### SECTION 11
OVERHEAD CONTACT SYSTEM (OCS)

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11-1 GENERAL REQUIREMENTS

11-1.01 SUMMARY OF WORK

PART 1 – GENERAL

1.01 WORK INCLUDED IN SECTION 11

A. Designing, furnishing, installing and testing a new Overhead Contact System (OCS) for an approximately 4.7-mile extension from Meadowview Station and south to Cosumnes River Community College Station at Calvine Road. The work includes, but is not limited to the following:

1. Designing, furnishing, and installing OCS foundations, including surveying.

2. Designing, furnishing, and installing OCS pole assemblies, including grounding connections and installation of feeder conduits.

3. Designing, furnishing, and installing OCS support assemblies, including but not limited to Cantilevers, headspans, and Pull Offs.

4. Designing, furnishing, and installing a simple-Catenary auto-tensioned Contact Wire system.

5. Installing pole-mounted disconnect switches specified under Section 12, Traction Power Substation Site Work and Cable System, and connecting to the OCS.

6. Installing surge arresters and grounding systems specified under Section 12 and connecting to the OCS and the grounding system.

7. Designing, furnishing, and installing modifications to the existing OCS, including demolishing, removing, and salvaging or disposing of redundant poles, foundations and conductors and associated equipment, and relocating existing OCS.

8. Producing and implementing staging plans for the work, including Interface to the existing operating system, and cutover of the complete system.

9. Inspecting and testing OCS system during and after completing construction.

10. Developing QC records during construction.

11. Developing record documents and photographs of the completed OCS.
12. Developing manuals and documents necessary for the operation and maintenance of the OCS.

13. Developing OCS training program, including producing materials for class and conducting training class.

B. Work specified in this Section 11 applies only to the OCS, unless specifically referenced by other Specification Sections.

1.02 MEASUREMENT AND PAYMENT

A. Payment for work described in this Subsection is covered under other Subsections.

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Contractor must perform work as indicated on Contract Drawings and in these Technical Specifications.
11-1.02 MEASUREMENT AND PAYMENT

PART 1 – GENERAL

1.01 SUBSECTION INCLUDES

A. Information for measurement and payment that applies only to this Section 11.

1.02 MEASUREMENT AND PAYMENT

A. Work in this Section 11 will be paid as either a lump sum or by unit price as stated on the Bid Form.

1. Lump Sum:
   a. Complete payment for the work described for that item in the Contract.
   b. Contractor must break down each lump sum bid item as required by General Provision 6.61.1, Schedule of Values.

2. Unit Price: Work indicated as unit priced will be measured by RT as described in the applicable Technical Specification Subsection.

1.03 PAYMENT ITEMS

A. Contractor Quality Control Program (CQCP): For payment of CQCP, see General Conditions Section 6.47.18, Payment for CQCP General Requirements.

B. OC-001, OCS Foundations and Poles:

1. Measurement for this item will be lump sum.

2. Payment for this item includes all direct and indirect costs associated with furnishing all design, submittals, labor, materials, equipment, inspection and testing, and incidentals required to provide OCS foundations and poles as indicated in the Contract Documents. Work includes, but is not limited to the following:
   a. Drilling pier shafts;
   b. Constructing forms and installing reinforcing and Anchor Bolts;
   c. Providing concrete and finishing;
d. Providing OCS poles;
e. Repairing sidewalk and pavement, where required;
f. Providing feeder conduits on poles;
g. Grounding poles.

C. OC-002, OCS Segment EX IB:
   1. Measurement for this item will be lump sum.
   2. Payment for this item includes all direct and indirect costs associated with furnishing all design, submittals, labor, materials, equipment, inspection and testing, and incidentals required to modify OCS segment EX IB, OCS at Meadowview crossover, and temporary OCS for Meadowview sequence work as indicated in the Contract Drawings.

D. OC-003, OCS Segment EX OB:
   1. Measurement for this item will be lump sum.
   2. Payment for this item includes all direct and indirect costs associated with furnishing all design, submittals, labor, materials, equipment, inspection and testing, and incidentals required to modify existing OCS segment EX OB as indicated in the Contract Documents.

E. OC-004, OCS Segment C01:
   1. Measurement for this item will be lump sum.
   2. Payment for this item includes all direct and indirect costs associated with furnishing all design, submittals, labor, materials, equipment, inspection and testing, and incidentals required to provide OCS segment C01 as indicated in the Contract Documents. Work includes, but is not limited to the following:
      a. OCS fittings and Hardware;
      b. OCS span, pull-off, and Guy assemblies;
      c. OCS support assemblies;
      d. OCS conductors;
      e. OCS conductor terminations
f. OCS Insulators;
g. OCS Section Insulators;
h. OCS pole-mounted dc disconnect switches;
i. OCS pole-mounted surge arresters, including grounding of surge arresters;
j. OCS inspection, testing, and acceptance measurements;
k. OCS record documents.

F. OC-005, OCS Segment C02:

1. Measurement for this item will be lump sum.

2. Payment for this item includes all direct and indirect costs associated with furnishing all design, submittals, labor, materials, equipment, inspection and testing, and incidentals required to provide OCS segment C02 as indicated in the Contract Documents. Work includes, but is not limited to the following:

a. OCS fittings and Hardware;
b. OCS span, pull-off, and Guy assemblies;
c. OCS support assemblies;
d. OCS conductors;
e. OCS conductor terminations
f. OCS Insulators;
g. OCS Section Insulators;
h. OCS pole-mounted dc disconnect switches;
i. OCS pole-mounted surge arresters;
j. OCS inspection, testing, and acceptance measurements;
k. OCS record documents.

G. OC-006, OCS Segment C03:

1. Measurement for this item will be lump sum.
2. Payment for this item includes all direct and indirect costs associated with furnishing all design, submittals, labor, materials, equipment, inspection and testing, and incidentals required to provide OCS segment C03 as indicated in the Contract Documents. Work includes, but is not limited to the following:

   a. OCS fittings and Hardware;
   b. OCS span, pull-off, and Guy assemblies;
   c. OCS support assemblies;
   d. OCS conductors;
   e. OCS conductor terminations
   f. OCS Insulators;
   g. OCS Section Insulators;
   h. OCS pole-mounted dc disconnect switches;
   i. OCS pole-mounted surge arresters;
   j. OCS inspection, testing, and acceptance measurements;
   k. OCS record documents.

H. OC-007, OCS Segment C04:

   1. Measurement for this item will be lump sum.

   2. Payment for this item includes all direct and indirect costs associated with furnishing all design, submittals, labor, materials, equipment, inspection and testing, and incidentals required to provide OCS segment C04 as indicated in the Contract Documents. Work includes, but is not limited to the following:

   a. OCS fittings and Hardware;
   b. OCS span, pull-off, and Guy assemblies;
   c. OCS support assemblies;
   d. OCS conductors;
   e. OCS conductor terminations
f. OCS Insulators;
g. OCS Section Insulators;
h. OCS pole-mounted dc disconnect switches;
i. OCS pole-mounted surge arresters;
j. OCS inspection, testing, and acceptance measurements;
k. OCS record documents.

I. OC-008, OCS Segment C05:

1. Measurement for this item will be lump sum.

2. Payment for this item includes all direct and indirect costs associated with furnishing all design, submittals, labor, materials, equipment, inspection and testing, and incidentals required to provide OCS segment C05 as indicated in the Contract Documents. Work includes, but is not limited to the following:

a. OCS fittings and Hardware;
b. OCS span, pull-off, and Guy assemblies;
c. OCS support assemblies;
d. OCS conductors;
e. OCS conductor terminations;
f. OCS Insulators;
g. OCS Section Insulators;
h. OCS pole-mounted dc disconnect switches;
i. OCS pole-mounted surge arresters;
j. OCS inspection, testing, and acceptance measurements;
k. OCS record documents.

J. OC-009, OCS Segment C06:

1. Measurement for this item will be lump sum.
2. Payment for this item includes all direct and indirect costs associated with furnishing all design, submittals, labor, materials, equipment, inspection and testing, and incidentals required to provide OCS segment C06 as indicated in the Contract Documents. Work includes, but is not limited to the following:
   a. OCS fittings and Hardware;
   b. OCS span, pull-off, and Guy assemblies;
   c. OCS support assemblies;
   d. OCS conductors;
   e. OCS conductor terminations;
   f. OCS Insulators;
   g. OCS Section Insulators;
   h. OCS pole-mounted dc disconnect switches;
   i. OCS pole-mounted surge arresters;
   j. OCS inspection, testing, and acceptance measurements;
   k. OCS record documents.

K. OC-010, OCS Segment C07:

1. Measurement for this item will be lump sum.

2. Payment for this item includes all direct and indirect costs associated with furnishing all design, submittals, labor, materials, equipment, inspection and testing, and incidentals required to provide OCS segment C07 as indicated in the Contract Documents. Work includes, but is not limited to the following:
   a. OCS fittings and Hardware;
   b. OCS span, pull-off, and Guy assemblies;
   c. OCS support assemblies;
   d. OCS conductors;
   e. OCS conductor terminations;
f. OCS Insulators;
g. OCS Section Insulators;
h. OCS pole-mounted dc disconnect switches;
i. OCS pole-mounted surge arresters;
j. OCS inspection, testing, and acceptance measurements;
k. OCS record documents.

L. OC-011, OCS Segment C08:

1. Measurement for this item will be lump sum.

2. Payment for this item includes all direct and indirect costs associated with furnishing all design, submittals, labor, materials, equipment, inspection and testing, and incidentals required to provide OCS segment C08 as indicated in the Contract Documents. Work includes, but is not limited to the following:

a. OCS fittings and Hardware;
b. OCS span, pull-off, and Guy assemblies;
c. OCS support assemblies;
d. OCS conductors;
e. OCS conductor terminations;
f. OCS Insulators;
g. OCS Section Insulators;
h. OCS pole-mounted dc disconnect switches;
i. OCS pole-mounted surge arresters;
j. OCS inspection, testing, and acceptance measurements;
k. OCS record documents.

M. OC-012, OCS Segment C09:

1. Measurement for this item will be lump sum.
2. Payment for this item includes all direct and indirect costs associated with furnishing all design, submittals, labor, materials, equipment, inspection and testing, and incidentals required to provide OCS segment C09 as indicated in the Contract Documents. Work includes, but is not limited to the following:

   a. OCS fittings and Hardware;
   b. OCS span, pull-off, and Guy assemblies;
   c. OCS support assemblies;
   d. OCS conductors;
   e. OCS conductor terminations;
   f. OCS Insulators;
   g. OCS Section Insulators;
   h. OCS pole-mounted dc disconnect switches;
   i. OCS pole-mounted surge arresters;
   j. OCS inspection, testing, and acceptance measurements;
   k. OCS record documents.

N. OC-013, OCS Segment C10:

   1. Measurement for this item will be lump sum.

   2. Payment for this item includes all direct and indirect costs associated with furnishing all design, submittals, labor, materials, equipment, inspection and testing, and incidentals required to provide OCS segment C10 as indicated in the Contract Documents. Work includes, but is not limited to the following:

   a. OCS fittings and Hardware;
   b. OCS span, pull-off, and Guy assemblies;
   c. OCS support assemblies;
   d. OCS conductors;
   e. OCS conductor terminations;
f. OCS Insulators;
g. OCS Section Insulators;
h. OCS pole-mounted dc disconnect switches;
i. OCS pole-mounted surge arresters;
j. OCS inspection, testing, and acceptance measurements;
k. OCS record documents.

O. OC-014, OCS Segment C11:

1. Measurement for this item will be lump sum.

2. Payment for this item includes all direct and indirect costs associated with furnishing all design, submittals, labor, materials, equipment, inspection and testing, and incidentals required to provide OCS segment C11 as indicated in the Contract Documents. Work includes, but is not limited to the following:

a. OCS fittings and Hardware;
b. OCS span, pull-off, and Guy assemblies;
c. OCS support assemblies;
d. OCS conductors;
e. OCS conductor terminations;
f. OCS Insulators;
g. OCS Section Insulators;
h. OCS pole-mounted dc disconnect switches;
i. OCS pole-mounted surge arresters;
j. OCS inspection, testing, and acceptance measurements;
k. OCS record documents.

P. OC-015, OCS Segment C12:

1. Measurement for this item will be lump sum.
2. Payment for this item includes all direct and indirect costs associated with furnishing all design, submittals, labor, materials, equipment, inspection and testing, and incidentals required to provide OCS segment C12 as indicated in the Contract Documents. Work includes, but is not limited to the following:

   a. OCS fittings and Hardware;
   b. OCS span, pull-off, and Guy assemblies;
   c. OCS support assemblies;
   d. OCS conductors;
   e. OCS conductor terminations;
   f. OCS Insulators;
   g. OCS Section Insulators;
   h. OCS pole-mounted dc disconnect switches;
   i. OCS pole-mounted surge arresters;
   j. OCS inspection, testing, and acceptance measurements;
   k. OCS record documents.

Q. OC-016, OCS Segment C13:

   1. Measurement for this item will be lump sum.
   2. Payment for this item includes all direct and indirect costs associated with furnishing all design, submittals, labor, materials, equipment, inspection and testing, and incidentals required to provide OCS segment C13 as indicated in the Contract Documents. Work includes, but is not limited to the following:

       a. OCS fittings and Hardware;
       b. OCS span, pull-off, and Guy assemblies;
       c. OCS support assemblies;
       d. OCS conductors;
       e. OCS conductor terminations;
f. OCS Insulators;

g. OCS Section Insulators;

h. OCS pole-mounted dc disconnect switches;

i. OCS pole-mounted surge arresters;

j. OCS inspection, testing, and acceptance measurements;

k. OCS record documents.

R. OC-017, OCS Segment C14:

1. Measurement for this item will be lump sum.

2. Payment for this item includes all direct and indirect costs associated with furnishing all design, submittals, labor, materials, equipment, inspection and testing, and incidentals required to provide OCS segment C14 as indicated in the Contract Documents. Work includes, but is not limited to the following:

   a. OCS fittings and Hardware;

   b. OCS span, pull-off, and Guy assemblies;

   c. OCS support assemblies;

   d. OCS conductors;

   e. OCS conductor terminations;

   f. OCS Insulators;

   g. OCS Section Insulators;

   h. OCS pole-mounted dc disconnect switches;

   i. OCS pole-mounted surge arresters;

   j. OCS inspection, testing, and acceptance measurements;

   k. OCS record documents.

S. OC-018, OCS Segment C15:

1. Measurement for this item will be lump sum.
2. Payment for this item includes all direct and indirect costs associated with furnishing all design, submittals, labor, materials, equipment, inspection and testing, and incidentals required to provide OCS segment C15 as indicated in the Contract Documents. Work includes, but is not limited to the following:

   a. OCS fittings and Hardware;
   b. OCS span, pull-off, and Guy assemblies;
   c. OCS support assemblies;
   d. OCS conductors;
   e. OCS conductor terminations;
   f. OCS Insulators;
   g. OCS Section Insulators;
   h. OCS pole-mounted dc disconnect switches;
   i. OCS pole-mounted surge arresters;
   j. OCS inspection, testing, and acceptance measurements;
   k. OCS record documents.

T. OC-019, OCS Segment C16:

   1. Measurement for this item will be lump sum.

   2. Payment for this item includes all direct and indirect costs associated with furnishing all design, submittals, labor, materials, equipment, inspection and testing, and incidentals required to provide OCS segment C16 as indicated in the Contract Documents. Work includes, but is not limited to the following:

      a. OCS fittings and Hardware;
      b. OCS span, pull-off, and Guy assemblies;
      c. OCS support assemblies;
      d. OCS conductors;
      e. OCS conductor terminations;
f. OCS Insulators;
g. OCS Section Insulators;
h. OCS pole-mounted dc disconnect switches;
i. OCS pole-mounted surge arresters;
j. OCS inspection, testing, and acceptance measurements;
k. OCS record documents.

U. OC-020, OCS Segment X01:
   1. Measurement for this item will be lump sum.

   2. Payment for this item includes all direct and indirect costs associated
      with furnishing all design, submittals, labor, materials, equipment,
      inspection and testing, and incidentals required to provide OCS segment
      X01 as indicated in the Contract Documents. Work includes, but is not
      limited to the following:
      a. OCS fittings and Hardware;
      b. OCS span, pull-off, and Guy assemblies;
      c. OCS support assemblies;
      d. OCS conductors;
      e. OCS conductor terminations;
      f. OCS Insulators;
      g. OCS Section Insulators;
      h. OCS pole-mounted dc disconnect switches;
      i. OCS pole-mounted surge arresters;
      j. OCS inspection, testing, and acceptance measurements;
      k. OCS record documents.

V. OC-021, OCS Segment X02:
   1. Measurement for this item will be lump sum.
2. Payment for this item includes all direct and indirect costs associated with furnishing all design, submittals, labor, materials, equipment, inspection and testing, and incidentals required to provide OCS segment X02 as indicated in the Contract Documents. Work includes, but is not limited to the following:
   a. OCS fittings and Hardware;
   b. OCS span, pull-off, and Guy assemblies;
   c. OCS support assemblies;
   d. OCS conductors;
   e. OCS conductor terminations;
   f. OCS Insulators;
   g. OCS Section Insulators;
   h. OCS pole-mounted dc disconnect switches;
   i. OCS pole-mounted surge arresters;
   j. OCS inspection, testing, and acceptance measurements;
   k. OCS record documents.

W. OC-022, OCS Spare Parts:
   1. Measurement for this item will be lump sum.
   2. Payment for this item includes all direct and indirect costs associated with furnishing all submittals, labor, materials, equipment, inspection and testing, and incidentals required to furnish and deliver specified spare Parts.

X. OC-023, OCS Operation and Maintenance Manuals:
   1. Measurement for this item will be lump sum.
   2. Payment for this item includes all direct and indirect costs associated with furnishing all submittals, labor, and materials required to furnish and deliver specified OCS Operation and Maintenance Manuals.
Y. OC-024, OCS Training and Instruction:

1. Measurement for this item will be lump sum.

2. Payment for this item includes all direct and indirect costs associated with furnishing all submittals, labor, materials, equipment, and incidentals required to furnish and deliver specified OCS training and instruction.

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

Not Used.
11-1.03  SUBMITTAL PROCEDURES

PART 1 – GENERAL

1.01  SUBSECTION INCLUDES

A. Submittal procedures that apply only to work in this Section 11.

B. Requirements for submittals that modify or exceed the requirements of General Conditions Section 6.45, Project Submittals and Deliverables.

1.02  MEASUREMENT AND PAYMENT

A. Work specified in this sub-section is incidental to Work described in other Subsections.

1.03  DEFINITIONS

A. Product Data: As defined in General Conditions Section 6.45.9, Product Data.

1.04  SUBMITTALS

A. Schedule of Submittals: Within the time required in General Conditions Section 6.45.1, Contract Submittal and Deliverable Requirements Lists (CSDRL), Contractor must submit a complete Technical Submittal List (TSL) for this Technical Specification Section 11 as part of the required CSDRL:

1. Contractor must include each submittal listed in the “Submittals” paragraph of each sub-section of this Section 11, whether or not a submittal date or time from NTP is given.

2. Contractor must include, for each planned submittal:

   a. Submittal title.


   c. Drawing or document numbers.

   d. Date on which each submittal will be submitted.

   e. Submittal description, identifying the product by description, model number, style number, serial number, or lot number.

   f. Intended resubmission date(s).
g. Lead time to delivery/anticipated delivery date(s).

h. Submittal status.

3. Contractor must highlight submittals that are on the critical path.

4. Contractor must add submittals as requested by the Engineer.

5. Contractor must add critical path submittals to progress schedule described in General Conditions Section 6.29, Progress Schedule.

6. Contractor must update and resubmit on a monthly basis as part of the Monthly CPM Schedule Update, as described in General Conditions Section 6.29.6, Monthly CPM Schedule Update Submittals.

1.05 CONTRACTOR’S RESPONSIBILITIES

A. General:

1. Contractor must furnish each submittal listed in the Submittal Article of each Subsection of this Section 11.

2. Submittals must be in Imperial (or British) units and in the English language.

3. Identification:

   a. Submittal Number: For each submittal, the submittal number is the corresponding number of the section, Subsection, article, paragraph, and subparagraph of the Contract Technical Specifications under which each is required.

   b. Tracking Number: In addition to submittal number, Contractor must furnish a sequential tracking number as required by General Conditions Section 6.45.2, General Requirements for Submittals.

   c. Revision Number: Furnish as part of the tracking number, as required by General Conditions Section 6.45.2.

4. Contractor must attach the “Submittal Cover Page,” as described in General Conditions Section 6.45.2, to each submittal. In addition to the requested information on this form, Contractor must furnish the following information:

   a. Submittal number.

   b. Applicable standards, such as ASTM or IEEE.
c. Related Contract Drawing numbers.

5. Submittal Medium:
   a. Contractor must furnish hard copies as required in General Conditions Section 6.45.2.
   b. Contractor must furnish electronic copy in pdf format with bookmarks to separate sections.
   c. Drawings: In addition to hard copies and pdf format requirements above, Contractor must furnish drawings in AutoCAD format, version as required by General Conditions Section 6.55, As-Built Plans.

B. Product Data:
   1. Contractor must clearly indicate on product selection tables which product and which options are being provided.
   2. Contractor must line through or delete information that is not applicable to the Contract.

C. Shop Drawings:
   1. Contractor must show dimensions, connections, and other details necessary to assure that the plans are accurately interpreted.
   2. Contractor must use standard IEEE/ANSI device symbols and nomenclature on drawings.
   3. Drawings must be fully legible. Text on 22” by 34” drawings must not be smaller than 1/8 inch and on 11” by 17” drawings must not be smaller than 1/16 inch.
   4. On each drawing, Contractor must furnish title block, and blank space for acceptance-stamp, per General Conditions Section 6.45.10, Submission of Working and Shop Drawings.

D. Samples:
   1. Procedures: General Conditions Section 6.45.12, Samples.
   2. Contractor must furnish samples indicated in Contract Drawings and Specifications.

E. Contractor must provide all submittals in a timely manner:
F. Contractor's Review:

1. Contractor must identify deviations from Contract Drawings and Contract Technical Specifications, as required by General Conditions Section 6.45.4, Deviation from Contract Requirements.

2. Contractor must stamp, and sign all submittals as reviewed and approved by Contractor before submitting, including subcontractor submittals.

3. Contractor must verify that submittal is in the English language.

G. Submittal Meetings: Contractor must attend meetings as requested by the Engineer to address issues related to the review of submittals.

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

Not Used.
11-1.04 REGULATORY REQUIREMENTS

PART 1 – GENERAL

1.01 SUBSECTION INCLUDES

A. Regulatory compliance and permit requirements that apply only to the work in this Section 11.

1.02 REFERENCE STANDARDS

A. This Subsection incorporates by reference the latest revisions of the following documents:

1. California Code of Regulations (CCR):
   a. CCR Title 8, Industrial Relations (OSHA)
      1) Construction Safety Orders, Division 1, Chapter 4, Subchapter 4.
      2) Low-Voltage Electrical Safety Orders, Division 1, Chapter 4, Subchapter 5, Group 1, (Sections 2299-2599)
      3) High-Voltage Electrical Safety Orders, Division 1, Chapter 4, Subchapter 5, Group 2, (Sections 2700-2989)

2. California Public Utilities Commission (CPUC):
   a. General Order (G.O.) 95, Overhead Electric Line Construction.

3. Institute of Electrical and Electronics Engineers (IEEE)

4. National Fire Protection Association (NFPA)
   a. NFPA 70, National Electrical Code (NEC)
1.03 MEASUREMENT AND PAYMENT

A. Work specified in this Subsection is incidental to Work described in other Subsections.

1.04 PRECEDENCE OF STATUTES, CODES, RULES, REGULATIONS, AND STANDARDS

A. Where the requirements of the Contract Documents differ from the requirements of applicable codes and ordinances, the more stringent requirements take precedence.

B. Where the Contract Documents require or describe products or execution of better quality, higher standard, or greater size or rating than required by applicable codes and ordinances, the Contract Documents take precedence.

C. Where applicable statutes, codes, rules, regulations, and standards require more care or greater time to accomplish Work, or require better quality, higher standards, greater size, or higher ratings, Contractor must perform Work in conformance to such requirements with no change to the Contract Time and Contract Sum, except where changes in the statutes, codes, rules, regulations, and standards occur subsequent to the execution date of the Contract.

D. When no requirements are identified in the Contract Documents, Contractor must comply with all requirements of applicable statutes, codes, rules, regulations, and standards of the Authorities Having Jurisdiction.

1.05 DATES OF STATUTES, CODES, RULES, REGULATIONS, AND STANDARDS

A. The applicable edition of all codes is that adopted by any Authority Having Jurisdiction and includes all modifications and additions adopted by that jurisdiction.

B. The applicable date of statutes, rules, regulations, and standards is the date of execution of the Contract to perform the Work.
1.06 SPECIFIC STATE REGULATIONS

A. At a minimum, Contractor must comply with regulations of the following state agencies, including but not limited to those regulations listed below each agency:

   a. General Order (G.O.) 95, Overhead Electric Line Construction.
      1) Where applicable, all work must comply with G.O. 95, which takes precedence over these Section 12 Technical Specifications.
      2) Representatives from the CPUC will randomly inspect the work for compliance with G.O. 95.

2. California Code of Regulations (CCR):
   a. Title 8, Industrial Relations (OSHA)
      1) Construction Safety Orders, Division 1, Chapter 4, Subchapter 4.
      2) Low-Voltage Electrical Safety Orders, Division 1, Chapter 4, Subchapter 5, Group 1, (Sections 2299-2599).
      3) High-Voltage Electrical Safety Orders, Division 1, Chapter 4, Subchapter 5, Group 2, (Sections 2700-2989).

1.07 MINIMUM STANDARDS

A. At a minimum, Contractor must comply with the following standards:

1. NFPA 70, National Electrical Code (NEC): Performance of the Work must meet or exceed the minimum requirements of NFPA 70 as adopted and modified by any Authority Having Jurisdiction.

1.08 PERMITS

A. Contractor must determine the licenses, permits, and plan review required by any Authority Having Jurisdiction, and comply with all requirements to perform Work.

B. Contractor must obtain required licensing, permitting, plan review, and inspections at no additional cost to RT, as required in General Conditions Section 6.5, Permits, Licenses, Fees and Notices.

C. Contractor may be required to adjust its design or provide such additional information as required by the City or State to obtain permit approval.

D. Modifications or delays necessary to receive the City or State approval must not result in additional costs or schedule delays to RT.

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

3.01 POSTING PERMITS

A. Contractor must post permits at the site of Work, if required by applicable laws or regulations.
11-1.05 REFERENCES

PART 1 – GENERAL

1.01 SUBSECTION INCLUDES

A. Requirements that apply only to the work of this Section 11


C. Explanation of Contract Technical Specifications style for this Section 11.

D. Reference Standards.

E. Standard Specifications.

F. Abbreviations.

G. Definitions.

1.02 MEASUREMENT AND PAYMENT

A. Work specified in this Subsection is incidental to Work described in other Subsections.

1.03 DEFINITION OF TERMS, AS USED IN THIS SECTION 11 (these terms may be used elsewhere in the Technical Specifications with a different meaning):

A. Furnish, Install, and Provide:

1. Furnish means to supply and deliver to Project site, ready for installation.

2. Install means to place in position for service or use.

3. Provide means to furnish and install, complete and ready for intended use.

B. Authority Having Jurisdiction (AHJ) has the definition set out in the NEC.

1.04 TECHNICAL SPECIFICATION STYLE

A. These Section 11 Technical Specifications are generally written in imperative mood and streamlined form. This imperative language is directed to the Contractor, unless specifically noted otherwise. The words “must be” or “must comply with”, as appropriate, are included by inference where a verb form is used without a subject. The use of the phrase “Contractor must” in certain locations within these Section 11 Technical Specifications may not be used to
draw any inferences regarding the absence of such directive language elsewhere in the document.

B. Examples:

1. “Prepare meeting minutes within 3 days following the meeting,” means that the Contractor must prepare the meeting minutes.

2. “Adhesive: Spread with a notched trowel” means “adhesive must be spread with a notched trowel” and the Contractor is responsible for this work.

1.05 REFERENCE STANDARDS

A. Reference standards are referenced in other Subsections of this Technical Specification Section 11 to establish requirements for the Work. These references are identified in each Subsection by document number and title.

B. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

C. Conflicting Requirements: Where compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to the Engineer for a decision before proceeding.

D. Publication Dates: Comply with standards in effect as of date of the Contract Documents, unless otherwise indicated.

E. Copies of Standards: Each entity engaged in Work on this Contract must be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.06 STANDARD SPECIFICATIONS

A. All work must conform to or exceed the requirements of State Standard Specifications.
### 1.07 ABBREVIATIONS

A. The following abbreviations are in addition to those indicated in the Caltrans standard specifications:

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC</td>
<td>Alternating Current</td>
</tr>
<tr>
<td>AEIC</td>
<td>Association of Edison Illuminating Companies</td>
</tr>
<tr>
<td>APTA</td>
<td>American Public Transit Association</td>
</tr>
<tr>
<td>ASCII</td>
<td>American Standard Code for Information Interchange</td>
</tr>
<tr>
<td>AWG</td>
<td>American Wire Gauge</td>
</tr>
<tr>
<td>CALTRANS</td>
<td>State of California, Department of Transportation</td>
</tr>
<tr>
<td>CDRL</td>
<td>Contract Data Requirements List</td>
</tr>
<tr>
<td>CPM</td>
<td>Critical Path Method</td>
</tr>
<tr>
<td>CPUC</td>
<td>California Public Utilities Commission</td>
</tr>
<tr>
<td>CSI</td>
<td>Construction Specifications Institute</td>
</tr>
<tr>
<td>DBE</td>
<td>Disadvantaged Business Enterprise</td>
</tr>
<tr>
<td>DC</td>
<td>Direct Current</td>
</tr>
<tr>
<td>DWG</td>
<td>Drawing</td>
</tr>
<tr>
<td>EMC</td>
<td>Electromagnetic Compatibility</td>
</tr>
<tr>
<td>EMI</td>
<td>Electromagnetic Interference</td>
</tr>
<tr>
<td>FCC</td>
<td>Federal Communications Commission</td>
</tr>
<tr>
<td>FRA</td>
<td>Federal Railroad Administration</td>
</tr>
<tr>
<td>FTA</td>
<td>Federal Transit Administration</td>
</tr>
<tr>
<td>IEC</td>
<td>International Electrotechnical Commission</td>
</tr>
<tr>
<td>IES</td>
<td>Illuminating Engineering Society</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization for Standards</td>
</tr>
<tr>
<td>LED</td>
<td>Light Emitting Diode</td>
</tr>
<tr>
<td>LRT</td>
<td>Light Rail Transit</td>
</tr>
<tr>
<td>LRV</td>
<td>Light Rail Vehicle</td>
</tr>
<tr>
<td>MIL</td>
<td>Military Specification</td>
</tr>
<tr>
<td>NBS</td>
<td>National Bureau of Standards</td>
</tr>
<tr>
<td>NTP</td>
<td>Notice to Proceed</td>
</tr>
<tr>
<td>OCS</td>
<td>Overhead Contact System</td>
</tr>
<tr>
<td>PIV</td>
<td>Peak Inverse Voltage</td>
</tr>
<tr>
<td>RMS</td>
<td>Root Mean Square</td>
</tr>
<tr>
<td>ROW</td>
<td>Right-of-way</td>
</tr>
<tr>
<td>RT</td>
<td>Sacramento Regional Transit District</td>
</tr>
<tr>
<td>RTU</td>
<td>Remote Terminal Unit</td>
</tr>
<tr>
<td>SCADA</td>
<td>Supervisory Control and Data Acquisition</td>
</tr>
<tr>
<td>SI</td>
<td>International System of Measurement</td>
</tr>
<tr>
<td>SSP</td>
<td>System Safety Program</td>
</tr>
<tr>
<td>TES</td>
<td>Traction Electrification System</td>
</tr>
<tr>
<td>TIG</td>
<td>Tungsten Inert Gas</td>
</tr>
<tr>
<td>TOR</td>
<td>Top of Rail</td>
</tr>
<tr>
<td>TPSS</td>
<td>Traction Power Substation</td>
</tr>
<tr>
<td>UBC</td>
<td>Uniform Building Code</td>
</tr>
<tr>
<td>UPRR</td>
<td>Union Pacific Railroad</td>
</tr>
<tr>
<td>UOS</td>
<td>Unless Otherwise Specified</td>
</tr>
<tr>
<td>USASI</td>
<td>United States of America Standards Institute</td>
</tr>
</tbody>
</table>
1.08 DEFINITIONS

A. The following definitions are in addition to those indicated in the State Standard Specifications:

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Along Track Movement</td>
<td>The motion of auto-tensioned OCS caused by thermal expansion or contraction of the conductors.</td>
</tr>
<tr>
<td>Alteration</td>
<td>A change or substitution in the form, character, or detail of the work done or to be done within the original scope of the Contract.</td>
</tr>
<tr>
<td>Anchor</td>
<td>Strain termination of a conductor or other wire or cable.</td>
</tr>
<tr>
<td>Anchor Bolt</td>
<td>A bolt inserted into a concrete foundation to form an attachment for a pole or support Bracket.</td>
</tr>
<tr>
<td>Anchor Plate</td>
<td>A buried plate at the lower end of an anchor rod used with down Guys; on an attachment to the face of a structure for anchoring OCS.</td>
</tr>
<tr>
<td>Arrangement</td>
<td>A group of assemblies arranged in a specific configuration.</td>
</tr>
<tr>
<td>Assembly</td>
<td>A collection of subassemblies and Components required to perform specific functions within the context of a larger system. Examples of assemblies are OCS Cantilevers or switches</td>
</tr>
<tr>
<td>Blow- off</td>
<td>Lateral displacement of a conductor due to wind.</td>
</tr>
<tr>
<td>Bond</td>
<td>An electrical connection between metal Components to eliminate voltage difference.</td>
</tr>
<tr>
<td>Bolted Base Poles</td>
<td>Poles with a base plate for use on foundations with Anchor Bolts as opposed to plain poles which are either planted or embedded.</td>
</tr>
<tr>
<td>Backbone</td>
<td>A span Guy or wire between structures used to pull the Contact Wire (and messenger) laterally to conform to the track curvature.</td>
</tr>
<tr>
<td>Bracket</td>
<td>A connection by which an assembly is attached to its supporting structure.</td>
</tr>
<tr>
<td>Bracket Arm</td>
<td>A horizontal structural member Cantilevered out from and rigidly connected to a pole from which the OCS conductors are supported on Insulators.</td>
</tr>
<tr>
<td>Cantilever</td>
<td>The support frame and Registration assembly supporting the OCS conductors from a pole on Insulators with hinged Brackets.</td>
</tr>
<tr>
<td>Cantilever Offset</td>
<td>Along Track distance measured from the position where the Cantilever is perpendicular to the track and the position where the Cantilever is displaced due to heating or cooling of the conductors. The Offset is a function of the position of the Cantilever in the tension length.</td>
</tr>
<tr>
<td>Carbon Collector</td>
<td>The carbon strip on top of the Pantograph that</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Catenary</td>
<td>The combination of conductors, Hangers and in-span Hardware of the overhead contact system used in LRT operation, not including supports and crossarms.</td>
</tr>
<tr>
<td>Catenary Suspension</td>
<td>A form of overhead construction that includes a single Contact Wire suspended from a Messenger Wire by Hangers.</td>
</tr>
<tr>
<td>Certification</td>
<td>Certificates or certified test results submitted by Contractor that demonstrate proof of compliance with the specified standards and Technical Specifications for products, materials, equipment, systems and qualifications of personnel, manufacturers, fabricators, and installers.</td>
</tr>
<tr>
<td>Clipping In</td>
<td>Clamping the OCS conductors at permanent supports.</td>
</tr>
<tr>
<td>Clearance Gauge</td>
<td>The clearance diagram for vehicles and appurtenances into which no part of the TES may intrude.</td>
</tr>
<tr>
<td>Clearance Envelope</td>
<td>The space around trains into which no part of the TES, except the Contact Wire and its direct support, may intrude.</td>
</tr>
<tr>
<td>Component</td>
<td>Portions of equipment not typically repaired or disassembled, such as nuts, bolts, resistors, fittings, single-piece castings. Used interchangeably with &quot;Parts.&quot;</td>
</tr>
<tr>
<td>Contact Bridge</td>
<td>An assembly, up to 5 feet long, fixed closely above and attached to the in-running Contact Wire forming a slot for a second Contact Wire to pass through, thereby preventing differential Uplift of crossing Contact Wires.</td>
</tr>
<tr>
<td>Contact Wire</td>
<td>The wire in the OCS against which the vehicle Pantograph glides.</td>
</tr>
<tr>
<td>Contact Wire Gradient:</td>
<td>The rate at which the Contact Wire elevation changes elevation relative to track elevation.</td>
</tr>
<tr>
<td>Contact Wire Height</td>
<td>The height of the underside of the Contact Wire above top of rail level when not Uplifted by the Pantograph, measured along a perpendicular line projected from a line joining the top surfaces of both rails.</td>
</tr>
<tr>
<td>Minimum</td>
<td>The minimum allowable Contact Wire height that takes due account of vehicle clearance envelope, vehicle bounce, track tolerances, conductor temperature effects and Electrical Clearances. May also take future track raising into account if so required.</td>
</tr>
<tr>
<td>Maximum</td>
<td>The maximum allowable Contact Wire height that considers Pantograph reach.</td>
</tr>
<tr>
<td>Creep</td>
<td>The natural stretching of conductors under tension.</td>
</tr>
<tr>
<td>Cross Contact</td>
<td>A rigid length of Contact Wire, about 6 feet long,</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Fixed End</td>
<td>An OCS conductor termination without counterweights.</td>
</tr>
<tr>
<td>Fixed-Termination Equipment</td>
<td>A Catenary style whose conductors are terminated without Tensioning Devices.</td>
</tr>
<tr>
<td>Grounded</td>
<td>Connected to the conducting mass of the earth via ground rods, ground grid or both to ensure an immediate discharge of electrical potential without danger.</td>
</tr>
<tr>
<td>Guy</td>
<td>A steadying or positioning wire.</td>
</tr>
<tr>
<td>Down or Back Guy</td>
<td>A wire attached high on a pole and coming down at an angle to an anchor in the ground.</td>
</tr>
<tr>
<td>Head or Span Guy</td>
<td>A wire between two points but not anchored to ground.</td>
</tr>
<tr>
<td>Hardware</td>
<td>All materials and Components necessary for an operable Catenary system except poles, Contact Wire, Messenger Wires, span wires, anchor wires, Hanger wires, feeder cables, and Jumper wires.</td>
</tr>
<tr>
<td>Hanger</td>
<td>A wire and fittings that support the Contact Wire</td>
</tr>
<tr>
<td>Crossover</td>
<td>A special track assembly that allows the vehicle to cross from one track to another.</td>
</tr>
<tr>
<td>Cross Span</td>
<td>An installation of a wire or wires fastened to structures on either side of the track supporting the Contact Wire and messenger, as appropriate.</td>
</tr>
<tr>
<td>Current Collector</td>
<td>The rubbing strip at the top of a Pantograph that rides along under the Contact Wire.</td>
</tr>
<tr>
<td>Direct Suspension Single Contact System (DSSC)</td>
<td>A single Contact Wire directly suspended from OCS Cantilevers and cross-span wires.</td>
</tr>
<tr>
<td>Electrical Clearance</td>
<td></td>
</tr>
<tr>
<td>Passing</td>
<td>The minimum distance between live Parts of the OCS and any Grounded Part or structure on a rail vehicle, or between the Pantograph and any Grounded Part or structure under any permissible conditions of rail vehicle operation. These conditions include, but are not limited to: maximum vehicle roll, maximum vehicle lateral movement, maximum Pantograph sway, maximum track alignment tolerances, maximum track cross level tolerances, and maximum pole deflection.</td>
</tr>
<tr>
<td>Static</td>
<td>The minimum distance between live Parts of the OCS, not subject to Uplift from a Pantograph, and any Grounded Part or structure.</td>
</tr>
<tr>
<td>Working</td>
<td>The minimum depth of clear working space in front of electrical equipment.</td>
</tr>
<tr>
<td>Feeders</td>
<td>Conductors that supply power to or augment the power carrying capacity of the conductors in an OCS.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Head Span</td>
<td>An installation of two or more wires that cross the tracks and support the Contact Wire and messenger, as appropriate.</td>
</tr>
<tr>
<td>Heel Setting</td>
<td>Vertical distance measured from underside of Contact Wire to the pin connecting the Contact WireRegistration arm with the Cantilever frame.</td>
</tr>
<tr>
<td>Impedance Bond</td>
<td>An inductive device bridging an insulated rail joint used for allowing passage of DC traction return current while preventing passage of AC current used for signaling.</td>
</tr>
<tr>
<td>Insulator</td>
<td>Any body or substance provided and designed for the purpose of surrounding or supporting a conductor so as to restrict the flow of electricity to a desired path.</td>
</tr>
<tr>
<td>Interface</td>
<td>The points where two or more systems, subsystems, or structures meet, transfer energy, or transfer information.</td>
</tr>
<tr>
<td>Jumper</td>
<td>An electrical connection in the OCS installed to provide electrical conductivity.</td>
</tr>
<tr>
<td>Continuity or Full Current</td>
<td>A Jumper capable of carrying full load current from one OCS segment to another at Overlaps and track turnouts.</td>
</tr>
<tr>
<td>Equalizing</td>
<td>A Jumper in the OCS connecting the Messenger Wire to the Contact Wire.</td>
</tr>
<tr>
<td>Knuckle</td>
<td>Registration assembly connecting conductors of two systems.</td>
</tr>
<tr>
<td>Maximum Operating Wind Speed</td>
<td>The maximum wind speed at which vehicles will continue to operate. The wind speed selected for Pantograph security calculations.</td>
</tr>
<tr>
<td>Messenger Wire</td>
<td>The upper wire in a Catenary system from which the Contact Wire is suspended by means of Hangers.</td>
</tr>
<tr>
<td>Midpoint Anchor</td>
<td>The structure approximately midway between two counterweights of a Tension Section where the messenger and/or Contact Wire is anchored to stabilize the system.</td>
</tr>
<tr>
<td>Midspan Offset</td>
<td>The deviation of a static Contact Wire at midspan from centerline of the track.</td>
</tr>
<tr>
<td>Non-Operating Condition</td>
<td>The climatic conditions where wind speeds and ice formation are in excess of those at Operating Conditions and therefore necessitate discontinuation of Normal service even though the overhead system is structurally Safe.</td>
</tr>
<tr>
<td>Normal</td>
<td>As in, &quot;Normal Operating Conditions&quot; or &quot;operating Normally.&quot; A condition in which relevant equipment is not in a failure mode and the environment is as specified.</td>
</tr>
<tr>
<td>Normal Temperature</td>
<td>As used when referring to the OCS, it is the temperature at which the OCS is in its mean position.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Offset</td>
<td>Deviation of the static Contact Wire from the centerline of a static Pantograph.</td>
</tr>
<tr>
<td>Operating Condition</td>
<td>The acceptable climatic conditions that allow revenue trains to operate in Normal service.</td>
</tr>
<tr>
<td>Overhead Contact System (OCS)</td>
<td>A complete OCS, including OCS assemblies, Tensioning Devices, poles, OCS conductors and cables, supporting a Contact Wire by Catenary suspension or directly from Cantilevers or cross-span wires.</td>
</tr>
<tr>
<td>Simple Catenary System</td>
<td>Comprising a Contact Wire supported from a Messenger Wire by Hangers.</td>
</tr>
<tr>
<td>Single Contact Wire System</td>
<td>Comprising a Contact Wire only, without Messenger Wire and which may or may not be accompanied by overhead or underground along track Feeders.</td>
</tr>
<tr>
<td>Overlap Section</td>
<td>That portion of the OCS between two main structures where the contact and Messenger Wires of two adjoining Tension Sections Overlap.</td>
</tr>
<tr>
<td>Span</td>
<td>The length of OCS system between adjacent Overlap structures.</td>
</tr>
<tr>
<td>Insulated</td>
<td>Insulators installed in the out-of-running wires to provide electrical sectionalizing.</td>
</tr>
<tr>
<td>Pantograph</td>
<td>The assembly on the light rail vehicle used for collecting electrical power from the OCS.</td>
</tr>
<tr>
<td>Head</td>
<td>The uppermost part of the Pantograph, which is fitted with the Current Collector.</td>
</tr>
<tr>
<td>Sway</td>
<td>Lateral displacement of the Pantograph with respect to the vehicle induced by roll and lateral loads.</td>
</tr>
<tr>
<td>Security</td>
<td>The Safety margin on the Pantograph head after allowing for lateral displacement between Pantograph collector tip and Contact Wire considering maximum vehicle and Pantograph sway, track maintenance tolerances, superelevation, erection tolerances, wind and temperature effects.</td>
</tr>
<tr>
<td>Part</td>
<td>See Component, above.</td>
</tr>
<tr>
<td>Pole Offset</td>
<td>The dimension from the centerline of the pole to the centerline of the track.</td>
</tr>
<tr>
<td>Portal</td>
<td>A frame support structure consisting of vertical columns supporting each end of a horizontal beam.</td>
</tr>
<tr>
<td>Prestress</td>
<td>Initial stress applied to a conductor at a higher tension than for Normal operation to reduce the rate of future Creep.</td>
</tr>
<tr>
<td>Proof (used as a suffix)</td>
<td>As in splashproof, dustproof. The device and contents are Safeguarded against, impervious to, or unharmed by, application of the indicated material.</td>
</tr>
<tr>
<td>Pull Off</td>
<td>The Registration towards the pole from the centerline of track.</td>
</tr>
<tr>
<td>Push Off</td>
<td>The Registration away from the pole from centerline of track in relation to the pole.</td>
</tr>
<tr>
<td>Raceway</td>
<td>An enclosed channel designed for holding cables or...</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>busbars</td>
<td>as defined by the National Electrical Code.</td>
</tr>
<tr>
<td>Radial Load</td>
<td>Across-track horizontal loads exerted by conductors.</td>
</tr>
<tr>
<td>Rail Bond</td>
<td>Electrical connection between adjacent lengths of rail.</td>
</tr>
<tr>
<td>Rake</td>
<td>Lean of the pole from vertical, measured at the top of pole.</td>
</tr>
<tr>
<td>OCS Project Record</td>
<td>Documents as described in the General Conditions and “OCS Documents” of this Section 11.</td>
</tr>
<tr>
<td>Registration Tube</td>
<td>The horizontal pipe or tube to which the drop Bracket or the heel of the Steady Arm is attached.</td>
</tr>
<tr>
<td>Reliability</td>
<td>The probability of performing a specified function, without failure and within design parameters, for the period of time indicated.</td>
</tr>
<tr>
<td>Riser</td>
<td>A vertical cable supplying power upward from the underground feeder system to the OCS.</td>
</tr>
<tr>
<td>Saddle</td>
<td>A Sleeve attached to the Messenger Wire, which retains the upper loop of a Hanger.</td>
</tr>
<tr>
<td>Safe</td>
<td>Secure from liability to harm, injury, danger, or risk; free from danger or risk.</td>
</tr>
<tr>
<td>Safety</td>
<td>The condition in which persons are free from threat or danger, harm, or loss arising from manufacture, assembly, malfunction, or failure of the TES or any of its Components or elements.</td>
</tr>
<tr>
<td>Sag</td>
<td>The height of the conductor at its support point less its height at the lowest point in the span.</td>
</tr>
<tr>
<td>Sag-Tension Charts</td>
<td>Charts used during wire stringing which compensate for conductor temperature during the system tensioning.</td>
</tr>
<tr>
<td>Salvage</td>
<td>Work required to disassemble removed equipment, transport to the RT storage facility, and make ready for inventory.</td>
</tr>
<tr>
<td>Section Insulator</td>
<td>A device for dividing the overhead system into electrical sections while maintaining mechanical continuity and a continuous path for the Pantographs.</td>
</tr>
<tr>
<td>Service Proven</td>
<td>With successful service history in the same or similar application over at least 5 years.</td>
</tr>
<tr>
<td>Single Wire</td>
<td>Comprising a Contact Wire only.</td>
</tr>
<tr>
<td>Pipe Sleeve</td>
<td>A short length of smaller diameter pipe fitted into a larger diameter pipe to reduce the internal diameter of the larger pipe.</td>
</tr>
<tr>
<td>Chaffing Sleeve</td>
<td>A Sleeve around a conductor to reduce damage from abrasion.</td>
</tr>
<tr>
<td>Span</td>
<td>An overhead Guy spanning between two support points, generally suspending some overhead equipment.</td>
</tr>
<tr>
<td>Length</td>
<td>Distance along track between structures.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Width</td>
<td>Distance across track between the columns of a Portal, cross span, or headspan.</td>
</tr>
<tr>
<td>Stagger</td>
<td>The Offset of the Contact Wire from the track center at a support structure due to Registration.</td>
</tr>
<tr>
<td>Steady Arm or Registration Arm</td>
<td>The lateral restrainer on the Contact Wire at a structure.</td>
</tr>
<tr>
<td>String Length</td>
<td>See &quot;versine&quot;.</td>
</tr>
<tr>
<td>Subassembly</td>
<td>A collection of Components used to perform a distinct function, usually in conjunction with other subassemblies and Components, as part of a larger system. Subassemblies are usually replaceable as units, such as circuit boards, circuit breakers, and switches.</td>
</tr>
<tr>
<td>System Height or Depth</td>
<td>The vertical distance between the messenger and Contact Wire at a support.</td>
</tr>
<tr>
<td>Tensioning Device</td>
<td>Counterweight, pneumatic, spring or hydraulic device installed at the ends of a Tension Section to maintain constant tension in the overhead conductors.</td>
</tr>
<tr>
<td>Tension Section</td>
<td>The section length of overhead between its mechanical terminations.</td>
</tr>
<tr>
<td>Tight (used as a suffix)</td>
<td>As in watertight, airtight, enclosed or protected as to completely exclude the indicated material from passage.</td>
</tr>
<tr>
<td>Track Tolerances</td>
<td></td>
</tr>
<tr>
<td>Vertical</td>
<td>Allowable variation in vertical track alignment.</td>
</tr>
<tr>
<td>Lateral</td>
<td>Allowable variation in track horizontal alignment.</td>
</tr>
<tr>
<td>Cross Level</td>
<td>Allowable variation between the levels of the two rails.</td>
</tr>
<tr>
<td>Traction Electrification System</td>
<td>Traction power supply and traction power distribution systems, taken together.</td>
</tr>
<tr>
<td>Traction Power Supply System</td>
<td>Traction power substations located at predetermined spacing along the route along with the required AC supply power from the utility to points of utilization, AC cables and DC Feeders.</td>
</tr>
<tr>
<td>Traction Power Distribution System</td>
<td>The OCS and running rails along with interconnecting cable and switches.</td>
</tr>
<tr>
<td>Uplift</td>
<td></td>
</tr>
<tr>
<td>Dynamic</td>
<td>Lift of the conductors due to the Pantograph passing.</td>
</tr>
<tr>
<td>Static</td>
<td>Lift of the conductors due to stationary Pantograph.</td>
</tr>
<tr>
<td>Versine</td>
<td>Measurement of track curvature made by stretching a string between two points on a rail, so that it forms a chord to the curve, and measuring the distance between the string and the rail, midway between the two points.</td>
</tr>
</tbody>
</table>
11-1.06 QUALITY CONTROL

PART 1 – GENERAL

1.01 SUBSECTION INCLUDES
   A. General quality control requirements for this Section 11.

1.02 MEASUREMENT AND PAYMENT
   A. Work specified in this Subsection is incidental to Work described in other Subsections.

1.03 SUBMITTALS
   A. Procedures: Subsection 11-1.03, Submittal Procedures.
   B. Contractor must submit quality control submittals required by General Conditions Section 6.47, “Contractor Quality Control Program” (CQCP).

1.04 QUALITY CONTROL
   A. Quality control must be in accordance with General Conditions Section 6.47 CQCP General Requirements and this Section 11 of the Contract Technical Specifications.
   B. As required by the CQCP, Contractor must maintain, as Quality Records, the documentation for inspections, tests, and measurements submitted to Engineer for approval as required by Subsection 11-1.03, Submittal Procedures, and Technical Specifications Sections in this Section 11.

PART 2 – PRODUCTS
Not Used.

PART 3 – EXECUTION
Not Used.
11-1.07  SYSTEM ASSURANCE

PART 1 – GENERAL

1.01  SUBSECTION INCLUDES

A. Requirements that apply only to the work of this Section 11.

B. Developing and implementing a Systems Assurance Program for this Section 11, encompassing system Safety and Reliability engineering, to accomplish the following:

   1. Avoid, eliminate or reduce potential identified hazards at the early stage of the project life.

   2. Control and minimize hazards to passengers, personnel, and public.

   3. Incorporate fail-Safe design principle if possible.

   4. Use high Reliability and predictable failure modes Components.

C. Support for RT’s Safety Certification Program.

1.02  MEASUREMENT AND PAYMENT

A. Work specified in this Subsection is incidental to Work described in other Subsections.

1.03  REFERENCE STANDARDS

A. This Subsection incorporates by reference the latest revisions of the following documents:

B. U.S. Department of Transportation, Federal Transit Administration


1.04 SUBMITTALS

A. Procedures: Subsection 11-1.03, Submittal Procedures.

B. Qualifications:

1. Resume for each proposed person preparing required submittals.

2. Samples of similar documents prepared by each proposed person for previous projects.

C. Proposed Software: Product data, list of projects where used, sample output.

D. System Safety Program Plan (SSPP):

1. A schedule for submittal of the required hazard analyses that conforms to the schedule in DOT-FTA-MA-26-5005-00-01.

2. The following hazard analyses included in the SSPP in compliance with DOT-FTA-MA-26-5005-00-01:

   a. Preliminary Hazard Analysis (PHA).

   b. Failure Modes and Effects Analysis (FMEA).

   c. Fault Tree Analysis (FTA).

   d. Operating Hazard Analysis (OHA).

1.05 QUALITY CONTROL

A. Qualifications:

1. Documents required in this Subsection 11-1.07, System Assurance, must be prepared by persons with a minimum of 5 years experience preparing comparable documents for the transit industry.

2. Provide samples of documents from previous projects that demonstrate familiarity with the process and subject matter.

B. Software

1. Prepare required documents using recognized industry analysis software.
PART 2 – PRODUCTS

2.01 SYSTEM SAFETY PROGRAM PLAN (SSPP)

A. The SSPP is designed to identify and eliminate hazards where possible, and where not possible, to control identified hazards.

B. Prepare the following Safety analyses in accordance with the guidelines in DOT-FTA-MA-26-5005-00-01. Conform to the schedule in DOT-FTA-MA-26-5005-00-01:

1. Preliminary Hazard Analysis (PHA): Perform during the concept-planning phase.

2. Failure Modes and Effects Analysis (FMEA): Perform during preliminary design so that identified changes can be incorporated into the final design. Update during the commissioning and integrated testing phase if additional hazards are identified.

3. Fault Tree Analysis (FTA): Perform at the beginning of final design.

4. Operating Hazard Analysis (OHA): Perform during the latter portion of final design. Update during the commissioning and integrated testing phase if additional hazards are identified.

“Preliminary design” and “Final design”, for purposes of this section, refers only to the design work performed by Contractor, and not any design work performed by RT’s design consultants.

PART 3 – EXECUTION

3.01 IMPLEMENTATION OF SYSTEM SAFETY

A. After completion of required Safety submittals, implement changes required to eliminate or mitigate hazards, at no cost to RT:

1. Change design if necessary to eliminate identified hazards.

2. Where hazards cannot be eliminated, include Safety devices and warning devices in design to mitigate hazards.

3. If an identified hazard can be mitigated only by procedures and training, identify specifically where the hazard has been addressed in training program and Operation and Maintenance Manuals.
3.02 SAFETY CERTIFICATION PROGRAM

A. RT is required by the FTA to implement a Safety Certification Program (reference DOT-FTA-MA-90-5006-02-01).

B. Support RT’s implementation of the program as directed by Engineer.

C. Participation includes activities such as assisting RT with development of checklists and documentation, identifying submittals that satisfy requirements of the Certifiable Item List, providing standards to which Components are designed and tested, and identifying Safety-related instructions in training and maintenance documents.
11-1.08 PRODUCT REQUIREMENTS

PART 1 – GENERAL

1.01 SUBSECTION INCLUDES

A. Requirements that apply only to the work in this Section 11.

B. General Section 11 product requirements.

1.02 MEASUREMENT AND PAYMENT

A. Work specified in this Subsection is incidental to Work described in other Subsections.

PART 2 – PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Provide products that comply with these Technical Specifications.

B. Do not use products that have been discontinued by the manufacturer, even if new.

C. One Supplier:

1. OCS support assemblies and OCS wiring assemblies (all material from the pole face out to, but excluding, the conductors) must primarily be products of one supplier.

2. Products of the same generic type must be by the same manufacturer.

D. Certificates of Compliance:

1. See General Conditions, Section 6.50 for requirements applicable to Certificates of Compliance.

2.02 OCS ASSEMBLY REQUIREMENTS

A. Service History: Materials used in OCS assemblies must have demonstrated satisfactory use in revenue service in similar Light Rail Transit (LRT) systems in the United States for a period of five years and meet or exceed the specified requirements.
B. Permitted Manufacturers: For maintainability with the existing LRT system, OCS materials must be manufactured by one of the following or approved equal:

1. IMPulse NC.
2. K&M (MAC Products)
3. Siemens

PART 3 – EXECUTION

Not Used.
11-1.09  WARRANTIES

PART 1 – GENERAL

1.01  SUBSECTION INCLUDES

A.  Warranty periods for products in this Section 11.

1.02  RELATED SUBSECTIONS

A.  Subsection 11-2.01 – Common Work Results for Metals
B.  Subsection 11-4.02 – OCS Steel Poles

1.03  MEASUREMENT AND PAYMENT

A.  Work specified in this Subsection is incidental to Work described in other Subsections.

1.04  SUBMITTALS

A.  Procedures:  Subsection 11-1.03, Submittal Procedures.
B.  Warranties:  Submit as Project Records in compliance with General Conditions 6.77, Warranty.

1.05  MANUFACTURER WARRANTY

A.  This section does not modify the Warranty Provisions contained in General Conditions Sections 6.77, Warranty; 6.78, Warranty Bond; 6.79, Warranty on Replaced Parts; or 6.80, Systematic Failures.

B.  Provide the following extended manufacturer’s warranties:

1.  OCS Pole and Cantilever Pipe Finish:

   a.  Four years from issue of Letter of Final Acceptance, as described in General Conditions Section 6.56, Final Inspection and Acceptance. See Section 11-4.02, OCS Steel Poles, for specific requirements.

   b.  Pole finish includes hot-dip galvanizing and paint coating system as specified in Subsection 11-2.01, Common Work Results for Metals.

   c.  Cantilever pipe finish includes hot-dip galvanizing and paint coating system as specified in Subsection 11-2.01, Common Work Results for Metals.
PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

Not Used.
11-2 METALS

11-2.01 COMMON WORK RESULTS FOR METALS

PART 1 – GENERAL

1.01 SUBSECTION INCLUDES

A. Requirements that apply only to the work in this Section 11.

B. Requirements for galvanizing.

C. OCS pole shop-applied paint coating system.

D. Cantilever pipe shop-applied paint coating system.

1.02 MEASUREMENT AND PAYMENT

A. Work specified in this Subsection is incidental to Work described in other Subsections.

1.03 REFERENCE STANDARDS:

A. ASTM International (ASTM)

1. ASTM A123/A123M, Standard Specifications for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

2. ASTM A143/A143M, Standard Practice for Safeguarding against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement

3. ASTM A153/A153M, Standard Specifications for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

4. ASTM A384/A384M, Standard Practice for Safeguarding against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies

5. ASTM A780/A780M, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

6. ASTM B6, Standard Specification for Zinc

7. ASTM B117, Standard Practice for Operating Salt Spray (Fog) Apparatus
10. ASTM D610, Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces
11. ASTM D714, Standard Test Method for Evaluating Degree of Blistering of Paints
15. ASTM D2248, Standard Practice for Detergent Resistance of Organic Finishes
16. ASTM D2485, Standard Test Methods for Evaluating Coatings For High Temperature Service
19. ASTM D3359, Standard Test Methods for Measuring Adhesion by Tape Test
20. ASTM D3363, Standard Test Method for Film Hardness by Pencil Test
22. ASTM D4060, Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser


26. ASTM D5894, Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet)


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

29. ASTM D6695, Standard Practice for Xenon-Arc Exposures of Paint and Related Coatings


31. ASTM G151, Standard Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources

32. ASTM G155, Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials

B. Society for Protective Coatings (SSPC)

1. SSPC Painting Manual, Volume 2
   a. SSPC-PA 1, Shop, Field, and Maintenance Painting of Steel
   b. SSPC-PA 2, Measurement of Dry Coating Thickness with Magnetic Gages
   c. SSPC-PS 13.01, Epoxy Polyamide Painting System
   d. SSPC-QP 3, Standard Procedure for Evaluating Qualifications of Shop Painting Applicators
1.04 SUBMITTALS

A. Procedures: Subsection 11-1.03, Submittal Procedures.

B. Contractor must provide the following submittals before starting cleaning and coating activities:

1. A complete schedule of items to be painted, material of item, color and color number. Include manufacturer's brand name, type of material for each coat of the system used.

2. Descriptive and technical data sheets describing products proposed for use. Include, for each indicated substrate, chemical and performance characteristics of each coating system.

3. Detailed procedures for preparation, application, and touch-up work.
   a. Galvanizing. Submit separate procedures for articles that will be painted after galvanizing.
   b. Paint coating system.

4. Certification from coating manufacturer that proposed coatings are suitable for the intended substrate.

5. QC Mock-Up Panel.
   a. A 1/8" thick 8" wide and 32" long sample of each cleaning and coating step as outlined below, which must be representative of the work to be performed;
   b. Cleaning (abrasive blasting) and each paint coating must be in the form of actual application of the accepted material/color on the actual material surface.
   c. The 32" long panel must be divided into progressive layers of the cleaning and paint coatings starting from the bare steel abrasive blasted section progressing through to the final layers of all coatings including the top coat, as below:
      1) Section 1: Minimum section size 8” x 8” square of the surface preparation (i.e SSPC SP-10 abrasive blast).
      2) Section 2: Minimum section size 8” x 8” square of the surface preparation (i.e SSPC SP-10 abrasive blast) including the prime coat.
3) Section 3: Minimum section size 8” x 8” square of the surface preparation (i.e SSPC SP-10 abrasive blast), including prime coat, including intermediate coat.

4) Section 4: Minimum section size 8” x 8” square of the surface preparation (i.e SSPC SP-10 abrasive blast), including prime coat, including intermediate coat, including top coat.

6. Qualifications for:
   a. Applicators.
   b. Inspectors.
   c. QC Mock-Up Panel.

C. Submit the following for galvanizing:
   1. Inspection and test reports prepared by Independent Galvanizing Inspector as defined in paragraph 1.05.B.2 below.

D. Submit inspection and test reports for all cleaning, abrasive blasting and paint coating activities.

1.05 QUALITY CONTROL

A. General Requirements: Subsection 11-1.06, Quality Control.

B. Definitions:
   1. "Paint": coating systems including primers, emulsions, enamels, epoxies, stains, sealers, and fillers, whether used as prime, intermediate or finish coats.
   2. "Shop Coating": The surface preparation and coating of steel surfaces inside an enclosed, conditioned building.
   3. "Field Touch-Up Coating": The on-site touch-up coating of steel structures after erection.

C. Material Quality: Provide top-of-the line quality commercial grade (professional painter) paints and coatings; materials not bearing manufacturer’s identification as best-grade product are not acceptable. Contractor must:
   1. Primers: Provide premium grade primers recommended by paint manufacturer for substrates indicated and for finish systems specified.
2. Undercoats and Barrier Coats: Provide undercoat paints produced by same manufacturer as intermediate and finish coats; use only thinners approved by paint manufacturer, and use only within recommended limits.

3. Finish Coats: Provide finish coats capable of being washed with mild detergent without loss of color, sheen, or pigments.
   a. Color pigments: Pure, non-fading (UV resistant), applicable types to suit substrates and service indicated; no lead content permitted.

4. Finish Coat Coordination: Provide finish coats that are of the same manufacturer and compatible with prime paint coats, undercoats and barrier coats used.
   a. Review other Specification sections in which prime paints are provided; ensure compatibility of total coatings system.
   b. Upon request from other contractors/trades, furnish information on characteristics of finish materials proposed for use.

D. Applicator: Use only qualified applicators who are thoroughly familiar with the material, method of application, and application requirements.
   1. Submit documentation for the Engineer’s review and acceptance that the coating applicator has successfully applied multiple Component zinc rich, epoxy, and urethane coatings and that the following requirements are met.
      a. The applicator must be certified or meet the requirements in accordance with SSPC – QP3 “Standard Procedure for Evaluating the Qualifications of Shop Painting Applicators” and with SSPC – QP1 “Standard Procedure for Evaluating Painting Contractors (Field application to complex Industrial Structures).
      b. The shop and field applicators must meet the above standards requirements in their entirety.
      c. Contractor must submit Certification of these requirements for RT review and acceptance.

E. Adhesion: If good paint coating practices cannot be verified or if deficiencies occur, test adhesion in accordance with ASTM D3359 and must achieve minimum of 4B rating. All tested surfaces must be repaired by Contractor following the test.
F. Testing Equipment: Provide, and make available at all times during shop, field and touch-up painting, the following testing equipment.

1. Magnetic surface temperature
2. Sling psychrometer
3. Wet film thickness gauge
4. Dry film thickness (DFT) gauge
5. Blast surface profile test equipment

G. Follow all manufacturer’s recommendations, at a minimum, in addition to the requirements stated herein.

H. Inspection/Testing

1. Provide independent qualified inspectors to inspect and document all processes.
   a. Inspectors must be certified with a minimum of NACE International Coating Inspector Level 3 Certification.

2. Process Control: All painting work and materials must be inspected by Contractor’s inspector including shop and field touch-up coating activities. The inspector must:
   a. Verify coatings and other materials are as specified.
   b. Verify that surface preparation and applications are as specified.
   c. Verify DFT of each coat and total DFT of each coating system is as specified using wet film and dry film gauges.

3. A preparatory meeting and then a FAI must be conducted jointly by Contractor and RT for each paint coating phase. RT reserves the right to hold all shipping releases until all deficiencies are corrected.

4. Coating Defects: Contractor’s inspector must check coatings for film characteristics or defects that would adversely affect performance or appearance of coating systems.

5. Report. Contractor’s inspector must:
   a. Submit coating inspection forms (Attachment 1) to RT on a daily basis.
b. Report on actions taken to correct nonconforming work.

c. Report nonconforming work not corrected.

d. Submit copies of the report to RT.

I. Quality Assurance:

1. In addition to the Contractor’s Quality Control inspectors, RT reserves the right to perform Quality Assurance inspections/tests on a random basis to ensure work is progressing in accordance with these specifications and adequate contractor QC inspections/tests are being performed.

2. Inspections and tests (as determined by RT) may be conducted on any paint coating activities.

3. If RT performs any type of destructive test Contractor must repair the test area at their sole cost.

4. Contractor must provide access to all paint coating activities at all times.

J. OCS Pole Galvanizing Testing

1. Provide the services of an Independent Galvanizing Inspector to inspect galvanized items for conformance with the requirements of the following ASTM specifications, as applicable.

   a. Galvanizing Compliance: ASTM A123/123M or A153/A153M.

   b. Embrittlement: ASTM A143/A143M.

   c. Distortion: ASTM A384/A384M.

2. Submit inspection and test reports for the following:

   a. Visual examination of samples and finished products.

   b. Tests to determine weight of mass of zinc coating per square foot of steel surface.

   c. Tests to determine distribution and uniformity of zinc coating.

   d. Tests to determine thread fittings of units, washers and bolts.
K. Coatings:

1. All coatings must be inspected by a NACE International Level 3 Certified Coating Inspector in-process and upon completion.

2. Submit inspection reports for both in-process inspections and final inspections upon completion.

L. Qualifications:

1. Independent Galvanizing Inspector: NACE Level 3 Certified Coating Inspector.

2. Shop-Applied Coating Inspectors:

   a. Qualified NACE International Level 3 Certified Coating Inspector.

PART 2 – PRODUCTS

2.01 OCS MATERIAL AND HARDWARE

A. Galvanizing:

1. Steel and malleable iron Hardware, bolts, lock washers, and nuts must be hot-dip galvanized in accordance with ASTM A153/A153M.

2. All other Hardware must be galvanized per ASTM A123/A123M.

3. Conform to ASTM A143/143M to prevent embrittlement of the steel.

2.02 POLE AND PIPE GALVANIZING

A. Complete pole, including fittings and accessories, and Cantilever pipes must be hot-dip galvanized after fabrication in accordance with ASTM A123/A123M and A153/A153M with smooth finish.

B. Galvanize entire length of each pole and pipe in a single dipping operation. Successive dipping is not permitted.

C. Zinc for hot-dip galvanizing: Prime Western Grade, or approved equal, conforming to ASTM B6.

D. Post-galvanizing treatments and quenching that could interfere with powder or paint adhesion or produce a surface difficult to finish must not be used on poles and pipe requiring a finish.

E. Hexavalent chromium humid storage stain treatments must not be used.
F. Factory touch-up of galvanizing must be made by the hot-zinc-based-solders method, in accordance with ASTM A780/A780M; the paint method and spray method must not be used.

2.03 PRODUCT STORAGE AND HANDLING

A. Control materials in original, new and unopened packages and containers bearing manufacturer’s name and label with:

1. Name of materials.

2. Color name, number and sheen.

3. Manufacturer’s name, stock, batch, or lot number and date of manufacture.

4. Contents by volume, for major pigment and vehicle constituents.

5. Product Data Sheets, including mixing, thinning and application instructions.

6. Product Material Safety Data Sheets (MSDS).

B. Shelf life and storage parameters.

1. Store materials in tightly covered containers, in a clean dry area, and within temperature range in accordance with manufacturer’s instructions.

2. Do not use materials beyond manufacturer's shelf life limits. Products without lot numbers and shelf life dates clearly marked may not be used.

2.04 MANUFACTURERS

A. Color and number references are not intended to imply that the product of the named manufacturer is required to the exclusion of equivalent manufacturers.

B. Approved Manufacturers:

1. P.P.G. Industries, Inc., Coatings and Resins Division (Pittsburgh Paints)

2. ICI Devoe

3. Tnemec


5. Dunn-Edwards Corp
6. Approved equal

C. Manufacturer's Shop Services: Contractor must obtain technical assistance and guidance for surface preparation abrasive grit size and application of coating systems from manufacturer's representative’s.

2.05 MATERIALS

A. OCS Poles, Cantilevers and Balance weights: Contractor must apply metal primer and finish paint systems in accordance with SSPC-PA1. Materials and application for prime and intermediate coats must be in accordance with SSPC-Paint 20 and SSPC-Paint 22. In addition, the intermediate coat applied directly to the surface coated with the zinc-rich primer must be in accordance with SSPC-PS Guide 8, except as noted in these Technical Specifications.

1. OCS Pole Exterior:
   a. 1st coat: Moisture Cure Urethane Zinc Rich Primer (97-699GR/97-699P)
   b. 2nd Coat: Epoxy (Pitt Guard Rapid Coat DTR Epoxy Mastic 95-245, Series 95-2412).
   d. 4th Coat: Same as 3rd coat.

2. OCS Pole Interior (inside diameter):
   b. 2nd Coat: Same as 1st coat.

3. Cantilevers and Balance Weights (hot dip galvanized metals):
   a. 1st Coat: Epoxy (Pitt Guard Rapid Coat DTR Epoxy Mastic 95-245, Series 95-2412)
   c. 3rd Coat: Same as 2nd coat.

4. The epoxy coat must be the same color as the finish coats.
B. Sheens: Contractor must comply with ASTM D523, reflectance of paint. All finish coats to be semi-gloss unless otherwise specified.

1. Flat: 1-10
2. Satin: 15-30
3. Eggshell: 30-45
4. Semigloss: 45-75
5. Gloss: 75-100
6. High Gloss: 90-100

2.06 COLOR SCHEDULE

A. All items to be painted must be Black.

2.07 ENVIRONMENTAL CONDITIONS

A. Environment

1. Air and Surface Temperatures: Contractor must prepare surfaces and apply and cure coatings within air and surface temperature range in accordance with manufacturer's instructions and NACE/SSPC standards.

2. Surface Temperature:
   a. Contractor must not apply paint coatings when the temperature of the surface to be coated and the surrounding air temperature is below 50°F or above 90°F, unless otherwise permitted by the manufacturer in writing and accepted by the Engineer.

3. Contractor must not apply paint coatings when the surface temperature is less than 5°F above dew point and there is any sign of moisture, frost or ice is on the substrate.

4. Relative Humidity: Contractor must prepare surfaces and apply and cure coatings within relative humidity range in accordance with manufacturer's instructions and may not apply coatings if the relative humidity is over 85%.

5. Precipitation: Contractor must not prepare or apply coatings in rain, snow, fog, or mist.
6. Wind: Contractor must not spray coatings if wind velocity is above 5 miles per hour or over the manufacturer's limit.

7. Ventilation: Contractor must provide ventilation during coatings evaporation stage in confined or enclosed areas in accordance with manufacturer's instructions.

8. Dust and Contaminants. Contractor must:
   a. Perform coating work in protected area to avoid excessive dust and airborne contaminants.
   b. Protect work areas from excessive dust and airborne contaminants during coating application and curing.

B. Contractor must comply with manufacturer's established guidelines for application and drying conditions, and may not paint in any condition that may have deleterious effect on the color or finish.

2.08 REGULATIONS

A. Volatile Organic Compound (VOC) Emissions: Select materials that generate least amount of pollution, considering pollution and VOC emissions generated during manufacturing, transport, installation, use, and disposal.

B. Comply with the local air quality control rules and regulations, and select coating materials, including primers, finishes and solvents, that comply with Title 40, Code of Federal Regulations Articles 59.400 – 59.413 governing VOC emissions for architectural coatings. Contractor is cautioned that the product of this Section is restricted in certain areas.

PART 3 – EXECUTION

3.01 DESCRIPTION OF WORK

A. Work includes: Furnish all materials, labor and equipment to prepare, coat and finish, inspect and test all OCS Poles (both round and wide flange type), Cantilevers and balance weights at the Cosumnes River College passenger station.

B. OCS poles, Cantilevers and balance weights must be coated the color Black as defined on the K series drawings. All OCS Hardware must be galvanized. Contractor must submit samples for acceptance by RT. All OCS poles, Cantilevers and balance weights must be coated in a shop with a controlled environment. Poles that are to be paint coated must not be galvanized. Cantilevers and balance weights to be paint coated must be galvanized.
C. All substrate cleaning and paint coating must be applied as a Shop Coating.

D. It is the intention and purpose of this Technical Specification section that Contractor paint all surfaces of the entire interior and exterior, that are not sealed from the environment, of all OCS poles (including openings, hand holes, covers, bolts, etc.), Cantilevers and balance weights except only those surfaces hereinafter specified not to be painted. All other surfaces must be painted whether or not such work is fully described in this Subsection.

1. Surfaces not requiring painting:
   a. Surfaces that are not exposed and are permanently sealed off from effects of the environment.
   b. Galvanized and stainless steel Hardware.
   c. Inside diameter of galvanized Cantilever.

2. Surfaces for which painting is prohibited:
   a. Threaded connections, rollers, etc.

3.02 COORDINATION

A. Apply all coatings as Shop Coatings.

B. Paint to match the adjacent similar materials or areas unless noted otherwise:
   1. Inside edges of cut-outs and backsides of covers such as handholes.
   2. Exposed bolt, screw, and fastener heads.
   3. Exposed conduits, Raceways, junction boxes, and other electrical equipment that is not pre-finished.
   4. Exposed items or surfaces not specifically mentioned in Schedules.

C. Contractor must protect surrounding areas and surfaces not scheduled to be coated from damage during surface preparation and application of coatings.
3.03 SURFACE PREPARATION

A. Contractor must remove Hardware and accessories not to be painted, or provide surface-applied protection prior to painting operation and, after painting, reinstall removed items.

1. Painting preparation must be in strict accordance with manufacturer's recommendations and as specified herein.

2. Contractor must not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to a durable paint film.

3. Contractor must correct steel and fabrication defects revealed by surface preparation. Contractor must:
   a. Remove all weld spatter and slag.
   b. Round sharp edges and corners to a smooth contour.
   c. Smooth weld undercuts and recesses.
   d. Grind down porous welds to pinhole-free metal.
   e. Remove weld slag from surface.
   f. Ensure surfaces are dry.

4. Contractor must not begin work until all repairs and cleaning are satisfactorily completed.

B. Contractor must remove all surface contaminants including grease, oil, dirt, and loose particles in accordance with SSPC-SP1.

C. Galvanized steel and non-ferrous metals. Contractor must:

1. Remove stabilizers on the surface of the galvanized steel by chemical treatment prior to coating to promote adhesion.

2. Remove insoluble contaminants (rust, white rust etc.) by hand or power tool cleaning (SSPC-SP2 or SP3) or Brush-off Blast cleaning (SSPC-SP7).

3. Remove any surface imperfections by sanding smooth.

4. Remove all oil, grease, dirt and foreign matter by solvent or detergent cleaning (SSPC-SP1).
5. Treat the surface with a phosphoric acid based chemical treatment that is designed to produce a zinc phosphate coating on galvanized (zinc coated) metal surfaces.

6. Chemically treat in accordance with the manufacturer’s recommendations.

D. Steel: Contractor must commercially blast clean per SSPC-SP6. The cleanliness of steel surfaces must be verified by comparison with NACE TM-0175 Visual Standards and/or SSPC-VIS-1-89, "Visual Standard for Abrasive Blast Cleaned Steel."

E. The anchor pattern or surface profile for Moisture Cure Urethane Zinc-Rich Primer (97-699GR/97-699P) must be sharp, with no evidence of a polished surface. The surface profile must be 1.0 – 2.0 mils. Surface profile is to be determined by the "Keane-Tator Surface Profile Comparator," "Clemte X Anchor Pattern Standards," or "Testex Tape" in accordance with NACE RP-0287-87.

F. Contractor must discontinue cleaning each day in sufficient time to permit the surfaces cleaned to be primed within 6 hours of blast cleaning and the surface must be kept at least 5 °F above dew point. Surface areas that have not been kept 5°F above dew point, from the time they were abrasive blast to the time the primer is applied, must be re-blasted to meet the described standard.

3.04 APPLICATION

A. Application must be in strict accordance with manufacturer’s recommendations and as specified herein. Contractor must:

1. Comply with manufacturer’s requirements with respect to temperature and application conditions.

2. Keep containers closed when not in use to avoid contamination.

B. Mixing: Contractor must mechanically mix painting materials in accordance with manufacturer’s directions. Contractor must:

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

2. Stir materials before application to produce mixture of uniform density (allow induction time in accordance with product data sheet for two-part products), and stir as required during application; not stir surface film into material; and if necessary, strain material before using.
3. Maintain constant agitation by the use of an industrial coating agitator during use to prevent settling of the Moisture Cure Urethane Zinc Rich Primer.


C. Contractor must shop apply all coatings.

D. Contractor must coat blast-cleaned surfaces prior to the occurrence of flash rusting with one complete application of primer as soon as practicable but in no case may the surface be coated more than 6 hours after blast cleaning and the surface must be kept at least 5 °F above dew point.

E. Paint must be spray applied. Contractor must:

1. Use application equipment, tools, pressure settings, and techniques in accordance with manufacturer's instructions.

2. Uniformly apply coatings at spreading rate required to achieve specified DFT. Film thickness is based on the closest 0.5 mil. Application of both prime and finish coatings below minimum or above maximum may adversely affect coating performance.

3. Apply coatings to be free of film characteristics or defects that would adversely affect performance or appearance of coating systems. Each coat of material must be applied as a continuous unbroken film of uniform thickness free of porosity. Any thin spots or areas missed in application must be re-coated and permitted to dry before the next coat is applied.

4. Apply additional coats when stains or blemishes show through final coat (not to exceed maximum DFT for a single coat or final DFT), until paint is a uniform finish, color and appearance.

5. Apply coating to show no runs, holidays, Sags, or other defects. Finished surface must be uniform in sheen, color, and texture. Do not overspray.

6. Apply one stripe coat of primer and one stripe coat of intermediate (barrier) coat to all sharp edges, corners and bolts prior to the respective coating applications. Contractor must apply two stripe coats to all welds meeting NACE RP-0178-89, Surface Profile Designation D, prior to spray application. Contractor must grind weld profiles meeting NACE Surface Profile Designation E prior to coating application. Any grinding done after sandblasting must be blast-cleaned by Conractor to obtain proper anchor pattern.
7. Application DFT of each Coat:
   a. Moisture Cure Urethane Zinc Rich Primer: 3-4 mils DFT
   b. Epoxy: 4-7 mils DFT (each coat)
   c. Acrylic Aliphatic Urethane: 2-3 mils DFT (each coat)

F. Scheduling Painting: Contractor must apply first coat to surfaces that have been cleaned, pretreated or prepared for painting as soon as practicable after preparation.

1. Each coat must be in a proper state of cure before the application of the succeeding coat. Contractor must follow the paint manufacturer's recommendation concerning cure times for various types of paint at a minimum. Additional cure time may be required based on coating thickness, steel temperature and/or atmospheric conditions.

2. Contractor must not exceed maximum time between recoats listed on the Product Data sheet. If this time is exceeded, Contractor must follow Product Data sheet for recoat, and sand lightly before each succeeding coat.

3.05 STORAGE AND HANDLING OF FABRICATIONS

A. All shop painted items must be accepted by RT QA prior to shipment and field installation.

B. Contractor must protect all materials, both before and after fabrication, from rust corrosion, dirt, grease and other foreign matter.

C. Contractor must protect materials during handling, application, storage, shipping and installation to prevent damage or contamination; adequately handle, ship and store so that structures are not scratched or damaged in any manner; and adequately protect or cover structures from standing water and degradation from atmospheric conditions. Contractor must handle and ship all painted products by covering shipping, handling equipment and dunnage with protective carpet. Excessive damage of coatings on products must be sent back to the shop for repair.

D. Contractor must wrap all painted items in a protective material suitable for shipping and storage. Painted items must then be covered during storage.
3.06 FIELD TOUCH-UP PAINTING

A. After installation, for appurtenances that can only be field installed (i.e. conduit, bolts, junction boxes, etc.) and areas in which Shop Coating has been damaged, Contractor must re-prepare the surface as specified for shop coating, unless otherwise approved by the Engineer. Contractor must use the same products, materials and equipment for touch-up as applied for Shop Coating; and inspect and test for all conditions identified for Shop Coating. Field touch-up must be to the satisfaction of the Engineer.

B. Repair: At completion of work of other trades, Contractor must touch-up and restore damaged surfaces or defaced painted surfaces. Contractor must:

1. Damaged Coatings: Touch-up or repair damaged coatings. Touch-up of minor damage is acceptable where the result is not visibly different from adjacent surfaces. Recoat entire surface where touch-up result is visibly different, either in sheen, texture, or color.

2. Coating Defects: Repair, in accordance with manufacturer’s instructions, coatings that exhibit film characteristics or defects that would adversely affect performance or appearance of coating systems.

3.07 GALVANIZING FIELD REPAIR

A. Field repair cut edges and minor damage to galvanized surfaces using a procedure accepted by Engineer with the following criteria:

1. Repair using the brazing method described in ASTM A780/ASTM A780M. Zinc rich paints must not be used.
ATTACHMENT I - SACRAMENTO REGIONAL TRANSIT DISTRICT
COATING INSPECTOR’S DAILY REPORT

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Comments (including special instructions to Contractor, problems, etc.)

Inspector
Sacramento Regional Transit District, Quality Assurance Form
11-3 OCS FOUNDATIONS

11-3.01 OCS DRILLED-PIER FOUNDATIONS

PART 1 – GENERAL

1.01 SUBSECTION INCLUDES

A. Requirements that apply only to the work in this Section 11.

B. Requirements for OCS drilled-pier foundations.

C. Installation of dc feeder conduit Risers.

1.02 RELATED SUBSECTIONS

A. Subsection 12-4.05 – Grounding and Bonding

1.03 MEASUREMENT AND PAYMENT

A. OCS pole foundations are included in the OCS Foundations and Poles Bid Line Item. See OCS Foundations and Poles Bid Line Item in Subsection 11-1.02, Measurement and Payment.

1.04 REFERENCE STANDARDS

A. American Concrete Institute (ACI)

1. ACI 301, Specifications for Structural Concrete

B. ASTM International (ASTM)


2. ASTM A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

3. ASTM A563, Standard Specification for Carbon and Alloy Steel Nuts

4. ASTM A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

5. ASTM A706/A706M, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement

6. ASTM A767/A767M, Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
7. ASTM A780/A780M, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

8. ASTM C33/C33M, Standard Specification for Concrete Aggregates


10. ASTM C494/C494M, Standard Specification for Chemical Admixtures for Concrete

11. ASTM F436, Standard Specification for Hardened Steel Washers

12. ASTM F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

1.05 SUBMITTALS

A. Procedures: Subsection 11-1.03, Submittal Procedures.

B. Product Data: OCS foundation fasteners. Engineer may require detailed Shop Drawings and calculations to verify the fastener's design characteristics meet or exceed the requirements for RT's application.

C. Mix design of concrete.

D. Test Reports:
   1. Concrete tests.

1.06 QUALITY CONTROL

A. General Requirements: Subsection 11-1.06, Quality Control.

B. First Article Inspections:
   1. Before pouring concrete, conduct a First Article Inspection (FAI) for each type of OCS pole foundation required under this Contract.
   2. Provide Engineer with 10 days' advance notice for each FAI.
   3. Subsequent pole foundations may not be constructed until the FAI for that type of OCS pole foundation has been accepted by Engineer.
PART 2 – PRODUCTS

2.01 MATERIALS

A. Concrete: Ready-mixed class A concrete, minimum 564 pounds of Portland cement per cubic yard, with 28-day compressive strength of 3,500 psi.

1. Cement: Standard brand of Portland cement in accordance with ASTM C150/C150M.

2. Admixtures: Water reducing, retarding, accelerating, workability agents and other types of admixtures may be used after Engineer’s written acceptance.
   a. Conform to ASTM C494/C494M.
   b. Under no circumstances may calcium chloride be used in concrete as an admixture.

3. Aggregates: Well graded, composed of sand, and clean, uncoated round or angular particles of gravel.
   a. Conform to ASTM C33/C33M.
   b. Maximum nominal size: 1-1/2”.

4. Water:
   a. Potable with no impurities, algae or dissolved natural salts in amounts that will cause corrosion of reinforcing steel, volume change that will increase shrinkage cracking, and efflorescence.
   b. Minimum pH level: 5 minimum.

5. Slump:
   a. Maximum: 4”.
   b. Minimum: 2”.

B. Reinforcing steel: Deformed bars, conforming to ASTM A706/A706M, Grade 60, and fabricated as shown in Contract Drawings.

C. Anchor rods for Guy foundations: ASTM A706/A706M Grade 60, galvanized per ASTM A767/A767M after bending.
D. Anchor Bolts:

1. Anchor Bolt steel: ASTM F1554, Grade 55.

2. Anchor Bolt nuts: Heavy hex conforming to ASTM A563, Grade A.

3. Washers: Plain, conforming to ASTM F436 Type 1.


E. Conduit: See sub-section 12-4.07, Raceway and Boxes, for product requirements.

F. Ground rods: See Subsection 12-4.05, Grounding and Bonding, for product requirements.

G. Concrete forms: Sonotube or approved equal.

PART 3 – EXECUTION

3.01 INSTALLATION

A. General:

1. Contractor’s work methods and actions must ensure that buildings and other structures adjacent to the OCS foundations are not damaged by excavation or construction of OCS foundations.

2. Contractor is responsible for necessary repairs due to the excavation and construction of the OCS foundations.

3. Perform concrete work in accordance with ACI 301.

B. Drilling:

1. Standard Soil Condition:

   a. Drill foundation pier shaft at locations and to the dimensions indicated on Contract Drawings, and control them within the specified tolerance.

   b. The overall foundation length must be equal to depth as indicated in the notes and the tables of Contract Drawings.
2. Other Soil Conditions:
   a. If the soil does not support OCS foundation excavation, determine alternate drilling method to use, at no cost to RT.
   b. Steel casing shells:
      1) Withdraw as concrete is placed.
      2) Maintain an adequate head of concrete above the bottom of casing.
      3) Where site conditions make it necessary or desirable to leave casing in place, obtain written permission from Engineer.
   c. Controlled density fill (CDF):
      1) Contractor may request written approval from Engineer to backfill excavation with CDF having minimum compressive strength of 100 psi and rebore the foundation.
      2) Bring backfill up to the elevation of the surrounding soil.
      3) Costs associated with backfill and reboring are the responsibility of Contractor and no additional costs will be paid by RT.

C. Assembly:

1. Provide reinforcing steel and Anchor Bolts as follows:
   a. Place reinforcing cage symmetrically about the axis of foundation, and brace securely to maintain the minimum clearance of concrete cover as indicated. Reinforcement may not be spliced.
   b. Locate and orient Anchor Bolt assembly and indicated, within the tolerances specified in the Contract Documents.
   c. Provide a rigid metal template for each foundation type to verify bolt pattern and conduit layout so that Anchor Bolts and conduits are constructed within Contract tolerances. Use templates for QC verification and acceptance of all foundations. The rigid metal template(s) must be fabricated from ½" thick aluminum alloy and must be turned over to RT at the completion of OCS foundation work. An FAI of each template must be conducted prior to start of foundation work.
2. Feeder conduits:
   a. Provide feeder conduit Risers where indicated on Contract Drawings.
   b. Install within the area(s) of the foundation as required to allow the Risers to pass through the pole baseplate.
   c. Modify steel reinforcing cage, if necessary, to allow conduits to enter into the foundation as indicated on Contract Drawings.

3. Pole Grounding:
   a. See Subsection 12-4.05, Grounding and Bonding, for additional material and installation requirements.
   b. Provide grounding plate and ground wire in the foundation in accordance with Contract Drawings.
   c. Exothermically weld anchor bolts to reinforcing cage using bare copper conductor as indicated on Contract Drawings and as specified in Subsection 12-4.05, Grounding and Bonding.

4. Surge Arrester Grounding:
   a. Provide ground rod outside reinforcing cage and drive a minimum of 3’ into the native earth below the bottom of the foundation.
   b. Exothermically weld bare copper-coated steel conductor to ground rod, as specified in Subsection 12-4.05, Grounding and Bonding.
   c. Route copper-coated steel conductor through reinforcing cage and leave a 6’ pigtail sticking up through top of foundation to interface with OCS pole as indicated on Contract Drawings.

D. Concrete Formwork:
   1. Construct foundation piers above ground level using sonotube forms with sufficient strength to withstand concrete pressure and provide a smooth surface.
   2. Provide temporary formwork or mechanical supports to keep the sonotube forms, Anchor Bolts, reinforcing steel cage, and GRS feeder conduits in proper orientation and within tolerances during the placement of concrete.
E. Before Concrete Placement: Remove loose material from bottom of drilled shafts and dewater as required.

F. Concrete Placement:
   1. Place concrete for each foundation in one continuous monolithic pour.
   2. Maximum vertical drop: 5’, to prevent segregation of concrete. If greater than 5’ in drop is necessary, use a tremie tube.
   3. As concrete is deposited, mechanically vibrate the concrete continuously to consolidate it around the reinforcing steel cage, Anchor Bolt assembly, and feeder conduits.
   4. Take measures to prevent voids or “rock pockets” from forming in the piers above ground.

G. Concrete Finish:
   1. Trowel and smooth finish top surface of foundation. Gently slope top of OCS foundation to drain water away from pole baseplate, minimum 2 percent slope.
   2. Use care to provide a smooth finish on the portion of foundation visible when the form is stripped off.
      a. Repair excessive voids or visible accumulations of aggregate.
      b. Corrective action must be accepted in writing by the Engineer.

H. Foundation Curing:
   1. Apply curing compound on all exposed portions of the foundation immediately after concrete placement and finishing.
   2. Allow minimum 7 days cure after concrete is poured before setting poles.
   3. Allow minimum 28 days cure after concrete is poured before any load is applied to the poles.

3.02 PROTECTION AND REPLACEMENT

A. Protect foundations, conduits, ground rods and Anchor Bolts during subsequent construction activities.
B. Damage from heavy equipment, heating of bolts, mechanical realignment (deformation), etc., will result in the foundation being rejected at the sole discretion of the Engineer.

C. Rejected foundations must be removed by Contractor and replaced at Contractor’s expense.

3.03 TOLERANCES

A. Along Track Modifications:

1. To avoid local obstructions along track location, foundation may be modified as follows:
   
a. Not adjacent to special trackwork: Plus or minus 5’.
   
b. Adjacent to special trackwork: Plus or minus 2’ 6”.

2. Modifications, including any required changes to the OCS design, are subject to prior written acceptance by the Engineer.

3. Changes to the OCS design may be required due to the new locations. Any changes must be included in the A-Built drawings.

B. Cross Track: Plus or minus 1”.

C. Anchor Bolt placement in foundation:

1. Horizontal: Within 1/8” of horizontal measured at top of bolt.

2. Vertical: Within 1/2 degree of vertical.

D. Anchor Bolt assembly orientation: Within 2 degrees horizontally of its orientation with respect to the tangent of track.

E. Foundation diameter and length: Not less than indicated on Contract Drawings.

F. Axis of foundation shaft: Within 1 percent of plumb.

G. Top of pier foundation: Top of concrete within 1/4” of elevation indicated on Contract Drawings.
3.04 SITE QUALITY CONTROL

A. Inspection and Acceptance of Foundations:

1. Each foundation must be inspected before concrete is poured, in accordance with these Technical Specifications and with the CQCP General Requirements.

2. Give Engineer 72 hours notice of when concrete placement is planned to take place.

3. The Engineer may inspect each foundation before concrete is poured.

4. Foundations not inspected before pouring are subject to rejection at the Engineer’s sole discretion.

B. Concrete Testing:

1. Perform testing in accordance with the CQCP General Requirements.

2. Slump test: Perform for each separate batch of concrete on each day concrete is delivered.

3. Compressive strength cylinders: Take at least one set for each separate batch of concrete on each day concrete is delivered and perform compression test on each.

4. Submit test results.

C. Exothermic Connections:

1. Electrical connections to steel Components must be achieved by exothermic welding in accordance with the weld manufacturer’s instructions. If required, welds must be cleaned by brushing or other suitable means. All welded connections must be inspected and must be struck with a 2 lb. hammer, after completion of the weld. The weld must then be inspected for completeness of bonding. Any evidence of incomplete bonding will be cause for rejection and the weld must be removed. Encapsulation of the weld joint must completely enclose the contact zone between the reinforcement and the terminal to avoid the creation of a galvanic corrosion cell.
11-4 OCS

11-4.01 COMMON WORK RESULTS FOR OCS

PART 1 – GENERAL

1.01 SUB-SECTION INCLUDES

A. Requirements that apply only to the work in this Section 11.

B. OCS personnel qualifications.

C. Contractor Final Design: Final engineering design of complete Overhead Contact System (OCS) by Contractor.

D. Requirements for Contractor design calculations, drawings, and installation procedures.

E. OCS Design Criteria: General requirements of the Overhead Contact System (OCS) for the South Sacramento Corridor Phase 2 Project that apply to all OCS Technical Specification Subsections.

F. OCS Material and Hardware: General requirements that apply to all OCS Technical Specification Subsections.

G. Installation: General requirements that apply to all OCS Technical Specification Subsections.

H. OCS Inspection and Repair: General requirements that apply to all OCS Technical Specification Subsections.

1.02 RELATED SUBSECTIONS

A. Subsection 12-4.04 – Medium-Voltage Conductors and Cable

1.03 MEASUREMENT AND PAYMENT

A. Work specified in this Subsection is incidental to Work described in other Subsections.

1.04 REFERENCE STANDARDS

A. ASTM International (ASTM)

2. ASTM A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

3. ASTM A780/A780M, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

1.05 SUBMITTALS

A. Procedures: Subsection 11-1.03, Submittal Procedures.

B. OCS Personnel Qualifications: Before starting work on OCS, submit experience and training records of the following:

1. OCS Superintendent,

2. OCS foremen.

3. OCS Installers.

C. Submit for information only: Design data, calculations, and engineering sealed by a Professional Engineer registered in the State of California.

D. Submit OCS layout plans sealed by a Professional Engineer registered in the State of California.

E. Shop Drawings: Submit detailed Shop Drawings.

F. Installation Procedures: Submit and obtain review with no exceptions taken before starting installation.

G. Staging Plans: Show how the work is to be installed and how the work of each stage will Interface with the other work of the Project, and RT revenue service operations.

H. Subcontractor Certification: Obtain from each subcontractor a written Certification that the method being used for installation and connection of its equipment by Contractor is satisfactory to the subcontractor or manufacturer.

I. Bill of Materials: Complete for OCS Hardware and assemblies.

1.06 QUALITY CONTROL

A. General Requirements: Subsection 11-1.06, Quality Control.
B. Qualifications:

1. OCS Superintendent: Demonstrate previous experience in successfully managing OCS installation projects of similar size and complexity in position of OCS Superintendent, including the following:
   a. Supervision and training of OCS installers, and
   b. Interpretation of OCS specifications and design drawings, OCS equipment manuals, and OCS manufacturer’s design drawings.

2. OCS Installation Crew Foreperson: Demonstrate 3 years experience and training in OCS installation and experience as foreperson of OCS installations or similar overhead line work.

3. OCS Installers must be:
   a. Qualified by experience and training to perform the specified work;
   b. Outside linesman or journeyman who has completed a State of California or federally-approved Outside Line Construction and Maintenance apprenticeship program of 6000 hours of on-the-job training; and
   c. Employees of a California licensed (C-10) electrical contractor

C. First Article Inspections:

1. Conduct a First Article Inspection (FAI) for each type of OCS assembly required under this Contract.

2. First completed OCS segment:
   a. Conduct FAI from balance weight assembly or fixed termination to adjacent termination.
   b. Minimum length: 1,700’ unless otherwise specified.
   c. Subsequent "production" OCS segments must not be installed until this OCS FAI has been witnessed and accepted by the Engineer.

PART 2 – PRODUCTS

2.01 CONTRACTOR FINAL DESIGN

A. Contractor must provide a complete final OCS design.
B. The Contract Drawings and Contract Technical Specifications provide performance parameters, design criteria, and locations of fixed structures for Contractor's use in completing the final OCS design.

C. Assemblies shown on Contract Drawings are based on one manufacturer, but are intended to represent generic assemblies, and other manufacturers are not precluded.

D. Contractor's drawings must follow the general layout of Contract Drawings and must comply with the requirements provided in the Contract Documents.

E. Contractor's final design must include selecting suitable support assemblies, dc disconnect switches, Insulators, section Insulators, span wires, Jumpers, surge arresters, and other OCS assemblies and products required for a complete final OCS design.

1. Selected assemblies and products must support Contractor-calculated loads within the specified factor of Safety.

2. Selected assemblies and products must meet requirements of the Contract Documents.

3. Where Contractor determines that an assembly shown on Contract Drawings is not suitable as shown, the Contractor must select a suitable assembly for final design and submit to the Engineer for acceptance before purchase and installation.

4. Contractor is responsible for the engineering, form, fit, and function of all Components provided for the OCS.

F. Calculate new and existing loads on existing poles and span wires and loads on new poles and span wires and verify that poles and span wires are adequate for actual loads and service conditions.

1. Where Contractor's calculation results for pole deflection exceed the specified limit, report the issue to the Engineer.

G. Information furnished in Contract Drawings and Contract Technical Specifications and used for Contractor's final design must be verified by Contractor's OCS designer before incorporation into Contractor's drawings.

H. Calculate pole attachment heights and loadings for conductor anchors, Cantilevers, cross-spans, and headspans for each location in accordance with Contractor's drawings.
I. Contractor’s design documents must be prepared and sealed by a Professional Engineer registered in the State of California.

J. Submit design documents as described below.

2.02 CONTRACTOR DESIGN CALCULATIONS

A. Design data, calculations, and engineering.

1. Include Table of Contents.

2. Bind in one 8-1/2” by 11” volume.

3. Calculations must include but not be limited to:

   a. Calculations for support structures: Include verification that support structures can safely carry proposed pre-stress tension used during installation.

   b. Cantilever framing methodology and calculations.

   c. Pole attachment heights and maximum and construction tensions and applied loads.

   d. Sample calculations to verify computer calculations.

B. Package must bear the seal of a Professional Engineer registered in the State of California, qualified by experience with OCS design, who personally supervised the preparation of the Contractor’s OCS design.

2.03 CONTRACTOR DESIGN DRAWINGS

A. General

1. Title Block: Furnish each drawing with a title block that includes the following:

   a. “Sacramento Regional Transit District.”

   b. RT’s contract number.

   c. Contractor’s name.

   d. Drawing Number: Assign individual drawing numbers to each drawing.

   e. Revision with date.
f. Drawing title: Descriptive of drawing contents.

2. Use standard IEEE/ANSI device symbols and nomenclatures on drawings.

3. Contractor must comply with RT CAD Standards in preparing all drawings.

B. OCS layout plans sealed by a Professional Engineer registered in the State of California.

1. Drawings must be similar to Contract OCS Layout Plan Drawings:
   a. Use the same scale.
   b. Include the same enlargements.
   c. Use the same cut lines.

2. Drawings must show the following information based on Contractor’s design:
   a. Stationing of poles and other support structures.
   b. Structure number.
   c. Stagger.
   d. Midspan Offset dimensions.
   e. Stringline dimension or track radius dimension with end stationings.
   f. Contact Wire height.
   g. Termination height.
   h. Reference for each assembly, to cross reference to detailed Shop Drawings.
   i. Section Insulator types and locations.
   j. Contact bridges.
   k. Overlaps.
   l. Jumpers by type.
   m. Feeder and switch connections.
3. Engineer will provide the ITB .dwg CAD files of Contract Drawings for Contractor’s use.

C. Shop Drawings:

1. Submit detailed Shop Drawings to identify the physical size, strength, weight, form, and fit of all Components and their composite assemblies needed to complete OCS construction.

2. The title of each Shop Drawing must include an assembly reference designation for cross reference to layout plans.

3. Show proper connections, tolerances and Interfaces with adjoining work in detail.

4. Where adjoining work requires Interfaces, submit all Shop Drawings for approval at the same time so that connections and tolerances can be accurately checked.

5. Fittings and assemblies: Show loading criteria and evidence of testing Certification.

6. Shop Drawings include but are not limited to OCS poles, Cantilevers, headspan and Backbone assemblies, Hardware, fittings and wiring plans.

D. Staging Plans: Show how the work is to be installed and how the work of each stage will Interface with the other work of the Project and RT revenue service operations.

2.04 CONTRACTOR INSTALLATION PROCEDURES

A. Include the following:

1. Safety precautions.

2. Foundation construction instructions for each type of pole configuration

3. Pole, Cantilever, headspan, cross span, and Backbone assembly and erection instructions.

4. OCS conductor and wire stringing procedure.

5. OCS conductor and wire tension adjustments.

6. List of equipment and special tools to be used.
7. List of material and Parts to be assembled.

8. Any impact or non-impact to existing RT or Freight Track service.

9. List of process procedures and quality instructions to be followed: i.e. welding, bolt torque requirements, etc.

10. Acceptance and Rejection criteria.

11. Inspection and testing to be performed.

12. Repair procedures to be used if repairs must be made

2.05 DESIGN CRITERIA

A. Climatic Conditions:

1. Temperature:
   a. Ambient temperature at time of maximum loading: Minus 5 degrees F.
   b. Normal ambient temperature for computing erection conditions: 70 degrees F.
   c. Maximum ambient temperature for calculations: 125 degrees F.

B. Wind Loading:

1. Maximum wind speed for structural design: 70 mph.

2. Gust factor: 1.3.


C. Light Rail Vehicle:

1. Vehicle, Pantograph, and dynamic envelope are indicated on Contract Drawings.

2. Consists:
   a. Normal: One, two, three, or four cars.
   b. Emergencies: Up to six cars.

4. Pantograph:
   a. Each car in a train will have a Pantograph in service.
   b. Uplift force: 18 to 20 pounds static, each Pantograph.

D. Pantograph Security: 3” minimum.

E. Electrical:
   1. Vehicle operating voltage: 750 Vdc nominal, plus 20 percent, minus 30 percent.
   2. Maximum voltage: 900 Vdc, no-load voltage on OCS.

F. Insulation:
   1. Provide a minimum of two levels of insulation between the energized messenger and Contact Wires and Grounded structures as indicated on Contract Drawings and in accordance with CPUC G.O. 95.
   2. Each level of insulation must be rated at the system insulation class.

G. Maximum Contact Wire Gradient:
   1. Constant Gradient: 1 in 5 x track section speed limit (in mph)
   2. Gradient Change: 1 in 10 x track section speed limit (in mph)

H. Midspan Offset:
   1. Design Values: Tables with permissible values are provided in Contract Drawings.
   2. Installation Tolerance: An additional 1” is permitted.

I. Contact Wire Radial Loads:
   1. Maximum Contact Wire deviation at a single Contact Wire swivel clamp: 7 degrees.
   2. Where the Contact Wire Registration loads exceed 500 lbf at 60 degrees F, use two Steady Arms.
   3. Direct Push Off assembly loads: Maximum 100 lbf at 70 degrees F.
J. Steady arm Heel Settings:

1. Straight arm up to 100 lbf push-off load: 6” maximum.
2. Straight arm up to 200 lbf pull-off load: 6” maximum.
3. Curved arm up to 500 lbf Registration load: 3” maximum.
4. Two curved arms over 500 lbf Registration load: 3” maximum.
5. Steady arms: Minimum 1” Heel Setting.
6. The heel point of the Steady Arm must be outside of the horizontal limits of the Pantograph envelope.

K. Electrical Clearances:

1. Non-energized portion of OCS assemblies and conductors or Pantograph envelope: 3” minimum.

L. Safety Factors:

1. Minimum Safety factors must be determined for the worst case conditions over the indicated ambient temperature range and wind pressure.
2. Minimum Safety factors are indicated below:
   a. Strain Insulators:
      1) Porcelain: 2.0
      2) Fiberglass: 3.0
   b. Hardware:
      1) Ferrous: 2.0
      2) Non-ferrous: 3.0
   c. Conductors:
      1) Messenger: 2.0
      2) Contact Wire (30 percent worn): 2.0
2.06 COMPATIBILITY WITH EXISTING SYSTEM

A. OCS assemblies must be compatible with the existing RT overhead contact system. The physical characteristics of the RT Metro system are as follows:

B. Underground Feeder Cable: 500 kcmil, Class B, annealed copper.

C. Feeder Cable Connected to Contact Wire: 500 kcmil, Class H, annealed copper.

D. Cable Insulation Class:
   1. Existing cables: 5 kV.
   2. New cables: Per Subsection 12-4.04, Medium-Voltage Conductors and Cable.

E. Contact Wire: 350 kcmil, solid grooved, hard-drawn copper.


G. Jumper Wire: 500 kcmil, Class H, annealed copper.

H. Wire Tension:
   1. Contact Wire:
      a. SCAT: 3,000 lb at 70 degrees F.
      b. DSSC: 2,500 lb at 70 degrees F.
   2. Messenger Wire: 4,500 lb at 70 degrees F.

I. Wire Height:
   1. Minimum Contact Wire Height Over Freight Track: 22’ 6”.
   2. Nominal Contact Wire Height: 20’ 3” above top of high LRT rail or as indicated on Contract Drawings.
   3. Minimum Contact Wire Height: 19’ 6” above top of high LRT rail or as indicated on Contract Drawings.

2.07 WARNING SIGNS

A. Material: As indicated on Contract Drawings.

B. Color: As indicated on Contract Drawings.
PART 3 – EXECUTION

3.01 INSPECTIONS BY AUTHORITY HAVING JURISDICTION

A. Electrical inspections, if required by any Authority Having Jurisdiction, may be observed by the Engineer.

B. Schedule electrical inspections 7 days in advance with the Engineer and as required by any Authority Having Jurisdiction.

C. Perform corrections required by authorities inspector at no additional cost to RT.

3.02 INSTALLATION

A. Installers and Supervision:

1. OCS work must be performed by workers skilled and experienced in the installation of OCS systems.

2. Workers must be outside linesmen or journeymen qualified by experience and training to perform the specified work.

3. Appoint a foreperson for each crew.

B. Surveying: Perform surveying, if needed to accomplish the specified Work.

3.03 SUBCONTRACTOR CERTIFICATION

A. Obtain from each subcontractor a written Certification that the method being used for installation and connection of its equipment by Contractor is satisfactory to the subcontractor or manufacturer.

3.04 FABRICATION OF OCS ASSEMBLIES:

A. Provide all OCS Hardware needed to meet the specified OCS construction and spare Parts requirements and achieve the project construction schedule.

B. Fabricate OCS assemblies to fit the final installed track and poles.

C. Take measurements and make calculations necessary to fabricate and install such assemblies in conformance with the Contract.
D. Hardware, Fasteners, and Fittings:

1. Assemble Hardware using tools and methods recommended by the manufacturer and accepted by the Engineer.

2. Install fasteners and fittings used in OCS assemblies in accordance with the manufacturer's recommendations, including bolts, nuts, locknuts, washers, pins, turnbuckles, machine screws and other items that may be used to attach items together.

3. Bolt projection:
   a. Two full threads must extend beyond nuts and locknuts.
   b. End of the bolt must not extend more than 1/2" beyond the nut or locknut.
   c. Excess bolt lengths must not be sawn off. The bolt must be replaced by a shorter one.

4. Lightly lubricate threads of bolts, nuts and machine screws before assembly

5. Torque bolts using a calibrated torque wrench, with current calibration sticker, in accordance with manufacturer’s recommendations.

6. Torque mark each bolt and nut using a permanent marker (torque marks must be a straight line including bolt, nut and parent item).

7. Turnbuckles: Install in a manner that provides 6" minimum adjustment in each direction after final adjustment to provide for future maintenance.

8. Cause for Rejection: Fittings, fasteners, or any other attachments that do not fit, are cracked, have sustained galvanizing damage during installation, have been cut off, or are found to be defective in any way, will be rejected.

E. Adjust Bracket heights for pole attachments and modify fabricated assemblies as necessary to comply with clearance envelope requirements.

3.05 WARNING SIGNS

A. Provide warning signs as indicated on Contract Drawings.
3.06 FIELD QUALITY CONTROL

A. Inspection:

1. Randomly inspect Anchor Bolt and OCS assembly connections for correct torque; maintain data as Quality Records.

2. Inspect galvanized Components for damage to galvanizing.

B. Repair:

1. Repair Hardware, fittings, and surface areas field cut or damaged during installation using approved repair procedures and materials.

2. Galvanizing Repair: Field repair minor damage in accordance with Subsection 11-2.01, Common Work Results for Metals.

3. Repairs will be inspected by the Engineer.

   a. Repairs that do not conform to approved submittals will result in the equipment, assembly Hardware, fittings, etc. being rejected, at the sole discretion of the Engineer.
11-4.02 OCS STEEL POLES

PART 1 – GENERAL

1.01 SUBSECTION INCLUDES

A. Requirements that apply only to the work in this Section 11.
B. Steel OCS poles.

1.02 RELATED SUBSECTIONS

A. Subsection 11-2.01 – Common Work Results for Metals
B. Subsection 11-3.01, OCS Drilled-Pier Foundations
C. Subsection 12-4.05 – Grounding and Bonding

1.03 MEASUREMENT AND PAYMENT

A. OCS poles, including sidewalk and pavement repair, if required, are included in OCS Foundations and Poles Bid Item. See OCS Foundations and Poles Bid Item in Subsection 11-1.02, Measurement and Payment.
B. Raceway used for positive dc feeder Risers on OCS poles is included in Foundations and Poles Bid Item. See OCS Foundations and Poles Bid Item in Subsection 11-1.02, Measurement and Payment.
C. Underground Raceways that Interface with OCS positive dc Riser conduits are included in TES Cable System Work Bid Item. See TES Cable System Work Bid Item in Subsection 12-1.02, Measurement and Payment.

1.04 REFERENCE STANDARDS

A. American Institute of Steel Construction (AISC)
   1. AISC 303, Code of Standard Practice for Steel Buildings and Bridges
   2. AISC 360, Specification for Structural Steel Buildings
B. American Society of Mechanical Engineers (ASME)
C. American Society for Nondestructive Testing (ASNT)
   1. ASNT SNT-TC-1A, Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing
D. ASTM International (ASTM)
   1. ASTM A36/A36M, Standard Specification for Carbon Structural Steel
   2. ASTM A572/A572M, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
   3. ASTM A595/A595M, Standard Specification for Steel Tubes, Low-Carbon or High-Strength Low-Alloy, Tapered for Structural Use
   4. ASTM A780/A780M, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

E. American Welding Society (AWS)
   1. AWS D1.1/D1.1M, Structural Welding Code - Steel

1.05 SUBMITTALS

A. Procedures: Subsection 11-1.03, Submittal Procedures.

B. Product Data:
   1. Anchor Bolt Hardware.
   2. Pole-wrapping material for shipment.

C. Shop Drawings: Submit for each pole type, including materials, dimensions, and details.

D. Submit the following for Welding:
   1. Welding Procedure Specification (WPS) and supporting Procedure Qualification Records (PQR) including filler material manufacturer’s data sheets.
   2. Welder Qualification Test Records for each welder, welding operator and tack welder to be employed in the Work, including welding continuity logs.
   4. Independent Weld Testing Technician Certifications.
   5. Visual inspection reports.
   6. Test reports conforming to the requirements of AWS D1.1/D1.1M.
E. Submit the following for pole deflection testing:

1. Test procedures.

2. Test reports.

1.06 QUALITY CONTROL

A. General Requirements: Subsection 11-1.06, Quality Control.

B. Qualifications:

1. Welding Procedure Specifications per AWS D1.1 Structural Welding Code.


3. Welder’s Certification for Specific Welds:
   a. Welder, welding operator and tack welder must be certified to perform each type of weld to be used by AWS D1.1.

4. Independent Weld Testing Technician: Qualified in accordance with AWS D1.1/D1.1M as CWI and ASNT SNT-TC-1A as Level 2.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect painted poles before shipping by one of the following methods:

1. Shrink-wrap with 12 mil shrink wrap.

2. Wrap in stretch wrap to a thickness of 12 mils.

3. Other equivalent method.

PART 2 – PRODUCTS

2.01 POLE DIMENSIONS

A. Fabricate pole shafts, fittings, and accessories to the dimensions indicated on Contract Drawings and within tolerances conforming to the AISC specifications, unless specified otherwise in the Contract Documents.

2.02 FABRICATION OF ALL POLE TYPES

A. Fabricate pole shafts, fittings, and accessories by methods conforming to the AISC specifications, unless otherwise specified.
B. OCS Poles must conform to AISC 303 and AISC 360.

C. Structural steel detailing must be in accordance with AISC 303.

D. Welding:

1. Welding must be performed by certified, qualified welders who make only those welds for which they have been qualified.


3. Welding electrodes and fluxes: Conform to AWS D1.1/D1.1M.

4. Welding filler metal: Must conform to Section 3 and 4 of AWS D1.1.

   a. Filler materials must meet Charpy V-Notch (CVN) impact requirements of 20 ft-lbs at -20 degrees Fahrenheit. Electrodes must be as recommended by their manufacturers for the position and conditions of use.

5. Strength of weld must not be less than that of the highest strength base metal connected.

6. Welds must be as indicated on Contract Drawings unless alternative weld joint details are accepted in writing by the Engineer.

   a. Such acceptance will be contingent upon the proposed weld joint passing both weld procedure and non-destructive testing as deemed necessary by the Engineer.

   b. All costs of supplemental testing must be borne by Contractor.

7. Remove all spatter, slag and dross.

E. Tolerances:

1. Pole Shaft:

   a. Pole shafts must be straight.

   b. Variation under no-load conditions must not exceed 1”, measured from base to top.

2. Pole length: Plus 2” and minus 0”.

3. Base plates:

   a. Bolt Circle: 1/32”
b. Hole Diameter: 1/16"

c. Location of Holes: Plus 1/16" in each direction.

F. Galvanizing: Hot-dip galvanized in accordance with Subsection 11-2.01, Common Work Results for Metals, complete with base plates, handholes, pole caps, feeder spouts, fittings, and accessories as indicated on Contract Drawings.

G. Finish: Powder coat, as specified in Subsection 11-2.01, Common Work Results for Metals.

2.03 REQUIREMENTS SPECIFIC TO TAPERED, TUBULAR POLES

A. Type: PA, as indicated on Contract Drawings.

B. Fabrication:

1. Pole Shafts:
   b. Single-ply sheet-steel construction, mandrel-formed to be round with no discernible bends.
   c. Welding:
      1) Longitudinal seam welds: Continuous, 100 percent full-penetration welds.
      2) Transverse splice welds: Continuous, 100 percent full-penetration welds.
   d. Taper: 0.14" per linear foot, measured as a change in diameter.

2. Handholes:
   a. Reinforce to obtain strength equal to that of a pole without hand hole opening.
   b. Conform to details on Contract Drawings.
   c. Locate handholes opposite the longitudinal seam welds.
   d. Provide with rain-tight covers and attachment Hardware.
   e. Cover screws: Stainless steel, 1/4-20 spanner screws.
3. Pole Base Plate:
   a. Fabricate from plate steel conforming to ASTM A572 Grade 50. The minimum yield stress capacity of the base plate steel must not be less than 75 percent of the yield stress capacity of the pole shaft steel.
   b. Preheat base plate before welding in accordance with AWS D1.1/D1.1M.
   c. Finish exposed edges smooth.
   d. Round exposed corners unless otherwise indicated on Contract Drawings.


C. Pole caps: Galvanized pressed steel, fitted with three tamper-resistant stainless steel set screws.

D. Hardware and fastening devices including screws, nuts and bolts accessible from grade level must be tamper-resistant to prevent unauthorized tampering or disassembly of the completed pole installation.

E. Feeder poles:
   1. Provide GRS, Sch. 40 feeder spout(s) as shown on Contract Drawings.

F. Tolerances:
   1. Pole diameter: Within 1/16" of design diameter.
   2. Pole wall thickness: Within plus 10 percent and minus 2.5 percent of the design thickness.
   3. Pole taper: Constant.
   4. Poles straightness: Within 1/2" per 20 feet of pole length (approximately 1:480).

2.04 REQUIREMENTS SPECIFIC TO WIDE-FLANGE POLES

A. Types: PC, PD, PF, PG, and PK, as indicated on Contract Drawings.

B. Fabrication:
   1. Structural steel: Conform to ASTM A36/A36M.
2. Pole shafts: Hot-rolled structural shape with wide flange sections fabricated to the length and weights as indicated on the Contract Drawings.

3. Pole Base Plate:
   a. Fabricate from plate steel conforming to ASTM A36/A36M. The minimum yield stress capacity of the base plate steel must not be less than 75 percent of the yield stress capacity of the pole shaft steel.
   b. Preheat base plate before welding in accordance with AWS D1.1/D1.1M.
   c. Finish exposed edges smooth.
   d. Round exposed corners unless otherwise indicated on Contract Drawings.

4. Miscellaneous Steel: ASTM A36/A36M.

2.05 CONDUIT AND ACCESSORIES

A. Comply with Subsection 12-4.07, Raceway and Boxes, and Contract Drawings for conduit, service entrance heads, bushings, and sealing cable supports.

2.06 POLE IDENTIFICATION

A. Identification (ID) Plate: Stamped stainless steel.

   1. Lettering: 1/4” minimum, durably engraved or stamped.

   2. Information:
      a. Name of manufacturer.
      b. Month and year of manufacture.
      c. Pole design type.
      d. Pole height.
      e. Serial number specific to each individual pole.

   3. Factory Attachment:
      a. Attach ID plate to each OCS pole before delivery to site.
b. Fasteners: Tamperproof stainless steel rivets or screws.

c. Height: 2'6" inches above base plate, or 6" below the handhole for tubular poles that have handholes.

B. Track data information marker: Stainless steel plate, 6" x 2-1/2" x 0.04" thick.

1. Information:

   a. Referenced track name.

   b. Stationing.

   c. Offset distance (face of pole to designed centerline of referenced track).

   d. Designed superelevation at the pole location.

2.07 SOURCE QUALITY CONTROL

A. Material Testing:

1. Furnish manufacturer’s mill test reports or laboratory tests showing chemical composition and mechanical properties of steel.

2. Yield Strength:

   a. Submit certified test reports to verify conformance to minimum yield strength.

   b. The test reports may be the mill test reports for the as-received steel.

   c. If as-received steel has a lower yield strength than required, furnish supportive test data to assure that manufacturer’s method of cold forming will consistently increase the tensile properties of the steel to meet the specified minimum yield strength.

   d. Supportive test data must include tensile and yield properties of the steel both before and after cold forming for specific heats and thickness.
B. OCS Pole QC Weld Inspection and Testing:

1. Provide the services of an independent AWS Certified Welding Inspector (CWI) with current Certification.

2. All welding must be inspected by CWI in process and upon completion.

3. CWI must perform the following in accordance with the Contract Documents:
   a. Inspect and document fabrication activities.
   b. Inspect in accordance with approved welding procedures.
   c. Inspect welder’s qualifications.
   d. Inspect welds made by welding personnel.

4. Provide the services of independent certified ASNT Level 2 Weld Testing Technicians to perform the following weld tests in conformance with AWS D1.1/D1.1M, Cyclically Loaded Connections:
   a. Visually Inspect (VT) all welds.
   b. Ultrasonic Testing (UT):
      1) Test all full penetration welds 5/16” thick or greater in their entirety.
      2) Welds that are ultrasonically tested do not require magnetic particle testing.
   c. Magnetic Particle Testing (MT):
      1) Test all full penetration welds less than 5/16” thick in their entirety.
      2) Perform magnetic particle testing on all welds, including longitudinal seam welds and welds at handholes, cable outlets, and other welded on attachments and reinforcements.

5. Submit inspection and test reports in conformance with AWS D1.1/D1.1M and CQCP General Requirements.
C. OCS Pole Deflection Testing:

1. Demonstrate to Engineer that each type of pole provided under this Contract is manufactured in conformance with the pole design.

2. Test actual deflection of manufactured pole and compare result with calculated deflection.

3. Conduct a non-destructive factory test at the place of the OCS pole manufacturer.

4. Submit test procedure before testing poles, including the following:
   a. Method of application of loads.
   b. Recording devices.
   c. Calibration of devices.
   d. Other information deemed pertinent by the Engineer.

5. Conduct test on a rigid foundation that resists all translation and rotation in any axis.

6. Engineer must observe a first article test of pole deflection testing performed by Contractor. Inspection by RT at the point of manufacture does not constitute acceptance of work as specified.

7. Conduct pole deflection tests on the first pole of each type manufactured.

8. If a pole deflects more than the allowable value, all poles of that type will be rejected unless they are subjected to an individual successful test.

9. Perform retests as required at no additional cost to RT.
10. Demonstrate the following parameters during the pole deflection test:

<table>
<thead>
<tr>
<th>Pole Type</th>
<th>Description</th>
<th>M Allowable (ft lbs)</th>
<th>P at 19'-6&quot; (lbs)</th>
<th>Calculated Deflection at 19'-6&quot; (inches)</th>
<th>Allowable Test Deflection at 19'-6&quot; (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA16</td>
<td>13&quot; Dia, 0 Gage, 28 ft</td>
<td>98,000</td>
<td>5,026</td>
<td>3.5</td>
<td>4.20</td>
</tr>
<tr>
<td>PA4, PA6, PA8, PA15</td>
<td>13&quot; Dia, 3 Gage, 30 ft</td>
<td>78,000</td>
<td>4,000</td>
<td>3.5</td>
<td>4.20</td>
</tr>
<tr>
<td>PA3, PA5, PA7, PA14</td>
<td>13&quot; Dia, 3 Gage, 26 ft</td>
<td>78,000</td>
<td>4,000</td>
<td>3.5</td>
<td>4.20</td>
</tr>
<tr>
<td>PA2</td>
<td>13&quot; Dia, 7 Gage, 30 ft</td>
<td>56,000</td>
<td>2,872</td>
<td>3.4</td>
<td>4.08</td>
</tr>
<tr>
<td>PA1</td>
<td>13&quot; Dia, 7 Gage, 26 ft</td>
<td>56,000</td>
<td>2,872</td>
<td>3.4</td>
<td>4.08</td>
</tr>
<tr>
<td>PA11, PA13</td>
<td>11&quot; Dia, 3 Gage, 26 ft</td>
<td>41,000</td>
<td>2,103</td>
<td>3.2</td>
<td>3.84</td>
</tr>
<tr>
<td>PA10, PA12</td>
<td>11&quot; Dia, 7 Gage, 26 ft</td>
<td>34,000</td>
<td>1,744</td>
<td>3.5</td>
<td>4.20</td>
</tr>
</tbody>
</table>

11. Maximum pole deflection: Values shown in table above in the last column, “Allowable Test Deflection.” Allowable test deflection values are 120 percent of values in the adjacent column, “Calculated Deflection at 19'-6’’.”

D. All weld repairs must be made in accordance with AWS D1.1.

PART 3 – EXECUTION

3.01 POLE FINISH REQUIREMENTS

A. Where Contract Drawings indicate that pole is painted, paint pole and finish with shop-applied paint coating system, in accordance with Subsection 11-2.01, Common Work Results for Metals.

B. Where Contract Drawings do not indicate that poles are painted, hot-dip galvanize pole and provide without additional finish.

3.02 INSTALLATION

A. Install type of pole at each location as indicated on Contract Drawings.
B. Accessories: Provide poles with pole caps, cap mounting screws, hand holes, feeder spouts and all miscellaneous Hardware required to complete the poles as shown on Contract Drawings.

C. Field Modifications: Poles bases must not be field cut except as specifically directed by the Engineer.

D. Foundation Curing: See Subsection 11-3.01, OCS Drilled-Pier Foundations, for length of cure time required before poles may be set and loaded.

E. During pole erection, take precautions to prevent contact with other energized OCS and utilities as applicable.

F. Handle and erect poles using nylon or similar non-marking slings and chokes.

G. Install tapered tubular poles with hand hole facing parallel with centerline of tracks.

H. Hardware:
   1. Provide nuts, washers, shims, Anchor Bolt retainers, and related materials required to install poles on the foundations.
   2. No fastener(s) may be installed until they are reviewed by the Engineer.
   3. Install fasteners using tools and methods recommended by the manufacturer and accepted by the Engineer.
   4. Torque bolts and nuts to manufacturer's recommendations.
   5. Torque mark each bolt and nut using a permanent marker.

I. Rake poles by means of double nuts and washers, with one nut, lock washer and flat washer above, and one nut and flat washer below the pole base plate.

J. Conduit: Install on wide-flange feeder poles as indicated on Contract Drawings, and in accordance with Subsection 12-4.07, Raceways and Boxes.

K. Grounding:
   1. Provide materials and ground each steel pole as indicated on Contract Drawings and specified in Subsection 12-4.05, Grounding and Bonding.
   2. Perform mechanical and electrical tests as indicated in Subsection 12-4.05, Grounding and Bonding.
3.03 INSTALLATION TOLERANCES

A. Installed OCS must conform to the dimensional requirements indicated on Contract Drawings with the following tolerances:

1. Pole base plate elevation:
   a. Open ballasted track: Plus or minus 2”.
   b. Station and sidewalk areas: Plus 0, minus 1”.

2. Pole Rake or verticality: Plus or minus 1” (measure pole Rake at Contact Wire height after loading).

3.04 SIDEWALK OR PAVEMENT REPAIR

A. Where pole bases are indicated on Contract Drawings to be recessed below sidewalk level, refinish sidewalk to a level flush with adjacent sidewalk sections, following approval of pole installation by Engineer.

B. Temporary pavement and permanent finish around foundation must be provided under this Contract at no cost to RT.

3.05 IDENTIFICATION

A. Structure Number: Immediately after installation, attach to each pole in accordance with Contract Drawings.

B. Track data information marker: Attach to pole with the top of the track data information marker 12” above top of high rail.

C. Milepost Numbers:

1. Stencil numbers shown on the layout schedule on each pole.

2. Orientation: Horizontal.

3. Location:
   a. Stencil both sides of pole so that numbering is visible along the tracks.
   b. Height: 8' from base of pole.

4. Size: 2” high x 1” wide.
5. **Stencil Paint:**
   a. Galvanized poles: 100% acrylic water borne enamel designed for direct metal application.
   b. Finished poles: Compatible urethane.

6. **Stencil Color:**
   a. Unfinished poles: Gloss black.
   b. Black or green poles: Gloss white.

3.06 **FIELD QUALITY CONTROL**

A. **Galvanizing Repair:** Inspect poles for damage to galvanizing and paint coating. Field repair minor damage in accordance with Subsection 11-2.01, Common Work Results for Metals.
11-4.03  OCS FITTINGS AND HARDWARE

PART 1 – GENERAL

1.01  SUBSECTION INCLUDES

A.  Requirements that apply only to the work in this Section 11.

B.  OCS fittings and Hardware, including but not limited to the following:
    1.  Pole Bracket assemblies.
    2.  Clevis fittings.
    3.  Clamps.
    4.  Nuts, bolts, and cotter pins.
    5.  Dead ends.
    6.  Turnbuckles.
    7.  Wire splices and connectors.
    8.  Knuckle assemblies.
    9.  Links and eyebolts.
   10. Thimbles and wire Sleeves.

1.02  MEASUREMENT AND PAYMENT

A.  OCS fittings and Hardware are included in OCS Segment Bid Items. See OCS Segment Bid Items in Subsection 11-1.02, Measurement and Payment.

1.03  SUBMITTALS

A.  Procedures: Subsection 11-1.03, Submittal Procedures.

B.  Product Data:
    1.  Submit product data for review and acceptance by the Engineer for each type of OCS fitting and Hardware before ordering.

C.  Shop Drawings:
    1.  Furnish for each type of fitting or Hardware provided under this Subsection.
2. Furnish to verify that product’s design characteristics meet or exceed the requirements for RT’s application.

D. Calculations: Furnish calculations to verify product’s design characteristics meet or exceed the requirements for RT’s application.

1.04 QUALITY CONTROL

A. General Requirements: Subsection 11-1.06, Quality Control.

PART 2 – PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Fittings and Hardware used for OCS assemblies must have the following characteristics:
   1. Selected and manufactured such that they can be reused after removal.
   2. Designed to allow an easy Interface with the other Components of the OCS system.
   3. Designed in a manner that will provide a homogenous OCS Hardware and assembly arrangement.
   4. Designed such that all fastenings and adjustments are accomplished with the same dimensional standards and tools.

B. Prohibited:
   1. Support arms, spacers, and turnbuckles using crimped pipe must not be used.

2.02 PRODUCTS

A. Pole Bracket Assemblies:
   1. Specific Bracket and band sizes must correspond to specific taper of tubular pole sizes.
   2. Brackets that are simple and small but have the required strength are desirable.
   3. Light duty pole bands, i.e. used for Cantilever support, must be field adjustable and secured by means of a removable tensioning bolt with blocks.
2.03  OPTIONAL HARDWARE

A. With the acceptance of the Engineer, Contractor may install Hardware such as turnbuckles and Guy grips not indicated on the assembly drawings in the Plans to facilitate installation.

B. The strength and quality of optional Hardware must meet or exceed the strength and quality of other Hardware in the assembly.

C. Introduction of this Hardware must not alter the function of the completed assembly.

PART 3 – EXECUTION

3.01  ASSEMBLY

A. Provide necessary OCS fittings and Hardware that, when combined with major OCS items, complete the total OCS system.

3.02  INSTALLATION

A. General Requirements:
   1. Do not install fittings or Hardware until they have been reviewed by the Engineer with No Exceptions Taken.
   2. Conductor Connections: Provide two Jumper clamps. Two-bolted clamps will not substitute for two individual clamps.
   3. Install fasteners using tools and methods recommended by the manufacturer and accepted by the Engineer.
   4. Torque all bolts, nuts, and machine screws to the manufacturer’s recommendations.

B. Pole Bracket Assemblies:
   1. Typical Bracket and band heights for pole attachments are indicated on Contract Drawings.
   2. Adjust Brackets and modify fabricated assembly as necessary to comply with clearance envelope requirements.
11-4.04 OCS SUPPORT ASSEMBLIES

PART 1 – GENERAL

1.01 SUBSECTION INCLUDES

A. Requirements that apply only to the work in this Section 11.

B. OCS Cantilevers.

1.02 MEASUREMENT AND PAYMENT

A. OCS support assemblies are included in OCS Segment Bid Items. See OCS Segment Bid Items in Subsection 11-1.02, Measurement and Payment.

1.03 REFERENCE STANDARDS

A. ASTM International (ASTM)


2. ASTM A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

3. ASTM A780/A780M, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

1.04 SUBMITTALS

A. Procedures: Subsection 11-1.03, Submittal Procedures.

B. Shop Drawings:

1. Detailed Shop Drawings to verify the Cantilever's design characteristics meet or exceed the requirements for RT's application.

2. Furnish separate drawings for each style of Cantilever assembly showing lowest value dimensions for pole Offsets and typical track super elevations. Include the following for each:

   a. The Pantograph clearance envelope on the superelevated track centerline at Contact Wire level.

      1) The Pantograph clearance envelope must be dimensionally correct for the actual Contact Wire height.
2) The Pantograph clearance envelope must include both the Contact Wire Uplift envelope and the mechanical clearance envelope as shown in the Contract Drawings.

b. Calculations for each Cantilever type showing the design loading requirements.

3. For each Cantilever installed, furnish diagrams or charts indicating actual Cantilever pipe lengths and diameters.

4. Furnish Shop Drawings for each type of support assembly provided under this Subsection.

C. Calculations:

1. Submit calculations to verify the Cantilever's design characteristics meet or exceed the requirements for RT's application.

1.05 QUALITY CONTROL

A. General Requirements: Subsection 11-1.06, Quality Control.

PART 2 – PRODUCTS

2.01 DESIGN

A. Cantilevers:

1. Select type of OCS Cantilever to be installed at each location based upon the site-specific pole loadings.

2. Provide double insulation.

3. Prepare detailed design drawings for each of the required Cantilevers shown on Contract Drawings.

   a. Cantilever drawings must show light rail vehicle dynamic envelope for the minimum clearance application for the Project.

   b. Designs must be based on the performance requirements, working loads and basic dimensions.

   c. Submit designs for review by the Engineer.
d. Prepare and submit diagrams or charts indicating the following:

1) Actual Cantilever pipe lengths and diameters for each Cantilever installed.

2) Location of each Cantilever: Track, stationing, pole number, and which wire is registered and supported.

B. Longitudinal Travel of Wires:

1. Design support Registration assemblies for the messenger and Contact Wires to permit longitudinal movement of the wires due to thermal expansion and contraction.

2. Hinge mechanisms may introduce only a minimal amount of friction to the constant tension system.

3. Design supports to allow longitudinal movement of the wire through 90 degrees either side of their Normal position.

C. Clearance:

1. Installed OCS, including Steady Arm in Uplifted position, must not intrude into the Pantograph clearance envelope, for the applicable Contact Wire height, allowing for Uplift of the Contact Wire.

2. Check strut pipes of Cantilevers during Cantilever design to ensure minimum Electrical Clearance to the Pantograph clearance envelope.

2.02 MATERIALS

A. Pipe:

1. Maximum pipe diameter: 2-1/2", unless otherwise accepted by Engineer.

2. Hot-dip galvanized per ASTM A123/A123M and Subsection 11-2.01, Common Work Results for Metals, after fabrication.

3. Finish: Paint, in accordance with Subsection 11-2.01, Common Work Results for Metals.

B. Lubricating Grease: Weather resistant.
PART 3 – EXECUTION

3.01 CANTILEVER PIPE FINISH REQUIREMENTS

A. Where Contract Drawings indicate that Cantilever pipes are painted, hot-dip galvanize pipe and finish with shop-applied paint coating system, in accordance with Subsection 11-2.01, Common Work Results for Metals.

B. Where Contract Drawings do not indicate that Cantilever pipes are painted, hot-dip galvanize pipe and provide without additional finish.

3.02 TOLERANCES

A. Cantilever along-track location: Plus 1” at 70 degrees F (at Contact Wire clip).

3.03 BEFORE FABRICATION

A. Before prefabricating Cantilevers, submit product data for materials.

B. Submit detailed Shop Drawings of assemblies for each type proposed that show Cantilever dimensions for each location.

C. Cantilever and Bracket arm design and dimensions must take into account design superelevation values and actual pole clearances to track, and provide required Contact Wire height and Stagger.

D. Strut pipes, Registration pipes and the heels of Steady Arms must be outside the mechanical Pantograph clearance envelope.

3.04 FABRICATION

A. Develop a suitable jig to allow pre-assembly of the Cantilevers to specific dimensions.

1. Fabricate Cantilevers for each location using wire heights, Staggers, and System Heights given in the Contract Drawings and as calculated by Contractor.

2. Use actual pole to track centerline site dimension, at Contact Wire level.

B. Measure, cut, drill, fabricate, and assemble all Components to be installed under this Contract.

C. After cutting Cantilever pipe, repair cut ends using field galvanizing repair method specified in Subsection 11-2.01, Common Work Results for Metals.
3.05 INSTALLATION

A. Cantilevers must not be installed until they have been reviewed by the Engineer with No Exceptions Taken.

B. Erect Cantilevers on each pole at heights necessary to obtain designed OCS heights.

C. For stability during conductor stringing, temporarily restrain Cantilevers in the along track direction to prevent collapse.

D. Cotter pins and nuts:
   1. Locate on each Cantilever on the side of the structure facing Normal direction of traffic.
   2. Orient assemblies fitted with these Components in a manner that holds the Components together by gravity should the pins or nuts become detached during service conditions.

E. Grease Components with a hinge or swivel using an approved grease before assembly of the rubbing surfaces, and clean off excess grease.

F. After installing Cantilevers and stringing conductors, adjust Stagger, Heel Setting, Contact Wire heights and alignment as necessary.

3.06 FIELD QUALITY CONTROL

A. Repair using the methods described in ASTM A780/ASTM A780M using the brazing method. Zinc rich paints may not be used.

B. Repair paint coatings using paint coating procedures as identified in the paint coating section 3.05 Field Touch Up Painting of these Technical Specifications.
11-4.05  OCS SPAN, PULL-OFF, AND GUY ASSEMBLIES

PART 1 – GENERAL

1.01  SUBSECTION INCLUDES

   A. Requirements that apply only to the work in this Section 11.
   B. Requirements for OCS cross spans and Head Spans.
   C. Requirements for OCS pull-off and back-bone assemblies.
   D. Requirements for OCS down-Guy, head-Guy assemblies, and Midpoint Anchor point span Guys.

1.02  MEASUREMENT AND PAYMENT

   A. OCS span, pull-off, and guyGuy assemblies are included in OCS Segment Bid Items. See OCS Segment Bid Items in Subsection 11-1.02, Measurement and Payment.

1.03  REFERENCE STANDARDS

   A. ASTM International (ASTM)
      1. ASTM A475, Standard Specification for Zinc-Coated Steel Wire Strand

1.04  SUBMITTALS

   A. Procedures: Subsection 11-1.03, Submittal Procedures.
   B. Product Data: Furnish product data for each Component.
   C. Shop Drawings:
      1. Furnish for each type of assembly provided under this Subsection.
      2. Furnish span wire cut lengths.

1.05  QUALITY CONTROL

   A. General Requirements: Subsection 11-1.06, Quality Control.
PART 2 – PRODUCTS

2.01 DESIGN

A. General Requirements:

1. Design Head Spans and cross spans for site-specific loading conditions.

2. The types of Head Spans, cross spans, and span Guys indicated on Contract Drawings are general in nature. Contractor is responsible for the detailed design, dimensions, and field adjustment.

3. Design and specify tensions and attachment heights of Head Spans, cross spans and Backbones, including bridles and pull-offs where required.

B. Head Spans:

1. Head spans must consist of two or more steel span wires with double insulation.

2. Use Head Spans on simple Catenary wire segments; design for single and multi-track arrangements.

C. Cross spans:

1. Cross spans must consist of a single steel wire with double insulation.

2. Cross spans must be used on single Contact Wire segments.


4. Single Contact Wire systems suspended from cross spans must use a bridle to support the Contact Wire on either side of the suspension point.

D. Pull-off and Backbone assemblies:

1. Pull-off and Backbone assemblies must be used to hold the OCS system in the correct alignment on curves indicated on Contract Drawings.

2. Direct pull-offs must be suitable for single or multiple track operations.

3. Provide with double insulation.

E. Design pull-offs to accommodate the loads at each location and maintain a minimum load of 200 pounds at all temperatures.
F. Suitable bull-rings may be used in Backbone systems to achieve correct tension distribution and accommodate the angles required.

G. If bull-rings are not used, the fittings used must not cause kinking or detrimental stresses in the Backbone wire.

H. Guys:
   1. Design Midpoint Anchor span Guys as indicated on Contract Drawings.
      a. Installed Guy tension: Nominal 1500 pounds at 70 degrees F, corrected for ambient temperature as shown in Contract Drawings.
   2. Design Guys for site-specific loading conditions.

2.02 MATERIALS

A. Span Wires:
   1. Bare galvanized steel wire strand, 19 strand, High-Strength grade, in accordance with ASTM A475.
   2. Zinc-coating: Class A, in accordance with ASTM A475.
   3. Size: 3/8”.
   4. Breaking strength: 15,000 pounds minimum.

B. Guy Wire:
   1. Bare galvanized steel wire strand, 7 strand, High-Strength grade, in accordance with ASTM A475.
   2. Zinc-coating: Class A, in accordance with ASTM A475.
   3. Size: 5/8”

C. Guy Guard: 8’ long, fluorescent Safety yellow.
PART 3 – EXECUTION

3.01 INSTALLATION

A. General Requirements:
   1. Install galvanized steel wire, wire rope, and pre-formed spirals using tools and methods recommended by the manufacturer and accepted by the Engineer.
   2. Galvanized steel wire strand must not be spliced.

B. Spans:
   1. Adjust Head Spans and cross spans to hold structures and overhead conductors in their proper final locations.
   2. Adjustment: Provide turnbuckles in spans near the poles with a minimum of 6” of adjustment in each direction after installation.

C. Down Guys:
   1. Provide on structures as indicated on Contract Drawings.
   2. Configuration: Provide two galvanized steel wire strands for each down Guy.
   3. Adjustment: Provide turnbuckles in Guys with a minimum of 6” of adjustment in each direction after installation.
   4. Install down Guys before installation of overhead conductors.
   5. Adjust down Guys and span Guys to hold structures and overhead conductors in their proper final locations.
   6. Install Guy guard on all down Guys.
11-4.06 OCS CONDUCTORS

PART 1 – GENERAL

1.01 SUB-SECTION INCLUDES

A. Requirements that apply only to work in this Section 11.
B. Contact Wire.
C. Messenger Wire.
D. Jumpers.
E. Contact bridges.

1.02 RELATED SECTIONS

A. Subsection 11-4.07, OCS Conductor Terminations

1.03 MEASUREMENT AND PAYMENT

A. OCS conductors are included in OCS Segment Bid Items. See OCS Segment Bid Items in Subsection 11-1.02, Measurement and Payment.

1.04 REFERENCE STANDARDS

A. ASTM International (ASTM)

1. ASTM B1, Standard Specification for Hard-Drawn Copper Wire
2. ASTM B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
3. ASTM B47, Standard Specification for Copper Trolley Wire
4. ASTM B116, Standard Specification for Figure-9 Deep-Grooved and Figure-8 Copper Trolley Wire for Industrial Haulage
5. ASTM B173, Standard Specification for Rope-Lay-Stranded Copper Conductors Having Concentric-Stranded Members, for Electrical Conductors

1.05 SUBMITTALS

A. Product Data:

1. Furnish for each type of conductor.
2. Furnish for terminations and splice kits.

B. Shop Drawings:

1. Furnish for each type of conductor provided under this Subsection.
2. Furnish for Contact Bridges.

C. Samples:

1. Furnish for each type of conductor.

D. Before shipping, provide Certification that conductors have been designed, manufactured, inspected, and tested in accordance with applicable portions of the referenced standards and these Technical Specifications.

E. Factory Test Reports:

1. Submit a certified copy of the test report for each cable reel before shipment. In addition, a copy of the test report must be packed with each reel.
2. Provide certified copies of manufacturer's production test reports for the specific conductors provided.

F. Stringing Procedure:

1. Submit Contact Wire and Messenger Wire stringing procedure 60 days before such work is scheduled to begin.
2. Separate submittals are required for each phase. Include procedure for implementing OCS relocation (see Subsection 11-4.10, Modifications to Existing OCS).
3. Include proposed procedure for reducing Contact Wire Creep before making final OCS adjustments.
4. Include proposed procedures for final terminations.
1.06 QUALITY CONTROL

A. General Requirements: Subsection 11-1.06, Quality Control.

1.07 DELIVERY, STORAGE AND HANDLING

A. Delivery and Acceptance Requirements

1. Reels:

a. Ship conductors on standard domestic non-returnable steel reels sized in accordance with ASTM B47, with heavy wood lagging.

b. Drum diameter: Minimum 36”; sufficiently large so as to avoid waves or kinks when the conductor is strung.

c. Reels must be suitable for the weight of the conductors and constructed to withstand shipping, handling, storage and stringing operations without conductor damage.

2. Conductors:

a. Protect conductors from damage during delivery and handling.

b. Pack conductors so they can be Safely handled by equipment Normally used and available for handling of such material.

c. Permanent twisting or rotation of Contact Wire on reel will be cause for rejection of reel at Contractor’s expense.

d. Provide one continuous conductor on each reel with required length so no splices are required in a tension length when installed.

e. Wind conductors on reels in even level wraps with no crossed, Overlapping or loose ends.

f. Specify to manufacturer the orientation of Contact Wire vertical axis relative to reel axis to suit intended construction method.

g. Paint a 1” stripe of contrasting color across the outermost layer on each reel prior to shipping. Visible conductor shift at this line, upon receipt at the Project site, will be cause for reel rejection.

3. Labeling: Each reel must have a strong, weatherproof tag or marker securely fastened to it, containing the following information:

a. Size and type of conductor.
b. ASTM designation.

c. Name and mark of manufacturer.

d. Month and year of manufacture.

e. Total reel length and weight.

f. Manufacturer’s special instructions.

g. Purchase order number.

B. Storage and Handling Requirements:

1. Store products in accordance with the manufacturer's instructions to ensure that material is protected from damage and exposure.

2. Handle wire and cable in accordance with manufacturer's instructions, so as to ensure that products are not damaged before or during installation.

3. Do not store materials or reels in direct contact with the ground; store in a manner and location that will not cause deterioration.

4. Damage to wire and cable is Contractor's responsibility; repair or replacement must be by Contractor in accordance with manufacturer's instructions, at no additional cost to RT.

PART 2 – PRODUCTS

2.01 MATERIAL

A. Contact Wire: 350 kcmil solid grooved, hard-drawn copper, uncoated, conforming to or exceeding the requirements of ASTM B47 and ASTM B116.


2. Coefficient of expansion: $9.4 \times 10^{-6}$ per degree F.


B. Messenger Wire: 500 kcmil, 19 strand, hard drawn, bare copper conforming to ASTM B8 and ASTM B1, Class AA, bare.

C. Jumpers: 500 kcmil, stranded annealed copper, bare, standard rope-lay, uncoated conductor, Class H stranding in accordance with ASTM B173.

1. Connections to conductors must be copper or bronze.
2.02 SOURCE QUALITY CONTROL

A. Contact Wire Joints: Mark factory contact-wire joints with paint or dye before wire drawing. Marks must be visible after the wire drawing process. Joints must meet minimum breaking strength requirements of Contact Wire.

B. Factory Production Tests:

1. Perform factory production tests on conductors as required in the applicable Standards and in accordance with Subsection 11-4.13, OCS Inspection, Testing, and Acceptance Measurements.

2. Perform tests on each reel before shipment.

PART 3 – EXECUTION

3.01 INSTALLATION

A. General:

1. All scrap lengths of wire and cable remain the property of RT and must be returned by Contractor to RT, as directed by the Engineer.

B. Wire Height:

1. In general, in-running heights of Contact Wires and Messenger Wires above top of rail must be the same as those on the adjacent tracks, unless otherwise noted on Contract Drawings.

2. Where adjacent tangent tracks differ in elevation, take measurements from highest rail to enable back to back Cantilever Brackets to be used. Differing track elevations on curved tracks may require Cantilevers to have individual Brackets.


4. Adjust Bracket heights and Hangers, as necessary, to bring new Contact Wire to required level.

5. If existing poles do not provide enough working height to meet minimum required wire heights, provide pole extensions or other means of achieving the same result.

6. Submit calculations or recalculation associated with pole extensions.
3.02 OCS CONDUCTOR STRINGING

A. Install overhead conductors in compliance with the Contractor's procedure, as accepted by the Engineer.

B. Verify that conductor erection tables provided in the Contract Drawings conform to actual wire data before using in wire stringing.

C. Field Conditions:
   1. During Contact Wire stringing, measure conductor temperature with a contact thermometer.
   2. Determine actual erection tension for each tension length based on conductor temperature, equivalent span, and verified conductor erection tables.

D. Contact Wire Creep: Take precautions to reduce the effects of initial Contact Wire Creep by using one of the following methods, or a combination of both, before making final OCS adjustments.
   1. Pre-stressing: Procedure must describe the proposed method and include:
      a. Pre-stress tension.
      b. Pre-stress time period to be applied before reducing to Normal tension.
      c. Verification that wire structures can Safely carry the proposed loading.
   2. Time-lapse: Allow the initial Creep to occur over a prescribed period of time by leaving the Contact Wire in temporary rollers or travelers for a minimum period. Procedure must include:
      a. The time-lapse period.
      b. Necessary precautions to be taken.

E. After initial Creep has been removed:
   1. Verify that Hangers are vertical.
   2. Secure conductors at the termination assemblies.
F. Install termination assemblies in accordance with Subsection 11-4.07, OCS Conductor Terminations.

3.03 TOLERANCES

A. Contact Wire Stagger:
   1. In running: 1”.
   2. Out of running: 1.5”.

3.04 SPLICES

A. Joints in conductors are not permitted unless accepted in writing by the Engineer or indicated on Contract Drawings.

B. Where joints are permitted, splice conductors in accordance with the splice-kit and conductor manufacturer's recommendations.

C. When permitted, splices must conform to the following:
   1. No more than one splice per span.
   2. Locate splices minimum 25’ from face of poles, and 20’ from conductor crossing points.

3.05 CONTACT BRIDGES

A. Use Contact Bridges for crossing of Contact Wires in Crossovers and other areas where in-running Contact Wires cross each other, as shown on Contract Drawings.

B. Double clamp Contact Bridges at each end.
11-4.07 OCS CONDUCTOR TERMINATIONS

PART 1 – GENERAL

1.01 SUBSECTION INCLUDES

A. Requirements that apply only to the work in this Section 11.

B. Fixed termination assemblies.

C. Balance weight assemblies.

1.02 MEASUREMENT AND PAYMENT

A. OCS conductor terminations are included in OCS Segment Bid Items. See OCS Segment Bid Items in Subsection 11-1.02, Measurement and Payment.

1.03 REFERENCE STANDARDS

A. ASTM International (ASTM)
   1. ASTM A475, Standard Specification for Zinc-Coated Steel Wire Strand

B. State of California Public Utilities Commission
   1. General Order (G.O.) 95, Rules for Overhead Line Construction

1.04 SUBMITTALS

A. Procedures: Subsection 11-1.03, Submittal Procedures.

B. Product Data: Furnish for the specified products.

C. Shop Drawings:
   1. Furnish for each type of assembly provided under this Subsection.

D. Submit and obtain Review with No Exceptions Taken of marking system before applying.

1.05 QUALITY CONTROL

A. General Requirements: Subsection 11-1.06, Quality Control.
PART 2 – PRODUCTS

2.01 DESIGN

A. General Requirements:

1. OCS Conductor terminations must meet the requirements of G.O. 95. Rule 74.4 F (1).

2. Strain type termination assemblies: Straight line design or other aesthetically-pleasing design.

3. Wire wrap, cone, or wedge type designs are acceptable.

4. Include turnbuckles with a minimum of 6” of adjustment capability in each direction after installation as indicated or where necessary.

5. Slip strength: Minimum of 100 percent of the breaking strength of the terminating conductor or wire.

B. Balance Weight Assemblies:

1. Automatic tension terminations: As indicated on Contract Drawings.

2. OCS balance weight assemblies must automatically regulate tension of OCS conductors by compensating for the variations in wire length resulting from changes in temperature due to ambient, solar and current heating.

3. Balance weights must operate freely within the specified temperature range.

4. Balance weights must be restricted from falling by means of an auxiliary span wire in case OCS conductors break.

5. OCS balance weight assemblies must include a rotation-resistant galvanized steel strand between the pulley wheels of the weight assembly.

6. Pulley assemblies must contain a braking mechanism that will keep weight from dropping if Contact or Messenger Wire breaks.

7. Yoke plate:

   a. The location of yoke plates in anchor spans is critical to the performance of the balance weights.
b. Yoke plate location dimensions are given on Contract Drawings.

8. Balance weight anchor spans must include a galvanized steel termination strand between the yoke plate and the pulley wheels of the balance weight assembly.

C. Fixed Terminations:

1. Provide two strain Insulators, separated by a minimum of 6’ and maximum 9’.

2.02 COMPONENTS

A. Balance Weight Terminations:


3. Steel Wire Strand: Galvanized steel strand meeting the requirements of ASTM A475.

B. Fixed Terminations:

1. Strain Insulators: See Subsection 11-4.08, Insulators.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install mid-anchor assemblies as shown on Contract Drawings.

B. Balance Weights:

1. Install balance weight assemblies such that they do not chafe on poles or guide pipes.

2. Temperature Range:

   a. Install OCS balance weight assemblies such that the weights are free to move throughout the temperature range of 25 degrees F to 125 degrees F ambient.

   b. Restrain movement above 125 degrees F using mechanical stops.
3. **Marking:**

   a. Permanently mark balance weight poles in 25 degree F increments from 25 degrees F to 125 degrees F to indicate the proper location of the counterweight assembly for ambient temperature.

C. **Yoke Plates:**

   1. Install perpendicular to ground.

   2. Rotation of yoke plate is not permitted.
11-4.08  OCS INSULATORS

PART 1 – GENERAL

1.01 SUBSECTION INCLUDES

A. Requirements that apply only to work in this Section 11.

1.02 MEASUREMENT AND PAYMENT

A. OCS Insulators are included in OCS Segment Bid Items. See OCS Segment Bid Items in Subsection 11-1.02, Measurement and Payment.

1.03 REFERENCE STANDARDS

A. American National Standards Institute (ANSI)
   1. ANSI C29.13, Insulators—Composite—Distribution Deadend Type

B. ASTM International (ASTM)
   1. ASTM A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
   2. ASTM D116, Standard Test Methods for Vitrified Ceramic Materials for Electrical Applications

1.04 SUBMITTALS

A. Product Data:
   1. Submit for each Insulator before ordering.

B. Certificate of Suitability: Provide Insulators with written Certification from the original equipment manufacturer of suitability of application and use for light rail OCS transit.

C. Shop Drawings:
   1. Submit for each Insulator. Include the following information:
      a. Dimensions.
      b. Working and ultimate loads.
      c. Electrical characteristics.
D. Calculations: If requested by Engineer, furnish calculations to verify
Insulator's design characteristics meet or exceed the requirements for RT's
application.

E. Submit design and production test procedures and test reports.

1.05 QUALITY CONTROL

A. General Requirements: Subsection 11-1.06, Quality Control.

PART 2 – PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Insulators must be suitable for the various assemblies including Cantilevers,
cross spans, Head Spans, and for use as strain Insulators.

B. Provide Insulators complete with integral Hardware suitable for connection to
supports or OCS Hardware.

C. Rating: 1000 Vdc, minimum for individual Insulators.

2.02 MATERIALS

A. Insulator metal Parts:

1. Malleable iron, ductile iron, or forged steel.

2. Galvanized before assembly to the body in accordance with ASTM
A153/A153M.

B. Insulator material:

1. Porcelain, fiberglass, or synthetic.

2. Polyester fiberglass Insulators must not be used.

C. Porcelain Insulators:

1. Manufactured from high quality commercial-grade wet process porcelain
conforming to ASTM D116.

2. Surface: Free of imperfections. Insulators will be rejected if
imperfections in glaze were repaired by recoating and refiring or by
retouching with paint.

3. Glazing: Cover entire porcelain surface that will be exposed after
assembly.

D. Synthetic Insulators may be fabricated from any of the following materials:

1. Molded ethylene propylene copolymer with hydrated alumina filler.

2. Fiberglass-reinforced epoxy solid rod.

3. Composite type with molded ethylene propylene copolymer jacket or skirts formed over a fiberglass-reinforced epoxy core.

2.03 ULTRAVIOLET (UV) PROTECTION

A. Incorporate UV protection into the insulating material.

B. Insulators must not rely on an epoxy paint or other outer coating of UV protective material for UV protection.

2.04 ELECTRICAL CHARACTERISTICS:

A. Nominal Voltage 750 Vdc.

B. Insulator class 2 kV.

C. Basic Impulse Level (BIL): 3.7 kVac, RMS.

D. Leakage Distance 1.88” (minimum).

E. Dry Flashover 35 kV.

F. Wet Flashover 18 kV.

2.05 MARKING

A. Include manufacturer's name or trademark and year of manufacture, clearly and permanently imprinted or attached on each Insulator.

B. If practical, imprint manufacturing batch number.

C. Mark must not leave an irregularity that would affect the electrical and mechanical performance of the Insulator.
2.06 SOURCE QUALITY CONTROL

A. Perform the following design tests in accordance with ASTM D116 for one Insulator of each type and rating supplied:

1. Electrical tests:
   a. Low frequency dry flashover voltage tests.
   b. Low frequency wet flashover voltage tests.
   c. Low frequency dry withstand voltage tests.
   d. Low frequency wet withstand voltage tests.
   e. Impulse flashover voltage tests.
   f. Impulse withstand voltage tests.

2. Mechanical tests:
   a. Ultimate mechanical-strength tests.
   b. Combined mechanical- and electrical-strength test (suspension Insulators).
   c. Time-load-withstand-strength test.
   d. Thermal test.

3. Provide test data to show that the Insulator material is resistant to ultraviolet radiation and electrical tracking.

B. OCS Strain Insulators: Perform the following additional tests in accordance with ANSI C29.13:

1. Aging or accelerated weathering test.

2. Torsional load test.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Do not install Insulators until they have been reviewed by the Engineer with No Exceptions Taken.
B. Clean Insulators, if required, immediately before installation, using cleaning cloths free from abrasive material. Wire brushes must not be used for cleaning. Follow Insulator manufacturer's recommendations.

C. Eye-to-eye strain Insulators, if used, must be installed such that no torsional force is applied to them.
11-4.09 OCS SECTION INSULATORS

PART 1 – GENERAL

1.01 SUBSECTION INCLUDES

A. Requirements only for work in this Section 11.

B. Requirements for section Insulators.

1.02 RELATED SUBSECTIONS:

A. Subsection 11-4.01 – Common Work Results for OCS

1.03 MEASUREMENT AND PAYMENT

A. OCS section Insulators are included in OCS Segment Bid Items. See OCS Segment Bid Items in Subsection 11-1.02, Measurement and Payment.

1.04 SUBMITTALS

A. Product Data:

   1. Submit for each Insulator before ordering.

B. Shop Drawings:

   1. Submit for each Insulator. Include the following information:

      a. Dimensions.

      b. Working and ultimate loads.

      c. Electrical characteristics.

C. Calculations: If requested by Engineer, furnish calculations to verify Insulator's design characteristics meet or exceed the requirements for RT's application.

D. Submit design and production test procedures and test reports.

1.05 QUALITY CONTROL

A. General Requirements: Subsection 11-1.06, Quality Control.
PART 2 – PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Provide OCS section Insulators that provide smooth passage of the vehicle Pantograph with minimum current interruption to Pantographs at operating speeds up to 55 mph.

B. Design section Insulators to satisfy the required factors of Safety specified in Subsection 11-4.01, Common Work Results for OCS.

2.02 DESIGN

A. Section Insulators must meet or exceed the following design requirements:

1. Ensure that the moving Pantograph is continuously in contact with the section Insulator.

2. Suitable for use by Pantograph carbons with 0 to 1” of wear.

3. Maintain electrical separation between adjacent OCS electrical sections at all times (electrically isolating one section from the other), except during the Pantograph passage of a bridging section Insulator.

4. Crosswinds:
   a. Section Insulator must remain stable (dynamically and structurally) for train operations under sustained crosswinds of 55 mph.
   b. Section Insulator must withstand sustained crosswinds of up to 70 mph and gusts of up to 91 mph without failure, including permanent deformation.

5. Design must allow for torsional forces resulting from the passage of Pantographs at 25 mph combined with lateral wind loads.

6. Pantograph drawing current while traversing the section Insulator must not cause excessive arcing or damage to the section Insulator or Pantograph.

B. Contact Wire skids or runners:

1. Provide Overlapping design to provide a smooth transition from one section to another.

2. Design to prevent deposits of molten material from arcing onto the Contact Wire.
2.03 SECTION INSULATOR TYPES

A. Bridging Type: Permits continuous current collection during the passage of a vehicle Pantograph without reduction in the conductivity of the Interface between Pantograph carbon strips and the section Insulator.

B. Non-bridging Type: Ensures that adjacent OCS sections remain electrically isolated from each other at all times during the passage of a vehicle Pantograph.

2.04 MATERIALS

A. Contact Wire skids or runners: Copper or copper alloy.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Provide section Insulators as shown on Contract Drawings and as finalized in Contractor’s final design documents that have been reviewed with No Exceptions Taken.

B. Install in accordance with the manufacturer’s instructions.

C. Handle section Insulators in accordance with the manufacturer’s instructions, so as to ensure that they are not damaged or misused before or during installation.

D. Adjust to provide smooth passage for the Pantograph with no rocking or arcing. The section Insulator must be free to move along track without twisting or becoming misaligned.

E. Install stabilizing Hangers with suitable means of field adjustment to restrict rotational movement of section Insulator and ensure correct alignment of the runners with respect to the Pantograph.

F. Prepare and protect electrical connectors and clamps externally and internally in accordance with the manufacturer's recommendations.

G. The method of installation must assure there is no damage to the OCS Contact Wire. Damage to the Contact Wire must be repaired or the wire replaced by Contractor at Contractor's expense.
11-4.10 MODIFICATIONS TO EXISTING OCS

PART 1 – GENERAL

1.01 SUBSECTION INCLUDES

A. Requirements that apply only to work in this Section 11.

B. Requirements for modifications to existing OCS as part of the work.

C. Requirements for tying in new OCS to existing OCS.

1.02 RELATED SUBSECTIONS

A. Subsection 11-4.06 – OCS Conductors

1.03 MEASUREMENT AND PAYMENT

A. OCS modifications are included in OCS Segment Bid Items. See OCS Segment Bid Items in Subsection 11-1.02, Measurement and Payment.

1.04 SUBMITTALS

A. Submit Contact Wire and Messenger Wire stringing procedure (see Subsection 11-4.06, OCS Conductors). Include the following related to OCS modifications:

1. Describe procedure for implementing OCS relocation, including planning and staging of work within the available work windows.

2. Furnish separate submittals for each phase.

B. Staging and implementation plans:

1. Include Interface to existing operating system, testing, and cutover of both completed systems.

2. Comply with the requirements of Special Provisions Section 7.10, Construction Staging Plans.

1.05 QUALITY CONTROL

A. General Requirements: Subsection 11-1.06, Quality Control.

PART 2 – PRODUCTS

Not Used.
PART 3 – EXECUTION

3.01 COORDINATION AND SCHEDULING

A. An essential element of the work is coordinating and scheduling construction activities to ensure that RT revenue service operations are not disrupted during the performance of this work.

B. See Special Provisions Subsection 7.10.3, Scheduled Interruptions, and Subsection 7.10.4, Unscheduled Disruptions of Service for additional requirements.

3.02 DEMOLITION

A. Poles and Assemblies:

1. Where indicated and required in the Contract Documents, remove and disassemble existing OCS poles and assemblies into Components including poles, down Guys, fixed terminations, Cantilevers and miscellaneous OCS Hardware.

   a. Where pole indicated for removal is a feeder pole, remove associated feeder cable and remove conduit to 18" below grade, unless directed otherwise in writing by Engineer.

2. Transport materials to a location approved by Engineer.

3. Label and box like Parts together and indicate quantities.

4. Transport OCS poles to the yard at the Marconi Light Rail Station.


6. RT reserves the right to change the delivery location at any time.

B. Foundations:

1. Remove or demolish foundations as shown in Contract Drawings:

   a. Non-ballasted area: Remove foundation to a depth at least 12" below final ground grade.

   b. Ballasted area: Remove foundation to a depth at least 12" below bottom of final subgrade.

   c. If the existing foundation is in conflict with planned structures, Remove foundation to the depth called out on Contract Drawings.
2. Replace subgrade to match existing.

3. Backfill holes to grade with approved material to match the surrounding surface treatment.

4. Form and method of demolition must be accepted in writing by the Engineer, with removed material disposed of in accordance with the General Conditions of the Contract Documents.

3.03 MODIFICATIONS

A. Modify, remove, and relocate existing OCS assemblies as shown in Contract Drawings and maintain RT operation during construction.

B. No additional costs will be paid by RT for successive modifications to the existing OCS to maintain RT operation during the construction.

C. Adjust relocated OCS assemblies to the dimensions given in Contract Drawings.

D. The criteria for acceptance of relocated OCS will be the same as for new equipment.

E. In general, OCS support assemblies must be new. However, Contractor may use existing support assemblies, subject to Engineer’s accepted if no support wires are spliced, and no additional "make-up" pieces are installed.

F. Take care to avoid kinks in Contact Wire, particularly during OCS relocation work. Kinks must be dressed out of the wire.
11-4.11 OCS POLE-MOUNTED DC DISCONNECT SWITCHES

PART 1 – GENERAL

1.01 SUBSECTION INCLUDES

A. Requirements that apply only to the work in this Section 11.

B. Requirements for installation of pole-mounted dc disconnect switches.

1.02 RELATED SUBSECTIONS

A. Subsection 12-8.03 – Dc Disconnect Switches

1.03 MEASUREMENT AND PAYMENT

A. Pole-mounted dc disconnect switches are included in OCS Segment Bid Items. See OCS Segment Bid Items in Subsection 11-1.02, Measurement and Payment.

1.04 SUBMITTALS

A. Warning and Disconnect Identification Number Sign:

1. Submit product data for back plate and lettering.

2. Submit sample of back plate and lettering.

3. Submit table of proposed text for all switches.

B. Shop Drawings: Show switch mounting.

1.05 QUALITY CONTROL

A. General Requirements: Subsection 11-1.06, Quality Control.

PART 2 – PRODUCTS

2.01 DC DISCONNECT SWITCHES

A. See Subsection 12-8.03, Dc Disconnect Switches, for switch product requirements.

B. Mounting Hardware:

1. Two switches mounted on same wide-flange pole: All-thread screws and nuts.
2. One switch mounted on wide-flange pole: Provide a clamp in addition to the all-thread screws and nuts as shown on Contract Drawings.

2.02 WARNING AND DISCONNECT IDENTIFICATION NUMBER SIGN

A. Materials: Computer-generated vinyl letters installed on an aluminum back plate.

B. Top half of sign:

1. Warning Signage: Red lettering on a reflective yellow background.

C. Bottom half of sign:

1. Identification Signage:
   a. Black lettering on a white reflective background.
   b. Include identification number and track designation of disconnect switch as indicated on Contract Drawings.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Clamp switch backplate to pole using Hardware as specified above and as indicated on Contract Drawings.

B. Operating Handle:

1. Mount at 4’ above grade.

2. Position operating mechanism so that handle does not intrude into the track clearance envelope and person operating switch will not be in danger from passing road vehicles or light rail vehicles.

3. Provide padlock on each switch.

C. Cable Connections:

1. Provide cable lugs for each cable and land cables on each switch.

2. Provide strain relief on each conductor to prevent racking of switch contacts.

3. Orient bolts securing cable lugs so that they do not reduce the Electrical Clearance to Grounded Parts of the switch.
D. Warning and disconnect number sign: Provide with each disconnect switch as indicated on Contract Drawings.

3.02 SUPERVISION OF SWITCH MANUFACTURER

A. Install first switch under the direct supervision of a qualified representative of the switch manufacturer.

B. Manufacturer’s qualified representative must certify that each switch is correctly installed and adjusted after installation and before initial energization.
11-4.12 OCS POLE-MOUNTED SURGE ARRESTERS

PART 1 – GENERAL

1.01 SUBSECTION INCLUDES

A. Requirements that apply only to the work in this Section 11.

B. Requirements for installation of pole-mounted surge arresters.

1.02 RELATED SUBSECTIONS

A. Subsections 12-4.03 – Low-Voltage Conductors and Cable

B. Subsections 12-4.05 – Grounding and Bonding

C. Subsections 12-8.04 – DC Surge Arresters

1.03 MEASUREMENT AND PAYMENT

A. Pole-mounted surge arresters are included in OCS Segment Bid Items. See OCS Segment Bid Items in Subsection 11-1.02, Measurement and Payment.

1.04 REFERENCES

A. Definitions:

1. Lighting arrester: This term is used synonymously with surge arrester and is not intended to have a different meaning, whether used in the Technical Specifications or on Contract Drawings.

B. Reference Standards:

1. ASTM International (ASTM)

   a. ASTM B3, Standard Specification for Soft or Annealed Copper Wire

   b. ASTM B172, Standard Specification for Rope-Lay-Stranded Copper Conductors Having Bunch-Stranded Members, for Electrical Conductors

1.05 SUBMITTALS

A. Shop Drawing:

1. Submit surge arrester pole mounting detail.
1.06 QUALITY CONTROL
   A. General Requirements: Subsection 11-1.06, Quality Control.

PART 2 – PRODUCTS

2.01 POLE-MOUNTED DC SURGE ARRESTERS
   A. See Subsection 12-8.04, Dc Surge Arresters, for surge arrester product requirements.

2.02 GROUNDING CONDUCTOR
   A. Insulated cable: Copper, 2 kV rated insulation. Refer to Subsection 12-4.03, Low-Voltage Conductors and Cable, for requirements.

PART 3 – EXECUTION

3.01 LOCATIONS
   A. At a minimum, provide surge arresters on OCS poles in the following locations, whether indicated on Contract Drawings or not:

      1. At each substation, provide one on each of the two Feeders, feeding each direction.

      2. One halfway between substations.

3.02 INSTALLATION
   A. Surge arresters must not be installed until the Product Data for the arrestors has been reviewed by the Engineer with No Exceptions Taken.

   B. Mount in a position such that catastrophic failure does not permit a positive cable to contact a pole.

   C. Install in accordance with surge arrester manufacturer’s instructions.

   D. Energized side of surge arrester: Provide insulated cable from surge arrester to Contact Wire or switch.

   E. Grounding:

      1. Connect ground side of surge arrester to pole, and run down to ground rod, as indicated on Contract Drawings.

      See Subsection 12-4.05, Grounding and Bonding for maximum resistance to ground value.
11-4.13 OCS INSPECTION, TESTING, AND ACCEPTANCE MEASUREMENTS

PART 1 – GENERAL

1.01 SUBSECTION INCLUDES

A. Requirements only for work in this Section 11.
B. OCS Inspection.
C. OCS Testing.
D. OCS Acceptance Measurements.

1.02 RELATED SUBSECTIONS

A. Subsection 12-4.04 – Medium-Voltage Conductors and Cable

1.03 MEASUREMENT AND PAYMENT

A. OCS inspection, testing, and acceptance measurements are included in OCS Segment Bid Items. See OCS Segment Bid Items in Subsection 11-1.02, Measurement and Payment.

1.04 SUBMITTALS

A. Procedures: Subsection 11-1.03, Submittal Procedures.
B. Master Inspection and Test Plan: Submit minimum of 90 days before the first test.
C. Test Procedures: Submit detailed test procedure and plan for each test minimum 30 days before test date.
D. Test Reports:
   1. Submit test reports within time required by General Conditions Section 6.47, Contractor Quality Control Program.
      a. Visual inspection reports.
      b. Clearance test reports.
   2. Electrical test reports:
      a. Continuity test.
      b. Dielectric test.
c. Hi-Pot test.

3. OCS Energization test reports.

4. Dynamic test reports

E. Acceptance Measurements Form:

1. Submit form and obtain review with No Exceptions Taken before using form to document acceptance measurements.

2. Submit Acceptance Measurements Form with measurements and other required data.

3. If corrections are made to the system, submit new acceptance measurement results as a revision of the original Acceptance Measurements Form.

1.05 QUALITY CONTROL

A. General Requirements: Subsection 11-1.06, Quality Control.

1.06 WITNESSING OF TESTS

A. Notify Engineer minimum of 7 days in advance of taking acceptance measurements or conducting testing.

B. Engineer must witness all acceptance measurements and testing.

1.07 REQUIREMENTS FOR TEST PLAN, TEST PROCEDURES, AND TEST REPORTS

A. Master Inspection and Test Plan (“Plan”):

1. Purpose: To achieve an early mutual understanding between Contractor and Engineer on range, depth and other aspects of inspections and tests to be conducted.

2. The Plan must demonstrate that Contractor has considered all of the OCS inspection and testing requirements contained in these Technical Specifications, and has made adequate provisions for inspection and testing in its overall program plans and schedules.
3. The Plan must contain, at minimum, the following data:

   a. The proposed schedule of inspections and tests, including all inspection and tests to be performed upon completion of the OCS reconfiguration or new installation.

   b. The personnel conducting the inspection and tests, including their qualifications.

   c. A list of test equipment, including manufacturer, model number, serial number and calibration date to be available on the Project site during the OCS testing activities, including the following:

      1) Optical Stagger gauge or laser equipment.
      2) Insulated height stick.
      3) Mechanical Pantograph gauge suitable for use on embedded track.
      4) Insulated tape measures.
      5) Hand level, 6’.
      6) Battery, 6 volt or 12 volt.
      7) Current measuring shunt.
      8) Megger, 1,000 volt.
      9) DC hi-pot test set.

   d. Description and drawing of Pantograph profile with sway ears to be used during Pantograph clearance tests.

   e. A list of individual Contact Wire heights and Staggers for every Contact Wire support or Registration point for each step of the OCS reconfiguration, on a stage-by-stage, step-by-step work schedule.

   f. A list of acceptance measurements to be recorded upon completion of the OCS reconfiguration or installation.

   g. List of electrical tests to be performed.

PART 2 – PRODUCTS

Not Used.
PART 3 – EXECUTION

3.01 OCS VISUAL INSPECTION

A. From ground level, verify the following (Ground-Level Visual Inspection):

1. OCS poles are vertical after wiring completion.

2. OCS Components are correctly installed.

3. Cantilevers are correctly positioned.

4. Steady arms are correctly positioned.

5. Balance weights and assemblies are properly installed and positioned.

6. Feeder disconnect switch operating mechanisms operate freely and correctly, open and close smoothly, and switchblade position corresponds to handle position.

7. Feeder disconnect switch name plates are correctly positioned.

8. OCS poles are correctly labeled or numbered.

9. Correct Contact Wire or span-related appurtenance that may be anticipated to Sag below required clearance envelopes.

B. Ground-Level Visual Inspection Results:

1. Remedy unsatisfactory conditions found during the inspection.

C. From Contact Wire level, verify the following (Wire-Level Visual Inspection):

1. Fit and tightness of all Components.

2. Split pins and locknuts are secure and in proper location. Paint-pen mark position of nuts after final adjustment.

3. Contact Wire is free of kinks, twists, nicks, or damage.

4. Stranded wires are free of damage to strands.

5. Steady-arm Heel Settings and fittings are correct.

6. Hinge fittings have freedom to move under load.

7. Jumpers are of the correct type, have adequate travel capability, are properly-fitted and are well-formed to avoid fatigue failure.
8. Clearance of wire passing through a Cantilever of the same electrical circuit is at least 3" under Normal climatic conditions.

9. Clearance and insulation between adjacent or crossing Contact Wires are sufficient.

10. No interference with passage of Pantographs, including spots where Pantographs could tangle with wires or suspension assemblies.

D. Wire-Level Visual Inspection Results:

1. Remedy unsatisfactory conditions found during the inspection.

3.02 CLEARANCE TESTS

A. Conductor Clearances:

1. Measure clearances between the conductors, OCS equipment that will be energized, and any fixed structure such as an overhead bridge.

2. Make corrections for temperature, for fixed terminations OCS and for Uplift of the conductors.

3. Mechanical and Electrical Clearances must be equal to or exceed the minimum as specified.

4. Adjust portions found to have insufficient clearance to provide the required clearance.

B. Pantograph Clearance Envelope:

1. Purpose: To verify the mechanical and Electrical Clearances of the vehicle

2. If possible, check anticipated or actual Pantograph clearance on a day with ambient temperatures greater than 90 degrees F, document, and submit results to Engineer.

3. Use a rail-mounted height and Stagger gauge having the same profile as the vehicle Pantograph and fitted with sway “ears.”

4. For test purposes, Uplift the Pantograph 3” to verify passing clearance of Steady Arms. Allow 1” of Pantograph carbon wear from a new carbon outline.
5. Measure the mechanical clearances from the Pantograph to OCS support Components such as the heels of Steady Arms and drop Brackets.

6. Measure the Electrical Clearance from the Pantograph and energized Parts of the OCS to non-energized or Grounded Components or structures.

7. Measure the Electrical Clearances from the Pantograph and any civil structure such as an overhead bridge.

8. Make corrections for temperature, for fixed termination OCS, and for Uplift of the conductors.

9. Clearances must be equal to or exceed the minimum as specified in the Contract Documents.

10. Adjust portions found to have insufficient clearance to provide the required clearance and notify of the Engineer in writing of adjustments made.

3.03 ACCEPTANCE MEASUREMENTS

A. Perform only on a completed OCS section, after completion of visual inspection and correction of defects.

B. Measurements are required for both new work and for existing work that has been affected by the new work.

C. Submit and obtain review with No Exceptions Taken of the blank Acceptance Measurements Form before tests are scheduled.

D. Record measures on the reviewed Acceptance Measurements Form.

E. If the Engineer requires adjustments to the system after reviewing the completed Acceptance Measurements submittal, make required adjustments, re-measure, record new data, and submit corrected results as a revision of the original, completed Acceptance Measurements Form.

F. Required entries on the Acceptance Measurements Form are as follows:

1. Track: Designation shown on Contract Drawings.

2. Wire Run Number: Tension-section numbers shown on Contract Drawings.
3. Conductor Lengths: Length from termination to termination shown on Contractor Drawings.

4. Drawing Number: Number on the Drawing(s) corresponding to the measurement.

5. Name(s) of the person(s) responsible for the measurement, their title and organization, and of the witnesses.

6. Sheet Number: Number in the series of forms on which the wire run measurements are shown.

7. Equipment Style: Style of OCS measured.

8. Conductor Temperature (degrees F): Temperature of conductors at time of measurement.
   a. Monitor temperature with a dial-type thermometer inserted into a hole bored lengthwise into a 10” length of Contact Wire.
   b. Keep thermometer/contact-wire assembly under the same ambient conditions as those experienced by the installed OCS.
   c. Record date and time of measurement.

9. Environmental Conditions: Ambient conditions and temperature at the time of measurement (for example: windy, raining).
   a. Record actual ambient conditions (not from internet or newspaper sources) before taking measurements.
   b. Monitor periodically throughout the day and record (minimum every 15 minutes if weather is changing).
   c. Take readings at the actual location of acceptance measurements.
   d. Use only test equipment that has been recently calibrated.
   e. Record date and time of measurement.

10. Structure Number: Structure number shown on Contract Drawings (if applicable).

11. Station (ft) and Milestone: Structure stationing and milestone shown on Contract Drawings.
12. Pole-to-Rail Distance (ft-in): Distance from running edge of nearest rail to pole centerline.

13. Foundation Height - Near Rail: Height difference from top of nearest rail of nearest mainline track to top of foundation.

14. Crosslevel (in): Height difference between tops of rails adjacent to structure (actual super-elevation).

15. Crosslevel Check: This field is for use by Engineer.

16. Stagger (in): Distance from Contact Wire to superelevated centerline of track measured at support location.
   a. Take measurement using an OCS position measurement device.
   b. Record Stagger as L (left) or R (right) when viewed in the direction of increasing stationing.
   c. Record Stagger to nearest 1/2”.

17. Stagger Check: This field is for use by Engineer.

18. Contact Wire Height (ft-in): Height of Contact Wire above mean rail level. Distance from Contact Wire to a line defined by top of both rails at point of measurement (the inclined reference point), measured using a mechanical or optical Stagger gage.

19. Span Length (ft): Distance measured at ground level between structure and next structure.

20. Midspan Crosslevel (in): Same as crosslevel above, except measured at midspan.

21. Midspan Crosslevel Check: This field is for use by Engineer.

22. Midspan Offset (in): Distance from Contact Wire to projected centerline of track.

23. Midspan Offset Check: This field is for use by Engineer.

24. Midspan C.W. Height (ft-in): Same as Contact Wire height above, except measured at midspan.

25. Sag and Presag (in): Computed average of Contact Wire height for the previous and next structures minus midspan contact height between the structures.
26. Sag and Presag Check: This field is for use by Engineer.

27. Gradient: Rate of change of Contact Wire height, computed as the difference between Contact Wire height at two adjacent supports divided by the distance between the supports.

28. System Height (ft-in): Height of Messenger Wire above Contact Wire measured at the structure.
   a. Compute this value from measurements of Messenger Wire and Contact Wire heights taken from track level.
   b. Not applicable to single Contact Wire equipment.

29. Mean Balance Weight Position at 70 degrees F: Position of balance weight top relative to foundation upper surface; taken from design calculations.

30. Balance Weight position ambient temperature in degrees F at time of measurement.

31. Calculated Balance Rise or Fall (in): Position of balance weight relative to foundation upper surface, taken from design calculations relative to the computed 70 degrees F position.

32. Actual Balance Weight Rise or Fall (in): Position of balance weight relative to foundation upper surface at ambient temperature.

33. Balance Weight Position of Stops (in): Position of upper and lower balance weight stops top relative to foundation upper surface, taken from design calculations.

34. In-Running Contact Wire Height: Height of in-running Contact Wire at Overlaps and turnouts.

35. Out-of-Running Contact Wire Height: Height of out-of-running Contact Wire at Overlaps and turnouts.

36. Bridge Clearance Approx. Sta.: Approximate station location of bridge clearance measurement, as measured from the nearest OCS pole location.

37. Bridge Face/Low/Mid: Designate whether the measurement is taken at a bridge face, the bridge midpoint, or at the estimated low point of the bridge lower surface.
38. Bridge Vertical Track Clearance: Vertical distance between the underside of the bridge and the super elevated centerline of the track.

39. M.W. to Bridge Dist. with 50 lbs. C.W. Uplift: Computed as the bridge vertical track clearance minus the Messenger Wire height minus the diameter of the Messenger Wire, based on a Messenger Wire height measurement taken with 50 lbs of Uplift to the Contact Wire. Not applicable to single Contact Wire equipment.

40. Materials Installed: All Components including pole, Brackets, etc., installed on the particular assembly by the supplier's reference number.

41. Distance from OCS (Contact Wire, appurtenances, etc.) to centerline of applicable freight track at top of rail where wire height is less than 22’ 6” inches.

3.04 ELECTRICAL TESTS

A. Continuity Tests:

1. Purpose: To prove the continuity of each section of OCS and track.

2. Test section: An OCS section between two substations, including positive Feeders and negative return cables from the substations.

3. Test steps for each test section:

   a. Verify that OCS section is de-energized.

   b. Jumper the OCS under test to the track at one end of the test section. Refer to Figure 11.1, below. In double track test sections, test the individual OCS-track sections separately.
FIGURE 11.1

c. Furnish and connect the following:

1) Battery, 6 or 12 V with sufficient current to demonstrate continuity in the section under test.

2) Current measuring shunt.

3) Voltmeter.

4) Ammeter.

5) Switch.

d. Take voltage and current measurements.

e. Record and average the results of three loop resistance measurements.

4. Repeat test for each possible scenario of applicable disconnect or bypass switches.

5. Passing continuity test: Nominal loop resistance not exceeding 0.02 ohms per 1,000 feet of single track OCS construction. Investigate the cause of higher loop resistance values.

B. Dielectric Test:

1. Purpose: Check for short circuits between OCS and rail before performing the higher voltage hi-pot test.
2. Test steps for each test section:
   a. Perform immediately before the hi-pot insulation test.
   b. Perform dielectric test on discrete sections of the OCS 1-2 miles in length.
   c. Verify that OCS section is de-energized and ungrounded.
   d. Disconnect surge arresters.
   e. Connect a 1000 V megohmmeter between the Contact Wire and the rail at one end of each test section as shown in Figure 11.2, below.

**FIGURE 11.2**


C. Hi-Potential Insulation Testing:

1. Purpose:
   a. Check Components such as Insulators and Feeders for leakage.
   b. Verify electrical withstand of section Insulators and disconnect switches.
   c. Provide a baseline for later periodically checking for reduction in insulation level of the OCS sections.
2. Precautions:
   a. The Hi-pot measurements require application of high voltage to the OCS. Proper regard must be paid to Safety.
   b. Clearly identify test zones.
   c. Strictly enforce Safety requirements established in the Safety Program concerning the public, work personnel, and equipment.
   d. Personnel not directly associated with the tests must be clear of the tracks.
   e. Isolate sections of OCS under test and associated Feeders from adjacent electrical sections.
   f. Ground OCS sections adjacent to the section under test by connecting OCS to rails.

3. Test steps for each test section:
   a. Perform immediately after the dielectric test.
   b. Perform dc hi-pot test on discrete sections of the OCS 1-2 miles in length.
   c. Verify that OCS section is de-energized.
   d. Disconnect surge arresters.
   e. Verify that a low resistance path exists for the rails between grounds and the test ground connection.
   f. Connect a hi-pot tester between the OCS and the rail at one end of each test section as shown in Figure 11.2, above.
   g. Use nominal dc hi-pot voltage of 2500 V for the test.
   h. Record weather conditions and air temperature.
   i. Apply dc voltage to the OCS section in 500 V steps up to 2500 V.
   j. Before each measurement is read, allow 1 minute to pass in order to stabilize the level of leakage current.
   k. Record each value.
   l. Hold the final test voltage for 30 seconds.
4. Passing hi-pot insulation test: Leakage currents must not exceed 5 mA per mile.

5. Failing hi-pot insulation test: If there is insulation breakdown or excessive leakage current, locate and determine the trouble, replace the defective cables, make necessary corrections, and retest the cables at no additional costs to RT.

D. Test Form: Contract must use the OCS Continuity Test Form in Attachment 2 for all continuity tests. Contractor must use the OCS Dielectric Test Form in Attachment 3 for all dielectric tests.

E. Test Report: Submit to Engineer before final termination.

F. High-Potential Traction Power Cable Test: See Subsection 12-4.04, Medium-Voltage Conductors and Cable, for cable testing.

3.05 OCS ENERGIZATION TESTS

A. Purpose:
   1. Test disconnection devices including switches and circuit breakers.
   2. Test section Insulators.

B. Test steps for each test section:
   1. Energize each electrical section of the OCS individually under the direction of the Engineer in conjunction with the traction power substation testing.
   2. Verify that each disconnection device energizes and de-energizes only the intended OCS section.
   3. Verify that each section Insulator insulates the de-energized section adjacent to the energized section under test.

C. Passing OCS Energization Test:
   1. Each disconnection device operates in accordance with the requirements of the Contract Documents.
   2. De-energized section adjacent to an energized section has a voltage of less than 2 V to rail.
3.06 OCS DYNAMIC TESTING

A. Following Clearance Tests, Acceptance Measurements, and Electrical Tests, Contractor will conduct dynamic testing with support from RT.

1. Engineer will furnish a light rail vehicle (LRV) and operator for each type of LRV (total of 3), and will conduct test at speeds starting at 5 mph and increasing to design speed in increments of 10 mph.

2. Make adjustments or changes to the OCS either immediately or later, to correct deficiencies discovered during dynamic testing.

3. Continue making adjustments until such time as Contractor receives a Letter of Final Acceptance

B. Final OCS test runs and a Final Inspection will not be scheduled until: (1) a train can be Safely operated on the track; (2) wayside signaling system is operational and ready for pre-revenue testing, and OCS is ready for testing.

3.07 OCS FINAL ACCEPTANCE

A. The OCS, at each site, will be accepted only after: (1) it has been finally-inspected; (2) testing is acceptable; and (3) the OCS is verified by test runs to be operational and to the satisfaction of the Engineer.

B. To obtain Final Acceptance, follow the procedures and requirements of GC Section 6.56, Final Inspection and Acceptance.

3.08 OCS DAILY INSPECTION

A. Engineer will inspect condition of OCS at the end of each work period if track is shared by time-of-day separation between revenue service and construction work during Interface work between existing line(s) and project.

B. Remove Safety-ground connectors and vacate Project site only after Engineer's "interim acceptance for Safe train operations."

C. Work contingent on rendering the OCS Safe for train operations for any service configuration will be at Contractor’s expense.

D. Notwithstanding Engineer’s interim acceptance of OCS, Contractor is for Safe operation of the OCS system by light rail vehicles performing daily revenue service until Final Acceptance.
Attachment 2- OCS CONTINUITY TEST FORM

All Test Form entries must be completed in blue ink. Correction fluid (e.g. Wite-out® or Liquid Paper®) is not permitted for corrections of entry data. An incomplete Test Form will be rejected and returned to Contractor without RT review.

1. Name(s) of Organization Performing Test: ____________________________
2. Name(s) of Personnel Performing Test: ____________________________
3. Date (mo/day/year) Test was Conducted: __________
4. OCS Wire Run #: __________
   • A separate test form must completed for each OCS wire run.
5. Time (hr:min am/pm) Test was Conducted: __________ am / pm (circle one)
6. Environmental Conditions:
   Temperature (°F): __________
   Relative Humidity (%): __________
   Wind Speed (mph): __________
   Precipitation: Clear / Cloudy / Fog / Rain (circle one)
7. General Procedure:
   STEP 1 Each OCS continuity test section must be formed by shorting the OCS to the track with a Jumper at each end of the section. A section is defined as the length of OCS, along the track, from insulated Overlap or section Insulator to the next insulated overlap or section Insulator, typically from one traction power substation to the next.
   STEP 2 Contractor must insert a 6-volt or a 12-volt battery and current measuring shunt in series with one of the OCS-to-rail shorting Jumpers. Contractor may install a switch to control the reading of the section current that should circulate when the test loop is energized.
   STEP 3 Contractor must measure the voltage applied to the OCS track loop and measure the current drawn by the circuit and average the results of three separate section resistance measurements.

Continuity Test Criteria: Less than 0.02 Ω per 1,000 feet (single track OCS)
Measured Continuity Resistance: __________ Ω per 1,000 feet (single track OCS)

Test reports must be furnished to RT in accordance with General Conditions Section 6.47.9.3, “Inspections and Test Logs and Reports.”

The following documentation must be submitted with this form:

☐ Detailed test procedures.
☐ Sample calculations used to arrive at submitted values.
☐ Current testing equipment calibration certificate.

______________________________    ______________________________
Printed Name, Contractor     Printed Name, QC Representative
_____________________________    ______________________________
Signature, Contractor      Signature, QC Representative

Sacramento Regional Transit District, Quality Assurance Form
Attachment 3- OCS DIELECTRIC TEST FORM

All Test Form entries must be completed in blue ink. Correction fluid (e.g. Wite-out® or Liquid Paper®) is not permitted for corrections of entry data. An incomplete Test Form will be rejected and returned to Contractor without RT review.

1. Name(s) of Organization Performing Test: ____________________________
2. Name(s) of Personnel Performing Test: ____________________________
3. Date (mo/day/year) Test was Conducted: __________
4. OCS Wire Run #: __________
   ▪ A separate test form must completed for each OCS wire run.
5. Time (hr:min am/pm) Test was Conducted: __________ am / pm (circle one)
6. Environmental Conditions:
   Temperature (˚F): __________
   Relative Humidity (%): __________
   Wind Speed (mph): __________
   Precipitation: Clear / Cloudy / Fog / Rain (circle one)
7. General Procedure:
   STEP 1 With the OCS feeder circuit breakers open, the OCS ungrounded and the lightning arresters disconnected, Contractor must connect a 1,000 volt Megger between the OCS and the rail at the end of each wire run. The resistance in each test must be greater than five mega-ohms.
   STEP 2 Contractor must then replace the Megger with a DC High Potential test set and test for leakage at 3,000 volts (DC) and 5,000 volts (DC). Before each measurement is recorded, Contractor must allow one minute of time to elapse. Leakage current must not exceed 600 micro-amps and 1,000 micro-amps at 3,000 volts (DC) and 5,000 volts (DC), respectively.

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<th>Greater than 5 MΩ @ 1,000 VDC</th>
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<tr>
<td>Megger Test Results:</td>
<td>Pass / Fail (Circle One)</td>
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<tr>
<td>High Potential Test Criteria:</td>
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<tr>
<td></td>
<td>Less than 1,000 µA @ 5,000 VDC</td>
</tr>
<tr>
<td>Measured High Potential Test Data:</td>
<td>__________ µA @ 3,000 VDC</td>
</tr>
<tr>
<td></td>
<td>__________ µA @ 5,000 VDC</td>
</tr>
<tr>
<td>High Potential Test Results:</td>
<td>Pass / Fail (Circle One)</td>
</tr>
</tbody>
</table>

Test reports must be furnished to RT in accordance with General Conditions Section 6.47.9.3, “Inspections and Test Logs and Reports.”

The following documentation must be submitted with each form:

☐ Detailed test procedures.
☐ Detailed calculations, with stated assumptions, used for all calculated values.
☐ Current testing equipment calibration certificate.

Printed Name, Contractor    Printed Name, QC Representative
______________________________    ______________________________
Signature, Contractor      Signature, QC Representative

Sacramento Regional Transit District, Quality Assurance Form
11-4.14   OCS SPARE PARTS

PART 1 – GENERAL

1.01   SUBSECTION INCLUDES

A.   Requirements that apply only to work in this Section 11.

B.   Mandatory OCS spare Parts.

C.   Recommended OCS Spare Parts.

1.02   MEASUREMENT AND PAYMENT

A.   OCS spare Parts will be paid at the lump sum amount for OCS Spare Parts. See OCS Spare Parts Bid Item in Subsection 11-1.02, Measurement and Payment.

1.03   SUBMITTALS

A.   Recommended OCS Spare Parts and Tools List: Submit within 90 days after NTP.

B.   Submit all items described in this paragraph a minimum of 90 days before delivery of first spare Parts:

   1.   Comprehensive lists of mandatory spare Parts in the formats described below:

      a.   List 1 – List by Assembly Number:

          1) Include manufacturer’s assembly or Part number for each assembly or Part listed in the Mandatory Spare Parts List at the end of this section.

          2) For each assembly, provide a break down listing the quantity of each individual Component that makes up the assembly, with the manufacturer’s Part number for each Component.

      b.   List 2 – List by Individual Component:

          1) List individual Components and products from List 1, “List by Assembly Number”, in alpha-numeric order.

          2) Show the total quantity or length for each individual Component or product.
2. Comprehensive list of mandatory special tools.

3. Unit price: Include on the submitted mandatory spare Parts lists a price that is valid for a period of two years from NTP for each item that can be purchased separately.

C. Product Data:

1. Submit manufacturer's catalog cuts showing details and dimensions of special tools.

2. Submit complete specifications of materials proposed for Components.

D. Submit verification that the capacity of the tools specified suit the construction and maintenance needs.

   1. Submit proposed list of tools for approval before procurement.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Package and deliver spare Parts by individual Component or product, not as assemblies, as detailed in List 2, "List by Individual Component," described above.

B. Delivery of spare Parts must be complete a minimum of 60 days before energization of system.

C. Provide Engineer notice of delivery, a minimum of 3 days before delivery.

D. Do not ship spare Parts until authorized by Engineer.

E. Deliver spare Parts to a location in Sacramento designated by the Engineer.

F. Package and label spare Parts in moisture-proof containers suitable for shipment and storage. Attach copies of shipping list in the package and to the exterior of the package.

G. Unload and store all items neatly in RT's storage facility as directed by the Engineer.

H. Engineer will open the packages and inspect spare Parts for damage. Damaged Parts will be returned to Contractor and must be replaced with undamaged Parts and materials at no additional expense to the RT.

I. Deliver special tool items in good working condition to the Engineer prior to Final Acceptance of the Project.
1.05 MANDATORY SPARE PARTS

A. Spare Parts must be identical to the installed items and must meet all requirements of the appropriate Subsections of this Technical Specification Section 11.

B. Specified spare Parts must be complete and ready for installation, except for wire or cable and Parts necessary for connections.

C. Provide quantity and type of spares specified.

D. See list at end of this Subsection.

E. Spare Parts for Warranty Repairs:

1. The spare Parts may not be used by Contractor for warranty repairs and warranty Parts replacements. The Engineer is not responsible for receiving or storing any Parts for warranty support.

2. At the end of the warranty period, RT may consider a negotiated price for purchase of Parts stocked by the Contractor for warranty support.

1.06 WARRANTY SPARE PARTS

A. If RT permits delivered spare Parts to be used for warranty repairs, Contractor must replace such spare Parts in a timely manner at no additional cost to RT.

1.07 RECOMMENDED SPARE PARTS AND SPECIAL TOOLS

A. Provide list of recommended spare Parts, including manufacturer contact information, Part number, Part description, usage instructions, recommended quantity, unit price, and normal delivery time from purchase order date.

1. Include a break-down of Parts within assemblies, such as Insulators, fittings, turnbuckles, balance weight assembly Components, and connectors.

2. Include custom or unique Components or assemblies with a lead time of over one month.

B. Provide list of recommended special tools, test, and maintenance equipment, with a unit price listed for each item that can be purchased separately. RT may or may not exercise purchase of the recommended items. The unit price must be valid for 2 years after NTP.
1.08 QUALITY CONTROL

A. General Requirements: Subsection 11-1.06, Quality Control.

PART 2 – PRODUCTS

2.01 GENERAL

A. Spare Parts must be identical to the project approved/installed items and must meet all requirements of the appropriate Subsections of this Technical Specification Section 11.

B. Specified spare Parts must be complete and ready for installation, except for wire or cable and Parts necessary for connections.

PART 3 – EXECUTION

Not Used.

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11-4.15 OCS OPERATION & MAINTENANCE MANUALS

PART 1 – GENERAL

1.01 SUBSECTION INCLUDES

A. Requirements that apply only to work in this Section 11.
B. Requirements for OCS O&M Manuals.
C. Requirements for OCS Parts Catalog.

1.02 RELATED SECTIONS

A. Subsection 12-8.03 – Dc Disconnect Switches
B. Subsection 12-8.04 – Dc Surge Arresters

1.03 MEASUREMENT AND PAYMENT

A. OCS Operation and Maintenance Manuals will be paid at the lump sum amount for OCS Operation and Maintenance Manuals. See OCS Operation and Maintenance Manuals Bid Item in Subsection 11-1.02, Measurement and Payment.

1.04 SUBMITTALS

A. Operation and Maintenance (O&M) Manuals.
   1. Submit for OCS.
   2. Submit one hard copy set and one electronic version for initial review a minimum of 90 days before scheduled training.
   3. After review by RT with No Exceptions Taken, submit six sets of O&M Manuals.
B. Parts Catalog: Submit one hard copy and one electronic version.

1.05 QUALITY CONTROL

A. General Requirements: Subsection 11-1.06, Quality Control.
PART 2 – PRODUCTS

2.01 O&M MANUAL CONTENT

A. The Manual must cover, but not be limited to, the following OCS topics:

1. Overhead Contact System description.
2. Safety Precautions.
3. OCS poles.
5. All splice types.
6. Insulators.
7. Section Insulators.
8. Disconnect switches: Submit preliminary O&M data under Subsection 12-8.03, Dc Disconnect Switches, and include final accepted material in O&M Manual.
10. Maintenance and inspection special tools.

2.02 PURPOSE

A. The Manual must enable RT’s maintenance staff to have, in convenient form, all information needed for preventive maintenance inspections, maintenance tasks, adjustment and installation, and on-site trouble diagnosis.

B. It must also contain a detailed description of each system Component so that RT maintenance staff can effectively service, inspect, maintain, adjust, troubleshoot, repair and replace it.

C. An integrated set of OCS Shop Drawings must be included as a separate section. All portions of the Shop Drawings must be legible when printed on 8 1/2 x 11 inch paper.

D. For each type of equipment assembly, include in the Manual:

1. General description.
2. Principles of operation.

3. Shop Drawings to Component level.

4. Preventive maintenance tasks and procedures, highlighting critical areas requiring meticulous attention for inspection and maintenance standards including wear limits, settings and tolerances.

5. Lubrication and cleaning, including frequency, methods, and trade identifications of recommended materials, Component location and description.

6. Summarized preventive maintenance schedules and recommended intervals.

7. Repair procedures, including dismantling, reassembly and testing procedures.

8. Operating instructions, special tools, jigs, Stagger and Clearance Gauges and their source of supply.

9. Test equipment lists and their description.

10. Spare Parts requirements.

11. Warning and Safety procedures during maintenance actions.

12. A description of OCS assemblies and assembly references.


14. List of special tools that are required for any given installation.

15. Any other information necessary to ensure proper operation and maintenance and as required by the Engineer.

2.03 PARTS CATALOG

A. The Parts catalog must list and describe every Component with its related Parts and necessary special tools, including the following:

1. Brand name, where applicable.

2. Manufacturer's Part number and any commercial equivalents.

3. Original manufacturer or supplier.
4. Address, telephone number, fax number, and name and e-mail of a contact person at original manufacturer or supplier.

B. Drawings must identify all sub-assemblies and Component Parts. A Component Part is defined as the lowest level of Component assembly that consists of a separate individually-fabricated Part.

C. Identify each Part or Subassembly as being part of the next higher level assembly.

D. Identify Parts that are custom manufactured only upon request.

E. Identify commonly-available material, such as galvanized pipe, galvanized steel wires and rods, nuts and bolts, thimbles etc. by standard Hardware nomenclature. Furnish a separate list of these items in the Parts catalog with information sufficient to order these items through local commercial suppliers.

F. The Parts catalog must have a complete itemization of all consumable Parts and servicing materials (oils, paints, special compounds, grease) required to install the Part or assembly.

G. In addition to the Normal cross-referencing noted in the preceding paragraphs, furnish at least three supply sources for all required consumables and servicing materials.

1. Supplies and materials must be specified by trade name and type.

2. Include current addresses for each supplier.

3. Of the three required sources, at least two must be located in the United States.

PART 3 – EXECUTION

Not Used.
11-4.16 OCS PROJECT RECORDS

PART 1 – GENERAL

1.01 SUBSECTION INCLUDES

A. Requirements that apply only to work in this Section 11.

B. Submittal of incremental and final Project Records for the OCS system, including the following:
   1. Final acceptance measurement records.
   2. Record material list.
   3. As-Built drawings.
   4. Record photographs.
   5. Pole installation records.

1.02 RELATED SUBSECTIONS

A. Subsection 11-4.13 – OCS Testing

1.03 MEASUREMENT AND PAYMENT

A. OCS Project Records are included in OCS Segment Bid Items. See OCS Segment Bid Items in Subsection 11-1.02, Measurement and Payment.

1.04 SUBMITTALS

A. Final Acceptance Measurement Records:
   1. Submit after final corrections and review have taken place under Subsection 11-4.13, OCS Testing.
   2. Furnish three sets for each tension length of OCS.

B. Record Material List:
   1. Include the following information at a minimum for each Part used in the Project:
      a. Generic description/specification.
      b. Standards with which it complies, with proof of compliance.
c. Brand name, where applicable.

d. Manufacturer's Part number.

e. Original manufacturer or supplier, including address, telephone and FAX number, and contact person.

f. Indication of any Parts that are custom manufactured only upon request.

C. As-Built Drawings:


2. Final Submission of As-Built Drawings: Before Final Acceptance, submit a complete set of OCS Project Records to the Engineer in hard copy and electronic format, as detailed in General Conditions Section 6.55.

3. Furnish As-Built drawings based on RT-provided Contract Drawings, as required by General Conditions Section 6.55, including the following:

   a. Layout drawings showing overhead wiring and cross-references to assembly Shop Drawings, corrected as necessary to show the as-built locations.

   b. Assembly drawings cross-referenced to Contractor's assembly Shop Drawings for each type of OCS assembly installed.

D. Requirements specific to Subsection 11, in addition to General Conditions Section 6.55:

1. On marked-up Contract Drawings, indicate items identified on the Project site as not being in agreement with the issued Contract Drawings.

2. In addition to As-Built markups of the Contract Drawings required by General Conditions Section 6.55, furnish Contractor's approved final design drawings marked up with as-built locations, including the following:


   b. As-Built cross-references to assembly Shop Drawings.
3. Furnish Shop Drawings of assemblies corrected as necessary to show the As-Built configuration, and showing cross-references to Contractor's As-Built final design drawings.

4. Hard copies:
   a. Drawing size: 24" by 36"
   b. Submit two sets.

E. Record Photographs:

1. Submit photographs in a form similar to, and capable of integration with the photographic record of the existing system. Verify existing record with Engineer.

2. Hard format:
   a. Minimum 5 x 7-inch color photographs, matte finish.
   b. Submit in 3-ring binders in chronological order, with dividers for each scope of work item listed in Subsection 11-1.01, Summary of Work.
   c. Submit two sets.

3. Electronic format:
   a. Digital, minimum 5 megapixel, JPEG.
   b. Compact discs, with pictures grouped in the same folder structure as the hard copies and brief, descriptive file names with information similar to captions.

4. Views:
   a. Include each independent pole, together with its Cantilever(s) and Backbone(s), or each cross-span with its two poles.
   b. Show view in the along-track direction facing increasing stations.
   c. Take photographs in pairs, one showing a wide angle view, the other showing the close-up detail.

5. Captions: Include the following information directly on each photograph:
   a. Pole structure numbers.
F. Pole Installation Records

1. For each pole, furnish an installation record including the following:

   a. Design criteria found on Contract Drawings, Contractor’s design drawings, and this Section of the Contract Technical Specifications.

   b. “As Installed” measurements.

   c. Inspection and test results.

   d. Digital photograph of the final installation.

1.05 QUALITY CONTROL

A. General Requirements: Subsection 11-1.06, Quality Control.

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

Not Used.
11-4.17 OCS TRAINING AND INSTRUCTION

PART 1 – GENERAL

1.01 SUBSECTION INCLUDES

A. Requirements that apply only to the work in this Section 11.
B. Requirements for training OCS personnel.
C. Requirements for submittal of OCS training manuals.

1.02 MEASUREMENT AND PAYMENT

A. OCS Training and Instruction will be paid at the lump sum amount for OCS Training and Instruction. See OCS Training and Instruction Bid Item in Subsection 11-1.02, Measurement and Payment.

1.03 SUBMITTALS

A. OCS Training Manuals.

1. Submit one hard copy set and one electronic version for initial review within 120 days after NTP, including the following:

   a. Syllabus.
   b. Written training materials
   c. PowerPoint presentations or slides.
   d. Videos, if Contractor plans to use.

2. After final approval, submit six sets of training materials.

3. The training manuals must be approved and delivered to RT minimum 30 days before training begins.

1.04 QUALITY CONTROL

A. General Requirements: Subsection 11-1.06, Quality Control.

PART 2 – PRODUCTS

2.01 TRAINING PROGRAM

A. Design program to train the RT’s maintenance and operations personnel in details of furnished equipment and systems and enable them to operate,
service, and maintain OCS system such that systems will perform and continue to perform in accordance with requirements of this Contract.

B. Provide a logically-related sequence of separate courses covering System Operation, Overall System Maintenance, and Equipment Operation and Maintenance.

C. Provide separate training that covers only the OCS.

2.02 CLASSROOM INSTRUCTION

A. Include the following for all Parts or systems discussed:

1. Details and function of Part or system.

2. Essentials of their routine care, including cleaning and lubrication schedules.


4. Contractor’s recommendations for test frequency, tolerance limits, and methods for testing, including instruments required, when applicable.

5. When methods of access, removal, dismantling, or application are not self-evident, the instruction must cover these matters.

6. Overhaul procedures.

2.03 TRAINING MATERIALS

A. Provide RT-specific materials prepared specifically for use as training aids.

B. Use reference manuals, Operations and Maintenance manuals, and user’s manuals as supplementary training materials.

C. Tailor principal documents used for training to reflect RT’s equipment and specific user requirements.

D. Provide each course participant copies of training manuals and other pertinent material before beginning courses.

E. RT will retain the master and two additional copies of training manuals and materials as reference documentation.

F. Upon completion of each course, instructor’s manuals, training manuals, and training aids become the property of RT unless such items are specifically exempted in writing by the Engineer.
G. RT reserves the right to copy training materials and aids for use in RT-conducted training courses.

H. Provide special tools, equipment, training aids, and other materials required to train course participants. Provide sufficient quantity of special tools and other training equipment for the number of participants attending the course.

I. Use actual Hardware and photographs taken during the assembly process wherever possible. Actual Hardware used for training must pass re-inspection and acceptance testing before being placed into service.

J. Videos:
   1. Use prerecorded lectures as supplementary training material.
   2. Do not use videos as a replacement for a classroom instructor, or as the primary training vehicle.
   3. RT retains the right to videotape training courses presented by Contractor. RT has the right to use these videotapes to train personnel in the future.

2.04 INSTRUCTOR GUIDES
A. Furnish one Instructor Guide for each training session.
B. Furnish details of instructor's actions during program presentation (e.g. 'Show PowerPoint Slide No. 4' or show video titled 'Contact Wire Installation').
C. Supply the following materials with each Instructor Guide:
   1. Microsoft PowerPoint presentation file on disk.
   2. Slides, pictures, charts used in support of the lesson.
   3. One complete student handout package.
   4. One copy of material referenced in the lesson.
D. Arrange each Instructor Guide in sections:
   1. Section 1, Title: short and descriptive, must contain lesson name and target audience.
   2. Section 2, Time to Teach: Designate estimated time to teach for each Instructor Guide, an approximate period that may vary due to student number and knowledge level.
3. Section 3, Objective: One or more performance-based objectives each of which specifies:
   a. End-of-course performance expected of the student.
   b. Conditions under which behavior will occur.
   c. Measurable minimum level of performance considered acceptable.

4. Section 4, References: List sources of material presented, include Operations and Maintenance manuals, test equipment manuals, and other documents developed for this Contract.

5. Section 5, Materials List: List materials needed to teach content, include training aids (such as overhead transparencies, charts, projectors, and size and type of facility), student handouts (such as books, drawings, and schematics), equipment (such as tools Parts for disassembly).

6. Section 6, Introduction: Cover at least the following areas:
   a. Introduction of subject covered by the lesson.
   b. Lesson objectives.
   c. An outline of the lesson.
   d. A schedule of the lesson's activities.

7. Section 7, Presentation: Presentation should be in outline form, narrative is acceptable but not necessary.
   a. Suggested numbering system:
      
      A.  
      B.  
      1.  
      2. 
      a.  
      b.  
      (1)  
      (2) 
      (a)  
      (b)  

      E. Presentation portion of the Instructor Guide should be detailed enough to:
      1. Serve as a written record of the specific facts and information.
2. Allow another instructor with knowledge of the area to teach the class.

3. Ensure that the subject delivery is consistent each time the lesson is given.

4. Allow replication of all evaluations, tests, and quizzes given in conjunction with this lesson.

2.05 OCS CONTENT

A. OCS topics include but are not limited to the following:

1. Section Insulators
2. Disconnect switches
3. OCS crossings
4. Surge arresters
5. Cross span assemblies
6. Cantilever assemblies
7. Insulators
8. Grounding and bonding
9. All splice types
10. Maintenance and inspection special tools

PART 3 – EXECUTION

3.01 TRAINING

A. Prior to Final Acceptance, train RT maintenance and engineering staff to the depth of detail necessary to equip them to perform preventive, corrective, and overhaul maintenance for systems and sub-systems supplied under this Contract.

B. As part of the training:

1. Give RT maintenance staff hands-on experience performing the more complex maintenance functions in the field and in the shop.

2. Introduce faults into the equipment to give RT maintenance staff experience with hands-on troubleshooting.
3.02  TRAINING REPORTS

A. Grading system: Establish to report progress of each trainee during a course and identify requirements for further training for each participant.

B. Training Reports:

1. Include graded tests (without names) with raw scores.
2. Include a summary of the results of monitoring and evaluating.
3. Include records of student attendance and performance.

END OF SECTION 11