01.

C. Carrier Transmission System Design: Submit detailed design drawings, and software and related data in CDRL-20090-02.
   1. Submit bandwidth calculations.
   2. Submit Optical Budgets.
   3. Submit data traffic modeling/simulations and related details.

D. Carrier Transmission System Miscellaneous: Submit other required data, such as test plans, power schematics, and provisioning list, in accordance with the requirements of the applicable Sections of these technical specifications in CDRL-20090-03.

E. Network Management System: Submit a detailed test plan in accordance with manufacturer’s requirements for a comprehensive test of the integrated system in CDRL-20090-04.

F. Carrier Transmission System Commissioning: Submit a commissioning plan for the CTS and Network Management System that will result in a documented fully functioning system in compliance with the Contract Documents and the manufacturer’s recommendations in CDRL-20090-05.

1.6 SYSTEM DESCRIPTION

A. Overview

1. The CTS provides a network link to each station along the route, to each bus station platform, to OCC at the Central Maintenance Facility (CMF), and to the General Office (GO).

2. The Contractor shall provide a ten gigabit based backbone communications system between OCC, GO and ten Gigabit Ethernet nodes at each station, configured logically in a ring to form a reliable high speed medium for the transport of, data, voice, and video services specified herein and indicated on the Contract Drawings between the BRT stations and remotely located authorized users.
3. The CTS network shall be installed as an integral part of the existing ACT network, with Virtual LANs (VLANs) configured to manage network loading and to provide security for specific information passing over the network.

4. CTS shall implement the Enhanced Interior Gateway Routing Protocol (EIGRP) with all ACT requested functions or ACT approved equal.

5. The CTS shall be a fiber optic cable based communications backbone. The fiber optic cables shall run in conduit between all BRT station platforms and the AC Transit GO and ACT OCC.

6. Fiber optic cable shall be Single-Mode (SM).

7. The CTS capability and bandwidth shall be adequate for handling all AC Transit EB BRT communications data requirements (e.g. for SCADA, PA, VMS, Fare Collection, and CCTV video) plus 25% spare capacity.

8. The CTS shall be configured so that it shall continue to operate normally on loss of a single fiber or any single equipment module.

9. CTS network management configuration shall be integrated with the overall ACT Network Management System (NMS). The ACT existing Network Management System (NMS) is Microsoft System Center Operations Manager and IP Switch WhatsUp Gold.

10. All communications equipment shall be connected to an Uninterrupted Power Supply (UPS) of sufficient capacity to continue normal operation of the communications systems for at least 1 hour.

11. The CTS shall include diagnostic functions to ensure failure-free operation and shall provide CTS equipment failure alarms through NMS and SCADA to the designated AC Transit personnel.

12. CTS shall include the following main components:

   a. Switches and Routers.
   b. Fiber Backbone Cable and accessories.
   d. Interconnecting panels to provide data to the end-point communications devices.

13. Contractor shall configure CTS and devices according to IP subnet and VLAN scheme that optimally minimizes size of routing tables or other forwarding tables, filtering tables and all other software-based resources, through route summarization and other industry best practice practices and methods, and provides seamless integration with ACT existing networks, as approved by ACT.

14. Contractor shall configure access lists (ACLs) on any and all interfaces (physical or virtual) as needed to provide adequate level of security in accordance with the Payment Card Industry (PCI) Data Security Standards (DSS). The Contractor shall submit the ACL to ATC for approval. Contractor shall participate in PCI DSS compliance inspections/audits, performed by an AC Transit provided PCI.
Compliance Qualified Security Assessor (QSA). PCI compliance audits will be performed during the Contractor’s design reviews and installation acceptance testing. The communications network’s configuration and design shall meet all security requirements in accordance with results of these compliance audits.

15. Draft network configuration parameters will be provided upon request to successful bidder.

16. Current conditions:
   a. ACT provides a Cisco Catalyst 6807 Core Ethernet Switch at GO equipment room.
   b. The ACT existing Network Management System (NMS) is Microsoft System Center Operations Manager and IP Switch WhatsUp Gold.
   c. The contractor shall provide and install one Cisco C6800-32P10G blade with required SFP+ modules for the ACT Cisco Catalyst 6807 Core Ethernet Switch.

B. Deployment
   1. The communications backbone system design shall provide fiber optic rings throughout the EB BRT corridor.
   2. This type of network topology shall establish fully redundant CTS that would ensure all the BRT communications systems are fully connected and integrated in the AC Transit existing network.

C. The CTS shall provide a communications system with following features:
   1. Field proven: The equipment shall be deployed in a minimum of 5 similar operating systems.
   2. Reliable: The network shall be designed for high reliability as specified herein.

D. Availability and Reliability
   1. The fiber optic network shall have an availability of 99.99 percent.
   2. The network shall be configured in a protected collapsed ring.
   3. Network hardware such as switches, routers shall be selected in the design phase that has a very high Mean Time Before Failure (MTBF) and a very low Mean Time to Repair (MTTR). The High/Low target ranging of these two parameters shall yield availability of 99.99 percent as calculated using standard equations commonly used in reliability engineering (e.g. A = MTBF / (MTBF + MTTR) or other equations approved by ACT.
   4. The maximum recovery time, in the event of a node failure or individual fiber break, shall not exceed 10 seconds.
   5. Dual power supplies (redundant) shall be provided.
6. Configuration data and specific software shall be implemented to ensure automatic and quick restart after a power outage.

7. As far as practical, equipment shall be configured and provisioned so that a loss of an interface card on a backbone switch does not result in the total loss of communications services at a site were multiple inputs for a function are provided.

E. System Bandwidth and Bandwidth Allocations

1. The main ring shall operate at 10 Gigabit per second between GO and OCC. The station rings shall also operate at 10 Gigabit per second.

2. The exact overall bandwidth requirements for the system are based upon the final equipment selected for use in the system as well as the number of units of each equipment type. The approximate bandwidth needs shall be determined by an accumulation of the per-unit bandwidths taken over the numbers of each unit type. A 25 percent spare capacity shall be added in order to prevent bottle-necks under certain conditions such as a device stuck streaming.

   a. The contractor shall submit the final count of networks bandwidth.

F. Network Security

1. Network security shall address physical security of fiber optic cable, servers, workstations, routers, switches, and all other network entry points.

2. Network security shall also address data security in layers of software and protocols for: traffic filtering, traffic segregation, firewalls and intrusion detection. Virtual Local Area Networks (VLANs) and Virtual Private Networks (VPNs) offer secured network tunnels that can also manage traffic loads. Network security must meet PCI certification requirements.

3. These network technologies shall be utilized throughout the communications components deployments.

4. Network Security shall have attack mitigation capabilities.

5. Network Security shall be implemented throughout the infrastructure.

6. The system security shall be designed to include the following as a minimum:

   a. Security Management;

   b. Reporting;

   c. Authentication and authorization of devices;

   d. Users and Administrators;

   e. Intrusion detection and prevention;

   f. Support for emerging networked applications;

   g. Resiliency and scalability.
G. Network Management System (NMS)

1. The existing ACT NMS shall be used to monitor and control the EB BRT CTS network and equipment. The ACT existing Network Management System (NMS) is Microsoft System Center Operations Manager and IP Switch WhatsUp Gold.

2. The EB BRT CTS shall be fully compatible with ACT existing NMS. The EB BRT CTS system shall fully integrate to the ACT NMS.

3. The NMS (provided by ACT) shall be reconfigured by the contractor to provide the ability for authorized users to configure, operate, and maintain the CTS network.

4. The NMS shall provide the following functions for managing the CTS network:
   a. Network configuration;
   b. Alarm monitoring and event reporting on CTS equipment;
   c. Performance monitoring of network traffic;
   d. Fault diagnostics.

5. The NMS shall provide the ability for authorized users to accommodate CTS modifications, including; the reallocation of devices on networks, the addition of devices, the deletion of devices, load reallocations, without the need to bring down the systems.

H. CTS Interfaces

1. Appropriate interface equipment shall be provided to connect each system to the CTS as detailed below. Interface shall include multiple VLAN switch virtual interfaces (SVIs) at each station that provide multiple isolated network segments on each station switch.

2. Interface equipment for each system shall be physically and functionally interchangeable without the need for adjustment.

3. CTS shall connect all the equipment for the EB BRT line; including the:
   a. Equipment at the Station Platforms:
      1) Bus Schedule Information system VMSs
      2) Close Circuit Television (CCTV) Cameras
      3) Network Video Recorders (NVR)
      4) Uninterrupted Power Supplies (UPS)
      5) Supervisory Control and Data Acquisition System PLC
      6) PA System VOIP Audio Devices
      7) Ticket Vending Machines (TVM)
8) Clipper Interface Devices (CID) - Clipper Card Readers

b. Control Center (OCC)/General Office (GO)
   1) BRT Video Monitoring System Workstations
   2) SCADA Virtualized Servers in existing ACT VM Ware environment
   3) CCTV Servers
   4) CCTV System Storage
   5) PA Virtualized Servers in existing ACT VM Ware environment
   6) BRT Workstations
   7) Engineering Workstation
   8) Fare Collection system server
   9) A credit/debit payment processing server (server provided by others) for the TVM equipment with a dedicated point to point communications circuit Provide V-LANS with Quality of Service (QoS) priority mapping in accordance with IEEE 802.1p.

1.7 REQUIRED FEATURES

A. Provide V-LANS with Quality of Service (QoS) priority mapping in accordance with IEEE 802.1p.

B. ACT OCC and GO network shall support Multi Protocol Label Switching (MPLS) as specified by the Metro Ethernet Forum (MEF), latest version.

C. No devices on the EB BRT network shall be at end sale or end of life.

D. None of the equipment supplied under this Contract shall be a gray market.

E. BRT network equipment shall be new, not used, or refurbished.

F. Provisioning, node turn-on, performance monitoring, alarm reporting, fault diagnosis and software upgrades for the network wide system shall be able to be made from the existing network administrative workstation.

G. Warranty: Provide in accordance with the requirements of the contract. The System shall possess intelligent protection switching to provide proactive performance monitoring and recording/logging, rapid self-healing after node or fiber facility trouble alarms and faults.

H. Contractor shall optimize IP subnet/VLAN schemes to minimize size of routing and other forwarding tables, through route summarization and/or other industry best practices; also access lists (ACLs) enabled and configured on physical and virtual interfaces (VLANs) that can provide adequate security to meet security requirements set forth by a licensed PCI QSA (Qualified Security Assessor)
2.1 SYSTEM PERFORMANCE/FUNCTIONAL REQUIREMENTS

A. The 10 Gigabit Ethernet system shall provide communications between GO and OCC. The 10 Gigabit Ethernet system shall also provide for all bus stations. All EB BRT communications equipment locations indicated on Contract Drawings.

B. Provide Ethernet based transport for the SCADA system with the same or greater performance/functionality as defined in Division 3.2, Section 34 42 36 – Supervisory Control and Data Acquisition System.

C. Provide Ethernet based transport for the CCTV system with the same or greater performance/functionality as defined in Division 3.2, Section 27 51 10 – Closed Circuit Television System.

D. Provide Ethernet based transport for the PA system with the same or greater performance/functionality as defined in Division 3.2, Section 27 51 16 – Public Address System.

E. Provide Ethernet based transport for the Fare Collection system with the same or greater performance/functionality as defined in Division 3.2, Section 27 53 50 – Fare Collection System.

F. Provide Ethernet based transport for the Bus Schedule system/VMS.

G. A separate VLAN shall be configured at each station for the fare collection system.

H. A separate VLAN shall be configured at each station for the Clipper Card system.

I. The system shall meet the environmental requirements defined in Division 3.2, Section 27 00 10 – Basic Communications Technical Requirements.

J. The system design shall follow all ACT standards and guidelines.

K. The EB BRT network shall seamlessly integrate with the existing network infrastructure.

L. The system shall support Voice Over IP (VOIP).

M. The system shall be resilient.

N. The network shall be a self-managed infrastructure.

O. The Contractor shall provide Smart Net support.

P. The system shall have security provisions for protection from operational misuse, intentional or non-intentional.

Q. The system shall allow for expansion.

R. The system shall have the capabilities for easy migration to future beneficial technologies.
S. The system components shall be standards based allowing for interoperability with multiple vendor products. Relevant standards include IEEE 802 and IEEE 802.1b, 802.1d, 802.1f, 802.1g, 802.1q 802.1p, 802.3, 802.1w (RSTP), 802.3af (POE) and etc.

T. The system shall support Simple Network Management Protocol (SNMP) version 3 data management standard or approved equal.

U. All ACT EB BRT equipment in the networks shall synchronize with ACT network time clock.

2.2 COMPONENT REQUIREMENTS

A. Meet or exceed the Mean Time Before Failure (MTBF) and Mean Time To Repair (MTTR) requirements as specified in Division 3.2, Section 01 43 20 – Communications System Assurance and as defined herein.

B. The network equipment shall equip with latest firmware.

C. Core Switch/Routers: ACT provides the Cisco Catalyst 6807 core Ethernet Switch at GO equipment room. The core switch will provide routing between VLANs on the CTS and access to the ACT enterprises network. The switch will also provide the functions for ACT enterprises networks. The core switch will terminate the station 10 Gigabit per second Ethernet links and ten Gigabit per second Ethernet ring between GO and OCC. The core switch will also connect BRT servers, storage and workstation at the GO equipment room. Contractor shall provide and install one Cisco C6800-32P10G blade with required SFP+ modules for the ACT core Ethernet switch. The new Cisco C6800-32P10G blade shall equipped with SFP+ modules:

1. Between OCC and GO, Four 10 Gbps single mode fiber SFP+ modules shall be provided. The Optics SFP+ module shall have a minimum rating of 20km.

2. The interface port to the station Ethernet switches shall be 10 Gigabit per second SFP port with single mode fiber optic SFP+ module minimum. 16 SFP+ modules shall be provided

3. The blade shall have 10G SFP+ ports with cables to connect Ethernet Access Switches

D. OCC Ethernet Switches: Contractor shall provide two Cisco Catalyst 6832-X-LE Ethernet Switches with IP & Enterprise Services License (or ACT approved equal) in OCC. The Ethernet Switches shall connect to Core Ethernet Switch at GO to provide 10 Gigabit per second ring and connect to station 10 Gigabit per second rings. The Ethernet Switches shall provide:

1. Between OCC and GO, High-speed 10 Gbps single mode fiber optic links as required. Optics SFP+ module shall have a minimum rating of 20km. Two SFP+ modules shall be provided on each switch.

2. The interface port to the station Ethernet switches shall be 10 Gigabit per second SFP port with single mode fiber optic SFP+ module minimum. SFP+ modules shall have LC type fiber optic connectors. Six SFP+ modules shall be provided on each OCC switch. The Ethernet switches shall also have 10Gbps SFP+ modules and cables to connect OCC Ethernet Access Switches.
3. The connections between the two OCC Ethernet switches shall be 10 Gigabit per second Multi-mode fiber SFP+ ports with Multi-mode fiber cables. Two SFP+ modules shall be provided on each OCC switch.

4. One local craft port (RS-232 or USB) minimum.

5. The switch shall be powered by redundant power supplies with dual AC power input.

E. Station Ethernet Switches and Ethernet Access Switches: The station Ethernet switches and Ethernet Access Switches shall be Cisco Catalyst 3850 Switch - WS-C3850-24P-E or ACT approved equal. The switches shall be provided at each Bus Station CIC Cabinet to interface with local devices. The Station Ethernet switch shall connect to the other station Ethernet switches or the Ethernet switches at GO/OCC via single mode fiber optic cable. The station Ethernet switches shall also interface with all equipment as required and as indicated on plans. This typically includes the CCTV Cameras, NVR, IP Audio Device, TVM, Clipper Card reader, SCADA PLCs, UPS, and VMS. The Ethernet Access Switches shall interface with Servers, workstations and storage via 10/100/1000 Base-T link at GO and OCC. The Ethernet Access Switches shall also have one 10G link to connect GO core Ethernet switch or OCC Ethernet switches. Each switch shall provide:

1. 24 10/100/1000Base-T ports.

2. All ports shall be 802.3af compliant for Power over Ethernet (PoE).

3. All ports shall be 802.1q compliant for VLANs.

4. 2 10G SFP+ uplink/downlink ports. SFP+ modules shall have LC type fiber optic connectors for the Station Ethernet Switches and Ethernet Access Switches. The Ethernet Access Switch One 10G uplink SFP+ with cable will connect to GO core Ethernet switch or OCC Ethernet Switches.

5. One local craft port (RS-232 or USB) minimum.

6. Remotely configurable via standard web browser or telnet web browser with HTTPS, telnet or SSH, with proper configuration as needed to pass PCI compliance audit via proper encryption and ACL packet filtering.

7. The switch shall be powered by redundant power supplies with dual AC power input.

8. The two Ethernet Access Switches at GO and OCC shall be stacked. Redundant stacking data cables and power cables shall be provided.

F. The SFP+ modules shall be Cisco, Proline or ACT approved equal.

2.3 SPARE PARTS AND TEST EQUIPMENT

A. The Contractor’s spare parts and test equipment list, as defined in Division 3.2, Section 01 45 25 – Communications Spare Parts and Test Equipment, shall meet performance and reliability requirements and be adequate to measure, maintain, and repair the system.
2.4 INTERCONNECT CABLEING/EQUIPMENT, RACKS AND CABINETS, AND MISCELLANEOUS EQUIPMENT

A. The Contractor shall provide all interconnect cabling between all equipment provided by the Contractor.

B. The Contractor shall provide all telecommunications interconnect equipment between all equipment, such as patch cords and patch panels.

C. The Contractor shall provide all equipment racks and cabinets (except noticed on the contractor drawings and specifications) for all communications equipment provided:
   1. Equipment shall be housed in free-standing cabinets and/or equipment racks, based on the location.
   2. Key locks shall be provided on the access doors for all cabinets. Provisions for the key locks shall be coordinated with ACT.

D. The Contractor shall provide all miscellaneous equipment not expressly stated in this Section, but required to ensure the system meets the operational intent of the CTS.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide all equipment, hardware, accessories, software, hardware and all ancillary material necessary for a complete operational system.

B. At each location (e.g., equipment rooms, station cabinets) make all necessary hardware, connections, and cross connections as required, including interfacing with other systems, to ensure a fully operational system.

C. Installation of all equipment and hardware shall submit to ACT for approval. The Contractor provided shop drawings shall be consistent with industry standard practices.

D. Contractor shall install and configure the CTS system. The system shall fully integrate to ACT existing system. The configuration plan shall submit to ACT for approval.

E. Installation of all nodes shall be consistent from site to site to provide uniformity in the installations.

F. Installed equipment and materials shall demonstrate the highest standards of quality workmanship.

G. Testing shall be in accordance with Division 3.2, Section 01 45 23 – Communications Commissioning and Testing of these specifications.

H. Training shall be in accordance with Division 3.2, Section 01 91 30 – Training of these specifications.

3.2 NETWORK MANAGEMENT SYSTEM

A. Each network element shall be provisioned, installed, numbered, and labeled in accordance with the NMS allocation tables submitted for and approved by ACT.
B. The NMS shall allow provisioning changes to be performed remotely by authorized users.

3.3 OPERATIONS CONTROL CENTER (OCC)

A. The CTS communications equipment shall be installed in existing racks as indicated on the EB BRT OCC (CMF) communications rack drawings. Contractor shall submit the shop drawings for ACT approval. Communications racks will be provided by others as described in Division 3.2, Section 27 01 00 – Operations Control Center.

B. All cabling between communications equipment components and servers/workstations will be per the Contractor’s Shop Drawings approved by the ACT.

3.4 GENERAL OFFICE (GO)

A. The CTS communications equipment shall be installed on the ACT existing racks. Contractor shall submit the shop drawings for ACT approval.

B. All cabling between CTS communications equipment components and servers, workstations, and existing AC Transit network will be per the Contractor’s Shop Drawings approved by the ACT.

3.5 STATION PLATFORMS

A. The CTS communications equipment shall be installed in the Communications Interface Cabinet (CIC) on each station platform as indicated on the Communications Cabinet equipment layout drawings. Contractor shall submit the shop drawings for ACT approval.

B. All cabling between communications equipment components and devices will be per the Contractor’s Shop Drawings approved by the ACT.

END OF SECTION
SECTION 27 15 10

COMMUNICATIONS WIRES AND CABLE

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes:

1. Requirements for communications subsystems wire and cable.
2. Requirements for fiber optic cable to be provided for the Communications System.

1.2 REFERENCES


1. AREMA C&S MANUAL, PART 10.3.20 – Recommended Design Criteria for Neoprene, Chlorinated Polyethylene and Chlorosulfonated Polyethylene Jacketing for Wire and Cable.

2. AREMA C&S MANUAL, PART 10.3.21 – Recommended Design Criteria for Polyethylene Insulation and Jacketing for Wire and Cable.

3. AREMA C&S MANUAL, PART 10.4.1 – Recommended Instructions for Wire and Cable Installation and Maintenance.


5. AREMA C&S MANUAL, PART 14.1.5 – Recommended Design Criteria for Molded Terminal Blocks.

6. AREMA C&S MANUAL, PART 14.1.8 – Recommended Design Criteria for Molded Blinding Post Type Terminal Block, Details and Assemblies.


B. American Society of Testing and Materials [ASTM]


C. Institute of Electrical and Electronics Engineers [IEEE]

D. Military [MIL]

E. National Electrical Manufacturers Association [NEMA]
   1. NEMA WC 70 – Nonshielded 0-2kV cables.
   2. NEMA WC-71 – Nonshielded 2001-5kV cables.
   3. NEMA WC-74 – Shielded power cable 5-46kV.

F. National Fire Protection Association [NFPA]
   1. NFPA 70 – National Electrical Code (NEC).


H. Telecommunications Industry Association/Electronic Industry Association [TIA/EIA]
   1. TIA/EIA-568-A – Commercial Building Telecommunications Cabling Standard.
   2. TIA/EIA-569 – Commercial Building Standard for Telecommunications Pathways and Spaces.
   3. TIA/EIA-598 – Optical Fiber Cable Color Coding.
   4. TIA/EIA-606 – Administration Standard for Telecommunications Infrastructure.

I. Underwriters Laboratories [UL]
   1. UL 83 – Thermoplastic-Insulated Wires and Cables.
   2. UL 486A – Wire Connectors and Soldering Lugs for Use with Copper Conductors.
   3. UL 854 – Service Entrance Cable.
   4. UL 910 – Test for Flame Propagation and Smoke Density Values for Electrical and Fiber Optic Cables Used in Spaces Transporting Environmental Air.

J. NETA ATS (Acceptance Testing Standard)
1. NETA ATS, Section 7.3.1-Cables, Low-Voltage, Low-Energy-Reserved.

1.3 SUBMITTALS

A. Communications Copper Cable Product Data (CDRL 20020-02): Submit product data for each type of cable proposed, including cable cut sheets, shop drawings and other related data.

B. Communications System Fiber Optic Cable Product Data (CDRL 20020-04): Submit product data for the cable, including associated hardware, for the Communications system. Include cable cut sheets, shop drawings and other related data.

C. Communications Cable Termination Product Data (CDRL 20020-05): Submit product data, termination panels, patch cords, splice enclosures, and cable termination details, including proposed terminals and crimping tools data.

D. Communications Cable Post-Installation Documentation (CDRL 20020-08): Submit power meter and OTDR data.

1.4 QUALITY ASSURANCE

A. NFPA 70: Conform to applicable codes and regulations regarding toxicity of combustion products of insulating materials.

PART 2 - PRODUCTS

2.1 GENERAL

A. All wire and cable constructions installed in stations shall be listed as being resistant to the spread of fire and shall have reduced smoke emissions in accordance with the requirements of NFPA 70 unless specifically approved by ACT.

B. Outside plant cable (OSP), as well as indoor/outdoor, cable shall be suitable for installation in an underground conduit environment, including constant immersion in water, for outdoor installations.

2.2 SIGNAL WIRES, CONDUCTORS AND CABLES

A. Manufacturers: Provide products that comply with requirements of one of the following (or approved equal):

1. Alcan Aluminum Corporation; Alcan Cable Div.
3. General Cable Corporation.
4. Senator Wire & Cable Company.
5. Southwire Company.

B. Conductor Material: Copper complying with NEMA WC 7; solid conductor for No. 10 AWG and smaller, stranded for No. 8 AWG and larger.

C. Conductor Insulation Types: Type THHN-THWN-2 complying with NEMA WC 5 or 7.
D. Multiconductor Cable: Type SO with ground wire.

2.3 GENERAL FIBER OPTIC CABLE REQUIREMENTS

A. Fiber Optic Installation, Splicing and Testing Equipment: Submit for pre-approval by ACT, all fiber optic fusion splicing, termination, and testing equipment and tools prior to the commencement of any fiber work requiring a Fiber Optic Technician. The submitted equipment shall utilize the most current technology available as determined by ACT. The Contractor shall supply to ACT, Standard Operating Procedures (SOP) for the installation, splicing, termination and testing of optical fiber. SOP’s shall adhere to the requirements contained in this specification.

B. Functional Requirements

1. Outside plant cable (OSP), as well as indoor/outdoor, cable shall be suitable for installation in an underground conduit environment, including constant immersion in water, for outdoor installations. All cable shall be loose-tube, all dielectric (non-metallic) construction, gel-filled, duct type.

2. The optical fibers shall be contained within loose buffer tubes. The loose buffer tubes shall be stranded around an all dielectric central member. Aramid yarn shall be used as a primary strength member, and a polyethylene outside jacket shall provide for overall protection.

3. Each optical fiber shall be glass and consist of a doped silica core surrounded by concentric silica cladding. All fibers in the buffer tube shall be usable fibers, and shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of these specifications. The required fiber grade shall reflect the maximum individual fiber attenuation, to guarantee the required performance of each and every fiber in the cable.

4. Ripcord - The cable shall contain at least one ripcord under the jacket for easy sheath removal.

5. Outer jacket - The jacket shall be free of holes, splits, and blisters and shall be medium or high density polyethylene (PE), or medium density cross-linked polyethylene with minimum nominal jacket thickness of 1 mm ±76 μm. Jacketing material shall be applied directly over the tensile strength members and flooding compound and shall not adhere to the aramid strength material. The polyethylene shall not promote the growth of fungus. The jacket or shall be marked with the manufacturer’s name, the words “Optical Cable”, the number of fibers, “SM”, year of manufacture, and sequential measurement markings every meter. The actual length of the cable shall be within -0/+1 percent of the length marking. The marking shall be in a contrasting color to the cable jacket. The height of the marking shall be approximately 2.5 mm.

6. The cable shall be provided and installed in continuous lengths. Splicing and/or cutting of the fiber cable is strictly forbidden except where called for explicitly in the Contract Drawings, or pre-approved by the ACT.

7. All fibers in the fiber optic cable shall be spliced and/or terminated as indicated on the plans, as specified, or as approved by ACT.

8. All optical glass cores shall be of the same manufacturer.
9. Only United States Manufactured optical fiber (glass core) shall be supplied for this project.

C. Bend Radius Requirements: The cable shall be capable of withstanding a minimum-bending radius of 10 times its outer diameter during operation and 20 times its outer diameter during installation without changing the characteristics of the optical fibers.

D. Each end of the cable shall be securely fastened to the reel to prevent the cable from coming loose during transit. Two meters of cable length on each end of the cable shall be accessible for testing. Each cable reel shall have a durable weatherproof label or tag showing the manufacturer’s name, the cable type, the actual length of cable on the reel, the Contractor's name, the contract number, and the reel number. A shipping record shall also be included in a weatherproof envelope showing the above information and also include the date of manufacture, cable characteristics (size, attenuation, bandwidth, etc.), factory test results, cable identification number and any other pertinent information.

E. Fiber Optic Cable Submittal Content: All OSP optical cable submittals shall include the following information from the Manufacturer:

1. Current Catalog Cut Sheet;
2. Manufacturer’s Production Cable Configuration Drawing(s);

2.4 COMMUNICATIONS SYSTEM FIBER OPTIC CABLE

A. Fiber Optic Network Cables: The CTS backbone fiber optic ring system shall be implemented via single mode fiber optic cables, as indicated on the Contract Drawings. Contractor shall implement the fiber optic ring using one of the fiber optic cables. One of the fiber optic cables shall be provided, installed, and used exclusively for the ACT BRT project as shown in the Contract Drawings. The other fiber optic cables shall be provided and installed, but reserved for others to use. All fiber optic cables shall be installed in an existing or new 3” or 4” conduit (#3 or #4), as shown on the plans, within the ductbank running the length of the BRT route, as indicated on the Contract Drawing Ductbank Plan.

B. Single-Mode Fiber Optic Cables: Single-mode fiber shall have the following characteristics:

1. Dielectric cable with standard single-mode fiber (Corning SMS-28E or equal) suitable for operation at a wavelength of both 1310 nanometers (nm) and 1550 nanometers.
2. Dielectric loose tube cable with standard single-mode fiber (Corning ALTOS or approved equal) suitable for operation at a wavelength of both 1310 nanometers (nm) and 1550 nanometers for the indoor/outdoor application.
3. Color-coded fibers and buffer tubes in accordance with the requirements of TIA/EIA-598 shall be provided. Fiber coloring blue, orange, green, brown, slate, white, red, black, yellow, violet, rose, aqua.
4. Capable of 10 Gigabit Ethernet operation.
5. Filled Construction with loose tubes containing color coded optical fibers.
6. Interstitial filling compound throughout the cable to prevent water entry.
7. Single-mode fiber optic cable shall have the following specifications

a. Operational wavelength 1310nm and 1550nm
b. Fiber coating diameter 250 microns
c. Fiber cladding diameter 125 microns
d. Core diameter 8.3 microns (nominal)
e. Cladding non-circularity ≤ 0.7%
f. Core/cladding concentricity ≤ 0.5 micron
g. Zero dispersion wavelength 1310 ± 010 nm
h. Maximum dispersion range ≤ 3.52 ps/nm•km (1285 to 1330 nm) ≤ 17.519 ps/nm•km (1550 nm)
i. Polarization mode dispersion ≤ 0.2 ps/√km
j. Water peak attenuation ≤ 0.4 dB/km @ 1383 nm ± 3 nm Cut-off wavelength ≤ 1260nm
k. Optical Attenuation ≤ 0.4 dB/km at 1310 ≤ 0.3 dB/km at 1550
l. Crush resistance 220 N/cm Cable diameter 0.5 – 0.8 inches
m. Minimum bending radius 10 times OD of cable (static)

C. Slack

1. For all cable installed in ductbanks, provide 30 foot of slack in each ductbank, pullbox, or manhole.

2. For fiber routed through the Communication Cabinet or an equipment cabinet a minimum of 10 ft of slack shall be provided.

D. Installation: Contractor shall meet fiber optic cable installation requirements as specified under Division 2.1 307-17.5.5.1 through 307-17.5.5.5.

E. Testing: All optical fibers shall be proof tested by the fiber manufacturer at a minimum load of 100 kpsi. All optical fibers shall be 100% attenuation tested at the factory for
compliance with performance specifications described herein. The attenuation data for each fiber shall be provided with each cable reel.

2.5 COPPER COMMUNICATIONS CABLE

A. Copper Communications Cable: Copper communications cable shall have the following characteristics:

1. PVC insulated 22 AWG and 24 AWG pairs.

2. Sheath of corrugated aluminum shield bonded to flame retardant, non-halogenated jacket. Outside plant cables (OSP) shall be gel-filled.

3. Copper communication cable shall have the following specifications:
   a. Conductor resistance – 22 AWG- 86 Ohms/mile (nominal), 24AWG-136 Ohms/mile (nominal)
   b. Insulation resistance – 10,000 Megohms/mile (minimum)
   c. Attenuation @ 1000 Hz – 22 AWG- 1.85 dB/mile (nominal), 24 AWG-2.26 dB/mile (nominal).

B. Public Address (PA) Speaker Cable: PA speaker cable shall be Belden 5240U1 or AC Transit approved equivalent with the following characteristics:

1. Type: Outdoor commercial speaker cable.

2. Outer Jacket: PVC.

3. Insulation: PVC.

4. Conductors: Stranded (719x2429) #16 AWG.

5. Number of conductors: 2.

C. SCADA PLC Digital Input (DI) Cable: SCADA PLC DI cable shall be Belden 1069A to 1074A or AC Transit approved equivalent with the following characteristics:

1. Type: Outdoor 600V tray cable.

2. Insulation: PVC insulated.

3. Pairs: Stranded (7x24) #16 AWG, twisted.

4. Number of pairs: 2 minimum. Contractor shall provide each SCADA PLC DI cable with a minimum of one pair per DI point plus one additional pair.

5. Shield: Overall aluminum polyester foil with drain wire. Drain wire shall be connected to ground at only one location, inside the CIC.

D. PA Ambient Noise System (ANS) Microphone Cable: ANS microphone cable shall have two pair cables. One pair cable shall be used for audio, and the other pair cable shall be used for 12-24V AC or DC power.

1. The ANS microphone audio cable shall be Belden 1814WB5300FE or AC
Transit approved equivalent with the following characteristics:

a. Type: Outdoor commercial audio cable.

b. Insulation: PVC insulated.

c. Conductor: Stranded (7x3026) #2218 AWG

d. Number of conductors: 2 pairs.

e. Shield: Overall aluminum polyester foil with shorting fold, and #224 AWG drain wire. Drain wire shall be connected to ANS microphone ground connection.

### 2.6 LAN CABLE

A. LAN Cable: The LAN cable shall be Category 6 cable with the following characteristics:

1. Outdoor rated solid copper conductors (4 pairs).

2. Third party certified to TIA/EIA 568B Category 6.

3. CAT 6 cable shall have the following specifications:

   a. DC resistance 24 Ohms/kft (maximum)
   
   b. Mutual capacitance 14 pF/ft @ 1 kHz (nominal)
   
   c. Characteristic impedance 100 Ohms (nominal)
   
   d. Attenuation:

      (1) @ 4 MHz – 3.7 dB/328 ft (nominal)

      (2) @ 10 MHz – 7.4 dB/328 ft (nominal)

      (3) @ 16 MHz – 7.4 dB/328 ft (nominal)

      (4) @ 31.25 MHz – 10.4 dB/328 ft (nominal)

      (5) @ 62.5 MHz - 15 dB/328 ft (nominal)

      (6) @ 100 MHz – 19.3 dB/328 ft (nominal)

### PART 3 - EXECUTION

#### 3.1 INSTALLATION REQUIREMENTS

A. General

1. Verify the required cable length for each cable run prior to installation. Civil stationing appearing on referenced drawings may be used for defining locations and estimating cable lengths, however, approved cable plans shall be used to determine final lengths and cuts. Actual lengths shall be determined by making on-site inspections and measurements.
2. Wires and cables shall be continuous without splices between junction boxes, terminals, pull boxes, manholes and hand holes.

3. Cable shall not be bent to a radius less than the greater of 12 times the diameter of the cable or the manufacturers’ recommended minimum bending radius, during installation or as finally installed.

4. Cable shall be laid with a minimum amount of crossover, shall be secured at least every 3 feet, and shall not be pulled or formed tightly around bends. Conduits for cable entering or leaving trays shall be rigidly attached and supported at their ends by suitable brackets and conduit straps.

5. Cable shall be protected after installation and prior to terminating or splicing. All cable shall be tagged and labeled after installation. Cable shall be tagged at their termination points. Cable shall also be tagged at aerial exits from conduit risers. Re-seal cable ends when a length is cut from a reel.

6. Install grommets or use other methods to protect incoming cable to other equipment from abrasion. Where cable is routed vertically, provide proper support as necessary to relieve strain. In no case shall the weight of cable be allowed to pull against cable terminations.

7. Exposed wire and cable entering or leaving junction boxes, and cable transition points shall be protected from abrasion. Chase nipples and/or split ring plastic grommets shall be provided in drilled or punched openings in junction boxes.

8. All cable entrance openings shall be sealed with either a compression type fitting or pliable sealing compound after the cable is in place. Sealing compound shall be used to seal the area around cable where the cable emerges from the end of a conduit or pipe. All spare conduits shall be sealed or plugged in an approved manner. Cable openings within signal building floors and/or walls shall be sealed with an approved fire sealant per ASTM E814.

9. Where cable leaves a conduit, the ends of the conduit shall be fitted with end bells to prevent damage to the cable.

10. Provide sufficient slack in installation of wire and cable for relief of stress due to vibration and to allow for 3 re-terminations of each conductor without re-servicing or re-pothreading the wire or cable. The Contractor shall provide service loops sufficient for the maintenance and free movement of attached electrical equipment.

11. Where multi-conductor cable is to be terminated in an enclosure, the outer jacket and shield (where applicable) shall be carefully removed to a point close to the cable entrance. At the end of the cable sheath or covering, apply two layers of an approved electrical plastic tape. Conductors shall then be neatly arranged, bundled, and tied approximately every 3 inch. These bundles shall be routed vertically to a point higher than the top terminal post and then turned and terminated from the top terminal down in reverse wire number order (highest number at the top). Observe all wire bend radius restrictions. Cable connections and splices shall be made in strict accordance with the manufacturer’s instructions.

12. Cable with aluminum or bronze tape shield shall have the shield grounded
only on one end of each cable run.

13. Open wiring on equipment racks shall be neatly arranged, bundled, and tied approximately every 3 inch with nylon straps. All straps shall be of the same color.

14. Where 120 VAC power cable is installed in the ductbank from one location to another, via facilities such as manholes, pullboxes and vaults, provide physical separation required to minimize EMI impacts to other systems.

15. The Contractor shall arrange the cable to allow free access to all existing cable for maintenance.

16. Cable shall be installed with freedom of horizontal movement to accommodate expansion and contraction of the cable in the conduits.

17. Cable shall not be pulled into a conduit that already contains conductors. If it becomes necessary to remove a cable from a conduit, all cable in that conduit shall be removed.

18. The Contractor shall provide appropriate special protection for cable in areas where the cable is unavoidably exposed to hazardous conditions such as vibration or sharp corners on equipment. Cable damaged due to Contractor’s neglect while installing cable shall be replaced by the Contractor at no additional cost to the Contract.

19. Cable installed in manholes shall be properly constrained and fastened to the walls of the manhole in accordance with the approved installation drawings.

B. Notification: Notify ACT 48 hours prior to any cable installation activities.

C. Ductbank

1. The ductbank shall be installed to accommodate power, and communication cable installation requirements. The ductbank system includes, but is not limited to:

   (1) Main line ductbank, including interfaces to facilities and equipment.

   (2) Manhole and pullboxes.

   (3) Utility and electrical feeds.

2. Cable installed in conduit, regardless of length, shall not exceed the maximum fill recommendations of the manufacturer, unless otherwise approved.

3. Provide any installation hardware necessary to route, support, terminate, or protect cable.

4. Ensure that conduits are dry before installation of cable and use a pulling compound or lubricant approved by the manufacturer, which is compatible with the cable. Utilize the lubricant in the quantity recommended by the lubricant supplier and shall be applied in a manner that ensures that the cable is lubricated throughout the entire length being installed. The lubricant shall be non-hygroscopic and vermin-proof.

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5. Cable made expressly for the purpose of direct burial shall not be installed in conduit.

6. Dewater and remove dirt and trash from manholes and pullboxes prior to, during and after installation of cable.

7. Cable installed in manholes shall not interfere with the future use of or access to unused conduit.

D. Cable Pulling

1. Calculations shall be made to estimate pulling tensions for cable pulls, which require the use of pulling apparatus. These tensions shall be calculated in both directions to determine which will result in less stress on the cable. The direction requiring lower tension shall be used where possible. Indicate how each installation will be completed within the limitations and recommendations of the manufacturer and these technical specifications. All installation calculations shall be submitted to ACT for approval prior to the start of cable installation, as part of the applicable Cable Installation Plan. Tension calculations need not be provided for short sections of cable, which will be installed by hand pulling.

2. Apparatus to be used in pulling-in cable shall be in good working order and shall be demonstrated to ACT for approval. Pulling apparatus shall be provided with a smooth variable speed control.
   a. A dynamometer shall be used for all cable installations that are not installed by hand.
   b. The dynamometer used for cable pulling shall bear a record of calibration against certified standards indicating calibration within the last 180 days.

3. Two-way communication between the pulling and feed end of each pull shall be established before and maintained during the installation.

4. Reels shall be stripped of all nails in outside edges of reel heads before pulling of cable, and shall be conveniently located for feeding cable into the conduit without excessive bending or possible injury to cable by abrasion on sides of pull boxes where pull boxes are required. Reels shall be jacked to clear ground level by at least 6 inches before pulling cable.

5. Cable reels shall be carefully handled to avoid injury to persons or cable. Movement of reels on loading skids or sloping grades shall be controlled by use of a snub line or wedge. Reels shall always be blocked after positioning.

6. Cable shall be pulled into conduits with the use of a pulling eye approved by ACT. Pulling ropes shall be attached to the pulling eye with ball-bearing swivels to prevent twisting of cable during pulling.

7. Cable shall be pulled into conduits under moderate tension. Manufacturer’s recommended maximum pulling tension shall not be exceeded at any time. Before pulling any cable into conduits, the Contractor shall first consult with ACT as to methods and locations of cable pulling.

8. Personnel shall be stationed between the reel and the conduit entrance during
pulling operations to inspect control and direct the passage of cable. The conduit mouth shall be equipped with conduit shields to prevent chafing of the cable. Use UL-listed lubricant and provide suitable installation equipment to prevent cutting and abrasion of wire during the pulling of feeders.

9. Avoid using any lubricant that may be injurious to the materials of the wire and cable to be installed. Provide installation procedure as recommended by the cable manufacturer, and approved by ACT.

10. Cable shall not be allowed to chafe on the ground, in manholes or handhole edges, or any sharp surfaces during pulling. Flexible pulling tubes shall be provided to guide and protect the cable, where necessary.

11. Pulling shall be done at a constant velocity, not less than 15 feet/min nor more than 50 feet/min, unless otherwise recommended by the cable manufacturer. The pull shall not be stopped once started unless absolutely necessary.

12. Measure, record, and submit the dynamometer reading and the actual pulling tension for each pull along with any conversion calculations and a copy of the certificate of calibration for each instrument. These cable installation records shall be filled out in the field and signed and dated by the installation/test engineer. Contractor shall submit the original forms to ACT.

13. After pulling, the tension end of the cable damaged in the pulling process shall be cut off.

E. Post-Installation Documentation: Submit documentation after installing cable, updating the installation plans, including the following:

1. Pull Tension Calculations (final).

2. Updated Conduit and Cable Schedule.


F. Schedule As-Builts: Update the attached conduit and cable schedules to reflect final as-installed conditions. Schedules shall correspond with final Contractor-provided cable plans.

G. Splices: Splices shall be installed with care in order to ensure a watertight fit. Notify ACT of each splice completion for visual inspection.

H. Test: Test wire and cable in accordance with Contract Specifications.

3.2 INSTALLATION PLAN

A. General

1. Develop a written cable installation procedure and check-off list for approval prior to cable installation for each location. Where multiple crossings overlay, if cable for all are to be installed at the same time, the Contractor may, with the approval of ACT, provide one plan covering all those locations. For communications, provide a plan for all stations.

2. Base the cable installation procedure on the review of the conduit plans and field site survey, and include installation information for each cable pull.
3. The cable installation plan shall include proper procedures for feeding cable into conduit, to maintain proper bend radii, and to minimize friction.

4. Document, and submit as part of the cable installation plan, the approved Conduit and Cable Schedule indicating in what conduit each cable is to be pulled in the ductbank. Indicate where multiple cables are installed in one conduit transition to other multiple use or individual local conduit. Update the table after installation is complete.

5. Identify staging work associated with installation of equipment and cable at any highway grade or freight line crossing. Existing crossing warning protection shall remain operational at all times, with the exception of approved shut-down periods.

6. The installation plan shall also address the following:
   a. Pulling layout including distances and tension calculations.
   b. Pulling equipment and tension monitoring devices.
   c. Procedures and materials for terminating the cable and preparing it for connection to the termination points.
   d. Proposed installation procedures including hardware, attachment methods, routing, conduit fill, and location of pulling equipment. Include proposed splice locations (if pre-approved by ACT) and methods.
   e. Manufacturer's instructions and procedures for potheading of each type underground cable to be furnished.

3.3 COMMUNICATIONS SYSTEM CABLE INSTALLATION

A. General: Installation of communications cable shall conform with TIA/EIA-568 and TIA/EIA-569 and to applicable sections of NFPA 70 and the requirements as specified herein.

B. Outside Plant (OSP) Cable: Shall be installed in conduit along the BRT Line as shown on the Contract Drawings.

C. LAN Cable: LAN fiber optic and CAT 6 cable shall be installed in facilities and stations as shown on the Contract Drawings and as required by the equipment manufacturers.

D. CCTV: CAT 6 cables shall be installed for CCTV and for data communications including cameras and Network Video Recorder (NVR).

3.4 FIBER OPTIC CABLE INSTALLATION - GENERAL

A. General: The fiber optic cable installation techniques shall be such that the optical and mechanical characteristics of the cables are not degraded during installation.

B. Cable Pulling

1. The cable pulling operation shall be performed so that a minimum-bending radius of the cable shall not be exceeded in the unreeling and pulling operations. Entry guide chutes shall be used to guide the cable into the
pullbox conduit ports. Lubricating compound shall be used to minimize cable-to-conduit friction. Lubricating compound must be a water-based compound sold specifically as cable lubricant specified to fiber optic cable, i.e. dish soap and other substitutes are not allowed. Corner rollers (wheels), if used, shall not have radii less than the minimum installation bending radius of the cable. A series array of smaller wheels can be used for accomplishing the bend if the cable manufacturer specifically approves the array. The pulling tension shall be continuously measured and it shall not be allowed to exceed the maximum tension specified by the manufacturer of the cable. Fuse links and breaks shall be used to insure cable tensile strength shall not exceed 600 lbs.

2. When simultaneously pulling fiber optic cable with other cables, separate grooved rollers shall be used for each cable.

C. Optical Splicing Requirements: All optical fibers shall be spliced or terminated by the Contractor as shown in the Splicing diagrams in the plans. Splices shall be allowed only in locations as shown within the plans or as directed.

D. Fusion Splicing: All splices shall use the fusion technique. Fusion splicing equipment shall be provided by the Contractor and shall be cleaned, calibrated and specifically adjusted to the fiber and environmental conditions at the start of each shift. Splice enclosures, organizers and incidentals, and cable end preparation tools and procedures, shall be compatible with the cable type being delivered and approved.

E. Splice Protection: Each spliced fiber shall be packaged in a heat shrinkable splice protection sleeve with strength member. The protection sleeve shall cover the splice and any bare fiber stripped of its coating. The use of RTV or silicone is strictly prohibited.

F. Splice Loss: Fiber Optic Cable shall be Fusion Spliced where indicated on plans. Fusion Splices shall not exceed 0.04 dB loss, measured bi-directionally.

1. All splice losses shall be recorded in tabular form and submitted for approval.

G. Splice Testing: Splices that are made between two cables shall be tested using an Optical Time Domain Reflectometer (OTDR). A full bi-directional test (using bi-directional averaging) shall be performed on all spliced circuits and unused fibers using the OTDR. No manual calculation of bi-directional averages are allowed. These splices shall be tested at both 1310 nm and 1550 nm and printouts and electronic files of the splice tests shall be provided. For further details, refer to Contract Specifications.

H. Optical Termination Requirements: Fiber Optic Connectors shall be LC. Type connectors shall comprise ceramic ferrule, nickel plated zinc connector body or composite connector body. The connector shall accommodate the fiber type and size associated with this project.

1. Fiber Optic Connectors shall not exceed the maximum insertion loss listed below for each connector type.

<table>
<thead>
<tr>
<th>Table 1. Optical Termination Losses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connector Type</td>
</tr>
<tr>
<td>LC, Single Mode</td>
</tr>
<tr>
<td>LC, Single Mode</td>
</tr>
</tbody>
</table>
I. Patch Cords

1. All factory pre-connectorized assemblies are to adhere to the applicable cable, cordage and fiber specifications noted in Part 2 of this Section. All inside plant patch cords shall meet NEC jacketing requirements for this project’s application and shall have outer jacket coloration of orange for multimode patch cords and yellow for single mode patch cords. All connectors used shall meet the Optical Termination Requirements specified above.

2. Connector types on either end of the patch cord shall mate directly to the optical interfaces on the equipment and to the optical coupler ports on the patch panel. No additional couplers are allowed. Only one manufacturer’s connector shall be used on any one assembly or group of assemblies used within this project. No splices of any type are allowed within an assembly.

3. Each assembly is to be fully tested and those test results place on a test tag for each mated pair of connectors that will then be attached to one end of each pair within the assembly. Each assembly is to be individually packaged within a plastic bag and that bag is to have the submitted manufacturer’s part number marked clearly on the outside of said bag. Each patch cord shall be labeled as directed by ACT.

3.5 FIELD QUALITY CONTROL

A. Stations

1. Testing: Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.

2. Test Reports: Prepare a written report to record the following:
   a. Test procedures used.
   b. Test results that comply with requirements.
   c. Test results that do not comply with requirements and corrective action taken to ACT.

END OF SECTION
PART 1 - GENERAL

1.1 WORK INCLUDED

A. The Work of this Section consists of the requirements for designing, furnishing and installing power supplies and distribution systems for communications systems throughout the EB BRT alignment.

1.2 Acronyms and Definitions

ACT – AC Transit
ANSI - American National Standards Institute
AWG – American Wire Gauge
BRT – Bus Rapid Transit
CCTV – Closed Circuit Television
CDRL – Contract Data Requirements List
CMF – Central Maintenance Facility
CIC - Communications Interface Cabinets
CTS – Carrier Transmission System
DC – Direct Current
EB – East Bay
EMI – Electromagnetic Interference
GO – General Office
IEEE – Institute of Electrical and Electronic Engineers
Kcmil – thousand circular mils
NEMA – National Electrical Manufacturers Association
NVR – Network Video Recorder
OCC – Operations Control Center
Psi – Pounds per Square Inch
PTZ – Pan-Tilt-Zoom
SCADA - Supervisory Control and Data Acquisition
SCU – Station Control Unit

SNMP – Simple Network Management Protocol

TVM – Ticket Vending Machine

UL - Underwriters Laboratories

UPS - Uninterrupted Power Supply

VMS – Variable Message Sign

1.3 REFERENCED STANDARDS

A. National Electrical Manufacturers Association [NEMA]
   1. NEMA 250 – Enclosures for Electrical Equipment (1000 volts maximum).
   2. NEMA ICS 4 – Industrial Control and Systems Terminal Blocks.
   3. NEMA WC 70 – Nonshielded 0-2kV cables.
   5. NEMA WC-74 – Shielded power cable 5-46kV

B. Institute of Electrical and Electronic Engineers (IEEE)

C. American National Standards Institute [ANSI]
   1. ANSI Z55.1 – Gray Finishes for Industrial Apparatus and Equipment.

D. Underwriters Laboratories [UL]
   1. UL 1059 – Terminal Blocks.
   2. UL 1449 – Transient Voltage Surge Suppressors.

1.4 SUBMITTALS

A. Communications System Power Supply Product Data: Submit manufacturer data for the uninterruptible power supply and other power equipment, including as a minimum, input and output voltage tolerances, physical dimensions, temperature ranges, monitoring and alarm features, and regulation without battery in CDRL-20110-01

B. Grounding Product Data. Submit manufacturer data for ground plates and all hardware not submitted under another section in CDRL-20110-02.

C. Submit power schematics, voltage drop calculations, and standby battery calculations, in CDRL 20110-03.

1.5 UNINTERRUPTIBLE POWER SUPPLY (UPS) FUNCTIONAL REQUIREMENTS
A. UPSs shall provide power for critical station platform equipment and also for the computers workstations and network equipment at the CCC and ACT GO, in case of a utility power failure. OCC and GO UPSs will be provided by others.

B. UPS shall be provided at passenger stations (inside CIC). Refer to Contract Drawings for additional locations, if applicable.

C. UPS shall provide backup power for minimum 1 hour, at each location.

D. UPS shall provide for back-up power for critical systems, in order to maintain operation in the event of a disruption in service of the main utility power.

E. Each UPS shall be designed to provide continuous regulated AC power at full load capacity, during normal and abnormal conditions including sags, surges, transients, and a total loss of main utility power.

F. Each UPS shall consist of a solid-state inverter, rectifier/battery charger, a 100% rated for continuous duty static switch, an internal maintenance bypass switch, and battery system.

G. Each UPS shall be provided with a communication module that provide a network connection to the Carrier Transmission System (CTS), and support SNMP (Simple Network Management Protocol).

H. Each UPS shall be equipped with an interface that shall provide isolated dry contacts for external monitoring of UPS status and alarm indications to the SCADA system, such as:
   1. Loss of Incoming AC Power;
   2. Load on Battery;
   3. Low Battery Reserve;
   4. Bypass;
   5. UPS Fault/Trouble.

I. Critical systems at the Station platforms that shall require backup power from the UPS include the following:
   1. Communications interface cabinet (CIC) equipment;
   2. CTS equipment inside CIC;
   3. SCADA PLCs inside CIC;
   4. Public Address (PA) equipment inside CIC and on platform;
   5. CCTV cameras on platform;
   6. Network Video Recorder (NVR) inside CIC;
   7. Variable Message Sign (VMS) on platform.

J. Each UPS shall be designed to operate in the following modes:
1. Normal Mode - inverter continuously supplies power to the critical loads.

2. Emergency Mode - without any interruption, due to loss of main utility AC power, critical loads supplied by the inverter from the battery system.

3. Recharge Mode - restoration of the main utility power source, prior to complete battery system discharge that provides power the inverter and simultaneously recharges the battery.

4. Bypass Mode - static bypass switch is used to transfer the critical loads to the bypass without any interruption to the critical load.

5. Maintenance Bypass/Test Mode - manual make before break maintenance bypass switch shall be provided to isolate the UPS and static bypass transfer switch for maintenance to allow the UPS to be tested or repaired without affecting load operation.

PART 2 - PRODUCTS

2.1 UNINTERRUPTIBLE POWER SUPPLIES

A. All UPS units supplied shall be capable of providing power to their connected loads with batteries disconnected for servicing.

B. UPS’ shall be capable of recharging depleted batteries within a 24-hour period while simultaneously supplying power to their respective connected loads.

C. Power supply regulation, harmonic, distortion, and noise characteristics of the UPS’ shall meet or exceed connected equipment requirements to assure that the UPS’ do not induce noise nor cause shut-down or failure problems in connected systems equipment.

D. UPS shall be provided with metering panels to read incoming and outgoing voltage and current levels.

E. Front panel controls shall include a UPS bypass switch to enable servicing of the unit without interruption of connected equipment.

F. Batteries provided for all communication UPS units shall be sealed, gel-cell types. Spill containment mats shall be provided at the base of the cabinet compartment to contain and neutralize cell leakage due to cell rupture.

G. Specifications common to all UPS units provided for Communications equipment at stations, are as shown below:

1. Input Voltage/Frequency - 120VAC, 60 Hz +/- 3 Hz.

2. Input Voltage Range - 92-147 volts.

3. Output Voltage - 120 VAC, +/- 3% from 0 to full load.

4. Output Waveform - with 1% of true sinewave, 0 to full load.

5. Surge Protection - 800 joules (min).

6. Multi-pole noise filtering per UL 1449.
7. Operating Temperature Ranges: 0˚ to 40˚ C (32˚ to 104˚ F)

H. UPS units shall be provided at all stations, integrated with batteries, within the station communications interface (CIC) cabinets.

I. UPS units at stations shall provide and maintain power to equipment as indicated in the contract drawings, plus 25 percent reserve capacity at their respective stations for a period not less than 1 hour in event of a power outage.

J. Battery Recharging:
   1. Each UPS shall have a solid-state rectifier that converts the incoming AC power to regulated DC voltage, which is subsequently filtered to provide power for the battery charging functions.
   2. The rectifier/battery charger shall have sufficient capacity to support recharging of the battery system.
   3. The rectifier/battery charger shall be protected by input breakers or fuses.
   4. The battery system shall include the cells, cabinets, battery trays, matting, connectors, wiring, and hardware that shall provide battery power source to be used with the rectifier/charger and inverter.

2.2 GROUNDING AND BONDING

A. Requirements shall be per UL 467 and NFPA 70.

B. Provide grounding conductors and equipment in accordance with the requirements

C. Provide a single point ground system for the communication system.
   1. Protect personnel and equipment from electrical hazards, including lightning and power surges.
   2. Reduce voltage potentials to system neutrals from grounded items.
   3. Reduce or eliminate the effects of Electromagnetic Interference (EMI) and electrostatic interference arising within the signal system.
   4. Isolate signal ground conductors from the equipment ground components, except at the single grounding point.
   5. Design grounding to minimize the noise voltage generated by currents from two or more circuits flowing through common ground impedance, and to avoid creating ground loops that are susceptible to magnetic fields and differences in ground potential. Ground all chassis or enclosures for electrical equipment to minimize shock hazards to passengers and personnel. In circuits, provide protection against high-energy surges by the use of loading resistors, arrestors, and other devices as required to protect equipment or personnel.

D. Communications Equipment Grounding
   1. Provide 1 ground rod in accordance with the requirements of the Communications Interface Cabinets (CIC) detail plan located in the Contract Drawings.
2. Provide two ground busbars in accordance with the requirements of the Communications Interface Cabinets (CIC) detail plan located in the Contract Drawings. One ground busbar use for Communications Signal Grounding and one ground busbar use for chassis grounding.

3. The two grounding bus bar shall mount on the rack. The grounding busbars shall be insulated with rack. Each bus bar shall connect to CIC ground rod with separated grounding cable.

4. The grounding busbars for communications system shall be predrilled, copper 1” height by ¼” deep, and of sufficient length to be mounted on the rack.

5. All grounding wires shall be insulated stranded copper conductors, size shall be no less than #6.

6. Coordinate grounding and lightning protection designs.

E. Exothermic Welds

1. Welding material shall consist of copper exothermic mixture employing tin-metal in an amount to effectively constitute 4.5 percent to 5.5 percent of the resulting weld metal. The resulting weld metal shall be of high electrical conductivity and shall have a minimum tensile strength of 39,000 psi.

2. Coating Materials for Thermite Welded Connections: Use black, rubber based compound coating materials, which are soft, permanently pliable, moldable, and unbacked, not less than 1/8 inch thick.

F. Terminal Lugs

1. Provide copper compression terminal lugs for #4/0 AWG and smaller conductors.

2. Provide long barrel, copper, double-compression terminal lugs for 250 kcmil and larger.

G. Ground Connectors

1. Similar in design to O-Z Gedney, Type KG or approved equal.

2. Two-piece, designed for connecting grounding conductor to bus bar.

3. Copper alloy body and silicon bronze bolt, nut and washer with interlocking clamp.

4. Provide exothermic welds per manufacturer’s recommendations.

5. Jumpers shall be insulated copper braided or leaf-type flexible jumper, sized as required.

H. Insulators for building ground: Provide fibrous glass reinforced polyester insulator with minimum diameter of 2 inches in length, threaded holes at both ends.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Install the complete power supplies and distribution system, complete with hardware and connecting material, per the approved design and the Contract Drawings.

B. The complete system shall include power panels, UPS, batteries, energy loops, wiring, conduit, couplings, fasteners, circuit breakers, resistors, and permanent identification.

C. Wiring and Conduit: Install conduit and wiring in accordance with the requirements of Division 3.2, Section 27 22 40 – Miscellaneous Communications Equipment and Division 3.2, Materials, and Section 27 15 10 – Communications Wires and Cable.

3.2 UPS INSTALLATION

A. Station Installations: Station UPS units and batteries shall be installed within space allocated within the station communications interface cabinets. Provide conduit, conductors and electrical devices for power distribution as indicated on Contract Drawings.

3.3 UPS TESTING

A. All testing shall conform to requirements as defined in Division 3.2, Section 01 45 23 – Communications Commissioning and Testing. Specific UPS tests are specified herein.

UPS testing shall be able to verify that upon interruption of utility power, the UPS automatically takes over providing backup power for at least 1.0 hour at a Station platform.

B. UPS testing shall be able to verify that an authorized user is able to manually enter different modes at each UPS.

C. UPS testing shall be able to verify that each UPS status and alarm indication is seen by SCADA and NMS.

D. UPS testing shall assure that each UPS enters charging mode and charges the batteries.

3.4 GROUNDING

A. Stations CICs

1. Maximum resistance shall be 3Ω, in accordance with the requirements of Specifications. Provide additional chemical ground rods if necessary to achieve this value.

2. The Contractor shall provide additional ground rods to meet maximum requirements. Should an acceptable ground resistance not be achievable after doubling (maximum requirement of the Contractor) the ground rods at a location, notify ACT in writing immediately.

B. Ground Connections

1. Use ground connector to connect ground grid grounding electrode conductor to the ground bus bars. Secure connector to the conductor so as to engage all strands equally by using tools and pressure recommended by the manufacturer.
2. Splices of grounding conductors are not permitted.

C. Grounding Bus Bar
   1. Bus Bars shall be mounted on insulators to electrically isolate them from the mounting plate.
   2. Provide insulator support at each end of grounding bus bars and at intervals not exceeding 3 feet.
   3. Bond the grounding electrode conductors to the bus bars using an approved ground connector.

D. Grounding of Separately Derived AC Power Systems: Bond the safety ground conductor to the bus bars using insulated stranded copper wire sized in accordance with NFPA 70. The insulation color shall be green.

E. Cable Shield Grounding: One end of all signal cable shields, including armored jackets on fiber cables, shall be grounded to the bus bar. Use the following guidelines to determine which end of the cable to ground:
   1. For cables running between Communications Nodes, the ground shall be applied at the facility closest to OCC. In no case shall the cable shield be grounded at both ends.
   2. When a cable goes between a Communications Node and any other facility ground the shield at the Communications Node.
   3. When a cable goes between the Communications cabinet or Node and station equipment, ground the shield at the Communications Cabinet/Node end. For cables that pass through any locations, the shield connection shall be maintained through the enclosure so the original ground is maintained (and no second ground point is added).

F. Ground Rods
   1. Ground rods shall have grounding wires attached 4 inch above grade to facilitate inspection. Drive rods within 6 inches of the equipment being grounded, unless specified otherwise, in a location that does not create a tripping hazard. All connections shall be made by an approved exothermic weld process.
   2. In areas where ground rods must be provided in concrete areas, provide ground wells and install rods inside.

END OF SECTION
SECTION 27 22 10

COMMUNICATIONS SERVERS, WORKSTATIONS AND VIDEO MONITORING SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The Work of this Section consists of the requirements for providing Communications Systems Servers, Workstations, and the Video Monitoring System.

B. The Work shall include design, installation, testing, training, and in-service performance verification of all Communications Systems Servers, Workstations, and the Video Monitoring System.

C. This Section includes a description of the Communications System Servers to be supplied, including:
   
   1. SCADA System Servers software;
   2. CCTV System Servers;
   3. PA System Head-End Servers software.

D. This Section includes a description of the components of the Video Monitoring System in the BRT Video Command Room within the OCC, including:

   1. BRT Video Monitoring System Workstations;
   2. BRT Video Monitoring System Panels (VMP).

E. This Section includes a description of the Workstation that shall be supplied and installed.

F. The Contractor shall coordinate with the ACT (Alameda Contra Costa Transit District) to ensure that no additional ACT Contracts affect the design of the Communications Systems Servers, Workstations, and the Video Monitoring System.

G. The Contractor shall coordinate with the ACT to ensure proper and timely installation of all the Communications Systems Servers, Workstations, and the Video Monitoring System.

H. The Contractor shall coordinate with the ACT to ensure proper and timely integration of all the Communications Systems Servers, Workstations, and the Video Monitoring System.

I. The Contractor shall coordinate with ACT to ensure that proper network segmentation, encryption and packet filtering are enabled and configured to provide adequate security for all Communications Systems servers, Workstations, and Video Monitoring System.
1.2 RELATED WORK

A. Division 1, Section 01 33 00, Submittal Procedures
B. Division 3.2, Section 27 01 00, Operations Control Center
C. Division 3.2, Section 27 13 10, Carrier Transmission System
D. Division 3.2, Section 27 51 10, Closed Circuit Television System (CCTV)
E. Division 3.2, Section 27 51 16, Public Address System
F. Division 3.2, Section 27 53 50, Fare Collection System
G. Division 3.2, Section 34 42 36, Supervisory Control and Data Acquisition

1.3 ACRONYMS AND DEFINITIONS

A. AC – Air Conditioning
B. ACT - Alameda Contra Costa Transit District
C. ARI – Air Conditioning and Refrigeration Institute
D. BRT – Bus Rapid Transit
E. OCC – Operations Central Control
F. CCTV – Closed Circuit Television
G. CDRL – Contract Data Requirements List
H. CIC - Communications Interface Cabinets
I. CMF – Central Maintenance Facility
J. CTS – Carrier Transmission System
K. dB - Decibel
L. DVI-D – Digital Visual Interface
M. EB – East Bay
N. GO – ACT General Office
O. HDMI – High Definition Multimedia Interface
P. HVAC – Heating, Ventilation & Air Conditioning
Q. KVM – Keyboard, Video, Mouse
R. MP3 - Moving Picture Experts Group Layer-3 Audio (audio file format/extension)
S. NEC – National Electric Code
T. NEMA – National Electrical Manufacturers Association
U. NFPA – National Fire Protection Agency
V. PA – Public Address
W. PCM – Pulse Code Modulation
X. SCADA – Supervisory Control and Data Acquisition
Y. SPL – Sound Pressure Level
Z. TVM – Ticket Vending Machine
AA. UL - Underwriters Laboratories
BB. UPS - Uninterrupted Power Supply
CC. VESA – Video Electronics Standards Association
DD. VGA – Video Graphics Array
EE. VMP – Video Monitoring Panel
FF. VoIP – Voice over Internet Protocol
GG. VPN – Virtual Private Network
HH. WMA – Windows Media Audio (Microsoft)

1.4 SUBMITTALS

A. Provide all submittals in accordance with the requirements of Division 1, Section 01 33 00– Submittal Procedures

B. Product Data: Submit product data as required to fully describe all provided and installed Communications Systems Servers, Workstations, and the Video Monitoring System, in CDRL-20150-01, including:

1. SCADA System Servers software;
2. Redundant CCTV System Servers and software;
3. CCTV System Data Storage Server. This is CCTV storage in addition to the NVRs in GO.
4. PA System Head-End Servers software;
5. BRT Video Monitoring Panels (VMP);
6. TVM Server; refer to Division 3.2, Section 27 53 50 Fare Collection System;
7. BRT Workstations;
8. BRT Video Monitoring System Workstation;
9. Engineering Workstation: Provided and installed in the GO;

10. Workstations shall include CPU, LCD monitors, keyboard, mouse, and headset;

11. Rack mount LCD monitor with integrated KVM switch

C. Shop Drawings: Submit shop drawings detailing methods of assembly and materials list in CDRL-20150-02.

D. Hardware Design Description (HDD) in CDRL-20050-03.

1. The HDD shall include the equipment configuration of all Communications Servers, Workstations, and the Video Monitoring System.

2. The HDD shall include detailed equipment block diagrams with physical interconnections and interfaces. Block diagrams shall show all connections of Communications Servers, Workstations, and the Video Monitoring System to the CTS network and logical connections (VPN) to all field elements.

3. The HDD shall include shall include a Bill of Materials (BOM), complete with product name, manufacturer, model numbers, and quantity. The BOM shall identify individual items as shown in the Shop Drawings (CDRL 20150-02).

4. The HDD shall include detailed scaled diagrams shall show all rooms that will house the Communications Servers, Workstations, and the Video Monitoring System specified herein. Rooms shall include the following:
   a. The CMF building containing the OCC Dispatcher Area where the BRT Workstation computers shall be located.
   b. The OCC equipment room at the CMF where Communications Servers shall be installed.
   c. The BRT Video Command Room at the CMF where the Video Monitoring System shall be installed.
   d. The equipment room at the ACT GO where Communications Servers and the Engineering Workstation shall be installed.
   e. Diagrams shall show dimensions and location of equipment to be installed, including details of where the CPU, computer cabinets, UPS (provided by others), BRT Workstations to be housed in the dispatcher workstation consoles (console furniture provided by others) including LCD monitors, keyboard, mouse, and headset with USB adapter shall be installed.

5. The HDD shall include power and heat load identifying each component's power requirement, to support UPS sizing at the CMF and GO.

6. The HDD shall include a grounding plan for all Communications Servers and Workstations located at the CMF and GO.

1.5 QUALITY ASSURANCE

A. Comply with the requirements as specified in Contract Specifications.
B. Comply with American Disability Act (ADA).

C. Comply with Underwriters Laboratories (UL).

1.6 GENERAL REQUIREMENTS

A. The Communications Servers, Workstations, and the Video Monitoring System shall be furnished and installed as indicated on plans and specified herein.

B. The Communications Servers, Workstations, and the Video Monitoring System shall include the following components:

1. SCADA System Servers:
   a. The SCADA System Servers shall be virtualized to the existing ACT VMware environment.
   b. The SCADA System Server software shall support existing ACT VMware environment.
   c. Contractor shall provide SCADA server software and install to the existing ACT servers.
   d. Refer to Division 3.2, Section 34 42 36 for requirements of the SCADA System.

2. CCTV System Servers:
   a. One rack-mount server provided and installed in the equipment room in the CMF OCC;
   b. One rack-mount server provided and installed in the equipment room in the GO;
   c. One CCTV Server shall be considered primary, the other secondary, with automatic failover between them;
   d. One CCTV Data Storage Server shall be provided in GO;
   e. Refer to Division 3.2, Section 27 51 10 for requirements regarding the CCTV System.

3. PA System Head-End Servers:
   a. The PA System Servers shall be virtualized to the existing ACT VMware environment;
   b. The PA System Server software shall support existing ACT VMware environment;
   c. Contractor shall provide SCADA server software and install to the existing ACT servers;
   d. Refer to Division 3.2, Section 27 51 16 for requirements regarding the PA System.
4. Workstations
   a. Contractor shall provide ten (10) BRT Workstations, eight (8) of which are to be installed in the OCC Dispatcher Area on consoles provided by others, and two (2) to be supplied as spares.
      1) Each BRT Workstation in the OCC Dispatcher Area shall connect to the KVM Switch that is provided by the CAD/AVL project.
      2) Refer to Division 3.2, Section 27 01 00 for requirements regarding shared contractor responsibility at the OCC.
   b. Contractor shall provide and install two workstations for use as the Video Monitoring System Workstations.
   c. One Engineering Workstation shall also be provided and installed at the GO.
   d. Operator positions, including consoles and chairs are existing equipment, and are not part of the scope of this Contract.
   e. The Video Monitoring System Workstations are CCTV workstations. Each Video Monitoring System Workstation shall be capable of all BRT software functions including, but not limited to the following:
      1) SCADA System
      2) CCTV System
      3) PA System
   a. Although the intent of the ACT is to use the Video Monitoring System Workstation exclusively for interfacing to the CCTV System, it is the Contractor’s responsibility to install and configure all software applications for each function, so that all applications can run simultaneously, and meet all functional requirements described in these Specifications without conflicts, errors, or failures.
      1) Necessary access control shall be included on the workstation to limit the software functions that are able to be executed on the workstation according to dispatcher login.
   b. The Engineering Workstation shall include all other BRT operator workstation functions. The Engineering Workstation shall also have the capability to do system/equipment program, systems diagnostic and systems maintenance.

5. All Communications System Servers and Workstations shall have network connections to the CTS at the CMF and GO as shown in the Contract Drawings. Refer to Division 3.2, Section 27 13 10 for requirements regarding the CTS.

6. All Communications System Server and Workstations time shall synchronize to ACT network clock source via Ethernet networks.
7. The links between the Ethernet switches and Servers, Workstations, and storage shall be 1000Base-T.

8. TVM Server.
   a. The TVM Server, as shown in the Contract Drawings, is part of the Fare Collection System, and requirements for this equipment are not in this section.
   b. Refer to Division 3.2, Section 27 53 50 for requirements regarding TVM Server.

9. Rack Mount LCD Monitor / KVM Switch
   a. A rack mount LCD monitor and integrated KVM switch shall be provided and installed at the CMF and GO. The LCD monitor with keyboard shall provide a console connection to each rack mounted CPU (servers).

PART 2 - PRODUCTS

2.1 SCADA SYSTEM SERVERS
   A. The SCADA System Servers shall be virtualized to the existing ACT VMware environment.
   B. SCADA System Servers shall be designed for data intensive applications. The SCADA System Servers shall provide SCADA user, operations, and management functions working in conjunction with the SCADA applications on the Communications Workstations (clients).
   C. The SCADA System Server software shall be fully compatible with existing ACT VMware environment.

2.2 CCTV SYSTEM SERVERS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Cisco UCS C220,
      2. Or ACT approved equivalent
   B. The CCTV System Servers shall provide user, operation, management, and backup storage functions for the real-time and recorded video from cameras and NVRs. CCTV System Server software applications shall work in conjunction with the CCTV System applications on the Communications Workstations (clients).
   C. Specifications:
      1. Processor:
         a. One Intel Xeon processor
         b. 2.4 GHz
2. Memory:
   a. 8GB

3. Hard Drive:
   a. 2.7 TB
   b. RAID 1

4. Optical Drive:
   a. External USB 2.0 DVD +/- RW

5. Network Interface:
   a. Two (2) 10/100/1000Base-T Ethernet
   b. Connectors: 2 x RJ-45

6. Software:
   b. Cisco Video Surveillance Manager
   c. Cisco Video Operations Manager
   d. User Access Licenses: 16
   e. Camera licenses: Up to 100 video streams

7. Connectors:
   a. Serial: One (1) RJ-45
   b. USB: Two (2) 4-pin, USB 2.0 compliant
   c. Video: One (1) 15-pin VGA
   d. KVM: One (1) console (supplies 2 USB, 1 VGA, 1 serial)
   e. Fibre Channel: Two (2)

8. Power:
   a. Dual, hot-plug, redundant
   b. 120VAC, 50-60 Hz
   c. 650W.

9. Operating Temperature:
   a. 0° to 40° C (32° to 104° F)
10. **Chassis:**
   a. Rack-mount, slide-out rails provided
   b. 2RU (typical)

### 2.3 PA SYSTEM HEAD-END SERVERS

A. The PA System Servers shall be virtualized to the existing ACT VMware environment.

B. The PA System Head-End Servers shall provide PA System software functionality as described in Division 3.2, Section 27 51 16. The PA System Head-End Servers shall provide PA System user, operations, and management functions working in conjunction with the PA System applications on the Communications Workstations (clients).

C. The PA System Server software shall be fully compatible with existing ACT VMware environment.

### 2.4 BRT VIDEO MONITORING SYSTEM

A. Provide an overview display system consisting of a total of 2 (two) separate BRT Video Monitoring System Panels (VMP) and BRT Video Monitoring System Workstations for the BRT components, installed in the BRT Video Command Room at the OCC.

B. **BRT Video Monitoring System Panels (VMP)**

1. The BRT Video Monitoring System Panels (VMP) shall consist of a rectangular 2x1 arrangement of individual Liquid Crystal Display (LCD) monitors to be installed in the BRT Video Command Room as shown in the Contract Drawings.
   a. Two (2) VMP shall be provided.
   b. Each panel within the VMP shall consist of 55-inch LED-lit LCD monitor with 1080p resolution. The VMP shall consist of two 55-inch panels.
   c. The border and any non-displayable area between the display screens of the adjacent units (e.g., the mullion) shall be no greater than 6 mm (0.25-inch).
      1) The maximum 6mm mullion shall be for two adjacent VMP together, in total.
   d. Provide LCD monitors of the same model and manufacturer.
   e. Using Contractor-supplied Video Electronics Standards Association (VESA) mounting brackets or other industry standard, the VMP shall be mounted adjacent to one another on the same plane in such a fashion as to create a single viewable monitor (e.g., “video wall”) as depicted in the Contract Drawings.
      2) The use of mounting brackets other than VESA shall be required to be approved in writing by the Construction Manager.

2. For the VMP, provide individual LCD monitors that shall meet, at a minimum, the following requirements for each monitor:
a. Display Type: Direct LED backlit S-PVA (P-DID) LCD, normally black
b. Viewable Size Image: 1396 mm (55-inch) diagonal
c. Active Screen Area (W x H): 1216 mm (47.9 in) x 687.4 mm (27.1 in)
d. Native Resolution: 1920 x 1080 (1080p)
e. Refresh Rate: 60 Hz
f. Pixel Density: 40 dpi @ native resolution
g. Luminance: 700 cd/m2
h. Contrast Ratio: Typical: 4000:1
i. Viewing Angle, typical
   1) Horizontal 178-degrees
   2) Vertical 178-degrees
j. Displayable Colors: more than 16.7 million
k. Screen Aspect Ratio: 16.9
l. Input Signals
   1) Video: Analog RGB 0.7 Vp-p/75 Ohms
   2) Sync: Separate sync: TTL Level (Positive/Negative)
   3) Sync: Composite sync: TTL Level (Positive/Negative)
   4) Sync: Composite sync on green: (0.3Vp-p negative 0.7Vp-p positive)
m. Input Terminals
   1) Digital: DisplayPort, HDMI, DVI-D
   2) Analog: VGA 15-pin D-sub
   3) Audio: Audio Mini-Jack, DisplayPort Audio, HDMI Audio
   4) External Control: RS-232C, LAN, DDC/CI
n. Power Consumption
   1) On: 150W
   2) ECO Mode Standby: <0.5W16.
o. Mounting
C. BRT Video Monitoring System Workstation

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Dell Precision T3610,
   b. Or ACT approved equivalent

2. The Contractor shall provide, install, configure and test two (2) Video Monitoring System Workstations to be located in the BRT Video Command Room. Refer to the Contract Drawings. The workstation shall be equipped as follows:
   a. CPU - installed inside the existing console.
   b. One 23-inch LCD monitor
   c. Keyboard
   d. Mouse
   e. Headset (speaker, microphone, USB cable)

3. The Video Monitoring System Workstation shall be connected to the Video Monitoring System Monitors, as specified herein. The Video Monitoring System Workstation shall be the primary operator workstation for interfacing to the CCTV System and shall provide all CCTV functionality as described elsewhere in the Contract Documents.
   a. Reference Division 3.2, Section 27 51 10, Closed Circuit Television System (CCTV) for specification of all required CCTV functionality.

4. Contractor shall note that all BRT software applications, including SCADA System, CCTV System, and PA System shall be available on each BRT Workstation and Video Monitoring System Workstation. It is the Contractor’s responsibility to install and configure all software applications for each function, so that all applications can run simultaneously, and meet all functional requirements described in these Specifications without conflicts, errors, or failures.
   a. Reference Division 3.2, Section 27 01 00, Operations Control Center for information concerning the OCC dispatcher workstation computers.

5. Specifications:
   a. Processor
      1) One Intel Xeon processor
      2) Quad core
      3) 3.6 GHz
b. Memory
   1) 8GB
   2) 1600 MHz

c. Hard Drive
   1) 500 GB

d. Optical Drive
   1) DVD +/- RW

e. Network Interface
   1) Two (2) 10/100/1000Base-T Ethernet
   2) Connectors: 2 x RJ-45

f. Graphics Card
   1) One (1) NVIDIA Quadro NVS310,
   2) One (1) additional NVIDIA NVS310 at BRT Security console only

g. Sound Card
   1) One (1) Sound Blaster Recon3D PCIe

h. Software
   1) Windows 10 Pro 64-bit
   2) SCADA System client application. See Division 3.2, Section 34 42 36.
   3) CCTV System client application. See Division 3.2, Section 27 51 10.
   4) PA System client application. See Division 3.2, Section 27 51 16.

i. Connectors
   1) USB 2.0: Six (6)
   2) USB 3.0: Four (4)
   3) Microphone: One (1)
   4) Headphone: One (1)

j. 23-Inch Monitor (each BRT console)
   1) Number provided: One (1)
2) Viewable area: 23-inch diagonal
3) Resolution: 1920 x 1080 @ 60Hz
4) Pixel pitch: 0.270mm
5) Brightness: 250 cd/m²
6) Contrast ratio: 1000:1
7) Viewing angle: 178°/178° (vertical/horizontal)
8) Response time: 7ms
9) Backlight: LED, 30,000 Hrs operation (min)
10) Speakers: Integrated, 2 x 1.5W
11) Connectors: VGA (D-sub), DVI-D, HDMI, Audio
12) Power: 120VAC, 60Hz, 26W typical
13) Stand: Height, tilt, swivel adjustable

k. Speaker Bar
1) Speakers: 2
2) Sound output: 1.3W RMS per channel, 10% THD
3) Frequency response: 200 Hz to 20 KHz
4) Sound pressure: 86 dB (0.1W @ 0.1 m)
5) Controls: On, off, volume
6) Power: USB powered
7) Cables: USB, audio cable shall be provided

l. Keyboard
1) 104 keys
2) Wired USB cable
3) Color: Black

m. Mouse
1) Optical
2) Wired USB cable
3) Buttons: 3
4) Scroll wheel

n. Headset and microphone
   1) Single ear, padded, replaceable
   2) Wired USB cable
   3) Microphone type: Bi-directional, noise cancelling
   4) Mic frequency response: 100Hz to 10kHz
   5) Mic sensitivity: -45 dB
   6) Speaker frequency response: 50Hz to 10kHz
   7) Speaker sensitivity: 90dB

o. Power:
   1) 120VAC, 60 Hz
   2) 425W.

p. Operating Temperature:
   1) 10˚ to 35˚ C (50˚ to 95˚ F)

q. Chassis:
   1) Tower
   2) Two (2) x PCIe x16 Gen 3
   3) One (1) x PCIe x16 Gen3 wired x8(half length)
   4) One (1) x PCIe x4 Gen 2
   5) One (1) x PCIe x1 Gen 2
   6) One (1) PCI 32bit/33MHz

2.5 BRT WORKSTATIONS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Dell OptiPlex 3020 Small Form Factor,
   2. Or ACT approved equivalent

B. The Contractor shall provide, install, configure and test eight (8) BRT Workstations to be located in the OCC Dispatcher Area. Two (2) other BRT Workstations shall be provided, configured and tested as spares. Refer to the Contract Drawings. The workstation shall be equipped as follows:
1. CPU - installed inside the existing console.
2. One 23-inch LCD monitor
3. Keyboard
4. Mouse
5. Headset (speaker, microphone, USB cable)

C. Contractor shall note that all BRT software applications, including SCADA System, CCTV System, and PA System shall be available on each BRT Workstation. It is the Contractor's responsibility to install and configure all software applications for each function, so that all applications can run simultaneously, and meet all functional requirements described in these Specifications without conflicts, errors, or failures.

1. Reference Division 3.2, Section 27 01 00, Operations Control Center for information concerning the OCC dispatcher workstation computers.

D. Specifications:

1. Processor
   a. Intel Core i5-4590 processor
   b. Quad core
   c. 3.30 GHz

2. Memory
   a. 8GB
   b. 1600 MHz

3. Hard Drive
   a. 1 TB
   b. SATA 6 0 GB
   c. 600 Megabytes Per Second data transfer rate
   d. 555 MB/s sequential read speed
   e. 500 MB/s sequential write speed
   f. 100 k IOPS random read speed
   g. 87k IOPS random write speed

4. Optical Drive
   a. 8x DVD +/- RW
5. Network Interface
   a. Two (2) 10/100/1000Base-T Ethernet
   b. Connectors: 2 x RJ-45

6. Graphics Card
   a. One (1) NVIDIA Quadro NVS310,

7. Sound Card
   a. One (1) Sound Blaster Recon3D PCIe

8. Software
   a. Windows 10 Pro 64-bit
   b. SCADA System client application. See Division 3.2, Section 34 42 36.
   c. CCTV System client application. Division 3.2, See Section 27 51 10.
   d. PA System client application. Division 3.2, See Section 27 51 16.

9. Connectors
   a. USB 2.0: Six (6)
   b. USB 3.0: Four (4)
   c. Microphone: One (1)
   d. Headphone: One (1)

10. 23-Inch Monitor
    a. Number provided: One (1)
    b. Viewable area: 23-inch diagonal
    c. Resolution: 1920 x 1080 @ 60Hz
    d. Pixel pitch: 0.270mm
    e. Brightness: 250 cd/m2
    f. Contrast ratio: 1000:1
    g. Viewing angle: 178°/178° (vertical/horizontal)
    h. Response time: 7ms
    i. Backlight: LED, 30,000 Hrs operation (min)
    j. Speakers: Integrated, 2 x 1.5W
k. Connectors: VGA (D-sub), DVI-D, HDMI, Audio

l. Power: 120VAC, 60Hz, 26W typical

m. Stand: Height, tilt, swivel adjustable

11. Speaker Bar
   a. Speakers: 2
   b. Sound output: 1.3W RMS per channel, 10% THD
   c. Frequency response: 200 Hz to 20 KHz
   d. Sound pressure: 86 dB (0.1W @ 0.1 m)
   e. Controls: On, off, volume
   f. Power: USB powered
   g. Cables: USB, audio cable shall be provided

12. Keyboard
   a. 104 keys
   b. Wired USB cable
   c. Color: Black

13. Mouse
   a. Optical
   b. Wired USB cable
   c. Buttons: 3
   d. Scroll wheel

14. Headset and microphone
   a. Single ear, padded, replaceable
   b. Wired USB cable
   c. Microphone type: Bi-directional, noise cancelling
   d. Mic frequency response: 100Hz to 10kHz
   e. Mic sensitivity: -45 dB
   f. Speaker frequency response: 50Hz to 10kHz
   g. Speaker sensitivity: 90dB
15. Power:
   a. 120VAC, 60 Hz
   b. 425W.

16. Operating Temperature:
   a. 10˚ to 35˚ C (50˚ to 95˚ F)

17. Chassis:
   a. Small form factor

2.6 CCTV NETWORK ATTACHED STORAGE

A. One CCTV Data Storage Server shall be provided and installed in GO Equipment Room.

B. The CCTV Network Attached Storage shall have the capacity to record, store, and back-up video data.

C. The CCTV Storage shall meet, at minimum the following requirements:

1. Processor:
   a. Dual-Core Intel processor
   b. 2.3GHz

2. Memory:
   a. 4GB of RAM

3. Hard Drive:
   a. 8-Bay, 3.5-Inch drive
   b. 32TB

4. Network Interface:
   a. Two (2) 10/100/1000Base-T Ethernet
   b. 2 x RJ-45 Connector

5. Required software for the storage

6. Power:
   a. Dual, hot-plug, redundant
   b. 120VAC, 60 Hz

7. Operating Temperature:
a. 10˚ to 35˚ C (50˚ to 95˚ F)

8. Chassis:
   b. Rack-mount, slide-out rails provided
   a. 1RU or 2RU

2.7 RACK MOUNT LCD MONITOR AND INTEGRATED KVM SWITCH

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Tripp Lite 16-port NetDirector rack mount console KVM switch,
   2. Or ACT approved equivalent

B. The Contractor shall provide, install, configure and test two LCD monitor / KVM switches, one each at the CMF and GO. Refer to the Contract Drawings.

C. Specifications:
   1. 1U rack mount console
   2. Power: 100 – 240 VAC, 50/60 Hz, 1A
   3. 19-inch LCD monitor, keyboard, touchpad
   4. LCD monitor supports resolutions up to 1280 x 1024
   5. Integrated 16-port KVM switch
   c. KVM switch shall have 16 x PS2/USB/VGA combo connections for keyboard, mouse, and video.
   d. Contractor shall provide and install a minimum of 16 Tripp Lite combo cable kits with each rack mount console KVM switch.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All Communications Servers and Workstation equipment described herein shall be installed as shown on Contract Drawings.

B. Contractor shall coordinate installation of all workstation equipment in the existing BRT operator consoles in the OCC at the CMF with the AC Transit and the OCC Relocation project coordinator prior to installation.
   1. Reference Division 3.2, Section 27 01 00, Operations Control Center for specification of the requirements for Contactor/OCC Relocation coordination.
C. Contractor shall follow all Installation and Inspection tests as specified in Division 3.2, Section 01 45 23 – Communications Commissioning and Testing.

3.2 FACTORY ACCEPTANCE TESTING (FAT)

A. FAT Testing shall follow all General Factory Test requirements as specified in Division 3.2, Section 01 45 23 – Communications Commissioning and Testing.

B. The Contractor shall provide a representative set of Communications Servers and Workstations equipment for FAT testing:

1. SCADA System Server
2. CCTV System Server
3. PA System Head-End Server
4. Fare Collection System Server
5. Video Monitoring System Workstations
6. BRT Workstation

3.3 SITE ACCEPTANCE TESTING (SAT)

A. SAT Testing shall follow all General Field and Subsystem Testing, Communications Proof of Concept Testing, and Communications System Field Testing requirements as specified in Division 3.2, Section 01 45 23 – Communications Commissioning and Testing.

B. The SAT shall verify operation and functionality of all installed Communications Servers and Workstation equipment at the CMF OCC and GO.

C. SAT associated with all functions including SCADA System, CCTV System, Fare Collection System, and PA System shall verify the operation of all Communications Servers and Workstations described herein.

D. During SAT and the warranty period, Contractor shall replace any failed or non-functioning component at no cost to ACT.

END OF SECTION
SECTION 27 22 30

STATIONS COMMUNICATIONS INTERFACE CABINET (CIC)

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The Work of this Section consists of the requirements for providing Communications Interface Cabinets (CIC), its associated hardware, interface equipment and other materials required throughout the EB BRT alignment.

B. The Work shall include design, manufacture, installation, supply, testing, training, and in-service performance verification of system hardware.

C. The Contractor shall coordinate with the ACT (Alameda Contra Costa Transit District) to ensure that no additional ACT Contracts shall affect the design of the CIC.

D. The Contractor shall coordinate with the ACT to ensure proper and timely installation of all the CIC equipment.

E. The Contractor shall coordinate with the ACT to ensure proper and timely integration of all the CIC elements.

1.2 ACRONYMS AND DEFINITIONS

A. AC – Air Conditioning

B. ACT - Alameda Contra Costa Transit District

C. ARI – Air Conditioning and Refrigeration Institute

D. BRT – Bus Rapid Transit

E. CDRL – Contract Data Requirements List

F. CIC - Communications Interface Cabinets

G. EB – East Bay

H. HVAC – Heating, Ventilation & Air Conditioning

I. NEC – National Electric Code

J. NEMA – National Electrical Manufacturers Association

K. NFPA – National Fire Protection Agency

L. UL - Underwriters Laboratories

M. UPS - Uninterrupted Power Supply
1.3 SUBMITTALS

A. Provide all submittals in accordance with the requirements of Division 3.2, Section 01 33 00– Submittal Procedures

B. Product Data: Submit product data as required to fully describe provided cabinet assemblies. CDRL-20031-01 Stations Communications Interface Cabinet Product Data shall include the following items.

1. AC Units;
2. Cabinet Insulation, panel and door materials, fasteners, hardware and related materials;
3. Door gasket materials and hardware, locking mechanisms, switches and accessories, including product data for keys and locks.
4. Heat load calculations to determine the capacity of the AC units.

C. Shop Drawings: Submit shop drawings detailing methods of assembly and materials list in CDRL-20031-02 Stations Communications Interface Cabinet Shop Drawings.

D. Compliance Certification: Submit certification letter indicating manufacturer and UL/NEC compliance and NEMA rating in CDRL-20031-03 Stations Communications Interface Cabinet Compliance Certifications.

E. Test methods and results in CDRL-20031-04 Stations Communications Interface Cabinet Test Methods and Results.

1.4 QUALITY ASSURANCE

A. Comply with the requirements as specified in Contract Specifications.

B. Comply with NFPA 70.

C. Comply with NEMA 250 rating.

D. Provide one complete cabinet as a pre-production prototype for first article inspection. The Contractor shall make modifications or changes to first article as needed to address all review comments and to certify compliance with standards, plans and specifications prior to proceeding with production of cabinets.

1.5 GENERAL REQUIREMENTS

A. The Communications Interface Cabinet shall be furnished and installed as indicated on plans and specified herein.

B. Cabinet shall meet the exterior height and width limitations established by the structural elements indicated on plans.

C. Cabinet shall be a lockable and the types of locks are to be coordinated with ACT.

D. The cabinet shall be provided with Air Conditioning (AC) units designed to condition the communications equipment space with an alternating current source compatible with the station electrical service. Refer to station electrical details.
E. Coordinate condensate drain connections from AC units with station plumbing design as required.

F. Cabinet design shall incorporate provisions for field installation of equipment and system components to maintain rating and integrity of cabinet.

PART 2 - PRODUCTS

2.1 Cabinet

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. DDB Unlimited
2. Or AC Transit approved equal

B. Enclosure

1. Requirements of the cabinet are indicated on system Contract Drawings.
2. Enclosure dimensions are shown on the Contract Drawings. Enclosure shall enclose communication system equipment, the UPS for the communications equipment and power service equipment.
3. Enclosure rating shall be NEMA 4, or as indicated on the plans.
4. Enclosure panels shall be constructed of 0.125" thickness aluminum minimum with a painted surface in accordance with ACT requirements. The paint color shall be determined by ACT.
5. Provide insulated wall and roof panels with minimum R4 thermal rated insulation materials.
6. Provide stiffeners as required to maintain flatness of enclosure panels to prevent waviness or "oil canning" of paneling.
7. Exterior exposed fasteners and hardware shall be tamper-proof to prevent unauthorized access.
8. Secure expanded metal to cabinet supports.
9. Bond all metal surfaces together to ensure continuity of grounding.
10. Provide mounting supports and penetration fittings for use in the installation of equipment and system components.
11. Contractor shall provide a simple intrusion detection circuit that shall utilize magnetic switches and be activated when any cabinet door is opened. The intrusion detection circuit shall provide one intrusion alarm indication and be connected to the SCADA system.
12. Provide air supply and return openings to the communications equipment bay sized in accordance with the HVAC unit manufacturer’s recommendations.
13. Provide a storage compartment in each Bay for manuals and drawings.

C. Enclosure Doors

1. Doors shall be finished and insulated same as wall panels and include casketing as needed to provide NEMA 4 rating.

2. Provide stiffeners to maintain flatness and eliminate bowing of doors.

3. Doors shall be provided with a cylinder lock, keyed to match ACT key system.

4. Doors shall provide unobstructed access to all bays. Designs which incorporate removable mullions or other components shall not restrict operator’s access to equipment.

5. Provide stainless steel door hardware and mounting accessories.

D. AC Units

1. Provide cooling unit with sufficient capacities to maintain the interior temperature to not exceed 85 deg F assuming the outside temperature is a maximum of 120 deg F. Contractor shall provide heat load calculations and submit as part of CDRL-20031-01 Stations Communications Interface Cabinet Product Data.

2. The AC unit shall be mounted on the side of the communications cabinet.

3. Units shall be modular, installed in the allocated space shown on the drawings.

4. The AC unit shall provide backup ventilation fan. The enclosure temperature is below designated set point. The fan is not required to operate and the louvers remain in a closed position. The enclosure air temperature rises above the set point due to the possibility of air conditioner failure. The thermostat contacts open, the fan will operate and the louvers will open. When the primary AC power supply fails; the backup power supply is normal. In this mode, the fan will operate and the louvers will open. When the primary AC power supply is restored, the fan will stop operation, the louvers will close and the timer will energize. If after a factory set time period of 1000 seconds or 16.67 minutes (adjustable), the thermostat contact is closed, indicating a satisfactory enclosure temperature, the fan will remain off and the louvers will remain closed. If after the factory set time period the thermostat contact is open, indicating an enclosure temperature above the thermostat set point, the fan will begin operation and the louvers will open.

5. Weatherproof insect screens and filter shall be provided for the backup fan louvers.

6. Unit installation shall allow removal of the units using only hand tools with no disassembly of any other equipment or cabinet elements.

7. Refrigerant system shall use R134a with hermetic compressor, coils, controls, built-in condensate evaporator and accessories.

8. Provide ball-bearing blower motors with centrifugal blowers. Enclosure interior airflow shall be isolated from the exterior condenser airflow with all duct joints sealed. Provide diffusers and filter grilles for the interior airflow.
9. Units shall be UL listed and ARI certified with operating voltage of 120VAC at 60 Hz powered from electrical panel.

10. Provide an adjustable thermostat for each AC unit located in the communications bay to monitor internal temperature and control AC units.

11. AC shall provide AC failure alarm dry contact for SCADA system.

E. Temperature Sensor

1. Provide thermostats or temperature sensors to monitor interior temperature with wiring for connection to SCADA.

2. Thermostat or temperature sensor shall be set for typical 85 deg F for temperature high alarm and 100 deg F for high alarm. Contractor shall adjust the value base on the selected equipment operating temperature.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Enclosure shall be installed on slab with sill as shown on Contract Drawings.

B. Coordinate conduit locations in slab with cabinet equipment and rack layouts to avoid cabling routing conflicts.

3.2 QUALITY CONTROL

A. Factory Testing: Prior to installation of communications equipment perform the following quality-control testing:

1. Test enclosure for compliance with NEMA rating.

2. Measure and record the operating characteristics of the AC units to confirm proper operation and simulate heat loads to confirm capacity rating.

B. Field Inspection: Cabinet shall be inspected following installation to ensure installation is level, plumb and aligned with station structure; doors operate and seal and panels are free from defect.

END OF SECTION
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SECTION 27 22 40
MISCELLANEOUS COMMUNICATIONS EQUIPMENT AND MATERIALS

PART 1 - GENERAL

1.1 SUMMARY
A. This Section describes requirements for the equipment, materials and manufacturing requirements for miscellaneous communications equipment necessary to install communications systems and terminate the metallic and fiber optic communication cables. The Contractor shall provide any miscellaneous equipment/hardware necessary for the proper implementation of each of the communication subsystems.
B. Refer to Division 3.2, Section 27 22 30 – Station Communications Interface Cabinet for station cabinet requirements.

1.2 RELATED WORK
A. Division 1, Section 01 33 00, Submittal Procedures
B. Division 3.2, Section 27 01 00, Operations Control Center
C. Division 3.2, Section 27 13 10, Carrier Transmission System
D. Division 3.2, Section 27 22 30, Station Communications Interface Cabinet
E. Division 3.2, Section 27 51 10, Closed Circuit Television System (CCTV)
F. Division 3.2, Section 27 51 16, Public Address System
G. Division 3.2, Section 27 53 50, Fare Collection System
H. Division 3.2, Section 34 42 36, Supervisory Control and Data Acquisition

1.3 SUBMITTALS
A. Miscellaneous Communications Equipment Product Data: Submit product data and specifications for items specified and not provided as part of another submittal in CDRL-20060-01
B. Provide all submittals in accordance with the requirements of Division 1, Section 01 33 00 – Submittal Procedures.
C. Communications Rack Product Data: Submit manufacturer’s catalog data for communications rack hardware. CDRL-20060-02
D. Communication Cabinet Rack Layout: Submit a layout plan for the communications cabinet, including all other equipment to be installed in the cabinet. CDRL-20060-03.
E. Communications Free Standing Rack Layouts: Submit layout Drawings for each of free standing communications rack, including all other equipment to be installed in the rack. Provide dimensions for all equipment, including dimensions between equipment. CDRL-20060-04.
1. Note that the Communications Free Standing Racks themselves (not the equipment to be placed therein) to be located in the OCC Server Room at the CMF shall be provided by others, as described in Division 3.2, Section 27 10 00, Operations Control Center.

F. Submit fully dimensioned shop drawings for all precast concrete items showing weights, steel reinforcing, openings, blockouts, and accessory items such as pulling irons, ladders, pullbox risers, covers, hatches, and sumps. CDRL-20060-05

G. Submit structural calculations for all precast concrete items as follows (CDRL-20060-06):

1. Submit structural calculations for all loads including traffic, soil pressure, and live loads.

2. Submit buoyancy calculations based on water table at five (5) feet below grade. All products shall have a buoyancy safety factor of 1.5 minimum.

3. The calculations shall include a statement by the structural engineer that products are suitable for use as allowed by the California Building Code.

PART 2 - PRODUCTS

2.1 PROTECTED ETHERNET PATCH PANEL

A. General: Provide 19” Rack Mounted Patch Panels. They shall meet the following requirements:

1. Certified Category 6 transmission values.

2. Meets Power-Over-Ethernet requirement. IEEE 802.3af and IEEE 802.3at compliant.

3. The panel shall have replaceable surge modules.

4. Surge protector breakover voltages shall be 16 V for signal and 68 V for power.

5. Surge protector shall have capacity of 10kA@8X20us Peak Surge Current.

6. Surge protector shall have <1ns Response Time.


8. Insertion Loss < 0.1 dB.

9. Patch panels shall use T568-B wiring scheme.

2.2 PROTECTED TERMINAL BLOCK

A. The Contractor shall provide, install, and test a protected terminal block (PTB) that shall provide surge protection on all copper cables entering the CIC for the following circuits:

1. SCADA PLC digital inputs (DI) from electrical cabinet and ticket vending machine (TVM) alarms.
2. Public Address (PA) speakers
3. PA ambient noise system (ANS) microphone

B. The PTB shall meet the following requirements:

1. Multi-stage modular terminal block with screw connections. Screw connections shall have the capacity to accept conductors from 24 AWG to 14 AWG.
2. Contractor shall provide a separate replaceable surge protector for each individual circuit.
3. Protection of 2 signal wires with common reference potential.
4. Disconnection of signal circuit by disconnect knife.
8. Nominal voltage: Vary (base on protected equipment) 120 VAC.
9. Nominal current: Vary (base on protected equipment) 300 mA.
10. Total surge current: 10 kA @ 8/20 us.
12. Response time (core-earth): ≤ 100 ns.
13. Cutoff frequency (50 ohm): 15 MHz (typical).
14. Cutoff frequency (150 ohm): 8 MHz (typical).
15. Resistance in series: 9.4 Ω.
17. Capacitance (core-earth): ≤ 2 pF.
18. Operating temperature: -40°C to 85°C.
19. Mounting type: DIN rail

2.3 FIBER DISTRIBUTION PANEL (FDP)

A. General: Provide fiber distribution panels (FDP) for use in the Operations Control Center (OCC) and General Office (GO). The FDP shall be sized as indicated on Contract Drawings and shall be equipped with internal splice trays for termination of single mode fiber pigtails on the Outside Plant (OSP) Cables. Each panel shall be equipped with the following components to support the number of ports required:

1. Single-mode (SM) pigtails with LC (Lucent connector) duplex connectors. Fiber
connector coupler Panel. Connector type shall match equipment specified in Division 3.2, Section 27 13 10 Carrier Transmission System,

2. Splice Trays,

3. 19” Rack mounted shelf, sized for the number of ports required, with lockable door.

4. Cable clamp kit and miscellaneous mounting hardware.

B. General: Provide 19 inch rack mounted FDP for use in the CICs at the Stations. The FDP shall be sized as indicated on Contract Drawings and shall be equipped with internal splice trays for termination of single mode pigtails on the OSP fiber cables. Each panel shall be equipped with the following components to support the number of ports required:

1. SM pigtails with LC duplex connectors. Fiber connector coupler Panel. Connector type shall match equipment specified in Division 3.2, Section 27 13 10 Carrier Transmission System.

2. Splice Trays.

3. 19 inch rack mounted FDP sized for the appropriate number of ports.

4. Cable clamp kit and miscellaneous mounting hardware.

2.4 FIBER PIGTAILS

A. General: Provide sufficient SM fiber pigtails to terminate all fiber optic equipment for this project. They shall have the following characteristics:

1. 9/125 Distribution style optical fiber nonconductive riser (OFNR) polyvinyl chloride (PVC) fiber.

2. LC fiber duplex connectors: Connector type shall match equipment specified in Division 3.2, Section 27 13 10 Carrier Transmission System

3. One (1) meter long breakouts.

4. Duplex (two fiber) pigtails.

5. Maximum insertion loss of 0.25dB. Minimum return loss 45 dB

2.5 FIBER PATCHCORDS

A. General: Provide sufficient (with 10 percent spare) SM fiber patch cords for all FDPs provided for this project. They shall have the following characteristics:

1. 9/125 distribution style OFNR PVC fiber.

2. LC fiber duplex connectors: type shall match equipment specified in Division 3.2, Section 27 13 10 Carrier Transmission System

3. Maximum insertion loss of 0.25dB. Minimum return loss 45 dB

4. Duplex (2 fiber) cords.
2.6 FIBER SLACK ENCLOSURE

A. General: Provide fiber slack enclosures for the OCC Communication Rooms and GO. The fiber slack enclosure shall be capable of storing two cable lengths of 30 ft each.

2.7 INTRUSION DETECTION

A. General:

1. Intrusion Detection Systems will be provided with each CIC, EIC and TVM.

2. Intrusion and trouble/supervisory conditions shall be transmitted to the OCC and GO via the SCADA system.

3. SCADA Interface: SCADA inputs for intrusion shall be provided for each station and facility.

B. Communication Interface Cabinets (CIC). The Contractor will furnish and install intrusion detection equipment in the CIC as specified in Division 3.2, Section 27 22 30.

C. Electrical Interface Cabinets (EIC). The Contractor will furnish and install intrusion detection equipment in the EIC. Contractor shall provide a simple intrusion detection circuit that shall utilize magnetic switches and be activated when any cabinet door is opened. The intrusion detection circuit shall provide one intrusion alarm indication and be connected to the SCADA system.

D. Ticket Vending Machine (TVM) Enclosures. The Contractor will furnish and install all intrusion detection equipment in TVM enclosures and provide alarms contacts (security relay status alarm).

2.8 COMMUNICATIONS CONDUIT

A. Contractor shall provide and install communications conduit in various sizes as shown in Communications Drawings ZM Sheets.

B. Contactor shall provide and install underground communications conduit as shown in Communications System Conduit Drawings SC Sheets.

C. Communications conduit shall include all fittings, couplings, elbows, risers, and nipples as needed.

D. Drag Line shall be 1/4" polypropylene monofilament 3 strand utility rope.

E. Contractor shall provide and install watertight plugs to plug conduits.

F. Contractor shall modify or verify wire and conduit size and routing for equipment chosen, submit shop drawings for ACT approval.

G. Metal Conduit and Tubing

1. Metallic conduit shall be galvanized rigid steel (GRS) per ANSI C80.1.

2. Metallic tubing shall be LFMC type liquid tight flexible metal conduit.

3. Fittings:
a. Compression type

b. Compatible with conduit and tubing materials

c. Meet ANSI/NEMA FB 1

c. For GRS, where conduits enter manholes, provide conduit bells and factory type long sweep 90 degree elbows. All elbows and risers shall be PVC (40 mil) wrapped through concrete

4. Manufacturers:

d. Republic Conduit

a. LTV Steel Tubular Products Company

b. Wheatland Tube Electrical Conduit

c. AFC Cable Systems, Inc.

d. Alflex Inc.

e. Anamet Electrical, Inc.; Anaconda Metal Hose

H. Nonmetallic Conduit and Tubing

1. Rigid nonmetallic conduit (RNC) shall be Schedule 40 and Schedule 80 PVC, conforming to NEMA TC 2 and UL G651.

2. RNC Fittings shall meet NEMA TC 3, and shall match to conduit or tubing type and material.

3. For RNC conduit, where conduits enter pull boxes or manholes, provide terminal adapters and flat washers to provide waterproof termination.

2.9 TEXTILE INNERDUCT

A. Textile innerduct shall be installed in new 3-inch conduit as shown in Communications System Conduit Drawings SC021 through SC225.

B. Textile innerduct shall be installed in existing 3-inch conduit, after removal of all existing cables, as shown in Communications System Conduit Drawings SC021 through SC225.

C. Textile innerduct shall be MaxCell 4G or AC Transit approved equivalent that shall meet the following requirements:

1. Textile innerduct shall be 3-inch 3-cell with the equivalent to three 1.25 inch innerducts.

2. Textile innerduct shall have a capacity to install up to 6 cables, two per cell, each with a diameter of up to 0.55 inch.

3. The textile innerduct shall have a maximum cable diameter per cell of 1.05 inches.
4. Textile innerduct shall contain a 1250 lb rated polyester flat woven pull tape.

5. Textile innerduct shall contain a solid copper, polyvinyl color coded conductor, #19 AWG minimum, for tracing, and rated for a minimum of 6A and 600V.

6. Textile innerduct shall be provided with inflation type termination bags for sealing around one or more innerducts and cables.

7. Textile innerduct fabric:
   
   f. Warp: polyester monofilament, diameter = 0.23 ± 0.02 mm, denier = 520 ± 25.

   a. Nylon filling: nylon 6 monofilament, diameter = 0.19 ± 0.02 mm, denier = 350 ± 25.


8. Sewing line: high tenacity multifilament polyester with stitches = 2.0 ± 0.2 stitches per cm.

9. Lubricant: 100% polydimethyl siloxane, temperature range = -50 to 200 °C, density = 8.4 ± 0.1 lbs/gal, viscosity = 350 ± 25 cps.

10. Operating temperature: -50 to 100 °C

2.10 COMMUNICATIONS PULL BOX

A. Contractor shall provide precast concrete pull boxes for communications cabling, sized and located where indicated on Communications System Conduit Drawings SC021 through SC225.

B. Communications pull boxes shall be Caltrans Type 6 and 6E, as shown in the Communications System Conduit Drawings. Pull boxes shall meet State specifications for Type 6 and 6E pull boxes.

C. Pull boxes manufacturer shall be OldCastle Precast (Christy Concrete) or AC Transit approved equivalent that shall meet the following requirements:

1. Pull boxes shall have integrally formed walls and floor with lid, or base unit with extension and lid.

2. Walls and floor of pull boxes shall be constructed of high density reinforced concrete. Pull box extension (Caltrans Type 6E) shall be 12 inch high density reinforced concrete.

   c. Concrete shall exceed ASTM-D1693 standards for environmental stress cracking resistance.

3. Pull box shall have non-settling shoulders positioned to maintain grade and facilitate back filling.

4. Pull boxes shall be provided with cast-in bolt down brackets, clip, and galvanized steel bolts for securing the lid.
5. Pull box lid shall consist of a galvanized steel checker plate with 8 inch round self-closing reading lid.

PART 3 - EXECUTION

3.1 GENERAL

A. Install miscellaneous equipment in accordance with approved design and installation Drawings.

B. Communication Interface Cabinets: The Contractor shall coordinate design of cabinets with ACT.

C. Test: Test cabinets in accordance with the requirements of Division 3.2, Section 01 45 23 – Communications Commissioning and Testing.

3.2 INSTALLATION OF COMMUNICATIONS CONDUIT

A. Underground Installation

1. Underground Installation shall conform to ANSI C 2 and NFPA 70, except as otherwise specified or indicated.

2. Changes in direction of runs exceeding a total of 10 degrees, either vertical or horizontal, shall be accomplished by long sweep bends having a minimum radius of curvature of 25 inches, unless otherwise indicated; sweep bends may be made up of one or more curved or straight sections or combinations thereof. Manufactured bends shall have a minimum radius of 36 inches. Select sweep radius based on cable manufacturer’s requirements. Trenches shall be excavated along straight lines from structure to structure before conduits are laid or structure constructed so the elevation can be adjusted, if necessary, to avoid unseen obstruction.

3. Conduit installed in a common trench with other utilities shall be 6 inches clear of other utilities.

4. Provide one 1/4 inch polypropylene drag line in each conduit including 3 feet of space at each end.

5. Conduit shall extend 10 feet beyond each end pull box and shall be plugged with watertight plugs. Provide stakes at grade, marked with survey flagging showing elevation and type of utility.

6. Conduit install under road shall have a minimum depth of 18”.

7. Plastic marking tape shall be placed approximately 12 inches below finished grade level.

B. Contractor shall provide and install fire stop sealant between conduit and entrance points into cabinets including CIC, electrical, and traffic cabinets, and into buildings including the Central Maintenance Facility (CMF) and General Office (GO).

3.3 INSTALLATION OF TEXTILE INNERDUCT

C. Provide textile innerduct in underground 3-inch conduit, and install textile innerduct using
continuous unspliced lengths of textile innerduct between pull boxes and/or termination points as indicated on the Communications System Conduit Drawings SC021 through SC225. Contractor shall remove all cables in existing conduit prior to installation of textile innerduct.

D. Contractor shall make a 2” incision, approximately 18” from the end of textile innerduct. Pull out and cut off approximately 2 feet of pull-tape. Thus allowing the pull tape ends to retract back into the cells.

E. Using approximately 6 feet of pull tape, tie a non-slip knot to the incision. Then tie 3 to 6 half-hitch knots down to the end of textile innerduct. Apply black vinyl tape over all knots and the end of textile innerduct. Using a Bow Line knot tie a swivel to the end of 3 feet pull tape.

F. Using a Bow Line knot, attach the pull rope located in the rigid conduit to the other end of the swivel. Install textile innerduct – ensuring that no twist is introduced to the innerduct.

G. Provide suitable textile innerduct slack in pull boxes, and at turns to ensure there is no kinking or binding of the product.

H. Textile Innerduct Mountings, Hangers and Attachments:

1. Do not fasten textile innerduct to steam, water, or other piping, ductwork, mechanical equipment, electrical equipment, electrical raceways, or wires.

2. For underground locations, use conventional plastic cable ties to secure textile innerduct through previously created incisions:

I. Pull Box Installation:

3. At locations where textile innerduct will be continuous through a pull box, allow sufficient slack so that the innerduct may be secured to the side of the pull box maintaining the minimum bend radius.

1. At pull boxes serving as the junction location, pull the exposed end of the innerduct to the far end of the pull box, install termination bag, and secure to the pull box.

J. Penetrations

1. Seal all conduit and textile innerduct entering structures at the first box or outlet to prevent entrance into the structure of gases, liquids or rodents. Contractor shall use duct water seal products suitable for closing underground and entrance conduit openings.

2. Inspect fire stopping between building structure and conduit, to verify integrity of installation.

3. Install conduit sleeves or fire barrier sealing systems in all openings where open and exposed textile innerduct passes through fire-rated walls and floors. After installation, install intumescent fire barrier penetration sealing material (Hilti system) between textile innerduct and sleeves or fire barrier system.

4. Protect adjacent surfaces from damage during water seal or fire stop installation. Repair any damage.
END OF SECTION

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SECTION 27 24 40
CONTROL CENTER AND MAINTENANCE FACILITY ANCILLARY EQUIPMENT

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This Section sets forth the minimum criteria that shall be used in the design, construction, installation of, and testing for, a complete, operational and reliable EB BRT System in OCC under Contract Documents.

B. The Contractor shall coordinate with the ACT to ensure that no additional ACT Contracts shall affect the design of the EB BRT System in OCC.

C. The Contractor shall coordinate with the ACT to ensure proper and timely installation of all the EB BRT equipment in OCC, software and furniture; including installation of ACT provided equipment and furniture in compliance with the Project Schedule.

D. The Contractor shall coordinate with the ACT to ensure proper and timely integration of all the EB BRT System project elements in compliance with the Project Schedule.

E. The following is an overview of the items and services that shall be supplied by the Contractor to complete the Work and fulfill the requirements of the Contract Documents. Full details are specified in the Contract Documents and any omissions below shall not relieve the Contractor of any contractual obligations specified elsewhere in the Contract Documents.

1. Provide BRT Video Monitoring System which shall be used by EB BRT CC personnel within the OCC facility.

2. Provide Engineering Workstation and monitor.

3. Provide servers, which shall connect to the console workstation(s) via an EB BRT Carrier Transmission System (CTS) network.

4. Provide an Uninterrupted Power Supply (UPS) for each EB BRT Station.

5. Provide for access to the ACT provided telephone system.

6. Provide secure access to the EB BRT System by requiring logon and password protection; provide secure access to the functions based upon user title. Interface through Microsoft Active Directory server at ACT for username and password authentication.

7. Provide the Closed Circuit Television (CCTV) System, including physical/virtual interface access lists (firewall rules), as needed to provide adequate security, which interfaces to each station’s CCTV equipment.

8. Provide the Public Address (PA) System, which interfaces to each station’s PA equipment.

9. Provide the Fare Collection System, including physical/virtual interface access lists (firewall rules), as needed to provide adequate security, which interfaces to each station’s TVM equipment.

11. Provide camera setup capability.

12. Select either real-time or recorded video streams to be sent to the EB BRT system in OCC and/or other locations; including configuration capability to select how the streams are monitored.

13. Provide for the selection and display of CCTV images on selected monitors in user specified configurations.

14. Provide for the capturing of selected video streams (e.g. in a file); video streams shall be date and time-stamped, identify the source location and shall be retrievable.

15. Provide the Supervisory Control and Data Acquisition (SCADA) system which interfaces to each station’s SCADA Programmable Logic Controller (PLC).

16. Provide monitoring and control of EB BRT devices; depicting equipment alarms/conditions, events and intrusions for operation personnel to provide applicable follow through.

17. Provide the capability to monitor the performance of all EB BRT software processes, computer systems and communications interfaces comprising the EB BRT System.

18. Provide an interface from the SCADA PLC to the EB BRT TVMs and Clipper Card Interface Devices (CIDs) to obtain intrusion detection alarms.

19. Interface the TVM intrusion alarm to the CCTV system to assure video capture from the CCTV camera monitoring the TVM location and to transmit the video to the EB BRT system in OCC when an intrusion is detected.

20. Provide an interface from SCADA to the Communications Interface Cabinets (CIC) and Electrical Interface Cabinets (EIC) to obtain intrusion detection alarms.

21. Provide for the logging of SCADA points; alarms, events and intrusions to be date and time-stamped, identify the equipment and specify the result indication, raw values and limits/ranges being used for comparison.

22. Provide for capture of video (e.g. as a named file).

23. Provide Logging and Reporting Systems for the purpose of collecting EB BRT information and storing that information for logging and reporting.

24. Provide archival/retrieval for the purpose of more permanent storing of selected video and data.

25. Provide for both the automatic and manual creation of reports.

26. Provide for standard and ad hoc reporting using EB BRT information; including attaching video files.

27. Interface to the ACT-provided networked printers with copier, fax and scanning capability.
28. Provide a complete software development environment consisting of source code, linkers, compilers, debuggers, Computer Aided Software Engineering (CASE) Tools and class browsers used during the development of the EB BRT System.

29. Provide a complete training program, including student workbooks, instructor guides and/or computer-based training course curricula. Some training may be provided by vendors.

30. Perform a complete series of tests to be performed on the EB BRT System (hardware and software) which includes: Factory Acceptance Test (FAT), Site Sub-system Test, System Integration Test, availability tests, reliability tests and Site Acceptance Test (SAT). Provide all plans, test cases/procedures and test results.

31. Provide one year warranty after SAT.

32. Provide Operations Support Services and maintenance for a one year period that includes, but is not limited to, all levels of servicing from equipment calibration, software, tuning, preventative servicing routines, circuit troubleshooting and alignments, through all modular, component and end-item repairs.

33. Provide one or more “secure zones” using firewall or router/switch access list rules for sensitive systems including but not limited to Fare Collection System server, Video Monitoring server and SCADA server, based on a design that is adequate for a PCI compliant environment and is approved by ACT, possibly under the guidance of a PCI DSS QSA (Qualified Security Assessor)

1.2 RELATED WORK

A. Division 1, Section 01 33 00, Submittal Procedures

B. Division 3.2, Section 01 45 23, Communications Commissioning and Testing

C. Division 3.2, Section 01 91 30, Training

D. Division 3.2, Section 27 01 00, Operations Control Center

E. Division 3.2, Section 27 13 10, Carrier Transmission System

F. Division 3.2, Section 27 51 10, Closed Circuit Television System (CCTV)

G. Division 3.2, Section 27 51 16, Public Address System

H. Division 3.2, Section 27 53 50, Fare Collection System

I. Division 3.2, Section 34 42 36, Supervisory Control and Data Acquisition

1.3 INTENT OF TECHNICAL SPECIFICATIONS

A. In cases where specific requirements for the Work are set forth in the Contract Documents, they are intended to be minimum requirements; the Contractor shall provide additional capability, if required by its solution. For example: If a requirement calls for 32 megabytes of memory to be provided, the Contractor shall provide a minimum of 32 megabytes; even if its system is capable of operating with less than 32 megabytes of
memory, the required 32 megabytes shall still be provided. In addition, if the Contractor’s proposed system requires 64 megabytes of memory to operate, then the required 64 megabytes shall be provided at no additional cost to ACT.

B. These Technical requirements include, but are not limited to, the performance requirements of the EB BRT System, and should not be interpreted as indicating any requirement to supply any specific product of any particular manufacturer, unless it is required for compatibility with existing ACT systems. The descriptions of equipment form and function, which are found in the following sections, are intended to indicate the salient characteristics of equipment that will satisfy the operational requirements of ACT and meet the requirements of the Contract Documents. All equipment, whether specifically identified or otherwise required to fulfill the requirements contained in the Contract Documents, shall be subject to written approval by the ACT.

C. Deviations from Contract Documents

1. The Contractor may propose alternative means of achieving the function and intent of specific requirements defined in the Contract Documents if such a change provides a material benefit to ACT and meets the established goals of the EB BRT System Project as defined within these Contract Documents.

2. The proposed alternative(s) shall be clearly described in a dated letter to the ACT. Reasons for requesting consideration of the alternative, and the impact and benefits to ACT, shall be clearly articulated. Specific references to Contract Document sections that need to be revised, to allow the alternative(s), shall be cited.

3. The ACT at its sole discretion will accept or reject any proposed alternative.

D. The Contract Documents taken together as a whole describe an integrated system and, as such, they are all interrelated. It is essential that the Contractor shall understand the integrated requirements of the EB BRT System to successfully deliver the EB BRT System. Therefore, it shall be the responsibility of the Contractor to understand the complete Contract.

1.4 APPLICABLE STANDARDS

A. Contractor’s design, fabrication, inspection, installation and testing shall comply with all applicable Standards and Codes as listed herein. All EB BRT System equipment and methods shall comply with the latest version of the standards as listed herein:

1. California Building Code Chapters 27 and 28
2. Americans with Disabilities Act (ADA)
3. Electronic Industries Association (EIA) RS-160-51 – Sound Systems
4. National Electrical Code (NEC)
6. Underwriters Laboratories (UL) 48 – Standard for Safety Electric Signs
7. UL 1433 – Standard for Safety Control Centers for Changing Message Type Electric Signs

1.5 Acronyms and Definitions

A. AC – Alternating Current
B. ACT - Alameda Contra Costa Transit District
C. ADA - Americans with Disabilities Act
D. ANS - Ambient Noise Sensing
E. AVL – Automated Vehicle Location
F. BART - Bay Area Rapid Transit District
G. BRT – Bus Rapid Transit
H. CAD – Computer Aided Dispatch
I. CASE - Computer Aided Software Engineering
J. CCTV - Closed Circuit Television
K. CIC - Communications Interface Cabinets
L. CTS – Carrier Transmission System
M. EB – East Bay
N. EIA - Electronic Industries Association
O. EIC - Electrical Interface Cabinets
P. EOC - Emergency Operations Center
Q. FAT - Factory Acceptance Test
R. GO - General Office
S. IGBT - Insulated Gate Bipolar Transistor
T. IT - Information Technology
U. LAN – Local Area Network
V. LDAP - Lightweight Directory Access Protocol
W. LED - Light Emitting Diode
X. Manufacturer’s Warranty - Preprinted written warranty published by individual manufacturer for particular product and specifically endorsed by manufacturer to ACT.
Y. NEC - National Electrical Code
Z. NVR - Network Video Recorder
AA. OCC - Operations Control Center
BB. PA - Public Address
CC. PIM - Passenger Information Message
DD. PIS - Passenger Information System
EE. PLC - Programmable Logic Controller
FF. PTZ - Pan Tilt Zoom
GG. PWM - Pulse Width Modulated
HH. RTM – Requirements Traceability Matrix
II. RTVM – Requirements Traceability Verification Matrix
JJ. SAT – Site Acceptance Test
KK. SCADA - Supervisory Control and Data Acquisition
LL. SCU - Station Control Unit
MM. SDF – Software Development Folder
NN. SNTP - Simple Network Time Protocol
OO. STI - Speech Transmission Index
PP. STP – Software Test Plan
QQ. TBD – To Be Determined
RR. TVM – Ticket Vending Machine
SS. UL - Underwriters Laboratories
TT. UPS - Uninterrupted Power Supply
UU. VLAN – Virtual Local Area Network
VV. VMS - Variable Message Sign
WW. VRLA - Valve Regulated Lead Acid
XX. VSS - Video Surveillance System

PART 2 - PRODUCTS

2.1 General

A. All equipment and material provided under this section shall be UL listed.
B. All grounding shall be in accordance with local standards, and specifications required by this Contract and in accordance with the recommendations of the manufacturer.

C. Discontinued product models, refurbished equipment, products at their end-of-life, or end-of-service shall not be used.

D. All products specified herein shall be subject to ACT approval based on the Contractor’s ability to demonstrate adherence to the specified requirement and approval of the manufacturer’s quality process.

1. The Contractor shall provide all product cut sheets required for the ACT’s evaluation.

2. The Contractor shall provide ACT with user manuals/maintenance manuals for all products provided.

E. Interior equipment installed at the head-end (servers and workstations) shall operate under the following conditions, unless otherwise specified:

1. Temperature: 10º to 35º C (50 to 95 F);

2. Humidity: 20% to 95%, non-condensing.

F. The Contractor shall provide for each system, including equipment, computers, and all associated software licenses, as indicated in the Contract Documents and Drawings.

### 2.2 CCTV System

A. Division 3.2, Section 27 51 10, Closed Circuit Television System (CCTV) describes the detailed technical requirements for the CCTV System to be designed, provided, installed, and tested under this Contract.

B. The following equipment from the CCTV system shall be provided as part of the EB BRT System:

1. Redundant head-end CCTV system servers, with all associated control and management software applications.

2. The BRT Video Monitoring System specifically designated as the CCTV user interface with two 55-inch high resolution monitors and an additional monitor used to control CCTV cameras and set up displays on the high resolution monitors, keyboard, and mouse.

   a. CCTV Security System software shall be capable of being executed from any OCC dispatcher workstation based on login permissions, but the BRT Video Monitoring System Workstation will be uniquely equipped with additional high resolution monitors for enhanced CCTV viewing;

   b. All associated software applications.

3. An interface to the following (at each Station):

   a. CCTV digital cameras;

   b. NVR;
C. Division 3.2, Section 27 51 10 describes the requirements of the CCTV System that shall provide for the control, monitoring, and management of real-time and recorded video from digital IP cameras along the EB BRT line.

D. Division 3.2, Section 27 22 10 describes the BRT Video Monitoring System.

2.3 SCADA

A. Division 3.2, Section 34 42 36, Supervisory Control and Data Acquisition describes the requirements of the SCADA system that shall provide for control of EB BRT Station equipment and for the monitoring of failure alarms, intrusion alarms and points on station equipment.

2.4 Public Address System

A. Division 3.2, Section 27 51 16, Public Address (PA) System describes the requirements of the PA System that shall provide for control of EB BRT Station equipment and for the making of audio announcements at stations.

2.5 Fare Collection System

A. Division 3.2, Section 27 53 50, Fare Collection System describes the requirements of the fare collection system that shall provide for control of fare collection equipment at stations.

2.6 Logging

A. The system shall handle all logged data in accordance with standards/guidelines established by ACT’s Information Technology (IT) department policies and procedures, applicable at the time of the EB BRT System implementation.

B. The system shall log:

1. All SCADA alarms and events;

2. All video from the EB BRT CCTV cameras;

3. All logons, both successful and unsuccessful;

4. All access to logged information, both authorized and unauthorized.

5. All networks equipment alarms in NMS.

C. The system shall ensure that absolutely no data is lost in the event of a logging system failure.

D. The system shall assure that all logged data is secure so that unauthorized individuals do not have access to data, or the capability to modify data through inadvertent, or malicious, tampering of the information and that sensitive data is not inappropriately accessed.

E. All accesses, both authorized and unauthorized (i.e., attempted) are to be logged with date and time, information being accessed and any user information that is available.
F. All logon attempts, both successful and unsuccessful are to be logged with date and time, username and the status of the logon.

2.7 Video Logging

A. All video from EB BRT CCTVs shall be logged to an NVR at the Station.

B. Each NVR shall provide a minimum of 30 days of continuous recording of all associated cameras.

C. The NVRs will automatically overwrite the oldest video once the capacity for the device has been reached.

D. The system shall provide authorized user with the capability to access Station NVRs to find the video for replay and find video by entering a start date and time, and by fast forwarding or reversing through the video.

E. The system shall provide the capability for an authorized user to make a video file (H.264 [AVC] format encoding and compression) from the playback from the NVR or a still photo.

F. The system shall provide the capability to display and/or print a video still image.

2.8 Logon Attempts Logging

A. All attempts at logon shall be logged such that they may be searched.

B. Text Message logs shall allow authorized user to search for messages by:
   1. Date and Time;
   2. Successful/unsuccessful logon;
   3. Username.

2.9 SCADA Alarms and Events Logging

A. All SCADA alarms and events (e.g. change of state) shall be logged such that the SCADA information may be searched.

B. The system shall be capable of storing a minimum of 20,000 SCADA messages.

C. An authorized user shall be able to search SCADA messages by:
   1. Date and Time;
   2. Person who Acknowledged the alarm;
   3. Acknowledged versus Unacknowledged alarms;
   4. SCADA alarm group;
   5. Equipment type (e.g. all CCTV cameras);
   6. Equipment identifier, or set of equipment identifiers;
7. Equipment at a Station, or by a set of Stations;
8. Message Type (e.g. alarm, incident);

D. The system shall provide the capability to entering the SCADA message log search results into a spreadsheet tool (e.g. Microsoft Excel), where the results may be filtered or sorted.

E. The system shall provide the capability to display and/or print the SCADA message log search results.

F. The system shall be capable of logging a minimum of 5,000 SCADA configuration changes. SCADA configuration changes include adding/deleting a SCADA point, changing limits for event/alarm conditions, programmable calculations and control algorithms, units and the states for the SCADA point.

2.10 Reporting

A. All logged data shall be available for real-time querying and reporting.

B. The system shall provide the capability to generate standard and ad-hoc reports, using a commercially available reporting tool such that a lay person may be able to prepare reports and to modify existing report structures.

C. The system shall support on-line maintenance, forms generation, administration functions and queries/reports.

D. Maximum flexibility in report generation shall be provided through the use of standard, commercially available software utilities for sorting, merging, report writing and random and indexed accessing of information.

E. Expansion of the reporting capability shall require the addition of minor hardware components such as disk drives and minor software changes only.

2.11 Archival/Retrieval

A. ACT has a specified server, used to archive files (typically when an incident occurs), and the system shall provide an interface so that the following types of files may be archived to that server from the EB BRT system:

1. Video files;
2. Search Result files;
3. Text files generated by operations or maintenance personnel

B. Files may only be archived to this server by an authorized user.

C. Files archived to this server must be retrievable from the server by any authorized user.

2.12 Product Storage and Handling Requirements

A. Store and protect products in accordance with manufacturers’ instructions.
B. Store with seals and labels intact and legible.

C. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.

D. Provide bonded off-site storage and protection when site does not permit on-site storage or protection.

E. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.

F. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

G. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

2.13 Product Warranties

A. Manufacturer’s Warranties shall be in addition to, and run concurrent with, warranties required by Contract Documents.
   1. Manufacturer’s disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of this Contract Document.

B. Approved Special Warranties shall be in addition to, and run concurrent with, warranties required by Contract Documents.
   1. Special Warranties - a draft shall contain appropriate terms and identification, as applicable to the project, and be submitted for approval by ACT before final execution.

2.14 Product Substitution

A. Requests for Substitutions shall be considered by ACT, or their designee, when the Contractor:
   1. Has requested the substitution in writing, submitted drawings and product data information or testing results attesting to the proposed product equivalence.
   2. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product.
   3. Has determined that proposed product has proof of operation in similar application.
   4. Will provide the same warranty for the Substitution as for the specified product.
   5. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to ACT.
   6. Waives claims for additional costs or time extension which may subsequently become apparent.
7. Will reimburse ACT for review or redesign services associated with re-approval of substituted product.

B. ACT shall provide notification in writing of decision to accept or reject the product substitution request.

2.15 Spare Parts And Maintenance Products

A. The Contractor shall provide spare parts, maintenance, and extra products in quantities specified in the individual specification sections, as agreed to with ACT and prior to Substantial Completion.

B. Delivery of Spare Parts and Maintenance Products shall be to a location, as directed by ACT.

C. Additional specification of spare parts shall be found in Division 3.2, Section 01 45 25 – Communications Spare Parts and Test Equipment.

PART 3 - EXECUTION

3.1 Control Center Development and Integration

A. A Requirements Traceability Matrix (RTM) shall be developed which maps each requirement, allocated to software, to the associated software design.

B. Design reviews shall be held to review EB BRT System designs, per the schedule of design reviews for the EB BRT project. The purpose of these reviews is to ensure that the Contractor fully understands the basis of design and can express rational assumptions relating to the design at the start of the detail design process.

C. A Final Design review shall be conducted and the design formally accepted by ACT prior to release of hardware to manufacturing for final assembly and test or for the start of new software development.

D. The Contractor shall be responsible for the integration of all EB BRT System hardware and software within their scope of supply.

E. The Contractor shall be responsible to manage the integration of EB BRT CC Systems with interfacing external systems that include hardware, software and human operations and maintenance support systems.

F. The Contractor shall be responsible for systems integration to ensure: compliance with all performance and functional requirements, safety certification requirements, system/subsystem reliability, availability and maintainability requirements, compliance with any and all security requirements, including PCI requirements.

G. The Contractor shall be responsible to coordinate with all affected stakeholders satisfactory integrated solutions to resolve all integration issues.

3.2 System Testing

A. System Testing shall follow the requirements as detailed in Division 3.2, Section 01 45 23 – Communications Commissioning and Testing and in the EB BRT Systems Test Plan, and as described in the Contractor-supplied Inspection and Test Plan (CDRL 01814-01).
3.3 Training

A. Training shall be performed as per the requirements as detailed in Division 3.2, Section 01 91 30 – Training and as described in the Contractor-supplied Training Plan (CDRL 01820-01).

END OF SECTION
PART 1 - GENERAL

1.1 WORK INCLUDED

A. The Work of this Section consists of setting forth the minimum criteria that shall be used in designing, furnishing, installing and testing a Closed Circuit Television System (CCTV) at the station platforms, Operation Control Center (OCC), and AC Transit General Office (ACT GO).

B. The Contractor shall coordinate with the ACT (Alameda Contra Costa Transit District) to ensure that no additional ACT Contracts shall affect the design of the CCTV.

C. The Contractor shall coordinate with the ACT to ensure proper and timely installation of all the CCTV equipment and software.

D. The Contractor shall coordinate with the ACT to ensure proper and timely integration of all the CCTV project elements.

E. The following is an overview of the items and services that shall be supplied by the Contractor to complete the Work and fulfill the requirements of the Contract Documents.

1. Provide the following CCTV equipment at the OCC and ACT GO:
   a. Redundant head-end CCTV servers, with all associated control and management software applications and video storage. One CCTV Server shall be installed at the OCC and one CCTV Server shall be installed at the ACT GO.
   b. CCTV software will run on new workstations at OCC. The OCC operation workstations in dispatch room and Video Command Room, one workstation per operator position. Contractor shall provide workstations at OCC and OCC BRT Video Command Room. The CCTV software shall also run on the new engineering workstation at GO.
   c. Refer to Division 3.2, Section 27 22 10 Communications Servers, Workstations, and Video Monitoring System for requirements associated with CCTV Servers and workstations.
   d. Be accessible from all console positions at the OCC.
   e. Software and all licenses shall be provided for Servers, workstations and storage.

2. Provide the following security equipment at each station platform:
   a. CCTV Cameras (Four fixed digital cameras with digital PTZ) with dome enclosures;
   b. One (1) Network Video Recorder (NVR).
3. Provide for the control, monitoring, and management of real-time and recorded video from fixed cameras.

4. Provide a logon function for operators to enter their username and password for access control into the CCTV system at the workstation(s).

5. Provide a means to integrate with the existing ACT access control system Microsoft Active Directory with Lightweight Directory Access Protocol (LDAP) to authenticate usernames and passwords.

6. Provide authorized users with the capability to define user profile and user rights in relation to viewing certain cameras on a per camera basis.

7. Interface the CCTV system with the SCADA System CIC, EIC, and TVM intrusion alarms such that one or more cameras at the station platform automatically executes a digital PTZ to better view the CIC, EIC, or TVM when triggered by the intrusion alarm. Contractor shall implement all necessary hardware interfaces (e.g. dry contact from intrusion alarm connected to digital input on camera) or software interface (e.g. SCADA system sends data message to CCTV System) so that when a specific alarm occurs, it causes the CCTV System to automatically route the video to pre-specified console workstation(s) / users and performs the digital PTZ to the TVM, CIC or EIC.

8. The Contractor shall configure and implement all security requirements for CCTV system as needed and as approved by ACT.

1.2 Related Work

A. Division 1, Section 01 33 00, Submittal Procedures

B. Division 3.2, Section 01 45 23, Communications Commissioning and Testing

C. Division 3.2, Section 01 91 40, Training

D. Division 3.2, Section 27 22 10, Communications Servers, Workstations, and Video Monitoring System

1.3 Intent of Technical Specifications

A. In cases where specific requirements for the Work are set forth in the Contract Documents, they are intended to be minimum requirements; the Contractor shall provide additional capability, if required by its solution. For example: If a requirement calls for 32 megabytes of memory to be provided, the Contractor shall provide a minimum of 32 megabytes; even if its system is capable of operating with less than 32 megabytes of memory, the required 32 megabytes shall still be provided. In addition, if the Contractor’s proposed system requires 64 megabytes of memory to operate, then the required 64 megabytes shall be provided at no additional cost to ACT.

B. These Technical requirements include, but are not limited to, the performance requirements of the CCTV System, and should not be interpreted as indicating any requirement to supply any specific product of any particular manufacturer, unless it is required for compatibility with existing ACT systems. The descriptions of equipment form and function, which are found in the following sections, are intended to indicate the salient characteristics of equipment that will satisfy the operational requirements of ACT and meet the requirements of the Contract Documents. All equipment, whether
specifically identified or otherwise required to fulfill the requirements contained in the Contract Documents, shall be subject to written approval by the ACT.

C. Deviations from Contract Documents

1. The Contractor may propose alternative means of achieving the function and intent of specific requirements defined in the Contract Documents if such a change provides a material benefit to ACT and meets the established goals of the EB BRT Project as defined within these Contract Documents.

2. The proposed alternative(s) shall be clearly described in a dated letter to the ACT. Reasons for requesting consideration of the alternative, and the impact and benefits to ACT shall be clearly articulated. Specific references to Contract Document sections that need to be revised, to allow the alternative(s), shall be cited.

3. The ACT at its sole discretion will accept or reject any proposed alternative.

D. The Contract Documents taken together as a whole describe an integrated system and, as such, they are all interrelated. It is essential that the Contractor understands the integrated requirements of the EB BRT System to successfully deliver the CCTV System. Therefore, it is the responsibility of the Contractor to understand the complete Contract.

1.4 APPLICABLE STANDARDS

A. Contractor’s design, fabrication, inspection, installation and testing shall comply with all applicable Standards and Codes as listed herein. All CCTV equipment and methods shall comply with the latest version of the standards as listed herein:

1. Society of Motion Picture and Television Engineers (SMPTE)
   a. SMPTE 296M – HDTV 720p
   b. SMPTE 274M – HDTV 1080p

2. Motion Picture Experts Group (MPEG)
   a. MPEG-4 – ISO/IEC 14496-10 AVC (H.264)

3. Federal Communications Commission (FCC)
   a. FCC Part 15 – Subpart B

1.5 ACRONYMS AND DEFINITIONS

A. ACT - Alameda Contra Costa Transit District

B. ADA - Americans with Disabilities Act

C. BRT – Bus Rapid Transit

D. OCC – Operations Control Center

E. CCTV - Closed Circuit Television

OCTOBER 2015
F. CIC - Communications Interface Cabinets
G. CTS – Carrier Transmission System
H. DVD – Digital Video Disk
I. EB – East Bay
J. EIC – Electrical Interface Cabinet
K. FAT - Factory Acceptance Test
L. FCC – Federal Communications Commission
M. GUI – Graphical User Interface
N. ID – Identification
O. IP – Internet Protocol
P. LDAP - Lightweight Directory Access Protocol
Q. Manufacturer’s Warranty - Preprinted written warranty published by individual manufacturer for particular product and specifically endorsed by manufacturer to ACT.
R. MPEG – Motion Pictures Experts Group
S. NEMA – National Electrical Manufacturers Organization
T. NVR – Network Video Recorder
U. PIS - Passenger Information System
V. POE – Power-over-Ethernet
W. PTZ – Pan. Tilt, Zoom
X. SAT – Site Acceptance Test
Y. SCADA - Supervisory Control and Data Acquisition
Z. SCU - Station Control Unit
AA. SMPTE - Society of Motion Picture and Television Engineers
BB. STP – Software Test Plan
CC. TCP – Transmission Control Protocol
DD. TVM – Ticket Vending Machine
EE. UL - Underwriters Laboratories
FF. UPS - Uninterrupted Power Supply
1.6 SUBMITTALS

A. Provide all submittals in accordance with the requirements of Division 1, Section 01 33 00– Submittal Procedures;

B. CCTV System Product Data: Submit CCTV System product data and specifications in CDRL 20070-01;

C. Shop Drawings: Submit shop drawings detailing methods of assembly and materials list in CDRL-20070-02;

D. Test Methods and Results in CDRL-20070-04;

E. NVR Storage Calculations in CDRL-20070-05.

1.7 FUNCTIONAL REQUIREMENTS

A. General

1. Furnish and install all equipment, hardware, software and connections to provide a fully functional CCTV system at the OCC, GO and along the EB BRT alignment.

2. All CCTV cameras and related equipment and materials provided shall meet all requirements specified.

3. All cameras provided shall be monitored by the CCTV workstations via the Carrier Transmission System (CTS).

4. The CCTV system camera view shall cover all station platform areas.

5. The CCTV cameras, servers, storage, workstations and the CTS connections shall meet security requirements adequate for the environment, as approved by ACT.

B. CCTV Interfaces

1. CCTV cameras at each station platform shall have 10/100Base-T network connections to the Station Ethernet switch located in the CIC cabinet at each Station platform.

2. NVRs at each station shall have capability to transmit high resolution video from the Station platforms to the OCC and GO.

3. The CCTV Security System shall interface with the SCADA system to received specific intrusion detection alarms from Ticket Vending Machines (TVMs), Communications Interface Cabinet (CIC), Electrical Interface Cabinet (EIC). This interface shall be via software (e.g. SCADA system sends a data message to the CCTV System). An alternative option to provide this function is to connect the cabinet intrusion alarm dry contact to the camera alarm input. The CCTV software will get the intrusion alarm.

4. The video streams shall be accessible from any workstation on the AC Transit BRT network, that contains the correct client software applications, has sufficient...
bandwidth to receive video streams originating on the EB BRT network and the user has an authorized username and password.

C. Graphical User Interface (GUI)

1. The CCTV Security System shall be supplied with a GUI showing a diagram or map of the EB BRT line indicating each Station platform, and from this map have the ability to select Station platform(s) and individual CCTV cameras and NVRs.

2. GUI showing a diagram or map of the EB BRT line shall contain the equipment status information, displayed to the user.

D. CCTV Cameras

1. The CCTV cameras shall be Internet protocol (IP) cameras, with power-over-Ethernet (POE).

2. The CCTV cameras shall be high resolution security cameras that adjust automatically for day (Color) / night (black and white) operation.

3. Real time video for each CCTV camera shall be able to be viewed at between 5 to 30 frames per second (fps) at up to 1920 x 1080 full HD resolution, and up to a resolution of 5 Megapixels at 2560 X 1920 at 5 fps, using H.264 (AVC) encoding and compression.

4. Full motion high quality (video resolution required) video shall be produced by the CCTV cameras.

5. An authorized user shall have the ability to adjusting a camera’s frame rate from 5 to 30 fps.

6. An authorized user shall have the ability to configure the following for each CCTV Camera:

   a. Color level;
   b. Brightness;
   c. Sharpness;
   d. Contrast;
   e. White balance;
   f. Exposure control;
   g. Backlight compensation;
   h. Camera name, location, IP address;
   i. Image resolution;
   j. Frame rate;
   k. Compression levels;
l. Network bandwidth;
m. Alarm/event triggers;
n. Automatic functions.

E. Video Streams

1. All video streams shall be uniquely identified by a name that should correspond to the camera location (Station platform) and an identifier that specifies northern camera and southern camera and the date and time of the video creation.

2. Camera Location Identifiers shall be consistent for each Station platform.

3. All video streams shall contain the current date and time in 24 hour format.

4. Playback video shall be identified from real time video only by the date and time stamp.

5. The number of simultaneous video streams transmitted to the OCC and GO shall be equivalent to the number of separate Station platforms on the EB BRT line, with 56 video feeds as the maximum available for the CCTV workstations. The assumption is that each camera requires 10 megabits per second bandwidth.

6. The number of simultaneous video streams shall be capable of future expansion of 100% by adding the necessary software licenses.

F. Network Video Recorders (NVRs)

1. The system shall include NVRs that shall be rack mounted with internal storage and associated network video and camera management software applications.

2. Each NVR shall be able to simultaneously record video from Station platform cameras and output recorded video via the CTS to the OCC and GO.

3. Each NVR shall include 10/100/1000 Base-T Ethernet communication interfaces to the CTS.

4. Recording Capacity

a. Video from each camera shall be recorded at up to 2560 x 1920 resolution, at 5 fps, 24 hours/day, using H.264 (AVC) encoding and compression, for a minimum of 30 days.

b. Contractor shall provide NVR Storage Calculations, for each NVR, to show the disk capacity provided meets this requirement, and shall document this in CDRL-20070-05 for review and approval.

5. An authorized user shall have the ability to configure the following for each NVR:

a. NVR name, location, IP address;
b. Image resolution;
c. Image frame rate;
d. Compression levels;
e. Network bandwidth.
G. Video Control and Monitoring

1. The system shall provide authorized users with real-time viewing and playback functions from workstations.

2. An authorized user shall be able to select one or more of the following video sources for simultaneous viewing:
   a. Real-time video from cameras;
   b. Recorded video from NVRs.

3. Each CCTV display monitor shall provide the ability to show one, four or sixteen video streams on each of the workstation monitors.

4. Each CCTV display shall be able to display live and/or playback camera video streams.

5. An authorized user shall have the ability for playback from a camera/NVR with forward and backward commands, playback speed control and frame-by-frame viewing commands.

6. An authorized user shall have the ability to create and print still images (jpeg) from the video.

7. An authorized user shall have the ability to search for recorded video from an identified camera.

8. An authorized user shall have the ability to search for recorded video on a specified camera/NVR using a "Go-To" time and date function.

H. Pan, Tilt Zoom (PTZ) Capability

1. The system shall provide authorized users at the workstation(s) with digital PTZ control

I. Responding to an Alarm Condition

1. Upon receipt of an intrusion detection alarm for TVMs, CIC cabinets or EIC cabinets, the camera shall view the device with pre-set PTZ and begin to send real-time video to the to the pre-specified console workstation(s) and/or users. The workstation(s) shall automatically pop up the camera picture.

2. The console positions and/or user logons to receive the video shall be configurable by an authorized user.

3. The system shall be capable of detecting the loss of video from any camera, and display a specific alarm on the user interface associated with the pre-specified workstation(s).

J. CCTV Security Logging

1. All CCTV Security System user activity shall be logged.
2. The CCTV Security System log shall contain the date, time, Station platform identifier, equipment identifier, user ID, activity/action/command, and whether an alarm condition had occurred.

3. The CCTV Security System Log shall be permanent and not alterable by any user.

4. The capacity for at least 30 days of CCTV Security System logging shall be provided.

5. Upon command by an authorized user, selected CCTV Security System log inputs shall be archived such that they may be retrieved at a later date.

6. An authorized user shall be able to view the CCTV Security System Log and be able to sort/filter the log contents by user specified date(s)/date ranges, date and time ranges, Station platform identifier(s), equipment identifier(s), user ID(s), activity/action/command(s), and alarm condition(s).

7. An authorized user shall be able to print out reports from the CCTV Security System log.

PART 2 - PRODUCTS

2.1 GENERAL

A. General: Furnish all products, services, software, and documentation necessary to meet the requirements in this specification, including to the following:

1. IP-CCTV Camera Assemblies with Integrated Enclosures;
2. Network Video Recorders;
3. Copper Cabling and Connectors;
4. Camera Mounting Hardware;
5. Spare Parts and Test Equipment;

B. The Contractor shall responsible for the storage of all equipment until each particular facility is ready for installation. Coordinate with the ACT for the delivery of all equipment to each facility.

2.2 HARDWARE

A. CCTV Cameras

1. Shall be dome type mounted in vandal-resistant, weatherproof enclosures with clear views of the length of the platform area, platform edge(s), and under the canopy.

2. Shall be UL listed, IP-66, and NEMA 4X rated.
3. Fixed dome camera shall be CISCO 7030E IP Camera, or AC Transit approved equal.

B. Network Video Recorder

1. Features of the recorder shall include, at a minimum
   a. Auto-delete mode to automatically delete recordings when hard drive is full, on first in, first out basis.
   b. The NVR shall be configured to record each camera at a resolution of 1920 x 1080, at 5 fps, 24 hours/day, using H.264 (AVC) encoding and compression, for minimum 30 days. Contractor shall provide the ability to change recording parameters for each camera including resolution and frame rate.
   c. Simultaneous recording and playback. Continue recording while reviewing, retrieving, or storing images on the network.
   d. Image Enhancement: Upon playback the system shall be able to enhance frames in terms of zoom, despeckling, brightness, contrast and sharpness of the image.
   e. Addition of text to an image and the ability to print video frames to a printer.
   f. Ethernet network capability with Ethernet port and TCP/IP protocols as required.
   g. Save images in H.264, or other approved format for easy distribution via the network.
   h. Support archival of Video data on recordable DVDs and Blu-Ray at the workstations.

2. NVR Hardware – The NVR shall be a Cisco UCS C240 2RU server or AC Transit approved equivalent meeting the following minimum requirements:
   a. Processor: Two x Intel 2.4 GHz Xeon processors
   b. Memory: Two (2) x 8GB DDR3 RAM
   c. Software: Cisco Video Surveillance Manager or approved equal
   d. Licenses: 8 camera, 16 streams
   e. Hard Drive: Integrated RAID 5, storage as specified herein
   f. Power Supply: Redundant, 650W, hot-swap
   g. Power usage: 390W max, 370W @90% load, 225W idle
   h. Network: Two x 10/100/1000Base-T Ethernet, RJ-45
   i. Cooling: Redundant, hot-swap fans, 1270 BTU/Hr
j. Ports: Two x USB 2.0, 1 x serial (RJ-45), 1 x KVM

k. Operating Temperature: 0˚ to 40˚ C (32˚ to 104˚ F)

C. NVR Software

1. Software to be provided and installed on each NVR shall be Cisco Video Surveillance Manager or ACT approved equal for servers including all licenses for up to 16 video streams from cameras.

2. All necessary software for remote viewing of video streams via network connections, for up to 16 simultaneous users shall be included on the NVR.

D. CCTV Servers, Workstations, and Software

1. Refer to Division 3.2, Section 27 22 10 Communications Servers and Workstations for hardware requirements regarding dual redundant CCTV Servers and workstations.

2. Contractor shall provide and install all necessary software on CCTV Servers and Workstations for seamless operation with NVRs and cameras. Software shall include, but not be limited to the following:

   a. Cisco Video Surveillance Manager or AC Transit approved equal;

   b. Cisco Video Surveillance Operations Manager or AC Transit approved equal;

   c. Cisco Safety and Security Desktop or AC Transit approved equal;

   d. AC Transit approved equivalent for all CCTV Servers, Workstation software applications.

3. All necessary licenses for remote viewing of up to 56 simultaneous video streams managed by either one of the redundant CCTV Servers shall be provided. The number of simultaneous video streams shall be capable of future expansion of 100% by adding the necessary software licenses.

E. Cable

1. Copper Cable: The Contractor shall provide copper cable in accordance with the requirements of Division 3.2, Section 27 15 10 Communications Wires and Cables.

F. Miscellaneous

1. Test Equipment: The Contractor shall provide test equipment in accordance with the requirements of Division 3.2, Section 01 45 25 Communications Spare Parts and Test Equipment.

PART 3 - EXECUTION

3.1 General
A. The Contractor shall provide and install all equipment in accordance with all Contract and manufacturers’ requirements, with ACT approved shop drawings and consistent with good commercial practices.

B. Refer to Division 3.2, Section 01 45 23 – Communications Commissioning and Testing, for testing requirements of the CCTV systems. All test equipment shall be provided as per Section 01 45 25 – Communications Spare Parts and Test Equipment.

C. Refer to Division 3.2, Section 01 91 30 – Training, for training requirements of the CCTV systems.

3.2 CCTV System

A. The Contractor shall provide and install all equipment, software, accessories and related hardware required to deliver a fully functional CCTV system.

B. The Contractor shall coordinate all work performed with AC Transit and perform work only during agreed to times and dates. Any work performed shall at no time interfere, degrade and disrupt existing operations and maintenance activities.

C. Operations Control Center and GO Installation

1. The Contractor shall furnish and install all CCTV equipment, software and cables as specified herein and as recommended by the manufacturer(s) at the OCC and GO to support full CCTV.

2. The communications equipment shall be installed in open racks (provided by others) as indicated on Contract drawings and coordinated with ACT.

3. All cabling between communications equipment components and devices at the OCC and GO shall be as per the approved shop drawings.

4. The Contractor shall configure network security at OCC and GO including but not limited to firewall or router/switch access list rules as needed and as approved by ACT.

D. Station Equipment Installation

1. The Contractor shall provide and install all CCTV equipment at the stations to support full CCTV system operation, as specified herein, as recommended by the manufacturer(s), as per the approved contract drawings, and as directed by the ACT.

2. CCTV equipment shall be setup and installed as per the manufacturer’s recommendations and as directed by the ACT.

3. CCTV system cable connections to/from copper termination blocks shall be made in accordance with approved shop drawings and appropriately labeled.

4. Setup the fixed position CCTV camera direction and viewing areas shall be as indicated on approved shop drawings.

5. Install the CCTV cameras shall be as per the approved shop drawings. The mounting configurations and cable grounding plans shall be submitted for ACT approval for each configuration.
6. The supplier shall coordinate with ACT to develop viewing positions appropriate for coverage of the CICs, EICs and TVMs at each station platform.

7. Install the power and signal cables in conduit shall be as indicated on the Station Block Diagrams, meeting federal, state and local codes and as directed by ACT.

8. Cameras shall be powered by the Ethernet switch in the cabinet that shall have POE capability.

9. Properly grounding and protection from lightning and power surges shall be installed for all CCTV equipment, per manufacturer's recommendations.

10. The Contractor shall configure network security at stations including but not limited to firewall or router/switch access list rules as needed and as approved by ACT.

### 3.3 CCTV SECURITY SYSTEM TESTING

A. All testing shall conform with requirements as defined in Division 3.2, Section 01 45 23 – Communications Commissioning and Testing. Specific CCTV tests are specified herein.

B. CCTV Security System testing shall be able to verify that an authorized user is able to manually select and receive video from each Station platform’s CCTV cameras, from each workstation.

C. CCTV Security System testing shall be able to verify that an authorized user is able to manually select and send commands to each Station platform’s cameras, from each workstation.

D. CCTV Security System testing shall be able to verify that an authorized user is able to configure all the parameters for all CCTV cameras from each workstation.

E. CCTV Security System testing shall be able to verify that an authorized user is able to manually select and receive video from each Station platform’s NVR, from each workstation.

F. CCTV Security System testing shall be able to verify that an authorized user is able to configure all the parameters for all NVRs, from each workstation.

G. Verify that each NVR has minimum 30 days recording time.

H. CCTV Security System testing shall verify that video images may be selected and viewed from a workstation on the AC Transit BRT network, equipped with the applicable client software, connected in a location with sufficient bandwidth.

I. CCTV system testing shall verify that the camera imagers can cover all station platform areas.

J. CCTV system testing shall verify the cabinet intrusion alarm functions.

K. The Contractor shall be able to perform the following CCTV Security System functional tests:

1. View one, four and 16 video streams on each monitor;
2. Scan through cameras with a configurable time for each camera;

3. View real-time and recorded video, simultaneously;

4. Create a still photo and print photo;

5. Create video files.

### 3.4 TRAINING

A. All training shall conform to requirements as defined in Division 3.2, Section 01 91 30 – Training. Specific CCTV training is specified herein.

B. The Contractor shall provide an all-encompassing training program for ACT personnel involved in the operations and maintenance of the CCTV.

C. The Contractor shall provide training for all software that is used within the CCTV, including platforms, tools, applications, COTS software, software development environment, semi-custom software and custom software.

D. The Contractor shall be required to design and provide several distinct, separate training courses.
   1. Courses that the Contractor shall provide include a hardware maintenance training course; a field maintenance training course; a system-administration software-maintenance training course; a relational-database training course (if required); an operations course for Controllers and Security personnel.
   2. All training products and training courses that are proposed by the Contractor shall be subject to review and approval by ACT

E. All products that are supplied as part of this Contract for the purpose of general training, or any other purposes, shall be of the highest quality and durability to provide service for their intended objective of training for both the currently employed group of ACT personnel and multiple generations, or “classes,” of employees thereafter.

F. The Contractor shall provide hands-on training to ACT personnel by allowing a side-by-side work environment with Contractor personnel.
   1. Hands on training shall allow ACT maintenance personnel to become familiar with the CCTV and to independently maintain the system once the warranty period has expired.
   2. This hands-on training shall include any and all adjustments made to any component, hardware and software, of the CCTV system.

END OF SECTION
SECTION 27 51 16
PUBLIC ADDRESS SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The Work of this Section consists of the requirements for providing a Public Address (PA) System, its associated hardware and software, interface equipment and other materials required throughout the EB BRT alignment, OCC and GO.

B. The Work shall include design, manufacture, installation, supply, testing, training, and in-service performance verification of all PA System elements.

C. The Contractor shall coordinate with the ACT (Alameda Contra Costa Transit District) to ensure that no additional ACT Contracts shall affect the design of the PA System.

D. The Contractor shall coordinate with the ACT to ensure proper and timely installation of all the PA System equipment.

E. The Contractor shall coordinate with the ACT to ensure proper and timely integration of all the PA System elements.

1.2 RELATED WORK

A. Division 1, Section 01 33 00, Submittal Procedures

B. Division 3.2, Section 01 45 23, Communications Commissioning and Testing

C. Division 3.2, Section 01 91 40, Training

D. Division 3.2, Section 27 22 10, Communications Servers, Workstations, and Video Monitoring System

1.3 ACRONYMS AND DEFINITIONS

A. AC – Air Conditioning

B. ACT - Alameda Contra Costa Transit District

C. ARI – Air Conditioning and Refrigeration Institute

D. BRT – Bus Rapid Transit

E. OCC – Operations Control Center

F. CDRL – Contract Data Requirements List

G. CIC - Communications Interface Cabinets

H. CMF – Central Maintenance Facility

I. dB - Decibel
J. EB – East Bay
K. GO – ACT General Office
L. HVAC – Heating, Ventilation & Air Conditioning
M. MP3 - Moving Picture Experts Group Layer-3 Audio (audio file format/extension)
N. NEC – National Electric Code
O. NEMA – National Electrical Manufacturers Association
P. NFPA – National Fire Protection Agency
Q. PA – Public Address
R. PCM – Pulse Code Modulation
S. SPL – Sound Pressure Level
T. UL - Underwriters Laboratories
U. UPS - Uninterrupted Power Supply
V. VOIP – Voice over Internet Protocol
W. WMA – Windows Media Audio (Microsoft)

1.4 SUBMITTALS

A. Provide all submittals in accordance with the requirements of Division 1, Section 01 33 00– Submittal Procedures

B. Product Data: Submit product data as required to fully describe all provided PA System elements, in CDRL-20050-01, including but not limited to the following:
   1. VOIP Audio Device (CIC cabinet);
   2. Noise Sensing Controller (CIC cabinet);
   3. Ambient Noise Sensing Microphone (Platform);
   4. Power Amplifier (CIC Cabinet);
   5. Speakers (Platform);
   6. PA System Workstations with speakers and desktop PTT microphone (OCC);
   7. PA System Head-End Servers Software

C. Shop Drawings: Submit shop drawings detailing methods of assembly and materials list in CDRL-20050-02.

D. Test methods, test procedures, and test results in CDRL-20050-04.
1.5 QUALITY ASSURANCE

A. Comply with the requirements as specified in Contract Specifications.

B. Comply with American Disability Act (ADA).

C. Comply Underwriters Laboratories (UL).

D. ITU-T - International Telecommunication Union standards for telecommunications
   1. G.711 – Standard for Audio Companding

   1. 60268-16 - Objective Rating of Speech Intelligibility by Speech Transmission Index.

1.6 GENERAL REQUIREMENTS

A. The PA System shall be furnished and installed as indicated on plans and specified herein.

B. The PA System shall include the following components:
   1. Equipment in each CIC at each of the platforms:
      a. VOIP Audio Device;
      b. Noise Sensing Controller;
      c. Power Amplifiers;
   2. Equipment at each of the platforms (refer to plans for total number):
      a. Ambient Noise Sensing Microphone
      b. Speakers
   3. PA System Workstations with speakers and desktop PTT USB microphone. Workstations to be located at ACT BRT operator positions inside the OCC at the CMF and GO (for the engineering workstation). Refer to plans for the total number of PA System Workstations.
      a. Contractor shall note workstations shall be capable of performing all system functionality including PA System, SCADA System, and CCTV System. It is the Contractor’s responsibility to install and configure all software applications, so that all applications can run simultaneously, and meet all functional requirements specified herein without conflicts, errors or failures.
   4. PA System Head-End Servers. The servers shall be virtualized to ACT existing VMware environment. The server software shall support existing ACT VMware environment and install to the existing ACT servers. Contractor shall coordinate with ACT to virtualize the PA servers in the existing ACT VMware environment.
5. Refer to Division 3.2, Section 27 22 10 - Communications Servers and Workstations, and Video Monitoring System for requirements associated with PA System workstations.

1.7 **PA SYSTEM FUNCTIONAL REQUIREMENTS**

A. The PA System shall provide the ability for authorized operators to send live audio messages to selected stations.

B. The PA System shall allow pre-recorded, scheduled and non-scheduled, messages to be initiated by authorized users from workstations.

C. The PA System shall provide the ability for authorized operators to generate ad-hoc recorded audio messages.

D. The PA System shall provide the ability for authorized operators to generate and store preprogrammed audio messages.

E. The PA System shall allow playing of preprogrammed audio messages.

F. The PA System shall allow recording of ad hoc audio messages generated by authorized users and sent to the PA System for presentation based upon a preset schedule.

G. The PA System shall provide the ability to send audio for presentation at:
   1. Individual Stations;
   2. Individual Platforms;
   3. Individual Platform message sides (Northbound/Southbound)
   4. Group of Stations/Platforms;
   5. All Stations/Platforms;
   6. All Northbound Platforms;
   7. All Southbound Platforms.

H. Audio messages shall be able to be directed to select station platforms.

I. The PA System shall provide the ability for authorized operators to create audio messages using the USB desktop microphone associated with the PA System Head-End Workstations.

J. The PA System shall provide the ability to play prerecorded audio messages at selected zones within 4.0 seconds after being selected by the operator, 95% of the time.

K. The PA System shall provide the ability to play “live” ad-hoc audio messages at selected zones within 20.0 seconds after being entered by the operator, 95% of the time.

L. The PA System shall provide the ability for authorized operators to create, edit, and maintain a schedule whereby audio messages are automatically played at selected station platforms, at pre-determined times by minute, hour, day, month, and year.
M. The PA System shall provide the ability for authorized operators to enter the following parameters with regard to audio messages:

1. Selection of the station(s) platform(s) that shall play the audio message

2. Message Priority or Message Type – indicating the relative importance of the message;

3. The starting time and date, to play the audio message. Default shall be the current time and date, i.e. the message is downloaded and played immediately;

4. The length of the time period (or end date and time) during which a message is to be played;

5. The repeat interval between each successive time the message is played; For example, the PA System operator may enter that the audio message is to be played on 07/04/2015, starting at 10:45 AM, play for 6 hours, and repeated every 15 minutes.

N. The PA system shall support Message Priority or Message Type for live, ad-hoc, and prerecorded messages based on the following:

1. Emergency Announcements or PA messages;

   a. Amber Alerts;

   b. Transit Informational Messages (schedule updates, station platform alerts and safety reminders);

   c. Advertisement/General Information Messages/Time of Day and Date.

O. The PA System shall automatically alert an authorized user, with specific permissions, of a failure to play audio within a given station platform.

P. The PA System shall accept and implement commands to play, stop, repeat, delete, and view the status of audio messages.

Q. The PA System shall provide the capability to prepare and create a library of preprogrammed voice messages, so that:

1. Audio Messages shall be provided in the English, Spanish, Cantonese and Mandarin languages.

2. Messages composed of assembled multiple message phrases shall be audibly smooth and contiguous.

R. The message library database shall be provided with an initial capacity of up to 5000 messages, (or segments to assemble 5000 messages), with the capability to expand to greater than 10,000 messages (or segments to assemble greater than 10,000 messages).

S. The nominal audio portion of a message shall be 30 seconds or approximately 2.6 MB of uncompressed, single channel, 16-bit PCM, 44.1 kHz digitized audio and compressed using MP3.
T. Because the system may have many messages, the message library shall have a scheme to easily locate messages. This may be by categorization, type or some other means.

U. Authorized users shall have the capability to search for messages within the message library.

V. All audio messages generated by PA System shall be logged.

W. The PA System log shall contain the date/time stamp of when the message was presented, station/platform presenting the message, message content, and whether automatic/manual initiation of the message had occurred. Note: to facilitate search capability, messages sent for presentation at multiple stations or platforms should have multiple log entries.

X. If manually initiated message, the log shall also contain the ID (identification) of the authorized user making the message request and/or generation.

Y. Audio files generated using the microphone (e.g. PA announcements) shall be logged to an audio recording device.

Z. The Passenger Message Log shall be permanent and not alterable by any user. The capacity for at least 30 days of PA System message logging shall be provided.

AA. Upon command by an authorized user, Passenger Messages shall be archived such that they may be queried and retrieved at a later date.

1.8 PA SYSTEM PERFORMANCE REQUIREMENTS

A. The PA System shall provide a means to adjust the PA sound levels to minimize/restrict noise spill-over to residential and business areas.

B. The PA System shall include ambient noise sensing and automatic sound level control function.

C. The PA System shall provide nominal audio Sound Pressure Level (SPL) of 10 dBA ± 3 dBA over maximum ambient noise level.

1. It is shown in the East Bay BRT Project Noise and Vibration Impact Assessment Technical Report that the maximum ambient noise level is approximately 75 dBA.

2. Therefore, the PA System shall be capable of providing a sound level of 85 dBA at a level of 4 Ft above the platform, averaged over 90 percent of the coverage area of each station platform.

D. The Maximum PA sound pressure level shall never exceed 104 dBA.

E. The coverage area meeting the sound level requirements shall not be less than 90 percent of each station platform’s PA zone of coverage as measured from a minimum of 10 locations throughout the coverage area.

F. The PA system shall provide an average Speech Transmission Index (STI) of 0.6 or better averaged over 90 percent of the coverage area of each station platform’s PA zone measured from a minimum of 10 locations throughout the coverage area.
G. The PA system shall provide a minimum STI of 0.5 or better over 100 percent of each PA station platform’s zone measured from a minimum of 10 locations throughout the coverage area.

H. In the event STI levels measured during site acceptance testing fall below requirements, the Contractor shall implement remedies including, but not limited to, the following:
   1. Adjusting the strength of the signal (i.e. increasing the signal to noise ratio) provided by PA components;
   2. Adjusting speaker and other PA component power settings;
   3. Adding more speakers;
   4. Adjusting the alignment of the center axis of speakers.

PART 2 - PRODUCTS

2.1 VOIP AUDIO DEVICE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Barix Annuncicom 100,
   2. Digital Acoustics IP7 Series,
   3. Or AC Transit approved equivalent

B. The VoIP Audio Device shall accept audio data via network connection, such as MP3 and WMA files, and provide analog audio output to the Noise Sensing Controller. The VoIP Audio Device shall accept audio data from the PA System Head-End Servers. The VoIP Audio Device shall be compatible with and operate seamlessly with the PA System software applications operating on the PA Head-End Servers.

C. Specifications
   1. Audio Formats:
      a. G.711
      b. PCM 8-bit and 16-bit
   2. Transport Bandwidth:
      a. 64 Kbps nominal (voice).
   3. Audio Latency:
      a. < 200 ms
   4. Audio Interface:
      a. 1.0V p-p nominal
5. Network Interface:
   a. 10/100Base-T Ethernet
   b. Auto-MDIX
   c. Protocols: TCP, UDP, RTP
   d. Connector: RJ-45

6. Power:
   a. – 32 VDC
   b. 5W max
   c. 120VAC power adapter shall be provided.

7. Operating Temperature:
   a. 0˚ to 40˚ C (32˚ to 104˚ F)

8. Mounting:
   a. DIN Rail

2.2 NOISE SENSING CONTROLLER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Protech 65302B,
   2. Or ACT approved equivalent

B. The Noise Sensing Controller shall automatically adjust the level of the audio signal to the power amplifiers based on the input from one or more Noise Sensing Microphones, as shown in the Contract Drawings. The Noise Sensing Controller shall “listen” to ambient noise conditions from the platform and automatically vary the output level to the power amplifiers to compensate for variations in noise level. The Noise Sensing Controller shall have sense hold on announcement function.

C. Specifications:
   1. Input Gain
      a. Off to 20dB gain
   2. Threshold, Priority Circuit:
      a. -25dBv
   3. Mute Attenuation
      a. 70 dB min
4. Maximum Input Level
   a. +18 dBv

5. Input Impedance
   a. 10K Ohms nominal

6. Sensing Input Impedance
   a. 1.1K Ohms nominal

7. Threshold Adjustment Range
   a. -60 dBv to 0 dB

8. Ratio Range
   a. 1:1 to 4:1

9. Auto Gain Limit Range
   a. 6 dB to 21 dB

10. Attack Time
    a. 1 to 60 seconds

11. Release Time
    a. 2 to 60 seconds

12. Output Limit Range
    a. 0 dBv to +20 dBv

13. Maximum Output Level
    a. +20 dBv

14. Overall Specifications
    a. Distortion: 0.1% Max
    b. Noise: 84 dB below +4 dBv out
    c. Frequency Response: 30Hz to 20KHz
    d. Power: 0.5 Amps / 120 VAC
    e. Operating Temperature: 0˚ to 40˚ C (32˚ to 104˚ F)

15. Mounting:
    a. Rack Mount
2.3 AMBIENT NOISE SENSING MICROPHONE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Crown PZM-11LLWR,
2. Or AC Transit approved equivalent

B. The Ambient Noise Sensing Microphone shall provided and installed on each platform as shown in the Contract Drawings. The Ambient Noise Sensing Microphones shall monitor ambient noise conditions on the platform and provide a signal to the Noise Sensing Controller in order to compensate the output to the power amplifiers for variations in noise level.

C. The Ambient Noise Sensing Microphones shall be a weather resistant pressure zone microphone with a balanced, line level output. The microphone capsule inside shall be protected against water damage.

D. Specifications:

1. Transducer Type
   a. Electret condenser
2. Frequency Response
   a. 80 Hz to 10,000 Hz
3. Polar Pattern
   a. Hemispherical
4. Impedance
   a. 75 Ohms balanced
5. Open Circuit Sensitivity (typical)
   a. 11.4 V/Pa
6. Equivalent Noise Level
   a. 26 dB SPL typical
7. Signal to Noise Ratio
   a. 68 dB at 94 dB SPL
8. Maximum SPL
   a. 100 dB produces 100% THD at max gain
9. Operating Voltage
a. 12 – 24V AC or DC
b. 120V AC to 12 – 23V DC power supply shall be provided

10. Polarity
a. Positive pressure on diaphragm produces positive voltage on audio + terminal with respect to audio – terminal.

11. Current Drain
a. 4 mA

12. Operating Temperature
a. -10˚ to 60˚ C (+14˚ to 140˚ F)

13. Materials
a. Steel plate and high impact plastic capsule holder, plastic mic membrane

14. Finish
a. Silver. If mic is painted, paint shall not intrude into louvered wall plate

15. Installation
a. Standard electrical box, 2.0 inch depth min, to fit louvered wall plate 4.53 x 2.78 inch (H x W)

2.4 POWER AMPLIFIERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Atlas Sound PA1001G,
2. Or AC Transit approved equivalent

B. The Contractor shall provide and install sufficient number of Power Amplifiers to provide up to the total maximum power handling capability of all speakers on the platforms as shown in the Contract Drawings. For example, if each PA speaker is rated at up to 30W maximum, and the number of speakers on the platform is 6, then sufficient power amplifiers shall be provided to handle up to 30W x 6 = 180W total. In this example, if one power amplifier is rated up to 100W maximum, then a minimum of 2 Power Amplifiers shall be provided.

C. The output of the Noise Sensing Controller shall be applied to each Power Amplifier provided.

D. Specifications:

1. Channels
   a. One (1)
2. Power Rating
   a. 100W x 1 @ 70.7V into 50Ω
   b. 100W x 1 @ 100V into 100Ω

3. Frequency Response
   a. 30 Hz to 20 kHz No high pass filter, ± 3dB
   b. 100 Hz to 20 kHz, High pass filter engaged, ± 3dB

4. Harmonic Distortion
   a. 0.002 (0.2 %)

5. Power Consumption
   a. 10W, Sleep mode (no audio being played)
   b. 16W, Active idle mode (audio recently played)
   c. 165W full load

6. Input Sensitivity
   a. Unbalanced: 10K Ohms

7. Input Impedance
   a. Unbalanced: 50mV to 320mV adjustable
   b. Balanced: 320mV

8. Audio Turn-On Trigger
   a. 1mV to 20 mV

9. AC Turn-On Trigger
   a. 100mA

10. Power
    a. 120 – 240 VAC, 50-60 Hz

11. Installation
    a. Rack mount
    b. Two (2) amplifiers shall occupy 1RU of rack space inside the CIC.
2.5 PA SPEAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Penton CELL20T,
   2. Or AC Transit approved equivalent

B. The Contractor shall provide and install sufficient number of PA Speakers as shown in the Contract Drawings in order to meet the PA System Performance Requirements specified herein. PA Speakers shall be installed on the station platform at locations as shown in the Contract Drawings.

C. All PA Speakers at a station platform shall be connected in a daisy chain fashion to the audio output of one of the required PA Amplifiers inside the CIC. Connections of PA Speakers shall be divided as evenly as possible between the PA Amplifiers.

D. PA Speakers shall be outdoor rated with speaker enclosures made of materials such as ABS plastic or aluminum. Speaker enclosures shall be painted; color shall be specified by the Architect. PA Speakers shall include all necessary outdoor rated non-corrosive mounting hardware, for both station canopy and light poles, which shall allow the speaker angle to be adjusted both vertically and horizontally.

E. PA Speakers shall accept copper speaker cable connections as shown in the Contract Drawings.

F. Specifications:
   1. Speaker
      a. Size: 4-inch minimum
      b. Material: Polypropylene
   2. Transformer
      a. 70.7V
      b. Number of taps: 4 minimum
   3. Power Handling
      b. Up to 28W maximum, 20W nominal
      c. Power setting (max volume) selectable via transformer taps
   4. Frequency Response
      a. 160 Hz to 18 kHz, ±5dB
   5. Sensitivity
      a. 92dB SPL @ 1W @1m (minimum)
6. Dispersion
   a. Circular pattern: 110°

2.6 PA HEAD-END SERVERS

A. The servers shall be virtualized to ACT existing VMware environment.

B. The server software shall support existing ACT VMware environment and install to the
   existing ACT servers.

C. PA Head-End Servers shall provide the software functionality as described herein

2.7 PA HEAD-END WORKSTATION FUNCTIONALITY

A. PA Head-End Workstation functionality shall provide the GUI for the software functionality
   as described herein. The PA Head-End Workstation functionality shall be provided on all
   workstations, including the BRT Workstations, the BRT Video Monitoring System
   Workstation, and the Engineering Workstation.

B. Contractor shall note that all workstations shall also perform other software functions
   including but not limited to SCADA System, and CCTV System. It is the Contractor’s
   responsibility to install and configure all software applications, so that all applications can
   run simultaneously, and meet all functional requirements specified herein without
   conflicts, errors or failures.

C. Refer to Division 3.2, Section 27 22 10 Communications Servers, Workstations, and
   Video Monitoring System for hardware requirements associated with PA System Head-
   End Workstation functionality.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All PA testing shall follow all requirements as specified in Division 3.2, Section 01 45 23
   Communications Commissioning and Testing.

B. All PA System equipment described herein shall be installed as shown on Contract
   Drawings.

C. Contractor shall coordinate final locations of all PA System station platform equipment,
   including PA Speakers, and Noise Sensing Microphones, with the AC Transit prior to
   installation.

3.2 FACTORY ACCEPTANCE TESTING (FAT)

A. The PA System Factory Acceptance Test (FAT) procedure shall be developed and
   delivered by the Contractor to ACT as part of CDRL-20050-04.

B. The PA System FAT shall verify operation and functionality of a representative set of PA
   System equipment including:

   1. VoIP Audio Device (minimum 3);

   2. Noise Sensing Controller (minimum 3) ;
3. Ambient Noise Sensing Microphone (minimum 3)

4. Power Amplifiers (minimum 6);

5. Speakers (minimum 12);

6. Head-End Workstation (minimum 2);

7. Head-End Server (minimum 1)

C. PA System FAT shall be able to verify that a minimum of 2 authorized users are able to logon, create, delete, and select, immediate ad/hoc audio messages to the station equipment to be played.

D. PA System SAT shall be able to verify that a minimum of 2 authorized users are able to logon, create, delete, and select, scheduled audio messages to the station equipment to be played.

3.3 SITE ACCEPTANCE TESTING (SAT)

A. The PA System Site Acceptance Test (SAT) procedure shall be developed and delivered by the Contractor to ACT as part of CDRL-20050-04

B. The PA System SAT shall verify operation and functionality of all installed PA System equipment at each station (platform and CIC), the Head-End Servers, and all and Head-End Workstations.

C. PA System SAT shall be able to verify that an authorized user is able to logon, create, delete, and select, immediate ad/hoc audio messages to be played to each station platform’s PA (each zone), from each Head-End Workstation.

D. PA System SAT shall be able to verify that an authorized user is able to logon, create, delete, and select, scheduled audio messages to be played at each station platform’s PA (each zone), from each Head-End Workstation.

E. PA System SAT shall verify message presentation timing to show that during 95% of a set time period (e.g. one 24 hour weekday) messages are played at the selected station(s) in 4.0 seconds or less from the time manually sent or scheduled to be played.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. Description. The Work under this item shall consist of furnishing, installing, testing, and commissioning the Fare Collection System. The BRT Fare Collection System (FCS) will consist of Ticket Vending Machines (TVM) and Clipper smart card readers installed on BRT station platforms. The Contractor shall perform the following work elements for the FCS:

1. Furnish Ticket Vending Machines (TVM) which shall be installed at each bus station platform as indicated in the Contract Drawings.

2. Furnish a ticket validator internal to the TVM to activate pre-paid tickets and to validate 10 trip tickets.

3. Installation of Clipper card reader mounting poles, that will be supplied by others, at each bus station platform as indicated in the Contract Drawings. The Clipper card readers shall be furnished, installed and commissioned by others.

4. Furnish Handheld Verifier for magnetic fare media.

5. Provide TVM Central Computer System which shall be installed at the Central Control Facility.

6. Provide network connections for the TVMs and Clipper readers to the Central Control Facility, utilizing the communications system between the Central Control Facility and bus stations. Refer to Division 3.2, Section 27 13 10 – Carrier Tranmission System.

7. Furnish and configure network security features, including but not limited to firewall rules or router/switch access lists, to provide adequate security to operate the entire Fare Collection System in a Payment Card Industry (PCI) compliant environment. Network security features shall be approved by AC Transit in accordance with the a PCI Data Security Standard (DSS) compliance audit and the guidance of a PCI Qualified Security Assessor (QSA).

B. Equipment Quantities.

1. The Contractor shall furnish a total of 47 TVMs. A single TVM shall be installed at 46 station platforms, and one TVM shall be delivered as a spare unit.

2. The Contractor shall install a total of 111 Clipper card reader mounting poles. The mounting poles installed at each bus station platform shall be as follows:
   a. Uptown – Northbound (NB) platform, Qty 3; Southbound (SB) platform, Qty 3
   b. 14th Street - NB platform, Qty 3; SB platform, Qty 3
   c. City Center - NB platform, Qty 3; SB platform, Qty 2
   d. Harrison - NB platform, Qty 3; SB platform, Qty 3
e. Madison - NB platform, Qty 3; SB platform, Qty 2
f. 2nd Street - NB platform, Qty 3; SB platform, Qty 3
g. 5th Street - NB platform, Qty 2; SB platform, Qty 2
h. 10th Street - NB platform, Qty 3; SB platform, Qty 2
i. 14th Avenue - NB platform, Qty 2; SB platform, Qty 3
j. 20th Avenue, Qty 2
k. 24th Avenue, Qty 2
l. 28th Avenue, Qty 2
m. 31th Avenue, Qty 2
n. Fruitvale, Qty 2
o. 39th Avenue, Qty 2
p. Hight Street, Qty 2
q. 48th Avenue, Qty 2
r. 54th Avenue, Qty 2
s. Seminary, Qty 2
t. 63th Avenue, Qty 2
u. 67th Avenue, Qty 2
v. 73rd Avenue, Qty 2
w. 77th Avenue, Qty 2
x. 82nd Avenue, Qty 2
y. 86th Avenue, Qty 2
z. 90th Avenue, Qty 2
aa. 95th Avenue, Qty 2
bb. 98th Avenue, Qty 2
c. 103rd Avenue, Qty 2
dd. Durant Avenue, Qty 2
e. Georgia Way - NB platform, Qty 2; SB platform, Qty 3
ff. San Leandro Civic Center - NB platform, Qty 2; SB platform, Qty 3
gg. Downtown San Leandro - NB platform, Qty 3; SB platform, Qty 2
3. The Contractor shall furnish ten (10) Handheld Verifiers.

4. TVMs and Clipper card reader mounting poles shall be installed at each bus station platform location as indicated in the Contract Drawings.

C. System Requirements: The BRT Fare Collection System shall enable patrons to purchase fare media that interfaces correctly with the existing AC Transit bus fare collection system. It shall be the Contractor’s responsibility to provide a system that is interoperable with the existing system and meets AC Transit’s fare policy.

1.2 RELATED WORK

A. Division 3.2, Section 26 05 15 – Basic Electrical Materials and Methods

B. Division 3.2, Section 27 00 10 – Basic Communications Technical Requirements

C. Division 3.2, Section 27 15 10 - Communications Wires and Cables

D. Division 3.2, Section 27 13 10 - Carrier Transmission System

E. Division 1, Section 01 33 00 – Submittal Procedures

1.3 SUBMITTALS

A. See Division 1, Section 01 33 00 Submittal Procedures, of the Contract Documents.

B. General. The Contractor shall be responsible for the contents of all submittals, their completeness, their conformance with observable field conditions, their conformance with the schedule, and any delays resulting from the rejection of submittals due to noncompliance with the requirements. Submittals shall be provided in accordance with the requirements of Division 1, Section 01 33 00 Submittal Procedures.

C. Contract Data Requirements List (CDRL). The Contractor shall provide a Contract Data Requirements List for FCS submittals required under this item in accordance with the requirements of Division 1, Section 01 33 00 Submittal Procedures. The FCS submittals required under this item shall include to the following:

1. ADA Compliance Approval, CDRL 20750-1

2. TVM Patron Messages, CDRL 20750-2

3. TVM Ticket Printing Format, CDRL 20750-3

4. Validator Printing Format, CDRL 20750-4

5. Handheld Verifier Design, CDRL 20750-5

6. Spare Modules List, CDRL 20750-6

7. System Design Report, CDRL 20750-7

8. Installation Drawings and Plans, CDRL 20750-8

9. Operational Test Plan, CDRL 20750-9
10. Operational Test Results, CDRL 20750-10
11. System Acceptance Test Plan, CDRL 20750-11
12. System Acceptance Test Results, CDRL 20750-12
13. Training Plan and Schedule, CDRL 20750-13
14. Training Curricula and Materials, CDRL 20750-14
15. Draft System Operations and Maintenance Manuals, CDRL 20750-15

1.4 QUALITY CONTROL

A. See Division 1, Section 01 40 00, Quality Requirements, of the Contract Documents.

B. Contractor Quality Control Plan. Perform the work in compliance with the approved Contractor Quality Control Plan (CQCP) as specified in Division 1, Section 01 40 00 - Quality Requirements.

C. Codes and Standards. The Contractor shall be responsible for compliance with the latest issue of all applicable local standards, codes, and permits required in connection with the proposed installation.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. The Contractor shall be required to provide the design, manufacturing, furnishing, assembly, testing, inspection, and installation of the Fare Collection System (FCS) for use by AC Transit. The Fare Collection System consists of Ticket Vending Machines (TVMs), Handheld Verifiers for magnetic tickets and passes, a Central Computer System (CCS) for the TVM network, related data communication equipment that allows the TVMs and the Clipper card readers to communicate with the central BRT facility, and the spare parts, tools, test equipment, documentation, training, technical assistance, and warranty required as part of this Contract.

B. The Contractor shall provide a magnetic ticket/pass validator integrated into the TVM. The validator installed within the TVM cabinet, shall provide the means to imprint data such as the time and date on an inserted ticket, and to provide the means for activating tickets. It shall be able to read and encode, print and activate magnetically encoded tickets.

C. The Contractor shall install the mounting poles and cables for the Clipper card readers. The Clipper card reader devices will be installed and commissioned by others.

D. The FCS specified herein shall be installed for use on AC Transit’s East Bay Bus Rapid Transit (BRT) Line. The TVMs installed shall dispense tickets and passes to the transit patrons by accepting coins and bills, and bank (credit/debit) cards. The TVM shall not dispense change.

E. The TVM shall dispense the following BRT System fare media in accordance with the AC Transit fare structure and policies:

1. Single trip tickets
2. Day passes

3. Reduced BART to BRT bus single trip transfer tickets

F. The TVM will validate and activate the above tickets and passes when dispensed.

G. The TVM validator will activate and validate the following AC Transit fare media:

1. Pre-paid single trip tickets – Adult, youth, senior and disabled

2. Pre-paid Day passes

3. Ten trip tickets - Validate and deduct rides.

H. Interoperable System - It shall be necessary for the BRT fare collection system to interface correctly with the latest version of AC Transit’s bus farebox operations. The Contractor shall furnish all equipment, materials, and software necessary to provide a complete and fully interoperable system compatible with the AC Transit bus farebox fare media. Technical specifications providing ticket encoding formats and ticket stock requirements for the bus system’s fare media will be made available to the Contractor at the contract NTP. The Contractor provided system shall be reliable in operation and in its interoperability.

I. AC Transit Furnished Materials - The Contractor shall provide all equipment and materials required to complete the Work, except for equipment and materials specifically identified as being AC Transit or others furnished as documented herein.

J. ADA Compliance - The Ticket Vending Machines located in the field shall be in compliance with requirements contained in the Americans with Disabilities Act (ADA).

K. PCI Compliance – The Fare Collection System shall be designed and configured in accordance with the requirements of PCI Data Security Standards. The Contractor shall submit design and product data to AC Transit as specified herein to support PCI compliance inspections and audits performed during design reviews and installation acceptance testing.

L. The Contractor shall employ appropriate industry standard levels of encryption as required for a PCI compliant environment, in the transmission of bank card holder data between the various systems involved in the FCS, including but not limited to the TVMs, the Central Computer System and the bank card service provider.

M. The Fare Collection System shall use Commercial off-the-shelf (COTS) equipment, hardware, software, and interfaces to the maximum extent feasible. Wherever the Contractor uses proprietary software, hardware, interfaces, or protocols, the Contractor shall identify such software and hardware equipment clearly in the system design and product data deliverables.

N. All software and hardware equipment installed at all stations shall be compatible with each other.

O. All similar equipment shall be interchangeable to the extent possible given availability of various software versions and hardware configurations.

P. The Contractor shall provide a Fare Collection System, which is service-proven as defined herein. The Contractor shall provide and install materials that are new and free of defects and that conform to the requirements of the Contract Documents.
Q. The Contractor shall complete all training 30 Days before the start of installation.

R. All spare modules, spare money containers, ticket stock, and operation and maintenance manuals shall be delivered to AC Transit at the start of installation.

2.2 SYSTEM REQUIREMENTS

A. The TVMs shall operate autonomously without operator intervention once programmed for regular day-to-day operations.

B. All TVMs shall communicate with the CCS and the bank card service provider, via the communications network described in Division 3.2, Section 27 13 10 Carrier Transmission System. The CCS shall be configured to have the following capabilities:

1. Collect sales and revenue data from the TVMs
2. Send information to the TVMs (such as fare structures, date/time, etc.)
3. Generate management reports on demand and automatically per pre-determined schedule
4. Monitor and report TVM maintenance, revenue, and security alarms
5. Control, monitor, manage, configure, and administer the TVMs.
6. Receive alarms in real time upon failure or interruption of major components or malfunctions in the TVMs including:
   a. Loss of communications with overall TVMs.
   b. Loss of communications with individual TVM Units.
   c. Tampering or theft of equipment that would cause a loss of communications.
   d. All hardware and software errors.
   e. Other errors or equipment malfunctions.

C. The Fare Collection System shall encrypt communications to/from the TVMs and the CCS and any other relevant endpoints using industry standard encryption of bank card holder data that’s required for a PCI compliant environment.

D. All TVMs shall communicate directly with the bank card clearing house for bank card transactions. Bank card data shall not be transmitted to, or stored in the CCS.

2.3 TICKET VENDING MACHINE (TVM)

A. The TVM shall be designed to ensure the safe, reliable and simple interface with patrons and maintenance/servicing personnel. The equipment shall provide patrons with displays, graphics and signage, controls and mechanisms, which are simple to use, easy to understand, and conveniently located.

B. The TVM must comply with the Americans with Disabilities Act (ADA) accessibility guidelines for reach, access, signage and Braille in accordance with the U.S. Access Board’s Americans with Disabilities Act Accessibility Guidelines for Buildings and
Facilities (ADAAG). All operable controls shall be on the front vertical plane of the equipment, and shall meet the requirements of the ADA in effect at contract NTP. The Contractor shall submit TVM product data for ACT review and approval during the design reviews in accordance with the requirements of Division 1, Section 01 33 00 – Submittal Procedures. The submittal shall include descriptions and drawings of how the TVM will achieve ADA compliance. CDRL 20750-1 ADA Compliance Approval

C. The TVM cabinet shall be of appropriate size for installation at the bus stations as indicated in the plans, and shall include:

1. Multi-point door locks and with a secure authorized ID access.
2. Audible intrusion alarms and alarm ID numbers for data tracking and monitoring.
3. The intrusion alarms shall have the ability to detect security breaches, and alert the central computer system.
4. Structural features for installation as a standalone unit.

D. The TVM shall have high security controlled locks to implement levels of security to separate maintenance and revenue servicing. High security locks and keys shall be furnished and are subject to the review and approval by AC Transit. The Contractor shall provide twenty (20) sets of keys for the TVM, and all keys shall be uniquely numbers.

E. TVM shall be a self-contained machine complete with its own cabinet and mounting stand or base, and shall be securely bolted to a concrete surface.

F. The TVM components shall be constructed and weatherproofed for outdoor usage fully exposed to the elements with vandal resistant finish. The TVMs shall utilize corrosion resistant components and fasteners suitable for outdoor installation.

G. The TVM shall be capable of being operated at the specified performance levels, stored, and maintained without impairment resulting from the natural or induced environmental conditions within which area AC Transit will use or store the equipment. TVMs shall be designed to be resistant to liquid ingress caused by driving rain and incidentally splashed water such as would occur during routine equipment and/or platform cleaning. Equipment enclosures shall comply with International Electrotechnical Commission standard 529 (IEC529) to level IP34 or equivalent.

H. The TVM finish, graphics panels, and all external surfaces, including lettering, maps, and other information displayed on the equipment shall be resistant to ultraviolet radiation and air contaminants. Airborne particulates shall not affect the operation of the TVMs.

I. TVM and its installation, shall comply with the latest federal, state and local seismic requirements and the applicable requirements of the latest Building Officials and Code Administrators (BOCA) National Building Code, the National Earthquake Hazards Reduction Program, and the US DOT final rule on Seismic Safety of Federal and Federally Assisted or Regulated New Building Construction.

J. The TVM and its installation shall conform to the following electrical requirements:

1. The TVMs shall not be affected by or generate measurable amounts of Electromagnetic Interference (EMI) and Radio Frequency Interference (RFI) from
sources in the general vicinity of the station locations that can cause interference with other electronic devices.

2. TVM shall be low power consumption able to use 120VAC 20 Amp power supplies and conform to UL and NEC specifications.

3. Power provided to the TVMs in each station will be 120 VAC, 60 Hz, 20 amp (maximum), single-phase alternating current with separate ground wires. Voltage range tolerance shall be ±10% and frequency range of +1 Hz to -3 Hz. Each TVM will be provided power from a dedicated, separate circuit.

4. The equipment shall be designed to comply with UL Standard 751, “Vending Machines,” NFPA 70, “National Electric Code,” and applicable local requirements.

5. The TVM and all of its components shall be grounded. The TVM cabinet assembly shall prevent electrical leakage or static charge. The TVM shall be designed to comply with UL Standard 751, “Vending Machines,” NFPA 70, “National Electric Code,” and applicable local requirements.

6. High voltage transients, on power and/or signal interface lines, including those due to nearby lightning strikes, shall not damage the equipment. Voltage transient suppression shall be provided for the protection of components and circuitry.

K. TVMs will use high quality electronics with built in communications capable of using Ethernet CAT6 cable with RJ-45 connectors for data transmissions.

L. All TVMs shall be furnished and supplied with failure and security alarms, which shall indicate an intrusion of the TVM or abnormal or degraded TVM operations. Additionally each TVM shall be capable of sending and receiving various data collection and monitoring signals.

M. The TVM shall provide a control relay for the station’s SCADA system which activates when an intrusion alarm is generated. The relay shall be dedicated to security violations and shall be activated in the open configuration when an intrusion alarm is detected.

N. TVM shall have user controls and a LCD display that provides easy ticket selection and payment details.

O. The TVM shall provide audio and visual assistance in English or Spanish.

P. The TVM shall make use of standard commercially available mass produced LCD color displays. The selected display shall represent the best value in terms of performance relative to the specified environment, unit cost, and long term availability and upgradeability. The displays shall be legible in full sunlight and backlit with LEDs. The displays shall not noticeably degrade in light output during the warranty period.

Q. The TVM shall include controls on the front panel to toggle the display and the audio message system between English and Spanish. The Contractor shall verify the proper language usage in both the audio and text files. The Contractor shall submit to AC Transit for approval information on the patron messages during the design review. CDRL 20750-2 TVM Patron Messages
R. The TVMs shall accept and store the following U.S. coins: nickels, dimes, quarters, Sacagawea, Susan B. Anthony (SBA) and the Presidential dollar coins. The coin acceptance and processing unit in the TVM shall meet the following requirements:

1. Contain a coin acceptor/verifier which includes a coin insertion mechanism and a verifier to accept only the specified U.S. coins.

2. The coin acceptor/verifier shall identify valid acceptable coins with at least a 99.95% accuracy.

3. Provide a coin escrow to return coins inserted by the passenger if the TVM transaction is cancelled before a ticket or pass is dispensed.

4. TVM shall be equipped with a coin vault having sufficient revenue service capacity.

S. Each TVM shall be equipped with a bill processing unit that includes a bill validator, bill escrow, bill vault, and the associated electronic assemblies. The bill processing unit shall meet the following requirements:

1. Capable of accepting each current variant of $1, $5, $10, $20, bills.

2. Accept at least 12 different types (variables) of bills inserted in any of the four possible length-wise orientations.

3. The bill validator shall have a first insertion bill acceptance of greater than or equal to 95%.

4. A bill escrow shall be included to return original bills to customer if the TVM transaction canceled.

5. The bill vault shall be a removable unit with a minimum capacity of 2000 stacked bills.

T. It shall not be possible to open the coin and bill vaults while they are installed in the TVM, nor shall it be possible to install an open or unlocked vault into the TVM.

U. The coin and bill vaults shall be designed and constructed as safe boxes of sturdy construction, manufactured from hardened steel or steel alloy of similar strength or other AC Transit approved material, and shall be able to withstand regular removal, replacement and normal handling without deformation or in any way interfering with the insertion and removal process. The coin and bill insertion shutters shall open automatically when vaults are inserted and close automatically when the vaults are removed.

V. The coin and bill vaults shall be self-locking and self-sealing, so that when they are removed from the TVM, they cannot be opened locally or re-inserted in a TVM without emptying the contents of the vaults through authorized means.

W. Bank card processing shall be provided in each TVM. The processing equipment shall consist of a bank card reader, a PIN pad and the associated control electronics, and shall meet the following requirements:

1. TVM shall accept credit cards (Visa, MasterCard, Discover, and American Express) and debit cards with encrypted PIN verification for high security transactions.
2. The bank card reader hardware supplied with the TVM shall be Europay, MasterCard and Visa (EMV) compliant. If software changes are required in the future to meet the EMV operational requirement, the TVM shall be EMV compliant without hardware changes or modifications.

3. The bank card reader shall be a push/pull (insert/remove) type device that accepts and processes standard size cards (2.125 " x 3.375 x .030 " thick) with magnetic stripe, and EMV compliant interfaces. The card reader shall be capable of simultaneously reading ISO/IEC 7811, tracks 2 and 3.

4. The PIN pad shall be a secure keypad for PIN entry whenever transaction procedure so dictate. The PIN pad shall be distinct from other TVM selection buttons, and shall be mounted adjacent to the bank card reader.

5. The PIN pad shall employ encryption as required in accordance with banking requirements.

6. The bank card reader and the PIN pad shall be fully compliant with the relevant EMV and/or Payment Card Industry (PCI) data security encryption standards in effect at the time of contract award.

X. The TVMs shall employ industry standard encryption to provide secure communications for bank card holder data transmitted over the CTS. The encryption shall be in accordance with the requirements for a PCI compliant environment.

Y. The TVM shall communicate directly with the bank card service provider/clearing house. The TVM shall not communicate with the CCS for bank card transactions and shall not provide bank card holder data to the CCS.

Z. The TVM shall have a ticket dispensing assembly meeting the following requirements:

1. The ability to vend paper single trip tickets and high coercivity magnetically encoded Day passes. Encoding specifications for magnetically encoded Day pass will be provided at Contract NTP.

2. Dispense Day passes that are compatible with the same Day passes dispensed from the existing AC Transit local onboard bus Fare Collection System.

3. Tickets and passes vended by the TVM shall be issued with an expiration date/time and station name printed onto the fare media, and shall be activated upon purchase.

4. The capacity to dispense up to three types of die cut blank paper or plastic ISO dimensioned stock. ISO dimensioned stock shall be in accordance with AC Transit's fare policies, fare structures, and approved fare media.

5. Print and issue patron bank card receipts and audit tickets for revenue accounting. The information printed for bank card receipts shall be in accordance with standard banking requirements.

6. The customer shall have the option to receive the printed bank card receipt.

7. The Contractor shall submit for review and approval, the printing formats and layouts for tickets, passes and receipts. CDRL-20750-3 TVM Ticket Printing Format
AA. The TVM shall allow overpayment of fare if the patron does not have the exact change for ticket or pass purchase. A maximum overpayment limit shall be adjustable by the Agency, and will limit the amount a patron will forfeit if an overpayment is made.

BB. The TVM System shall utilize the communications system between the Central Control Facility and bus stations. Refer to Division 3.2, Section 27 13 10, Carrier Transmission System.

CC. The TVMs shall have an established life cycle rating of ten (10) years or longer.

2.4 Ticket Validator

A. The Ticket Validator ("Validator") shall be contained within the TVM cabinet, and shall be able to operate independently of the TVM payment acceptance and ticket dispensing functions, should these fail to operate. The Validator shall be compatible with the ticket stock processed by the AC Transit bus fare collection system, as required in paragraph 2.1.G of this specification section. The functions performed by the Validator shall include the following:

1. Validate pre-paid single trip tickets automatically upon proper insertion of a ticket. Validation shall consist of imprinting the TVM number, date, time, and station identification code on a specified location on one side of the inserted ticket. Validation shall take no more than 3 second after a ticket has been inserted into the validation slot.

2. Activate pre-paid magnetic stripe Day passes automatically upon proper insertion of the pass by reading the magnetic stripe and determining if the data encoded on the stripe is valid. The Validator shall encode the activation date and time parameters on the magnetic stripe and it also shall encode the TVM number and station identification code. Activation shall take no more than 3 second after a pass has been inserted into the validation slot.

3. Deduct rides from Ten Trip tickets automatically upon proper insertion of a ticket. Validator shall read the Ten Trip ticket magnetic stripe and determine if the data encoded on the stripe is valid, and there are rides remaining. Rides shall be deducted from the ticket, and the Validator shall encode the remaining rides, the validation date and time parameters, and the TVM number and station identification code. Validation shall take no more than 3 second after a pass has been inserted into the validation slot.

4. The TVM shall contain a non-resettable electro-mechanical counter or non-volatile memory, which shall registers the total number of tickets activated by type.

5. Receive clock synchronization and configuration parameters from the Central Computer System.

6. Provide visual out-of-service enunciators on the TVM display to alert patrons of Validator malfunctions and when the Validator is out of service.

B. Ticket insertion and retrieval shall be through a horizontal slot and shall not require downward or upward movement of the ticket to effect ticket activation. The slot shall be clearly visible and readily identifiable as a ticket slot. Validators shall allow the patrons to insert and remove their ticket with a single movement of one hand.
C. Validators shall accept all ticket stock requiring activation as defined in Division 3.2, Section 27 53 50, Part 2.1.

D. The Validator shall allow tickets to be inserted only by the narrower dimension.

E. Validators shall print or magnetically encode the following information in appropriate space on an inserted ticket:
   1. Expiry Date - Month, day and the last two digits of the year, totaling six digits (e.g., 031598).
   2. Expiry Time - Four digits separated by a colon using a 12-hour clock, e.g., 11:45AM, 1:20PM (leading zero suppressed).
   3. Boarding Station Identification
   4. Remaining trips for Ten Trip tickets
   5. TVM number (3 digits)

The Contractor shall submit the Validation print format for review and approval.

CDRL-20750-4 Magnetic encoding shall comply with that tickets used on the AC Transit bus fare collection system.

Information printed or stamped on the ticket by the Validator shall be clearly understandable by patrons and fare inspectors. Larger print sizes are preferred where possible. Ticket printing shall not degrade the physical condition of the ticket. The Validator printed information shall not be erasable without obviously defacing the ticket.

F. The TVM display screen shall provide messages to customers to support Validator transactions. The display screen shall provide the following messages at a minimum:
   1. Expiry Time (Day Passes)
   2. Trips remaining (Ten Trip Tickets)
   3. Not able to process
   4. Validator Out of service

G. The Validator shall contain a clock, which shall be used to generate time signals and maintain an accurate record of year, month, day, date, and time. The clock shall receive clock synchronization information from the TVM.

H. Suitable graphics on the TVM shall direct the patron to the Validator insertion slot. Validator instructions provided on the TVM shall be in conformance with the current ADA signage requirements.

2.5 HANDHELD VERIFIER

A. The Handheld Verifiers (HHVs) shall be designed to be used by ticket inspectors that have a need for a portable magnetic ticket reading device. The device shall have the
capability to read and verify all magnetic fare media used on the existing AC Transit bus fare collection system, as required in paragraph 2.1.G of this specification section. The design of this device shall be subject to review and approval during the design review process. CDRL 20750-5 Handeld Verifier Design.

B. Functional Requirements

1. The primary function of the HHV is to allow fare inspectors to check that passengers have valid payment information on fare media that cannot be visually verified. Media includes magnetic passes and tickets. On reading the ticket, the HHV shall first indicate whether or not the ticket or pass is valid for the trip. This information shall be displayed to the fare inspector as a simple yes or no via a display. Specific logic rules to determine validity shall be determined by AC Transit and shall be downloadable to the HHV. These shall be software configurable parameters that can be modified from the CCS.

2. Audible feedback for ticket verification transactions shall also be provided. The HHV shall provide audible feedback for the results of scanning a ticket. Transaction status indicators shall include the following:
   a. Valid ticket
   b. Occurrence of a ticket reading error
   c. Invalid ticket - expired time, not activated or validated

3. Alternatively, the fare inspector may choose to display additional information such as time and location of last validation or activation. The fare inspector shall be able to check expiration date of period passes or remaining rides on a 10 trip tickets.

4. The HHV shall also be capable of reading ticket types and maintaining counts of various types of tickets inspected. The HHV shall maintain a cumulative count of each type of ticket inspected. The HHV shall also allow the inspector to manually enter data on locations, routes and runs checked.

5. The HHV shall create and store a transaction record for each inspection performed. At a minimum the following data shall be recorded and downloaded when required:
   a. Location (bus route or run)
   b. Date and time of transaction
   c. Validity of the ticket
   d. Type of ticket

6. The HHV shall have sufficient capacity to store a minimum of 5,000 transaction records.

7. The HHV shall have an internal clock and a time based algorithm by which to set inspection parameters and check ticket validity.

C. Physical Requirements
1. The HHV design shall incorporate human factors engineering principles and be of rugged ergonomic design. The unit shall be resistant to spills and dust particles.

2. The HHV shall be equipped with a commercially available rechargeable battery, which is easily replaceable in the field. An additional spare battery for each HHV shall be supplied with each HHV delivered. The battery shall last at least one full eight-hour shift. The battery life shall allow for continuous use during the eight hour shift. A main power failure or the occurrence of a low battery condition shall result in no loss of data stored in the HHV.

3. The HHV shall have sufficient keys and buttons to support minimum HHV functional requirements. Keys and touch screen shall provide tactile or audible feedback.

4. The HHV shall have a display capable of displaying alphanumeric characters. The display shall be easily read under all conditions of ambient light ranging from daylight to a darkened environment.

5. The HHV shall be a small unit and shall not weigh in excess of 25 ounces.

D. The HHV shall include communications interface equipment which allows for data exchange between the HHV and the CCS via a 10/100Base-T Ethernet network interface connection to the BRT communications network.

E. When connected to the HHV, the CCS shall be capable of recording the following information:

   1. Location and time where fare inspection has taken place
   2. Fare inspector identifying information
   3. Number of each type of fare checked and cumulative totals
   4. Number of invalid tickets read
   5. Other data on each transaction that takes place as accumulated by the HHV

F. Each HHV shall include equipment that allows for the charging of the device and spare batteries. Normal procedure shall be to insert the HHV or batteries into a cradle to perform the charging function. Optionally, cradles may be supplied that performs both the data exchange and charges batteries. Charging of batteries from the fully discharged state to the fully charged state shall not require more than four hours.

G. A spare battery assembly shall be furnished with each HHV.

H. The contractor shall provide belt mounted carrying cases for each HHV.

2.6 CENTRAL COMPUTER SYSTEM

A. System Requirements
1. All TVMs shall be connected to a Central Computer System (CCS), providing a single point of access for all TVM sales data and operation.

2. The CCS shall provide automatic monitoring and control of all TVMs connected to the network. The CCS shall also provide application software that allows access to the TVM data to authorized users on AC Transit supplied workstation computers, using the AC Transit wide area communications network.

3. The Contractor shall furnish, install, configure, and connect fare collection system servers and software for processing, displaying, communicating, and printing fare collection equipment data and information for security, maintenance, revenue, accounting and fare collection data analysis.

4. The CCS servers shall be the latest and most appropriate hardware and software. All hard drives utilized by servers shall be hot swappable and use RAID protection to increase performance and reliability. Total usable server hard drive space shall support two years of TVM transactional data and 10 years summary data and be of sufficient size to hold the operating databases, application software and all other applicable data on the CCS. Drive space shall be easily expandable to support future growth and be implemented with a spare capacity of 100%. Servers shall also contain the following features:

   a. Rack mountable chassis, with slide-out rails provided
   b. 10/100/1000 Base-T Ethernet network interface
   c. Dual, hot plug, redundant power supplies

5. Provide monitor, keyboard, pointing devices, and any other input/output devices connected directly to the CCS server.

6. The CCS shall employ industry standard security as required to meet the PCI compliance requirements and PCI compliance audits.

B. System Operations

1. The Central Computer System shall record all TVM events, sales, and alarms. The CCS shall not record or store bank card data. TVMs shall communicate directly with the bank card clearing house for bank card payment requests.

2. The Central Computer System shall provide standard and custom TVM reports and downloading of new ticket types, prices, and conditions of use.

3. The Central Computer System shall require different levels of login administration for operations.

   a. System Administration – Allows changes or modifications to any parameter.
   b. System Operator – Allows system use without access to system parameters.
   c. The management system shall keep a log of login activities and configuration changes.

4. Monitor the communications connections to the TVMs.
5. Provide a graphical user interface (GUI)

6. Maintain correct time of day, including following loss of power at various locations where system elements installed and operational.

C. Report Generation. The Central Computer System shall have the capability to generate reports documenting system performance, and other characteristics and statistics downloaded from the TVMs. As a minimum, it shall provide the following:

1. Capability to generate standard reports as well as ad hoc reports.

2. Capability to automatically generate standard reports at standard or regular time intervals (e.g. daily, weekly, monthly, etc.).

3. All output data shall be available, at a minimum, in either delimited text format or a standard data base format such as SQL.

2.7 BANK CARD CLEARING HOUSE

A. The AC Transit will establish arrangements with others to act as the bank and clearing house service provider for any bank card transactions made via the TVMs. The Contractor shall establish and maintain the connection to AC Transit’s selected bank card clearing house, and provide all associated software for purposes of determining validity of and approving (or rejecting) bank card transactions initiated at the TVM. The Contractor shall be responsible for coordinating any and all technical interfaces necessary with these service providers for handling bankcard transactions. AC Transit will provide to the Contractor the identification of its bank card clearing house service provider at the Contract NTP.

B. Contractor is responsible for configuring secure communications to/from the bank card clearing house including but not limited to industry standard encryption and network segmentation as required for a PCI compliant environment.

2.8 SYSTEM PERFORMANCE REQUIREMENTS

A. Ticket vending machines, including coin and bill acceptance functions, shall meet either the Mean Cycle Between Failure (MCBF) or Mean Time Between Failure (MTBF) criteria listed below, whichever occurs first:

1. MCBF of 10,000 cycles

2. MTBF of one failure per TVM per 60 days, calculated as an average of all machines in service over a period of 90 days.

For system performance measurements, TVMs will be grouped into those that exceed an average of 165 ticket sales and those that do not. TVMs that exceed an average of 165 ticket sales per day will be evaluated against the MCBF requirement; TVMs with an average of up to less than 165 ticket sales per day will be evaluated against the MTBF requirement.

B. TVMs that exceed an average of 165 ticket sales per day will be evaluated against the MCBF requirement; TVMs with an average of up to 165 ticket sales per day will be evaluated against the MTBF requirement.

C. Cycles shall be defined as one complete fare payment. This would include all required actions from fare media selection to the completion of the ticket issuing transaction.
D. The measures MCBF and MTBF shall be the average for the equipment type in revenue service.

2.9 SPARE TICKET STOCK

A. The Contractor shall furnish the following spare ticket stock for the BRT system operation:

1. Paper tickets – 2,000 tickets per roll or stack, quantity 1,000
2. Paper tickets with magnetic strip – 1,200 tickets per roll or stack, quantity 1,000

B. The graphics for all the ticket stock supplied shall be approved by AC Transit during the design review process. The text and graphic designs shall be similar to the current tickets used by AC Transit’s operations.

2.10 SPARE MONEY CONTAINERS

A. The Contractor shall furnish the following spare money containers for the BRT system operation:

1. Coin vault, quantity 47
2. Bill vault, quantity 47

2.11 SPARE MODULES

A. The Contractor shall furnish spare TVM modules for AC Transit use. The number of spare modules shall be equal to ten (10) percent of the total quantity of modules for all TVMs furnished under this Contract, rounded up, with a minimum quantity of one. As a minimum, these modules shall consist of:

1. CPUs
2. Ticket dispensers
3. Front Panel Displays
4. Front Panel keypads
5. Bank Card Reader and Pin pads
6. Power Supplies (of all types)
7. Bill Acceptors (including validators)
8. Coin Acceptors (including verifiers)

B. During the design review, the contractor shall submit the quantity of modules to be provided for approval. CDRL 20750-6 Spare Modules List
2.12 PRODUCT DATA

A. The Contractor shall provide product data for each component specified herein for review by AC Transit. The product data shall be sufficiently detailed to verify compliance with the Specifications or, for equipment not included in the Specifications but required for a fully operational and reliable system, shall be sufficiently detailed to verify suitability for the proposed function.

2.13 SYSTEM DESIGN REPORT

A. The Contractor shall submit a Fare Collection System Design Report for review. CDRL 20750-7 System Design Report The System Design Report shall describe the TVM components, subsystems, functions, system interfaces, and user interfaces. This report shall include but be not limited to the following:

1. System Operations and Management
   a. Fare Collection Management System
   b. Fare Collection System Operations

2. Report Generation

3. TVM unit
   a. Components
   b. Functions
   c. Communications

4. Central Computer System
   a. Operating, database and application software
   b. System hardware descriptions and configurations

5. PCI Compliance
   a. Description of methods used to meet PCI Compliance Standards
   b. Recommended security access control lists (ACL) and firewall rules
   c. Network diagram illustrating bank card data flows from TVM to Bank Card server.

6. System Performance

B. The System Design Report shall be sufficiently detailed to verify compliance with the System Requirements and to verify suitability for the proposed function.
2.14 EQUIPMENT WARRANTIES

A. Manufacturer's Standard Warranty
   1. All components to be supplied under contract shall include the manufacturer's standard warranty for replacement or repairs. The warranty shall include repair or replacement of all failed components at a factory authorized depot repair service.

B. Manufacturer's Extended Warranty
   1. Where the term of the manufacturer's standard warranty is less than two years from the completion of the System Acceptance Test and an extended warranty is available from the manufacturer, the Contractor shall provide the manufacturer's extended warranty for a period of not less than two years from the completion of the System Acceptance Test.

C. A warranty certificate shall be supplied for each component from the designated depot repair site indicating the start and end dates of the warranty, and each component's serial number. The certificate shall be supplied at the conclusion of the System Acceptance Test. The certificate shall name AC Transit as the recipient of the service, and shall warranty the component for a minimum of two years. AC Transit shall have the right to transfer this service to other private parties who may be contracted to perform overall maintenance of the equipment.

PART 3 - EXECUTION

3.1 INSPECTION OF EQUIPMENT BY AC Transit

A. AC Transit reserves the right to inspect any completed assemblies prior to delivery of the material to the project site. Any deviances from these specifications that are identified during such testing shall be corrected prior to shipment of the assembly to the project site.

3.2 INSTALLATION

A. Ticket Vending Machines
   1. The ticket vending machines shall be installed at the locations as indicated on the Contract Drawings.

   2. The Contractor shall install the necessary power supply cables and communications cables from the power supply source and communications equipment cabinet at each location.

   3. The cables shall be of sufficient length to terminate all required functions at its end points.

B. Clipper Card Reader Mounting Poles
   1. The Clipper card reader mounting poles furnished by others shall be installed at the locations as indicated on the Contract Drawings.

   2. The Contractor shall install the power cables and Ethernet communications cables for the readers.
3. The cables shall not be terminated and shall be installed with the lengths of cabling extended from the pole as shown in the drawings.

C. Central Computer System

1. The Contractor shall install the CCS hardware and software in a central control facility. The Contractor shall follow all installation requirements for the CCS servers as specified in Division 3.2, Section 27 22 10 – Communications Servers, Workstations and Video Monitoring System. AC Transit will provide the space suitable for the hardware installation, and an Ethernet connection to the BRT communications network. The Contractor shall indicate to the AC Transit the minimum space requirements for the CCS hardware.

2. The Contractor shall install the required software applications required to operate the CCS; on each AC Transit supplied workstation computers.

D. The Contractor shall submit Installation Drawings, showing installation details for the TVMs and Clipper card reader mounting poles at each bus station or group of bus stations, for review. CDRL 20750-8 TVM Installation Drawings and Plans

E. The Contractor shall install the HHV communications interface and power charges equipment in a central facility to be identified by AC Transit. The Contractor shall coordinate the installation of the equipment with AC Transit.

3.3 OPERATIONAL AND ACCEPTANCE TESTING

A. All testing shall comply with the requirements specified in Division 3.2, Section 01 45 23 Communications Commissioning and Testing. Additional testing requirements for the Fare Collection System are provided below.

B. Operational Test

1. The Contractor shall provide an Operational Test Plan for review and approval at least thirty (30) days prior to the commencement of the Operational Tests. CDRL 20750-9 Operational Test Plan

2. The Contractor shall conduct an Operational Test for the TVM equipment installed under this Contract. The Operational Test shall be conducted to verify that each component or subsystem of the TVM functions in accordance with the Specifications and as required for a fully operational TVM system.

3. The Contractor shall prepare and submit the Operational Test Results Data for review. CDRL 20750-10 Operational Test Results

4. The Contractor shall conduct an Operational Test on each TVM unit installed at a station. The Operational Test shall demonstrate each functional component of each TVM and including the ability of each TVM to communicate its functionality to the CCS.

C. System Acceptance Test.

1. The Contractor shall conduct a System Acceptance Test for the TVM System furnished and installed under this Contract. The System Acceptance Test shall be conducted to verify that installed equipment and systems function in accordance with the Specifications and as required for a fully operational TVM System.
2. The Contractor shall provide a System Acceptance Test Plan to AC Transit for review and approval at least thirty (30) days prior to the commencement of the System Acceptance Test. CDRL 20750-11 System Acceptance Test Plan

3. The System Acceptance Test shall be performed after all communication links, TVM equipment, and TVM Management Software has been implemented and completed operational testing.

4. The System Acceptance Test shall be performed over a period of ninety (90) days and shall, at the AC Transit's sole discretion, be re-started if the TVM System does not operate in accordance with the System Availability Specifications.

5. The Contractor shall prepare and submit the System Acceptance Test Results Data for AC Transit's review. CDRL 20750-12 System Acceptance Test Results

3.4 SYSTEM TECHNICAL SUPPORT

A. The Contractor shall provide on-call system technical support for a period of three (3) years from the date of Final System Acceptance. During the period when on-call system technical support is provided:

   1. All questions shall be answered and requests for information shall be provided within a 24-hour period when a request if posted.

   2. Spare parts requested by AC Transit, and that are not on AC Transit property, shall be delivered within forty-eight (48) hours of receipt of fax, email, or telephone request from the AC Transit's authorized representative.

   3. Correction of software deficiencies shall be completed within a time as agreed between the Contractor and AC Transit, based on the severity and criticality of the deficiency. At no time however, shall this time exceed ten (10) business days, unless prior approval is provided in writing by AC Transit. If the Contractor is unable to cure the deficiency within 10 business days, the Contractor shall present a "work-around" temporary solution acceptable to AC Transit.

3.5 TRAINING

A. All training shall comply with the requirements specified in Division 3.2, Section 019130 Training. Additional training requirements for the Fare Collection System are provided below.

   B. General Training Requirements

       1. The Contractor shall provide training in the operation and maintenance of the TVM System including but not limited to course development and providing instructors, supplying handouts, manuals, and classroom aids.

       2. Practical hands-on training on the TVM equipment shall occupy a significant portion of all training classes.

       3. The training presentations and material shall be in English.

       4. Training sessions shall be conducted at AC Transit facilities.
5. Instruction shall be designed to include courses described below and shall cover equipment familiarization and systems operations. The level of training shall be sufficient to bring designated employees to the level of proficiency required for performing their respective duties.

6. The Contractor shall provide experienced and qualified instructors to conduct all training sessions at AC Transit-designated training facilities. The Contractor shall be responsible for ensuring that the instructors teaching these training courses are not only familiar with the technical information, but are able to utilize proper methods of instruction, training aids, audiovisuals and other materials to provide for effective training.

7. The Contractor shall record onto standard DVD discs or other media acceptable to AC Transit at least one session of each different training course.

8. The Contractor shall provide training equipment that is identical to the equipment in the field to allow the users to receive hands-on training in the classroom environment.

9. The Contractor shall submit a Training Plan and Schedule for AC Transit review at least ninety (90) days prior to the commencement of the training. CDRL 20750-13 Training Plan and Schedule

10. The Contractor shall submit the Training Curricula and Materials for review by AC Transit at least sixty (60) days prior to the commencement of the training. No training shall occur until training materials have been approved by AC Transit. The curricula shall meet all training requirements and indicate course content, training time requirements, and intended audience. CDRL 20750-14 Training Curricula and Materials

11. The Contractor shall provide experienced and qualified instructors to teach the training courses as described below. The Contractor shall submit resumes of the instructors at least sixty (60) days prior to the beginning of the training course for approval by AC Transit.

12. Training will include details about the network security protocols and configurations installed by the Contractor. The training shall provide instructions for AC Transit employees to access all devices or nodes, and the proper means to remotely access these nodes.

C. Maintenance Training

1. The Contractor shall provide an instructor who is experienced and qualified in the troubleshooting and maintenance of the TVM equipment.

2. The Contractor’s instructor(s) shall instruct AC Transit instructors and technicians who will be responsible for maintenance of the equipment.

3. Maintenance technician training shall commence during the time when equipment is installed in, or at AC Transit facilities, including bus stations, transit terminals, and AC Transit maintenance facilities.

4. The Contractor shall conduct troubleshooting and repair tests to demonstrate the competency of the training participants in the maintenance of the equipment at the completion of the training.
D. Information Technology Training

1. The Contractor shall provide training to fully familiarize Information Technology (IT) personnel with all aspects of the Central Computer System and the TVM software including the structure of the application, tables utilized network connections and settings, plus other similar information.

2. The Contractor shall conduct training on the Central Computer System and the TVM that is sufficiently detailed to provide a thorough understanding of the following elements:
   a. Application architecture
   b. Data dictionaries
   c. Data flows
   d. System flows
   e. Interfaces
   f. Data base table relationships
   g. Development tools used
   h. Development assumptions
   i. Data conversion methods
   j. Directory structures
   k. Recommended backup procedures
   l. Processing scripts
   m. Application programs
   n. Data security
   o. Database tuning
   p. Archival processes

3. Data diagrams shall be developed using the latest version of Visio.

4. All programs shall be defined and described fully showing all inputs/outputs, samples of reports, logic flows and major functions described, as well as assumptions used during program development.

E. Operator Training

1. The Contractor shall provide an instructor who is experienced and qualified in the operation of the Fare Collection System.

2. The Contractor shall instruct AC Transit instructors and employees who will operate the equipment on a day-to-day basis.
3. The Contractor shall conduct operational tests to demonstrate the competency in the training participants in the operation of the TVM equipment at the completion of the training.

F. Training Materials

1. The Contractor shall prepare training materials as specified herein.

   a. Course Outlines. Course outlines with learning objectives shall be provided for each training course. The course outline shall provide a topic outline for each major operating function. Maintenance courses shall include a section devoted to system fault analysis and troubleshooting.

   b. Lesson Plans. A set of lesson plans shall be developed for each topic outline, and shall contain the following information:

      (1) Lesson title,
      (2) Lesson objectives,
      (3) Training aids required,
      (4) Sequence of Instruction.

   c. Training Aids. Visual aids shall be developed for each topic.

   d. Instructional Material. The primary source of instructional material shall be the applicable equipment operating and maintenance manuals. In addition, the Contractor shall develop, for each course, notebooks containing such additional drawings, descriptive information and procedures necessary to ensure that all learning objectives are met in an orderly and timely manner.

   e. Instructional Equipment. Training shall be conducted utilizing equipment that is identical to field equipment in normal operating condition. All operating equipment, tools, and test equipment needed for the training program shall be furnished by the Contractor.

3.6 SYSTEM DOCUMENTATION


C. System documentation shall be provided in the following quantities:

   1. Ten (10) complete System Operations Manuals printed and properly bound in three-ring binders or other equivalent.
2. Ten (10) complete System Maintenance Manuals printed and properly bound in three-ring binders or other equivalent.


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SECTION 34 42 36

SUPERVISORY CONTROL AND DATA ACQUISITION SYSTEM (SCADA)

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The Work of this Section consists of the requirements for providing Programmable Logic Controllers (PLCs), hardware, interface equipment, and related software and other materials required for SCADA monitoring and control at station platforms throughout the East Bay Bus Rapid Transit (EB BRT) alignment and the EB BRT Operations Control Center (OCC), and GO.

B. The Work shall include design, manufacture, installation, supply, testing, training, initial in-service support, and in-service performance verification of system hardware and software.

C. The Contractor shall provide a fully operational SCADA System that is compatible and integral with all systems/subsystems that are required for the EB BRT.

D. The Contractor shall coordinate with the ACT (Alameda Contra Costa Transit District) to ensure that no additional ACT Contracts shall affect the design of the SCADA System.

E. The Contractor shall coordinate with the ACT to ensure proper and timely installation of all the SCADA equipment and software.

F. The Contractor shall coordinate with the ACT to ensure proper and timely integration of all the SCADA project elements.

G. The Contractor shall coordinate with ACT and other system vendors to ensure that interfaces between SCADA and the other EB BRT subsystems (TVM, CCTV, Electrical) are successfully integrated.

H. The following is an overview of the items and services that shall be supplied by the Contractor to complete the Work and fulfill the requirements of the Contract Documents.

1. Provide for the control of station platform equipment and for the monitoring of failure alarms, intrusion detection and points on station platform equipment.

2. Configure network security including but not limited to firewall rules and router/switch access lists to provide adequate security for the sensitivity of the data being transmitted, as approved by ACT.

3. Provide the following components for the SCADA system:

   a. The SCADA servers associated control and management software applications shall be virtualized to ACT existing VMware environment. The server software shall support existing ACT VMware environment and install to the existing ACT servers. Contractor shall coordinate with ACT to virtualize the servers in the existing ACT VMware environment.

   b. All associated software applications, installed on Workstations at each BRT Workstation (including spares), Video Monitoring System Workstation, and Engineering Workstation, as shown in the Contract...
Drawings. Refer to Division 3.2, Section 27 22 10 Communications Servers, Workstations and Video Monitoring System. Be accessible from all console positions at the OCC (SCADA and Security);

c. SCADA PLCs shall be provided in each of CIC on the station platforms.

1.2 RELATED WORK

A. Division 1, Section 01 33 00, Submittal Procedures

B. Division 3.2, Section 27 16 10, Communications Low-Voltage Distribution

C. Division 3.2, Section 27 22 10, Communications Servers, Workstations, and Video Monitoring System

D. Division 3.2, Section 27 51 10, Closed Circuit Television System (CCTV)

E. Division 3.2, Section 27 51 16, Public Address System

F. Division 3.2, Section 27 53 50, Fare Collection System

1.3 INTENT OF TECHNICAL SPECIFICATIONS

G. In cases where specific requirements for the Work are set forth in the Contract Documents, they are intended to be minimum requirements; the Contractor shall provide additional capability, if required by its solution. For example: If a requirement calls for 32 megabytes of memory to be provided, the Contractor shall provide a minimum of 32 megabytes; even if its system is capable of operating with less than 32 megabytes of memory, the required 32 megabytes shall still be provided. In addition, if the Contractor’s proposed system requires 64 megabytes of memory to operate, then the required 64 megabytes shall be provided at no additional cost to ACT.

H. These Technical requirements include, but are not limited to, the performance requirements of the SCADA System, and should not be interpreted as indicating any requirement to supply any specific product of any particular manufacturer, unless it is required for compatibility with existing ACT systems. The descriptions of equipment form and function, which are found in the following sections, are intended to indicate the salient characteristics of equipment that will satisfy the operational requirements of ACT and meet the requirements of the Contract Documents. All equipment, whether specifically identified or otherwise required to fulfill the requirements contained in the Contract Documents, shall be subject to written approval by the ACT.

I. Deviations from Contract Documents

1. The Contractor may propose alternative means of achieving the function and intent of specific requirements defined in the Contract Documents if such a change provides a material benefit to ACT and meets the established goals of the EB BRT Project as defined within these Contract Documents.

2. The proposed alternative(s) shall be clearly described in a dated letter to the ACT. Reasons for requesting consideration of the alternative, and the impact and benefits to ACT shall be clearly articulated. Specific references to Contract Document sections that need to be revised, to allow the alternative(s), shall be cited.
3. The ACT at its sole discretion will accept or reject any proposed alternative.

J. The Contract Documents taken together as a whole describe an integrated system and, as such, they are all interrelated. It is essential that the Contractor understands the integrated requirements of the EB BRT System to successfully deliver the SCADA System. Therefore, it is the responsibility of the Contractor to understand the complete Contract.

1.4 APPLICABLE STANDARDS

A. Contractor’s design, fabrication, inspection, installation and testing shall comply with all applicable Standards and Codes as listed herein. All SCADA equipment and methods shall comply with the latest version of the standards as listed herein:

1. American National Standards Institute [ANSI]
   d. ANSI X3.135 – Standard Database Language SQL
   e. ANSI X3.124 – GKS Standard
   f. ANSI NCITS/J16 – Standards for Programming Language C++
   g. ANSI Z1.4-1993 – Sampling Procedures and Tables for Inspection by Attributes

2. Electronic Industries Association [EIA]
   a. EIA RS-422 – Recommended Standard Interface for Connecting Serial Devices
   b. EIA RS-232-C – Recommended Standard Interface for Connecting Serial Devices

3. Institute of Electrical and Electronics Engineers [IEEE]
   c. IEEE 829 – Standard for Software Test Documentation
   d. IEEE 830 – Recommended Practice for Software Requirements Specifications
   e. IEEE 1003.1 – Portable Operating System Interface for Computer Environments
   f. IEEE 1016 – Recommended Practice for Software Design Descriptions
   g. IEEE 1028 – Software Reviews and Audits
   h. IEEE 1058.1 – Standard for Software Project Management Plans

4. International Organization of Standardization [ISO]
   b. ISO 9899 – Programming Languages – C
   c. ISO – WG21 – Standards for Programming Language C++

5. Military [MIL]
   a. MIL STD-781 – Reliability, Test Methods, Plans, and Environments for Engineering, Development, Qualification and Production
   b. MIL STD-1472E – Human Engineering
   c. MIL STD-2167A – Data Item Description Specification

6. Telecommunications Industry Association [TIA]/Electronic Industries Association [EIA]
   a. TIA/EIA 568-B – Commercial Building Telecommunications Cabling Standard
   b. TIA/EIA 569 – Commercial Building Standard for Telecommunications Pathways and Spaces


1.5 ACRONYMS AND DEFINITIONS

A. ACT - Alameda Contra Costa Transit District
B. ANS – Ambient Noise System
C. ANSI - American National Standards Institute
D. BRT – Bus Rapid Transit
E. OCC – Operations Control Center
F. CCTV - Closed Circuit Television
G. CD – Compact Disk
H. CDRL – Contract Data Requirements List
I. CIC - Communications Interface Cabinets
J. CID – Clipper Interface Device
K. CTS – Carrier Transmission System
L. DVD – Digital Video Disk
M. EB – East Bay
N. EIA - Electronic Industries Association
O. EIC – Electrical Interface Cabinet
P. FAT - Factory Acceptance Test
Q. GUI – Graphical User Interface
R. ID – Identification
S. IEEE - Institute of Electrical and Electronics Engineers
T. I/O – Input/Output
U. IP – Internet Protocol
V. ISO - International Organization of Standardization
W. LAN – Local Area Network
X. LDAP - Lightweight Directory Access Protocol
Y. Manufacturer’s Warranty - Preprinted written warranty published by individual manufacturer for particular product and specifically endorsed by manufacturer to ACT.
Z. MIL - Military
AA. MPEG – Moving Pictures Experts Group
BB. NVR – Network Video Recorder
CC. PA – Public Address
DD. PLC – Programmable Logic Controller
EE. RTU – Remote Terminal Unit
FF. SAT – Site Acceptance Test
GG. SCADA - Supervisory Control and Data Acquisition
HH. SCU - Station Control Unit
II. STP – Software Test Plan
JJ. TCP – Transmission Control Protocol
1.6 **SUBMITTALS**

A. Provide all submittals in accordance with the requirements of Division 1, Section 01 33 00–Submittal Procedures

B. SCADA System Product Data: Submit product data for all products, including manufacturers catalog data sheets, model numbers, and specifications in CDRL 20040-01

C. Power Schematics: Submit SCADA power schematics, voltage drop calculations, and standby battery calculations, and include with CDRL 20110-03 as specified in Division 3.2, Section 27 16 10 Communications Low-Voltage Distribution. CDRL-20110-03.

D. SCADA System Software Programming: Submit a backup copy of the latest software used to program the SCADA central processing system, in a DVD or Compact Disk (CD) format, or other compatible media with software revision number clearly labeled, and dated. This DVD or CD backup shall be kept up to date. When a change is made to the software, a new backup shall be supplied. The backup shall include the complete system so that by following a procedure, a usable system can be reproduced from the DVD or CD. Each DVD or CD shall contain a document that explains the changes made to the previous version of software that creates the new version in CDRL-20040-02.

E. SCADA Points Lists: Submit site-specific, comprehensive, SCADA indication and control points list for each platform, each communications node and other facilities indicated on contract drawings in CDRL-20040-04.

F. SCADA Design: Submit detail design documents such as system architectural and network topology diagrams, screen layouts, alarms, messages, diagnostic alarms and messages, Software Requirements Specifications, and other design information in accordance with the requirements of Division 1, Section 01 33 00–Submittal Procedures. All SCADA design document shall be subject to ACT review and approval in CDRL-20040-05.

G. Requirements Management: Submit a Requirements Management Plan. CDRL-20040-09, which describes the requirements management processes (with defined roles and responsibilities), and the RM tool being used by the Contractor to track all requirements, in developing and delivering the SCADA system.

1.7 **FUNCTIONAL REQUIREMENTS**

A. General

1. Furnish and install all equipment, hardware, software and connections to provide
a fully functional SCADA system throughout the EB BRT alignment, OCC and GO.

2. All SCADA related equipment and materials provided shall meet all requirements specified.

3. Network security including but not limited to firewall rules and router/switch access lists to provide adequate security for the sensitivity of the data being transmitted, as approved by ACT.

B. SCADA Interfaces

1. SCADA PLCs in CIC at each station platform shall connect with, but not be limited to, the following devices alarm output; Ticket Vending Machines (TVMs), Uninterruptible Power Supplies (UPS) and Communications Interface Cabinets (CIC) and Electrical Interface Cabinets (EIC) intrusion detection devices.

2. Monitoring of equipment indications shall include, but not be limited to, the following typical systems and functions:

3. Monitoring of equipment indications shall include, but not be limited to, the following typical systems and functions:

   a. Intrusions alarms – EIC, CIC, TVM;

   b. EIC – Lighting ON/OFF status, Breaker open/close status, breaker trip alarm, loss of main power;

   c. CIC – high temperature, high temperature, A/C fault, UPS bypass switch on/off, breaker open/close status, breaker trip alarm;

   d. UPS – Loss of main AC power, load on battery, low battery, bypass, fault/trouble;

   e. CCTV Camera – Contractor is required to implement the automatic digital pan/tilt/zoom (PTZ) to specific target (TVM, CIC, EIC) triggered by associated intrusion alarms. Contractor shall implement all necessary software or hardware interfaces between the SCADA system and the CCTV System to achieve this requirement. Contractor can also use CCTV camera DI to trigger digital PTZ instead of SCADA system.

4. Contractor shall analyze all SCADA interfaces for each location (station platforms, communications node, and other facilities) as shown in the Contract Drawings, and shall document each instance of the SCADA interfaces as inputs or outputs in the SCADA Points List CDRL-20040-04.

C. Graphical User Interface (GUI)

1. SCADA shall be supplied with a GUI showing diagrams and map of the EB BRT line indicating each Station platform, and the ability to select Station platform(s) and each piece of Station platform equipment associated with the SCADA system.

2. The GUI shall have the capacity to show event log and history data.
3. The SCADA GUI shall include real-time status indications of equipment being monitored by SCADA along the EB BRT alignment.

D. Command, Control and Monitoring of SCADA Devices

1. SCADA shall support programmable calculation and control algorithms, which include the following mathematical and logical functions: add, subtract, multiply, divide, assign, log, exponential, sine, cosine, tan, arcsine, arccosine, arctangent, equal to, not equal to, greater than or equal to, less than, less than or equal to, square root, absolute value, reciprocal, AND, OR, NOT, and XOR.

2. A maximum of 2.0 second shall elapse from the first possible detection by a Programmable Logic Controller (PLC) of a read request for the current state of any input(s) or internal alarms, until the results are available for display and recording by the SCADA head end system at the OCC.

3. A maximum of 2.0 second shall elapse from the first possible detection by a PLC of a control request to change the state of any outputs, until the requested logic state of the output appears at the terminals of the Input/Output (I/O) module associated with the output.

4. The 2.0 second shall include the time for the PLC to receive the write request via the Carrier Transmission System (CTS), process it, and set the requested logic state of the output at the terminals of the I/O module.

5. The SCADA system shall be sized such that a minimum of 100% spare capacity, in terms of memory and I/O points, is available at delivery.

6. Full restoration of operation shall occur upon restoration of communications, after a loss of communication between the PLC and SCADA head end system.

7. PLC configuration and program software, diagnostic and testing software shall be provided.

E. SCADA Configuration

1. Alarms shall be categorized by user classification; there should be at least one user classification for each maintenance group, security and operations.

2. Authorized users shall be able to disable/re-enable or reset an alarm condition.

3. Alarms shall be given configurable attributes for “Viewing” and responsible for “Acknowledging” by user classification such that the alarms are only directed to the interested users.

4. Only one user classification shall be responsible for Acknowledgment of a particular alarm.

5. SCADA alarms shall be grouped as follows:

   a. Intrusion Detection;

   b. Equipment Alarms;

   c. Air Conditioning failure alarms and high temperature alarm;
d. Operations Alarms;

e. Power Alarms.

6. SCADA alarms shall also have audio tones, along with a visual alarm indication on console displays (e.g. workstation monitors).

7. SCADA alarm tones shall be configurable by an authorized user.

8. One of the SCADA alarm tone configurations shall be ‘no tone’.

9. Authorized users shall be able to enter SCADA values to equipment status to indicate when a device has been repaired and placed back into service.

F. SCADA Points

1. The SCADA GUI shall include real-time status indications of equipment being monitored by SCADA along the EB BRT alignment.

2. For each Station platform’s SCADA points for Health and Welfare shall be monitored.

3. For each Station platform’s TVM, SCADA points for Intrusion Detection shall be monitored.

4. For each Station platform’s CIC, SCADA points for Health and Welfare, Communications Panel Breaker alarm, High Temperature alarm, Intrusion Detection and UPS Loss of MainPower shall be monitored.

5. For each Station platform’s EIC, SCADA points for Health and Welfare, Electrical Panel Breaker alarm, Intrusion Detection, and Loss of Main Power shall be monitored.

6. For each Station platform’s UPS, SCADA points for UPS Health and Welfare, Loss of Main Power, Battery Status, UPS fault, and UPS By-Pass shall be monitored.

7. For each Station platform’s Lights, SCADA points for EIC cabinet Panel Breaker status and Main Panel Breaker alarms shall be monitored.

8. For each Station platform’s Air Conditioners (attached to CIC), SCADA points for Health and Welfare (e.g. high temperature alarm).

9. An authorized user shall be able to add/remove SCADA points to be monitored / controlled.

10. An authorized user shall be able to configure the SCADA point database, which contains the point identifier, units for the value, limits (may be a range of values that an input is compared against) and the associated state (may be textual for more meaningful messages).

11. The SCADA points data shall be stored in the SCADA points history database in the SCADA servers. All SCADA events (i.e. change of state of any point) shall be stored in the points history database.
12. An authorized user shall be able to configure the SCADA point database, which shall contain the point identifier, units for the value, limits (may be a range of values that an input is compared against) and the associated state (may be textual for more meaningful messages).

13. Example a Bus Station/platform Typical SCADA Points List

a. EIC Loss Main Power (DI)
b. EIC Main Breaker ON/OFF (DI)
c. EIC Main Breaker Trip (DI)
d. EIC Canopy LTG Breaker 1 ON/OFF (DI)
e. EIC Canopy LTG Breaker 1 Trip (DI)
f. EIC Canopy LTG Breaker 2 ON/OFF (DI)
g. EIC Canopy LTG Breaker 2 Trip (DI)
h. EIC Platform LTG Breaker ON/OFF (DI)
i. EIC Platform LTG Breaker Trip (DI)
j. EIC Lighting Control Breaker ON/OFF (DI)
k. EIC Lighting Control Breaker Trip (DI)
l. EIC Spare Breaker 1 ON/OFF (DI)
m. EIC Spare Breaker 1 Trip (DI)
n. EIC Spare Breaker 2 ON/OFF (DI)
o. EIC Spare Breaker 2 Trip (DI)
p. EIC CIC Breaker ON/OFF (DI)
q. EIC CIC Breaker Trip (DI)
r. EIC CIC HVAC Breaker ON/OFF (DI)
s. EIC CIC HVAC Breaker Trip (DI)
t. EIC Platform Receptacle Breaker ON/OFF (DI)
u. EIC Platform Receptacle Breaker Trip (DI)
v. EIC CIC Receptacle Breaker ON/OFF (DI)
w. EIC CIC Receptacle Breaker Trip (DI)
x. EIC TVM Breaker ON/OFF (DI)
y. EIC TVM Breaker Trip (DI)
z. EIC CCR Breaker ON/OFF (DI)
aa. EIC CCR Breaker Trip (DI)
bb. EIC Breaker ON/OFF (DI)
cc. EIC Breaker Trip (DI)
dd. EIC Intrusion alarm (DI)
e. Station Light On (DI)
ff. Station Light Control Fault (Calculation point)
gg. CIC Intrusion alarm (DI)
hh. CIC high temperature (AI or DI)
i. CIC high temperature (DI or using high temperature AI)
jj. CIC Air Conditioning fault (DI)
kk. CIC UPS Manual Bypass Switch ON/OFF (DI)
ll. CIC UPS Loss Main AC Power (DI)
mm. CIC UPS Load on Battery (DI)
nn. CIC UPS Battery Low (DI)
oo. CIC UPS Bypass (DI)
pp. CIC UPS fault/trouble (DI)
qq. CIC Main Breaker ON/OFF (DI)
rr. CIC Main Breaker Trip (DI)
ss. CIC Air Conditioner Breaker ON/OFF (DI)
tt. CIC Air Conditioner Breaker Trip (DI)
uu. CIC VMS Breaker ON/OFF (DI)
vv. CIC VMS Breaker Trip (DI)
ww. CIC Equipment Breaker A ON/OFF (DI)
xx. CIC Equipment Breaker A Trip (DI)
yy. CIC Equipment Breaker B ON/OFF (DI)
zz. CIC Equipment Breaker B Trip (DI)
aaa. CIC CTS Equipment Alarm 1 (DI)
bbb. CIC CTS Equipment Alarm 2 (DI)
ccc. CIC CTS Equipment Alarm 3 (DI)
ddd. CIC CTS Equipment Alarm 4 (DI)
eee. TVM Intrusion Alarm (DI)

G. Report

16. The SCADA system shall have the capacity to generate a report and print the report.

17. The data in the report data can be configured and defined from real-time data and history database data.

PART 2 - PRODUCTS

2.1 General

A. General: Furnish all products, services, software, training and documentation necessary to meet the requirements in this specification.

B. The Contractor shall be responsible for the storage of all equipment until each particular facility is ready for installation. Coordinate with ACT for the delivery of all equipment to each facility.

2.2 Hardware

A. All hardware shall be manufactured, fabricated, assembled, finished, and documented with workmanship of industry standard production quality and shall conform to all applicable quality control standards of the original manufacturer and the Contractor.

B. All hardware components shall be new and suitable for the purposes specified.

C. PLCs

1. PLCs shall be provided at station platforms as indicated on the Contract Drawings.

2. A main CPU module shall provide for data collection, message formatting, communication and transmission.

3. The Contractor shall provide necessary I/O peripherals modules required for the interface function for statuses, i.e. digital inputs (DI), controls and analog points.

   a. Contractor shall provide I/O modules for a minimum of 64 DI points.

4. Each PLC location shall be interfaced to the Communication Transmission System (CTS) for data transmission between the platforms and central processing equipment at OCC. PLC integrates to the CTS with network security.
including but not limited to firewall rules and router/switch access lists to provide adequate security for the sensitivity of the data being transmitted, as approved by ACT.

5. A visual indication, such as a LED, that the PLC is sending and receiving data on each link shall be provided.

6. Communications systems equipment, alarms, status and control (where applicable) may be interfaced via serial or Ethernet links.

7. Standard industry protocols supporting spontaneous exception reporting shall be used for data transmission.

8. The PLC programs developing kit shall be provided.

D. Overload and Surge Withstand Capability

1. SCADA system input and output signals shall operate under specified overload conditions, recover to normal operation after other specified overload conditions, and limit damage that can be caused by other, more severe, overload conditions. The overload and surge withstand requirements are described in the following:

   a. Input overload response characteristics shall be tested as described in ANSI MCS.1 (ISA RP 55.1).

   b. Overloads (dc or peak ac) shall not result in propagation of any damage beyond the single input or output point at which the overload has occurred.

2. The SCADA system I/O shall meet IEC 61000-4 requirements.

E. Power Supply Requirements

1. The SCADA system shall be capable of operation with the power sources that are supplied from an uninterruptible, conditioned power source (UPS). An input power circuit shall be provided to each enclosure as required.

2. Remote equipment, including station PLCs shall be powered from a Contractor furnished 120 VAC, single phase, 60 Hz uninterruptible power supplies (UPSs) capable of supporting PLC and other communication equipment operation for minimum 60 minutes in event of loss of power.

3. All fuses, breakers, switches, and surge protection necessary to protect the hardware supplied as part of the SCADA system shall be provided by the Contractor.

F. Environmental

1. All SCADA System station equipment shall be capable of operation in the temperature range of 0˚ to 65˚ C (32˚ to 150˚ F).

G. Spare Parts and Test Equipment

1. Provide spare parts and test equipment in accordance with the requirements of Division 3.2, Section 01 45 25 Communications Spare Parts and Test Equipment
PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall provide and install all equipment in accordance with all Contract and manufacturers’ requirements, with ACT approved Contractor drawings and consistent with good commercial practices.

B. Refer to Division 3.2, Section 01 45 23 Communications Commissioning and Testing, for testing requirements of the SCADA systems. All test equipment shall be provided as per Division 3.2, Section 01 45 25 Communications Spare Parts and Test Equipment.

C. Refer to Division 3.2, Section 01 91 30 – Training, for training requirements of the SCADA systems.

3.2 INTERFACE REQUIREMENTS

A. The system shall have the functional and physical interfaces associated with station platform devices that require supervisory control and remote monitoring from a user workstation running the SCADA software. Equipment status or alarms reported to PLCs are defined as “Indications”; likewise, commands sent to the equipment via PLCs are defined as “Controls”.

B. Points

1. The Contractor shall provision SCADA system equipment to provide points (controls and indications) at all locations indicated on the Contract Drawings.

2. PLCs, as installed, shall contain 100% spare indication points and 100% spare control points for each location.

C. Interfaces shall be provided for all equipment indicated on Contract Drawings and as necessitated by the Contractor’s final design.

3.3 INSTALLATION

A. Install equipment in accordance with Contract Requirements and ACT approved installation drawings. Installation plans shall show details containing cable runs and layouts, interconnections/interfaces, and physical space requirements.

3.4 TESTING

A. SCADA testing shall follow all requirements as specified in Division 3.2, Section 01 45 23 – Communications Commissioning and Testing and the Systems Test Plan.

B. SCADA testing shall verify that the system response time is no more than 2.0 seconds.

C. SCADA testing shall be able to verify that an authorized user is able monitor each Station platform’s equipment attached to SCADA, from each BRT Workstation.

D. SCADA testing shall be able to verify that an authorized user is able to manually select and send commands to each Station platform’s equipment, from each BRT Workstation.

E. SCADA testing shall be able to verify that an authorized user is able to configure all the parameters for each type of SCADA point, from each BRT Workstation.
F. SCADA testing shall be able to verify that an authorized user is able to configure GUI Slide and report.

G. The Contractor shall be able to perform the following SCADA functional tests:

1. View the SCADA graphical display(s) and select Station platforms and each piece of equipment being monitored and controlled by SCADA;

2. View all SCADA point values and see these changes;

3. Testing of the SCADA Report and Database capability.

3.5 TRAINING

A. SCADA training shall follow all requirements as specified in Division 3.2, Section 01 91 30 – Training.

B. The Contractor shall provide an all-encompassing training program for ACT personnel involved in the operations and maintenance of the SCADA.

C. The Contractor shall provide training for all software that is used within the SCADA, including platforms, tools, applications, COTS software, software development environment, semi-custom software and custom software.

END OF SECTION
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The work shown on the EBMUD Contract Drawings shall be done in accordance with the 2012 Edition of “EBMUD Standard Specifications” except as otherwise noted below, insofar as the same may apply, and in accordance with the 2012 Edition of “EBMUD Standard Drawings” and these Special Provisions.

Copies of the “EBMUD Standard Specifications for Installation of Water mains 20” and Smaller dated November 2012” are available online at: https://www.ebmud.com/sites/default/files/pdfs/stdspec20andsmaller_nov2012r1_web_1.pdf

Copies of the “EBMUD Standard Drawings for Installation of Water mains 20” and Smaller dated November 2012” are available online at: https://www.ebmud.com/sites/default/files/pdfs/stddwg20andsmaller_nov2012rev1.web__0.pdf

PAYMENT

Full compensation for obtaining permits and furnishing all labor, materials, water, tools, and equipment, and for performing all work shown on the EBMUD Contract Drawings and covered in these Specifications, including excavation for form work and removal and disposal of all waste surplus materials, shall be considered as included in the lump sum bid price for EBMUD Work covered in the estimate, complete in place.

Contractor shall provide the Engineer a detailed schedule of values, after contract award, including all items of work included in the lump sum bid price for EBMUD Work.

GENERAL CONDITIONS

The General Conditions of the 2012 Edition of “EBMUD Standard Specifications” are modified as follows.

1. DEFINITIONS

Replace 4th paragraph of Section 1, DEFINITIONS, of the General Conditions with:

Applicant: Contractor hired by Alameda Contra Costa Transit

Engineer: The Engineer of the owner (AC Transit) acting directly or through authorized agents, such agents acting within the scope of particular duties entrusted to them.

3. CHANGES

Replace Section 3, CHANGES, of the General Conditions with:

Not Used

5. CONTRACTOR’S LICENSE

Replace Section 5, CONTRACTOR’S LICENSE, of the General Conditions with:

Refer to the requirements of Division 0, Section 00 11 00, Part 1.4 of these Contract Documents.

6. INSTRUCTIONS TO APPLICANTS

Replace Section 6, INSTRUCTIONS TO APPLICANTS, of the General Conditions with:

Refer to the requirements of Division 0, Section 00 21 13 on these Contract Documents.

7. GUARANTEE
Replace Section 7, GUARANTEE, of the General Conditions with:

The Contractor hereby guarantees that any work performed by it under this contract will be performed in accordance with the drawings and specifications; that any material furnished by it will be in accordance with the drawings and specifications; and that both work and materials will fully meet the requirements of these specifications.

The Contractor agrees to promptly reinstall, at its own expense, any part f the water main or any appurtenance which has not been installed in accordance with these specification and drawings.

The District has sole responsibility for making any repairs to the newly installed pipeline and appurtenances once the pipeline is placed into service. The Contractor agrees that if, from the time that pipeline is placed into service, any portion of the work furnished, installed, or constructed by the Contractor fails to fulfill any of the requirements of the contract, then the Contractor shall reimburse the District for all costs of said repairs (including overhead) beginning from the in-service date to within two year after written acceptance of the work completed under contract.

The Contractor shall be responsible for the full expense incidental to fulfilling any and all of the above guarantees and agreements. The above guarantees and agreements are covenants, the performance of which shall be binding upon the Contractor and its sureties.

8. RELOCATION OF INSTALLED MAIN

Replace Section 8, RELOCATION OF INSTALLED MAIN, of the General Conditions with:

Not Used

10. CONTAMINANTS

Replace Item A in Section 10, Contaminants, of the General Conditions with.

A. Refer to the requirements of Division 0, Section 00 72 00, Part 10.03 of these contract documents.

11. WAGE AND HOUR LAWS

Replace Section 11, WAGE AND HOUR LAWS, of the General Conditions with:

Refer to the requirements of Division 0 of these contract documents.

END OF SECTION
SECTION 01000.1 - GENERAL REQUIREMENTS

Replace Item 1 in Item B in Section 1.2 PRE-JOB REQUIREMENTS with the following:

1. Earthwork and rough grading is completed; the pavement subgrade in Segment B is acceptable to the City of Oakland and the pavement subgrade in Segment A is acceptable to State of California; street area is rough and graded to within 0.5 feet to the plus of subgrade; and all sewage and storm drain pipelines have been installed as shown on improvement drawings as submitted to the District for design purposes of the new pipeline.

Add to Item C in Section 1.5 CONSTRUCTION FACILITIES AND CONTROLS:

4. Work in Segment B shall conform to Section 7-10 of the City of Oakland Specifications and Division 0 on these Contract Documents.

5. Work in Segment A shall conform to Section 7-1.02K(6), 7-1.03, 7-1.04 of the Caltrans Specifications and Division 0 on these Contract Documents.

Replace “local” in Item 1 in Item E in Section 1.5 CONSTRUCTION FACILITIES AND CONTROLS with the following:

local and State

END OF SECTION
Add Section 01140.0 to EBMUD Standard Specification:
SECTION 01140.0 - WORK RESTRICTIONS

PART 1 – GENERAL

1.1 DESCRIPTION

A. This section describes special requirements and construction constraints that may affect the work. These requirements and constraints are in addition to those appearing elsewhere in the specifications.

B. Coordination with EBMUD

1. EBMUD will need to access each relocation site twice. First access, when Contractor starts excavation at each site. Contractor will daylight existing pipe so EBMUD can install a tap to be used by Contractor to provide test water to flush, pressure test, chlorinate and sample the main(s) that will be installed. Second access, after the Contractor has successfully pressured tested, chlorinated and passed the required water quality tests, EBMUD will transfer the related services to the new main and then make final connections and any related kills. EBMUD will require one day for the first access and 5-7 days for second access.

2. Contractor will excavate and provide safe access for all areas needed for EBMUD to complete tie-ins and service lateral connections/renewals. Contractor will also provide and remove trench plates as necessary. Upon completion of EBMUD’s work, Contractor will backfill and re-pave work areas. EBMUD will require a 3 week notice from Contractor for work schedule. Contractor will provide schedule at weekly progress meetings to help coordinate field activities.

1.2 RELATED SECTIONS

A. Installation of Steel Pipe

1. Details on pipeline installation in EBMUD Standard Specification for Installation of Water Mains 20” and Smaller.

1.3 SUBMITTALS

A. Pipeline Connection Work Plan (for all Outages and Shutdowns). Plan shall be submitted no less than 15 work days prior to performing the work for the approval of the District.

B. The connection work plan shall include the details of final dewatering of the existing pipeline and installation of necessary pipe and valves during the shutdown. It shall also contain a schedule of items of work by time required.

C. A separate plan is required for each pipeline.

1.4 PIPELINE CONNECTIONS TO DISTRICT SYSTEM

The following requirements are applicable to temporary feeds, service transfers, final connections and kills.

A. The Contractor shall:

1. Pothole and verify connection points
2. Excavate, shore and secure excavations with trench plates or other approved methods.
3. Remove coating, verify size, etc. (prior to shutdown)
4. Dewater by gravity and pumping as needed for the work. The District will turn all valves and assist with placement of additional turnouts/blowoffs as needed.
5. Make the new pipe ready for connection.
6. Provide required field support to District connection crew, including traffic control, trench dewatering, excavation, lighting, trench plate removal, etc.

B. Following the District completing the applicable temporary feeds, service transfers, final connections and kills the Contractor shall:

1. Dispose of the water used to flush the length of the shutdown pipe. For estimating purposes, this is 1.5 volumes. In any case, sufficient water must be flushed to obtain passing water quality test results.

2. Repair coatings.

3. Backfill, compact, install temporary pavement, complete required concrete repairs and install approved pavement.

4. Abandon pipelines as required:
   a. Any pipe abandoned under the freeway, and any District pipe 16-inches and larger, shall be filled with a lightweight cementious flowable fill.
   b. Any other abandoned pipes shall be firmly capped or plugged with 1 foot of dry-pack grout at each end.

c. Related salvage and abandonment of existing facilities per Section 2511.1.

1.5 AVAILABLE UTILITIES

A. Water for hydrostatic testing, flushing and chlorinating the pipeline will be provided by the District. The water shall be drawn from a hard-piped connection to an existing appurtenance or temporary tap on an existing pipeline.

B. The Contractor shall provide all other water, and may use existing District fire hydrants when the proper permits and hydrant meters are obtained.

1.6 WATER DISPOSAL

A. The Contractor shall be responsible for containment, treatment, and disposal of all water including:

B. Water drained from the existing system to make ready for abandonment or connections. This includes water drained by gravity or pumping.

C. Water used for testing, flushing and chlorination of the new pipeline, as well as flushing segments of existing pipelines that are drained or un-pressurized to accommodate final connections.

1.7 SHUTDOWNS

A. Shutdowns of the water distribution system to make the connections must be performed according to the approved Pipeline Connection Work Plans.

B. Schedule of shutdown and return to service operations shall be prepared jointly by the Contractor and the District.

C. The Contractor shall give a written minimum 10 work-day notification to schedule a shutdown of existing pipeline, prior to any connection work in the field.

D. District personnel will operate all valves in the pipeline system for shutdown as well as for the return to service.

E. The District will not start a shutdown until the work location is excavated and shored, the existing pipe size verified, and pipe size adjustments prepared.

1.8 WORK HOURS

A. Work or activity of any kind shall be limited to the hours from 7:00 a.m. to 6:00 p.m. Monday through Friday with the exception of required outages.
B. Work in excess of eight hours per day, work on Saturdays, work on Sundays, or work on District holidays requires prior consent of the Engineer and is subject to Cost of Overtime Construction Inspection.

C. District holidays

The Contractor must schedule relocation work of EBMUD pipelines in accordance with the availability of EBMUD inspection staff per the EBMUD Holiday schedule below.

1. Holidays are:
   
   New Years Day
   Martin Luther King Day (3rd Monday in January)
   Lincoln's Birthday
   Washington's Birthday (3rd Monday in February)
   Chavez’s Birthday
   Memorial Day (last Monday in May)
   Independence Day
   Labor Day (1st Monday in September)
   Admission Day
   Columbus Day (2nd Monday in October)
   Veteran's Day
   Thanksgiving Day and following Friday
   Christmas Day

2. When a holiday falls on Sunday, the following Monday shall be observed as the holiday. When a holiday falls on Saturday, the preceding Friday shall be observed as the holiday.

1.9 COST OF OVERTIME CONSTRUCTION INSPECTION

A. Overtime construction work performed at the option of, or for the convenience of, the Contractor will be inspected by the District at expense of the Contractor. For any such overtime beyond the regular 8-hour day and for any time worked on Saturday, Sunday, or holidays the charges will be as shown in the following schedule:

<table>
<thead>
<tr>
<th></th>
<th>Charge per Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Associate Engineer</td>
<td>$89.00</td>
</tr>
<tr>
<td>Assistant Engineer</td>
<td>$81.00</td>
</tr>
<tr>
<td>Senior Construction Inspector</td>
<td>$79.00</td>
</tr>
<tr>
<td>Construction Inspector</td>
<td>$72.00</td>
</tr>
<tr>
<td>Junior Engineer</td>
<td>$70.00</td>
</tr>
<tr>
<td>Pickup truck</td>
<td>$13.00</td>
</tr>
</tbody>
</table>

B. There will be no charges for the inspection of overtime work ordered by the Engineer or required by the specifications.

END OF SECTION
(This page intentionally left blank)
Add Section 01330.0 to EBMUD Standard Specification:

SECTION 01330.0 – SUBMITTAL PROCEDURES

PART 1 – GENERAL

1.1 SUBMITTALS

A. The District uses a web-based submittal system (EADOC) for use by the Engineer.

B. Contractor shall send all submittals required herein through the usual chain of command established for the project.

1.2 DESCRIPTION

Work included:

1. The requirements of this section apply to all submittals in the Contract Documents for EBMUD Work.

2. Submit samples, drawings, and data for the Engineer's approval prior to EBMUD Engineer's approval which demonstrate fully that the construction, and the materials and equipment to be furnished will comply with the provisions and intent of this Specification. All submittals shall be written in Standard American English and all numerical data, whether in drawings, test reports, engineering calculations, manufacturer’s literature, or maintenance manuals, shall be in United States Customary System (USCS) measuring units (foot, pound, gallons, etc). If original design work was completed in metric units, their equivalent USCS dimension and unit shall be indicated. All submittals, in printed or electronic format, shall be original quality and completely legible. Any obfuscation or loss of clarity of original which may result in ambiguous interpretation is not acceptable.

3. Specific items to be covered by the submittals shall include, as a minimum, the following:

   a. For pipelines, submit a detailed layout of the pipeline with details of bends and fabricated specials and furnish any other details necessary. Show location of shop and field welds.

   b. Substitutions.

4. Additional submittals required: See pertinent sections of this specification.

5. Submit a Schedule of Submittals.

1.3 PRODUCT HANDLING

A. Submittals shall be accompanied by a letter of transmittal and shall be in strict accordance with the provisions of this section.

B. Compact disks or DVDs shall be packaged in a hard plastic case. The case and media shall be labeled as to content.

C. Submit priority of processing when appropriate.

D. Submit materials to the EBMUD Materials Testing Laboratory when so specified. Submit other submittals to Construction Division, EBMUD, in accordance with Article 3.1 unless specified otherwise.
PART 2 - PRODUCTS

2.1 SCHEDULE OF SUBMITTALS

A. Schedule of Submittals shall be in the form of a submittal log.

2.2 SHOP DRAWINGS

A. Scale required:
   1. Make all shop drawings accurately to a scale sufficiently large to show all pertinent features of the item and its method of connection to the work.

B. Type of prints required:
   1. Make all shop drawing prints in blue or black line on white background. Reproductions of District drawings are not acceptable.

C. Size of drawings required:
   1. The overall dimensions of each drawing submitted to the Engineer shall be equal to one of the District's standard sheet sizes as listed below. The title block shall be located in the lower right hand corner of each drawing and shall be clear of all linework, dimensions, details, and notes.

<table>
<thead>
<tr>
<th>Sheet Sizes</th>
<th>Height x Width</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>11&quot; x 8-1/2&quot;</td>
</tr>
<tr>
<td></td>
<td>11&quot; x 17&quot;</td>
</tr>
<tr>
<td></td>
<td>22&quot; x 34&quot;</td>
</tr>
</tbody>
</table>

D. Stamp or permanently print on each drawing “Reference EBMUD Drawing _____________” and enter the pertinent drawing number.

2.3 MANUFACTURERS’ LITERATURE

A. Where contents of submitted literature from manufacturers includes data not pertinent to the submittal, clearly show which portions of the contents are being submitted for review.

B. Clearly mark the literature with the materials and options being provided to illustrate conformance with the specification details.

C. Provide the complete part number and include the legend containing the descriptive details that define the meaning of each digit of the number.

2.4 SUBSTITUTIONS

A. Engineer's approval required:
   1. The contract is based on the materials, equipment, and methods described in the Contract Documents. Any Contractor-proposed substitutions are subject to the Engineer's approval.
   2. The Engineer will consider proposals for substitution of materials, equipment, and methods only when such proposals are accompanied by full and complete technical data, and all other information required by the Engineer to evaluate the proposed substitution.
   3. Where substitutions are proposed for consideration, Contractor shall submit a written request for the substitution and shall show that it is equal to the specified item. The proposed substitution shall be identified separately and included with the required submittal for the item. When submitting a variation or substitution the Contractor warrants that:
a. The contract has been reviewed to establish that the substitution, when incorporated, will be compatible with other elements of work.

b. The Contractor shall perform all necessary work for making substitutions workable and shall bear any additional cost necessary because of the proposed substitution.

4. Substitutions not specifically requested, although accepted through oversight, may be rejected at any stage of the work. The Contractor shall, at his own expense, reconstruct all work affected by the later rejection of a substitution that was not specifically requested.

2.5 AS-BUILT DRAWINGS

A. Marked-up as-built drawings:

1. Two sets of full-size contract and shop drawing mark-ups shall be kept on file in the Contractor’s site office exclusively for recording all as-built data associated with this work, including all addenda, force-account work, clarifications, and contract change orders. Information to be recorded shall include but not be limited to the following:
   a. Actual detail used where more than one option is allowed by the contract documents.
   b. Actual alignment of installed pipe.
   c. Specific details of pipe connections and manhole structures.
   d. Actual details of all material lists and schedules including quantities, descriptions, sizes, model numbers, and materials of construction.
   e. Field dimensions where they differ from those on the drawings.
   f. Other details showing as-built conditions that are shown differently or only in general on the drawings.
   g. Any deviations between the project drawings and the "as found" conditions encountered during the Contractor’s work including location of existing buried features uncovered during construction.

2. The Contractor shall record dimensions and changes during construction, and shall permit the Engineer to review the accuracy and completeness of the as-built data on a monthly basis.

   a. Red pencil shall be used to indicate additions and/or modifications to the drawings.
   b. Green pencil shall be used to indicate deletions to the drawings.
   c. Yellow highlighter or yellow pencil shall be used to indicate portions of the drawing that have been field verified to confirm portions installed as designed and to show construction progress.
   d. All marks on drawings shall be dark and legible. Text shall be legibly printed in block style letters.
   e. Only symbols and abbreviations shown on District Standard Drawings included in the contract reference drawings shall be used. Where no District
symbol or abbreviation is available, industry association standards such as ISA, IEEE, ANSI, etc. shall be applicable.

B. Record as-built shop and vendor drawings shall be created as described below:

1. Submit record as-built shop and vendor drawings to document any and all design work developed for this project by the Contractor, subcontractors, equipment manufacturers, vendors, or suppliers.

2. Create record as-built shop drawings utilizing Microstation or AutoCAD software. Drawings shall be sized 22-inch by 34-inch on vellum. Other drawing sizes are not acceptable. Manually drafted shop drawings in pencil or ink are not acceptable. Provide one set of record as-built shop drawings in addition to the number and type of shop drawings specified in Article “SUBMITTAL QUANTITIES” below. In place of vellum drawings, record as-built shop drawings may be submitted in PDF (compatible with Adobe Acrobat Version 7.0) on CD +/-R or DVD +/-R.

3. Text size used on drawings shall have a minimum height of 1/10 inch, if computer generated or typed, and 1/8" if printed by hand.

4. Drawings shall contain a 2-1/2" wide by 3/4" high blank box for the District’s use, which shall be placed directly against the margin at the bottom right corner of the drawing.

5. Drawings shall also contain the manufacturer’s title block at the bottom right side in a boxed area with a maximum size of 8" wide by 4" high. The manufacturer’s title block shall contain the manufacturer’s name, address, and telephone number, the name of the project as it appears on the cover of the project specifications, the District specification number, a descriptive title for the drawing, the date the drawing was approved, the total number of drawings included in the set of drawings, and the manufacturer's drawing number.

C. As-Built Log

1. The Contractor shall develop and maintain a spreadsheet or database type log recording all construction correspondence documents that identify modifications to the as-built drawings. The construction correspondence documents shall include RFIs, clarifications, change orders, field directives, submittals, letters, and any other construction correspondence that identifies modifications to the as-built drawings. At a minimum, the as-built log shall contain separate fields for the following information:

   a. Log Number: sequential integer numbering system

   b. Correspondence type (e.g. RFI, change order, letter, etc.)

   c. Correspondence number (if available)

   d. Title correspondence (if available)

   e. Correspondence date

   f. Contract drawing referenced in correspondence

2. Each as-built log entry (row) shall contain only one as-built drawing reference. For instance, if the response to a change order results in modifications to three as-built drawings, then three separate as-built log entries are required, one for each as-built drawing referenced in the change order. (Similarly, if 3 change orders affect a specific drawing, then three separate as-built log entries are required).
3. Provide an electronic file in Microsoft Excel format of the complete up-to-date as-built log at any time upon request from the Engineer.

D. Schedule for submitting Record As-Built Drawings.
   1. One final marked-up set of contract and shop drawings shall be submitted within 30 days after Ready for Integration Programming as a prerequisite for establishing that the facility is ready for service.
   2. Final electronic files and one (1) complete full-size hardcopy print shall be submitted at least 30 days prior to the beginning of the Startup Test. This submittal shall include all record as-built contract drawings and record as-built shop drawings. If there is not a Startup Test, the final electronic files and 1 complete full-size hardcopy print on vellum shall be turned over to the Engineer upon Contract Completion.
   3. Marked-up contract drawings or record as-built contract drawings refers to those drawings originally included in the bid documents, as modified by the Contractor (via hand-markup and electronic update, respectively) to reflect as-built conditions.

2.6 SUBMITTAL QUANTITIES
   A. Submit quantity specified of materials submitted to the EBMUD Materials Testing Laboratory.

2.7 ELECTRONIC SUBMITTALS
   A. Provide electronic submittals in PDF (compatible with Adobe Acrobat). All portions of the electronic submittals shall be legible and shall be in full color identical to the original material. Provide manufacturer’s literature in original electronic file, if available.
   B. Provide one electronic submittal file for each submittal except as noted hereinafter. The electronic submittal file name shall use the following format: submittal number – specification section number - description (e.g.: “001.1-01 33 00-Coating of Widgets”). Providing multiple electronic files for a single submittal (except as noted hereinafter) is not acceptable. The Contractor shall merge multiple files into a single electronic file.

PART 3 - EXECUTION

3.1 GENERAL

4. Submit all documents to the Engineer per the requirements set forth in Division 1, Section 01 33 00. After the approval of the Engineer, submit the following to the Engineer:
   A. Prepare and submit a transmittal form that includes the following information:
      1. "Project name and specification number
      2. "Date of submittal
      3. ""To: Construction Division, MS #62
         East Bay Municipal Utility District
         P.O. Box 24055
         Oakland, CA 94623-1055
         ATTN: Senior Engineer"
      4. "From:" Name and address of Contractor
      5. Name and address of subcontractor
      6. Name and address of supplier
      7. Name of manufacturer
      8. "Spec. Section, Article Number, Paragraph and Subparagraph Number and/or drawing number and detail references
      9. Location of use
10. *Submittal number
11. *Signature and title of transmitter
12. *Original submittal or resubmittal

Note: All transmittals shall include asterisked items as a minimum to be acceptable for review.

B. Use the "Item Number" on the Schedule of the Submittal for the corresponding submittal number. On a resubmittal, add a numerical suffix to the original submittal number. For example, 6.1 indicates the first resubmittal of submittal Number 6.

C. Use a separate transmittal form for each specific item or class of material or equipment within a division for which a submittal is required. Transmittal of a submittal of multiple items using a single transmittal form will be permitted only when the items taken together constitute a manufacturer’s "package" or when items are so functionally related that review of the group as a whole is appropriate.

D. If a submittal contains multiple items, then each item shall be clearly labeled throughout the submittal, or indexed in a manner eliminating confusion in identifying how each item relates to the whole. When submittal items have been assigned a “District equipment tag number” in the contract documents, each tag number shall be included throughout the submittal to clearly associate the specific submittal information to specific tag numbers.

E. Stamp or permanently print on each submittal the following certification statement.

"I hereby certify that the (equipment) (material) (article) shown and marked in this submittal is that proposed to be incorporated into Specification Number ____, is in compliance with the Contract drawings and specifications, can be installed in the allocated spaces, and is submitted for District (record/approval).

Certified by ________________________________ Date ___________"

3.2 SCHEDULE OF SUBMITTALS

A. Submit initial Schedule of Submittals within 15 days after Notice to Proceed.

B. Submit revised Schedule of Submittals within 15 days after date of request from the Engineer. Engineer will review Schedule of Submittals and will notify Contractor that schedule is acceptable or not acceptable within 10 days after receipt.

C. The Schedule of Submittals shall identify Contractor “or equal” substitution proposals made prior to bid opening, which have been accepted by the District.

3.3 COORDINATION OF SUBMITTALS

A. General:

1. Prior to submittal for Engineer’s review, use all means necessary to fully coordinate all material, including the following procedures:

   a. Determine and verify all field dimensions and conditions, materials, catalog numbers, and similar data.

   b. Coordinate as required with all trades and with all public agencies involved.

   c. Secure all necessary approvals from agencies having jurisdiction and signify with agency stamp, or other means, that approvals have been secured.
d. Clearly indicate all deviations from the Contract Documents.

B. Grouping of submittals:
   1. Unless otherwise specifically permitted by the Engineer, make all submittals in groups containing all associated items; the Engineer may reject partial submittals as not complying with the provisions of the Contract Documents.

C. Resubmittals:
   1. The Contractor shall include a Comment and Response sheet with each resubmittal. The Comment and Response sheet shall be the first item after the submittal transmittal form. The Comment and Response sheet shall include each review comment (word for word) from the previous submittal cycle, followed by the Contractor’s response clarifying how the comment has been addressed in the resubmittal. All responses shall at a minimum have a general description of what new information in the resubmittal addresses the review comment; and where in the resubmittal this new information can be located (tab number, page number, etc).
   2. Resubmittals that do not comply with the requirements set forth in subparagraph C.1 will be returned to the Contractor without review. The Contractor shall resubmit with an appropriate Comment and Response sheet as specified herein.

3.4 TIMING OF SUBMITTALS
   A. General:
      1. Make all submittals far enough in advance of scheduled dates of installation to provide all required time for reviews, for securing necessary approvals, for possible revision and resubmittal, and for placing orders and securing delivery.
      2. In scheduling, unless otherwise noted, allow at least twenty (20) work days for the Engineer's review and least twenty (20) work days for the EBMUD Engineer's review after the Engineer's approval, plus the transit time to and from the Engineer and to and from the Engineer to the District office.

3.5 APPROVAL BY DISTRICT
   A. Approval of each submittal by the Engineer will be general only and shall not be construed as:
      1. Permitting any departures from the contract requirements.
      2. Relieving the Contractor of the responsibility for any errors and omissions in details, dimensions, or of other nature that may exist.
      3. Approving departures from additional details or instructions previously furnished by the Engineer.
   B. One copy of each submittal, except manuals and as-built drawings, will be returned to the Contractor marked "Approved", "Approved as Noted", "Revise and Resubmit", or "Acknowledged Receipt", except that in some cases, all copies of a submittal may be returned to the Contractor marked "Returned without Review".
      1. "Approved" indicates that item covered by the submittal may proceed provided it complies with requirements of the specifications. Final acceptance will depend upon that compliance.
      2. "Approved as Noted" indicates that item covered by the submittal may proceed provided it complies with notations or corrections on the submittal and requirements of the specifications. Final acceptance will depend on that compliance.
      3. "Revise and Resubmit" indicates that the Contractor shall not proceed with any phase of the item covered by the submittal, including purchasing, fabrication,
delivery, or other activity. Revise or prepare a new submittal in accordance with the notations and requirements of the specifications.

4. "Acknowledged Receipt" indicates that the item is required to be submitted to the District primarily for information or record purposes, and is not subject to District review.

5. "Returned without Review" indicates that the submittal was not reviewed by the District due to the submittal being incomplete, illegible, inadequate, or otherwise failing to conform to the requirements of the specification. Contractor shall prepare a new submittal for this item.

C. Resubmit revised drawings or data as indicated, in eight (8) copies unless otherwise specified.

D. Work requiring District approval shall not begin until the submittals for that work have been returned as "Approved" or "Approved as Noted".

3.6 CHANGES TO APPROVED SUBMITTALS

A. A resubmittal is required for any proposed change to a submittal that has been "Approved" or "Approved as Noted". Changes which require resubmittal include, but are not limited to, drawing revisions, changes in materials and equipment, changes to installation procedures and test data. All resubmittals shall include an explanation of the necessity for the change.

B. Minor corrections to an approved submittal may be accomplished by submitting a "Corrected Copy".

3.7 SUBMITTALS

A. Documents and information to be submitted electronically include, but are not limited to, the documents described below.

1. Submittals:

   a. Shop Drawings

      1) Shop drawings and design data documents shall be submitted as MicroStation or AutoCAD format files and PDF attachments to the Engineer. Examples include, but are not limited to:

         a) Standard manufacturer installation drawings.

         b) Drawings prepared to illustrate portions of the work designed or developed by the Contractor.

         c) Steel fabrication, piece, and erection drawings.

         d) Electrical interconnection drawings.

   b. Product Data

      1) Product data and manufacturer’s instructions shall be submitted as PDF attachments to the Engineer. Examples include, but are not limited to:

         a) Manufacturer’s printed literature.

         b) Preprinted product specification data and installation instructions.
c. Samples

1) Sample submittals shall be physically submitted as specified in Division 1, Section 01 33 00 - Submittal Procedures; additionally, Contractor shall provide to the Engineer the submittal data information as an electronic file with a copy of the submittal form(s) attached to the actual sample. Examples include, but are not limited to:

   a) Product finishes and color selection samples.
   b) Product finishes and color verification samples.
   c) Finish/color boards.
   d) Physical samples of materials.


d. Administrative Submittals

1) All correspondence and pre-construction submittals shall be submitted to the Engineer. Examples include, but are not limited to:

   a) Permits.
   b) List of project personnel.
   c) Requests for Information (RFI).
   d) System Outage Requests.
   e) Monthly Subcontractor Payment Reports (P-047 Form).
   f) Certified payrolls.
   g) Plant Inspection Requests
   h) Survey Requests
   i) Requests for Meetings

2) All schedules and associated reports and updates shall be submitted as specified in these Contract Documents and as a native backed-up file of the scheduling program being used. The schedule shall be posted as a PDF file in the format specified in these Contract Documents and as backed-up file.

3) Plans for safety, demolition, environmental protection, and similar activities.

4) Outage Plans.

5) Meeting minutes for weekly construction meetings, progress meetings, pre-installation meetings, etc.

6) Any general correspondence submitted.
e. Compliance Submittals

1) Test reports, certificates, and manufacture field report submittals shall be submitted to Engineer as PDF attachments. Examples include, but are not limited to:

   a) Field test reports.

   b) Quality Control certifications.

   c) Manufacturers documentation and certifications for quality of products and materials provided.

f. Record and Closeout Submittals

1) Operation and maintenance data closeout submittals shall be submitted to the Engineer as PDF documents during the approval and review stage as specified, with actual hardcopy set of documents submitted for final. Examples include, but are not limited to:

   a) Operation and Maintenance Manuals: Final documents shall be submitted as specified.

   b) Extra Materials, Spare Stock, etc.: Submittal forms shall indicate when and where actual materials are submitted.

g. Financial Submittals

1) Schedule of Costs, Pay Estimates, Daily Extra Work Reports, and Change Order Requests shall be submitted to Engineer. Supporting material for Pay Estimates and Change Order Requests shall be submitted to Engineer as PDF attachments. Examples include, but are not limited to:

   a) Contractor’s Schedule of Costs utilizing both the EADOC Schedule of Costs format as provided by the Engineer and as required by the Contract Documents in both PDF and Microsoft Excel.

   b) Contractor’s Monthly Progress Payment Requests utilizing EADOC.

   c) Contract Change proposals requested by the District.

2) The Contractor shall provide the craft, material, and equipment data to Engineer, which will be utilized for Daily Extra Work Reports and Change Order Requests.

END OF SECTION
SECTION 01600.1 - MATERIALS

Replace Section 1.1 MATERIALS FURNISHED BY DISTRICT with:

A. Materials Furnished by District per Section 016405.

END OF SECTION
Add Section 01640.5 to EBMUD Standard Specification:

SECTION 01640.5 - DISTRICT–FURNISHED MATERIALS

PART 1 - GENERAL

1.1 GENERAL

A. The District will furnish, without charge, those materials so designated and listed in this Section or on the drawings. All other materials necessary and required for the work under this contract, including bolts, nuts, gaskets, and miscellaneous items, shall be furnished by the Contractor.

B. Unless another condition is specified, District-furnished materials are assumed to be in perfect condition upon delivery to the Contractor. The Contractor shall inspect and ascertain the condition of the materials at the time of delivery to him and shall assume all responsibility for the materials from time of delivery until final acceptance of the work by the District. Any material found to be defective after delivery to the Contractor and before final acceptance of the work by the District shall be replaced and installed by the Contractor at its own expense.

C. Upon completion of the required work, all excess materials furnished by the District shall be returned promptly to the location designated by the District. The value as carried on the District's books of all materials furnished to the Contractor and not accounted for by being incorporated in the work or by being returned to the District will be deducted from the Contractor's final payment. Value of the materials to be furnished to the Contractor by the District is estimated to be $100,000.

1.2 DELIVERY AND RETURN

A. In all cases, materials to be furnished by the District will be issued only upon approval of the Engineer. Receipts for materials signed by the Contractor shall be conclusive evidence of delivery.

B. Delivery of District-furnished materials shall be taken by the Contractor at the District location designated by the Engineer, either Oakport Storage Center, 5601 Oakport Street, Oakland (hours 8:30 a.m. to 11:45 a.m. and 12:15 p.m. to 3:30 p.m.) or at Central Warehouse, 1200 – 21st Street, Oakland (hours 8:30 a.m. to 3:30 p.m.)

C. At the completion of the job, all excess materials furnished by the District shall be returned promptly to the location designated on Material Return Order (Form P-015) made out by the Engineer. Materials that were assembled by the Contractor shall be disassembled prior to their return.

D. All handling, loading, and unloading from their delivery point of materials furnished by the District shall be performed by the Contractor, unless otherwise specified. All loading, hauling and unloading of materials returned to designated locations shall be performed by Contractor. Contractor shall provide all necessary materials handling equipment (including forklift), tiedowns, and dunnage.

1.3 MATERIALS FURNISHED

A. The following listed materials will be furnished to the Contractor by the District. The quantities listed for some items may not be the exact amount required; however, sufficient material will be supplied by the District to complete the work.
<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe, 6” ML&amp;PCS, Bell &amp; Spigot, 40’ lengths</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>Pipe, 8” ML&amp;PCS, Bell &amp; Spigot, 40’ lengths</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>Pipe, 12” ML&amp;PCS, Bell &amp; Spigot, 40’ lengths</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>Valve, Gate, 4”, Flanged with Nut Operating Extension</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>Valve, Gate, 6”, Flanged with Nut Operating Extension</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>Valve, Gate, 8”, Flanged with Nut Operating Extension</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>Valve, Butterfly, 12”, Flanged, Nut Operator</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>Elbow, Steel, 8”, 45°</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>Elbow, Steel, 8”, 90°</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>Elbow, Steel, 12”, 45°</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>Elbow, Steel, 12”, 90°</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>Taper, Steel, 8” x 4”</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>Taper, Steel, 12” x 8”</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>Tee, Steel, 12” x 8”</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>Tee, Steel, 12” x 6”</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>Tee, Steel, 8” x 6”</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>Tee, Steel, 8”</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>Tee, Steel, 12”</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>Saddle Plate, Steel, 12” x 4”</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>Skirted Flange, Steel, 6”</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>Skirted Flange, Steel, 8”</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>Skirted Flange, Steel, 12”</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>Nipple, Steel, 4”</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>Nipple, Steel, 6”</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>Nipple, Steel, 8”</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>Nipple, Steel, 12”</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>Buttstrap, Steel, 8”, as Shown on Std Dwg. 1932-A</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>4” Flexible Coupling for Insulating Joint as Shown on Standard Dwg. 3446-GB</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>6” Flexible Coupling for Insulating Joint as Shown on Standard Dwg. 3446-GB</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>8” Flexible Coupling for Insulating Joint as Shown on Standard Dwg. 3446-GB</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>12” Flexible Coupling for Insulating Joint as Shown on Standard Dwg. 3446-GB</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>Galvanic Anodes except plastic tape, cement mortar, epoxy putty, and exothermic welding kit</td>
<td>As Req’d</td>
</tr>
<tr>
<td>Pipeline Marker Posts as Shown on Std Dwg 1336-A</td>
<td>As Req’d</td>
</tr>
<tr>
<td>Fire Hydrants, including Hydrant Set, as shown on Standard Dwg. 9496-GB except Items A, B, E, and J</td>
<td>xxxx ft</td>
</tr>
<tr>
<td>Valve Extension</td>
<td>As Req’d</td>
</tr>
<tr>
<td>Chlorination Tap</td>
<td>As Req’d</td>
</tr>
</tbody>
</table>

Notes:
1. All required temporary blowoffs will be furnished by the Contractor per Section 2511.1
2. District furnished material will be issued on a site by site basis after the Contractor has satisfactorily completed all related submittals.

END OF SECTION
Add Section 02211.3 to EBMUD Standard Specification:

SECTION 02211.3 – CONSTRUCTION SURVEYING

PART 1 – GENERAL

1.1 QUALIFICATION

A. Survey work shall be conducted by a competent Land Surveying firm with at least five years of experience in utility layout. Principal shall hold a professional license from the State of California as a Professional Land Surveyor.

1.2 SUBMITTALS

A. Submit a copy of current California professional license.

B. Submit a resume showing required experience, including contact information of the owner or General Contractor who can confirm the cited work.

1.3 SCOPE OF WORK

A. Project field surveying responsibility is entirely the responsibility of the Contractor and his subcontracted Licensed Survey Firm.

B. Monuments shall be carefully preserved by the Contractor. A Licensed Land Surveyor retained by the Contractor shall research and locate all boundary and right of way monuments prior to construction and set references outside of the work area. Corner Records or a Record of Survey shall be filed with the County for all Monuments that may be disturbed during the execution of the work. As a precaution, any Monument that is determined to be sufficiently close to any work area shall also be surveyed. Subsequent to construction, all monuments shall be checked and replaced in kind as needed.

1. Failure to properly reference monuments in advance does not remove Contractor’s financial responsibility to replace any damaged or destroyed monuments.

END OF SECTION
SECTION 02316.1 - TRENCHING, BACKFILLING AND COMPACTING

Add to Item A in Section 1.2 QUALITY ASSURANCE:

4. In Segment B, the specified compaction requirements shall conform to Section 211 of the City of Oakland Specifications.

5. In Segment A the specified compaction requirements shall conform to Section 6-3.05 of the Caltrans Specifications.

Add to Item B in Section 1.4 JOB CONDITIONS:

6. Work in Segment B shall conform to Section 7-10 of the City of Oakland Specifications and Division 0 on these Contract Documents.

7. Work in Segment A shall conform to Section 7-1.02K(6) of the Caltrans Specifications and Division 0 on these Contract Documents.

Add to Item D in Section 3.1 EXCAVATION:

3. Curb shall be removed and replaced to the limits of the sidewalk removal and replacement.

Add to Item 7 in Item C in Section 3.4 BACKFILL OF TRENCHES:

c. In Segment B, the compaction requirements shall conform to Section 301-1.3 of the City of Oakland Specifications.

d. In Segment A the compaction requirements shall conform to Section 19-5 of the Caltrans Specifications.

END OF SECTION
SECTION 02951.1 - PAVEMENT REPLACEMENT

Replace Section 2.1 MATERIALS with the following:

2.1 MATERIALS

A. Aggregate Base:
   1. In Segment B, Crushed Aggregate Base shall conform to Section 200-2 of the City of Oakland Specifications.
   2. In Segment A, Class 2 Aggregate Base shall conform to Section 26 of the Caltrans Specifications.

B. Prime Coat:
   1. In Segment B, Liquid Asphalt Grade SC-250 shall conform to Section 203-2 of the City of Oakland Specifications.
   2. In Segment A, Liquid Asphalt Grade SC-70 shall conform to Section 93 of the Caltrans Specifications.

C. Tack Coat:
   1. In Segment B, Asphaltic Emulsion SS-1h shall conform to Section 203-3 of the City of Oakland Specifications.
   2. In Segment A, Asphaltic Emulsion Slow-Setting SS1 shall conform to Section 94 of the Caltrans Specifications.

C. Asphalt Concrete Pavement or Hot Mix Asphalt Pavement:
   1. In Segment B, Asphalt Concrete shall conform to Section 203.6 of the City of Oakland Specifications.
   2. In Segment A, Hot Mix Asphalt, Superpave (Type A) shall conform to Section 39 of the Caltrans Specifications.

D. Portland Cement Concrete, Jointed Plain Concrete Pavement, or Minor Concrete:
   1. In Segment B, Use Portland Cement Concrete shall conform to Section 201-1 of the City of Oakland Specifications.
   2. In Segment A, Jointed Plain Concrete Pavement shall conform to Section 40 of the Caltrans Specifications.
   3. In Segment A, Minor Concrete shall conform to Section 73 of the Caltrans Specifications.

Replace Item A in Section 3.1 EXISTING PAVEMENT with the following:

A. Replace structural pavement section (pavement and base materials) per the details shown on the Utility Contract Drawings.

Replace Item 1 in Item A in Section 3.3 PERMANENT PAVEMENT with the following:

1. The thickness of permanent pavement shall conform to the details shown on the Utility Contract Drawings.

Replace Item E in Section 3.3 PERMANENT PAVEMENT with the following:

E. Base Installation:
   1. In Segment B, install untreated base per Section 301-2 of the City of Oakland Specifications.
   2. In Segment A, install Class 2 aggregate base per Section 26 of the Caltrans Specifications.
Replace Item F in Section 3.3 PERMANENT PAVEMENT with the following:

F. Asphalt Concrete Pavement or Hot Mix Asphalt Concrete Pavement Installation:
   1. In Segment B, install asphalt concrete pavement per Section 302-5 of the City of Oakland Specifications.
   2. In Segment A, install hot mix asphalt (type A) per Section 39 of the Caltrans Specifications.

Replace Item G in Section 3.3 PERMANENT PAVEMENT with the following:

G. Portland Cement Concrete Pavement or Jointed Plain Concrete Pavement Installation:
   1. In Segment B, install Portland cement concrete pavement per Section 302-6 of the City of Oakland Specifications.
   2. In Segment A, install jointed plain concrete pavement per Section 40 of the Caltrans Specifications.

H. Concrete, Curb, Gutter, Walks, Cross Gutters, Access Ramps, and Driveway Installation:
   1. In Segment B, install concrete curb, walks, cross gutters, access ramps, and driveways per Section 303-5 of the City of Oakland Specifications.
   2. In Segment A, install minor concrete curb, gutters, sidewalks, cross gutters, curb ramps, and driveways per Section 73 of the Caltrans Specifications.

END OF SECTION