



April 2022

# SECTION III FORKS SUBSTATION CONSTRUCTION SPECIFICATION

---

## TABLE OF CONTENTS

|   |           |
|---|-----------|
| <b>PART 1 - GENERAL</b> .....                               | <b>1</b>  |
| 1.1 PROJECT GENERAL REQUIREMENTS .....                      | 1         |
| 1.2 CONTRACTOR'S SCOPE .....                                | 5         |
| 1.3 DRAWINGS AND INSTALLATION DATA.....                     | 6         |
| 1.4 CODES AND STANDARDS .....                               | 6         |
| 1.5 EROSION AND SEDIMENTATION CONTROL .....                 | 6         |
| <b>PART 2 - SITE PREPARATION</b> .....                      | <b>1</b>  |
| 2.1 GENERAL.....  | 1         |
| 2.2 DEMOLITION .....  | 1         |
| 2.3 CLEARING AND GRUBBING .....                             | 3         |
| 2.4 SITE GRADING.....                                       | 3         |
| 2.5 FINISH-SURFACE PREPARATION .....                        | 5         |
| 2.6 DRAINAGE STRUCTURES.....                                | 6         |
| <b>PART 3 - CONCRETE STRUCTURES</b> .....                   | <b>8</b>  |
| 3.1 GENERAL.....  | 8         |
| 3.2 CONCRETE REQUIREMENTS.....                              | 8         |
| 3.3 REINFORCING STEEL .....                                 | 9         |
| 3.4 ANCHOR BOLTS.....                                       | 9         |
| 3.5 EXCAVATION AND BACKFILL .....                           | 10        |
| 3.6 DRILLED PIERS.....                                      | 10        |
| 3.7 CASING .....  | 11        |
| 3.8 BOTTOM OF EXCAVATION .....                              | 11        |
| 3.9 FORMING.....  | 12        |
| 3.10 MIXING .....   | 12        |
| 3.11 CONCRETE PLACEMENT .....                               | 13        |
| 3.12 FINISHING .....  | 13        |
| 3.13 HOT WEATHER .....                                      | 14        |
| 3.14 TESTING AND LOGS .....                                 | 15        |
| <b>PART 4 - STRUCTURAL AND EQUIPMENT INSTALLATION</b> ..... | <b>16</b> |
| 4.1 GENERAL.....  | 16        |
| 4.2 STRUCTURE INSTALLATION .....                            | 16        |
| 4.3 FIELD WELDING .....                                     | 17        |
| 4.4 EQUIPMENT INSTALLATION - GENERAL.....                   | 18        |
| <b>PART 5 - BUSWORK</b> .....                               | <b>19</b> |
| 5.1 GENERAL.....  | 19        |
| 5.2 RIGID BUS INSTALLATION .....                            | 19        |
| 5.3 STRAIN AND JUMPER BUS INSTALLATION .....                | 19        |
| 5.4 CLEARANCE.....  | 20        |
| 5.5 FASTENERS .....   | 20        |
| <b>PART 6 - ELECTRICAL CONNECTIONS</b> .....                | <b>21</b> |
| 6.1 GENERAL.....  | 21        |
| 6.2 INSTALLATION .....                                      | 21        |
| 6.3 TERMINAL BLOCKS .....                                   | 21        |

|  |           |
|--|-----------|
| <b>PART 7 - ELECTRICAL INSULATION .....</b>  | <b>23</b> |
| 7.1 MATERIALS .....  | 23        |
| 7.2 INSTALLATION .....   | 23        |
| <b>PART 8 - DISCONNECT SWITCHES AND FUSES .....</b>  | <b>24</b> |
| 8.1 GENERAL.....   | 24        |
| 8.2 INSTALLATION .....   | 24        |
| <b>PART 9 - TRANSFORMER OIL CONTAINMENT.....</b>   | <b>25</b> |
| 9.1 SYSTEM DESCRIPTION .....   | 25        |
| <b>PART 10 - SUBSTATION GROUNDING.....</b>   | <b>26</b> |
| 10.1 GENERAL.....  | 26        |
| 10.2 INSTALLATION.....   | 26        |
| <b>PART 11 - CONDUIT &amp; FITTINGS.....</b>   | <b>28</b> |
| 11.1 GENERAL.....  | 28        |
| 11.2 MATERIAL .....  | 28        |
| 11.3 INSTALLATION.....   | 29        |
| 11.4 UNDERGROUND CONDUIT BURIAL.....   | 30        |
| <b>PART 12 - WIRE &amp; CABLE (SUBSTATION CONTROL &amp; LOW-VOLTAGE POWER CABLE) .....</b> | <b>31</b> |
| 12.1 MATERIALS .....   | 31        |
| 12.2 INSTALLATION.....   | 32        |
| <b>PART 13 - CONTROL ENCLOSURE .....</b>   | <b>35</b> |
| 13.1 GENERAL.....  | 35        |
| 13.2 SITE PREPARATION AND FOUNDATIONS .....  | 35        |
| 13.3 INSTALLATION REQUIREMENTS.....  | 35        |
| <b>PART 14 - INSTRUMENTATION.....</b>  | <b>36</b> |
| 14.1 INSTALLATION OF INSTRUMENT CONTROL PANELS AND BATTERY SYSTEM.....                     | 36        |
| 14.2 WIRING .....  | 36        |
| <b>PART 15 - PAINTING.....</b>   | <b>37</b> |
| 15.1 GENERAL.....  | 37        |
| 15.2 EQUIPMENT .....   | 37        |
| 15.3 STRUCTURAL STEEL.....   | 37        |
| <b>PART 16 - TESTING.....</b>  | <b>39</b> |
| 16.1 GENERAL.....  | 39        |
| 16.2 CONTROL AND LIGHTING SYSTEMS .....  | 39        |

# GENERAL

## PART 1 - GENERAL

### 1.1 PROJECT GENERAL REQUIREMENTS

#### A. Scope of Bid

1. The purpose of these specifications is to obtain on a contract basis qualified personnel and mechanized equipment as specified, for the performance of substation construction work (hereinafter called the "Project"), as set forth in the Prevailing Wage Information, attached hereto as **Exhibit "A"**; Contractor Safety Plan, attached hereto as **Exhibit "B"**; and all drawings and specifications attached hereto from C1-1 to SS1-1 as **Exhibit "C"**. The aforementioned exhibits are incorporated by reference as though fully set forth herein.

#### B. Location of Work

1. Location of the Project is in Clallam County at 441 West E Street, Forks, WA.
2. The Project will consist of rebuilding a 69 kV substation including demolition and removal of existing equipment and foundations, excavation, footings and other concrete work, steel erection, installation of all equipment including transformer, control wiring, installation of pre-fabricated control enclosure, all grading and drainage mobilizations, fencing, and other related work to provide a complete and operable electrical substation.
3. The project will involve working around an energized substation.
4. Limited material and electrical equipment will be provided by the District, as detailed in the specifications and drawings, the remainder will be provided by the contractor. Construction will take place at an existing substation with an energized mobile substation on the property within the construction area.

#### C. Permits

1. The Contractor shall, at its expense, be responsible for obtaining all permits required by governing authorities that affect its work, with the exception of the building permit.

#### D. Time and Manner of Work

1. The Contractor agrees to commence the construction of the Project no later than June 1, 2022. The Project must be completed no later than, September 1, 2022. The contractor shall provide a Strong Matrix Project Manager experienced in high voltage substation construction having the resources to complete the District's contract. The proposed Project Manager shall be approved by the District. Key project personnel, including but not limited to the project manager and an experienced high voltage substation construction foreman, cannot be changed without the approval of the District. Copies of photo identification and each qualified Journeyman or Apprenticeship card is required prior to work starting. The District can request that the Project Manager be changed with a 10-day notice if the project performance is not deemed satisfactory by the District. A preliminary Project Plan and Schedule, preferably a Gantt Chart shall be submitted with the bid and a final Project Plan and Schedule (Gantt Chart) shall be provided after the contract is awarded and before the beginning of any work. If the schedule moves, the Contractor shall update their Gantt Chart and notify the District of any changes immediately.

## GENERAL

### E. Supervision and Inspection

1. The Contractor shall cause the construction work on the Project to receive constant supervision by an experienced substation construction foreman who is qualified for work in an energized electrical substation and who shall be present at all times during working hours where construction is being carried on. The Contractor shall also employ, in connection with the construction of the Project, capable, experienced, skilled, and reliable workers as may be required for the various classes of work to be performed. Directions and instructions given to the foreman by the District shall be binding upon the Contractor.
2. The District reserves the right to require the removal from the Project of any employee of the Contractor if, in the judgment of the District, such removal shall be necessary in order to protect the interest of the District. The District shall have the right to require the Contractor to increase the number of its employees and to increase or change the amount or kind of tools and equipment if at any time the progress of the work shall be unsatisfactory to the District; but the failure of the District to give any such directions shall not relieve the Contractor of its obligations to complete the work within the time and in the manner specified in these documents.
3. The manner of performance of the work and all equipment used therein shall be subject to the inspection, tests, and approval of the District. The District shall have the right to inspect all payrolls and other data and records of the Contractor relevant to the work. The Contractor will provide all reasonable facilities necessary for such inspection and tests. The Contractor shall have an authorized agent accompany the inspector when final inspection is made and, if requested by the District, when any other inspection is made.
4. In the event that the District shall determine that the construction contains or may contain any defects, it shall be the right of the District to have an inspection made by an engineer approved by the District for the purpose of determining the exact nature, extent, and locations of such defects.

### F. Protection of Persons and Property

1. The Contractor shall be responsible for keeping the worksite free from trespassers. The Contractor shall at all times take all legal and reasonable precautions for the safety and convenience of all workers and the public, and shall comply with all applicable provisions of federal, state, municipal, and District safety regulations or laws and building and construction codes. All machinery and equipment and other physical hazards shall be guarded in accordance with the "Manual of Accident Prevention in Construction" of the Associated General Contractors of America, unless such instructions are incompatible with federal, state, municipal, or District laws or regulations. The Contractor shall comply in all respects with the requirements of the Federal Occupational Safety and Health Act as administered by the State of Washington (WISHA).
2. The following provisions shall not limit the generality of the above requirements:
  - a. The Contractor shall so conduct the construction of the Project as to cause the least possible obstruction of public highways or streets.
  - b. The Contractor shall provide and maintain all such guard lights and other protection for the public as may be required by applicable statutes, ordinances, and regulations or by local conditions.
3. The Contractor shall be familiar with and shall comply with the District's "Contractor Safety Plan" attached hereto as **Exhibit "B"**.

## GENERAL

### G. Hours of Work; Overtime; Prevailing Wages

1. Normal working hours are from 6:30 a.m. to 5:00 p.m., Monday through Thursday (excluding holidays), unless otherwise authorized by the District. The lunch period shall be observed from 11:30 a.m. to 12:00 p.m. unless unusual circumstances prevail.
2. The Contractor shall comply with Chapter 49.28 RCW and applicable regulations pertaining to overtime pay. The District may cancel this contract in the event of the Contractor's failure to so comply.
3. The Contractor will be required to pay prevailing wages on this project pursuant to Chapter 39.12 RCW and applicable regulations. Attached hereto as **Exhibit "A"** is the "Washington State Prevailing Wage Rates for Public Works Contracts". Any laborers, workers, or mechanics in each trade or occupation required for the work set forth herein shall be paid not less than such specified hourly minimum rate of wage. It shall be the Contractor's responsibility to verify current rates. This information may not be all-inclusive; any other occupation used on the Project but not listed in this information shall comply with the most recent applicable prevailing wage rate.
4. Before payment is made by the District, the Contractor and each and every subcontractor shall be required to submit to the District a "Statement of Intent to Pay Prevailing Wages" providing the Contractor's or subcontractor's registration certificate number and the prevailing rate of wage for each classification of workers entitled to prevailing wages and the estimated number of workers in each classification, which statement shall be approved by the Department of Labor and Industries prior to submission to the District.
5. Following the final acceptance of the Project, the Contractor and each and every subcontractor shall submit to the District an "Affidavit of Wages Paid" before the funds retained according to RCW 60.28.010 are released to the Contractor or subcontractor, which affidavit shall be certified by the Department of Labor and Industries prior to submission to the District.

### H. Holidays

1. The Contractor shall observe holidays that correspond with District holidays on the same day as observed by the District.

### I. Customer Relations

1. The Contractor agrees that its personnel and equipment shall at all times present a neat appearance. All work shall be done and all contacts with the public shall be handled with due regard for the District's public relations. The Contractor agrees that complaints of any nature received from property owners or public authorities shall receive immediate attention. All complaints shall be reported within 24 hours to the District Representative.

### J. Construction not in Specifications

1. The Contractor agrees that when it is necessary to construct units not shown or described in the specifications, it will construct such units for a price proposed in writing by the Contractor to the District and approved by the District prior to such work being done in accordance with the Change Order Process as set forth in Section IV, Contract.
2. No payment shall be made to the Contractor for correcting errors or omissions on the part of the Contractor that result in construction not in accordance with the specifications.

### K. Changes

## GENERAL

1. The District may, from time to time during the progress of the Project, make such changes in, additions to, or subtractions from, the specifications and/or exhibits as conditions may warrant. Any protest or claim by the Contractor arising from any such change shall be submitted as set forth in Section IV, Contract.

### L. Materials

#### 1. District-Supplied Materials

- a. Refer to Drawing E3-1, Assembly Material List and Nameplate Schedule, for a list of District-supplied equipment and materials for the project. All other materials for the project shall be supplied by the Contractor.
- b. All District-supplied materials shall be furnished by the District or arranged for by the District Representative. All materials issued to the Contractor become his responsibility. The Contractor will be required to provide a secure area for storage of material issued by the District's Warehouseman.
- c. All District-supplied materials shall be obtained by the Contractor at the District's Carlsborg Warehouse located at 100 Hooker Road, Sequim, WA 98382, Monday through Thursday between 7:00 a.m. and 4:00 p.m., except holidays. Contractor will be responsible for the safe storage of all materials.
- d. With the exception of major equipment to include the steel, station service transformer, circuit switcher, voltage regulators, 69kV switches, power circuit breakers, switchboard panels and the control enclosure, all District-supplied materials shall be handed over to the Contractor at one time.
- e. The Contractor shall give a minimum of 24 hours advance notice to the District Representative before materials are issued.
- f. The contractor or its authorized representative will be required to perform a complete inventory of all materials furnished to the Contractor and sign a receipt in such form as the District shall provide. Upon completion of the Project, the Contractor shall return to the District all materials furnished by the District in excess of those required for construction.
- g. The Contractor will be responsible for all excess material used on the Project not accounted for, together with any used material that is not returned to the District. Any materials that are not returned to the District by the Contractor will be billed to the Contractor at District book value plus warehousing.
- h. All materials issued by the District to the Contractor shall be in working condition when received by the Contractor. Any material not in good working condition upon completion of the Project shall be replaced at the Contractor's expense.

#### 2. Contractor-Supplied Materials

- a. The Contractor shall supply forms, rebar, concrete, mortar, grouting and sacking materials, specified wire and cable, fencing, crushed rock, together with other materials as detailed below and on the drawings attached in Exhibit "C".
- b. The Contractor shall supply all circuit breaker slab anchor bolts; above and below grade conduit; conduit fittings; junction boxes; stranded wire of the color, type, and size and type specified; compression-type copper terminal lugs for all wire terminations except for those in the panels and all the nuts, bolts, fittings, and clamps required to assemble and/or mount District-supplied equipment in order to provide a complete and fully functional substation. All Contractor-supplied bolts shall have

## GENERAL

nuts and lock washers, together with flat washers and locking nuts where required. All nuts, bolts, lock washers, flat washers, and lock nuts used indoors shall be zinc-plated; and those used outdoors shall be 316 stainless steel. All screws shall be round-head or pan-head unless otherwise specified. All slotted holes will require flat or Belleville washers.

- c. All electrical materials and equipment supplied by the Contractor shall be new and undamaged. Unless otherwise approved, similar items used throughout the job shall be the product of one manufacturer.

### M. Compliance with District Instructions

1. All work shall be done in compliance with District job orders or other instructions furnished to the Contractor by the District Representative when applicable. All questions or disputes as to the true meaning of the Specifications or drawings shall be decided by the District.

## 1.2 CONTRACTOR'S SCOPE

- A. Schedule pickup, delivery, and offloading of all equipment and materials supplied by the District.
- B. Removal of all existing materials and equipment that will no longer be used at the station. The Contractor shall return all salvageable materials identified by the District per the Demolition Package to the District's Central Warehouse as specified in Part 2 of this contract. Disposal of all remaining materials shall be in a manner acceptable to the District. Existing concrete foundations shall be removed in their entirety. Return salvageable materials per drawings. Large items including Transrupter and steel work can remain in Forks yard outside of the substation fence.
- C. Construction surveying, layout, site preparation, grading, erosion control, and drainage structures.
- D. Obtain locates for underground utilities in digging areas, including but not limited to sewer and water.
- E. All concrete foundations including all reinforcing steel and post-installed anchors.
- F. Below and above grade grounding cable and installation, including grounding of all electrical equipment, fencing and structures.
- G. Below grade conduit will be schedule 40 PVC, direct buried per drawings, including conduit connections and pull-boxes as required by the drawings, and adhere to ASTM D2855 for watertight fittings.
- H. Above grade conduits shall be ridged galvanized steel (RGS) coupled to the underground PVC via RGS/PVC couplers. All miscellaneous conduit connections, junction boxes and structure mounts as required by the drawings.
- I. Crushed rock surfacing to the depth and type as specified by the Drawings.
- J. Substation yard lighting equipment and wiring.



## GENERAL

- K. Installation of all District-supplied equipment including but not limited to steel structures, transformer, circuit switcher, disconnect switches, circuit breakers, voltage regulators, pre-fabricated control enclosure, surge arresters, relays and control panels.
- L. Control cable procurement, pulling and termination. Including station service AC power cable.
- M. Feeder power cable conduits shall be installed per drawings. District will install feeder power cables at later date.
- N. Procurement, pulling, and termination of all low voltage power and control cable
- O. All rigid copper buswork, cable bus and jumper connections as required by Drawings.
- P. The contractor must allow for “holds” when constructing and commissioning the facilities as the District will require inspection and approvals before certain work can proceed.
- Q. One half of the substation is a 69kV/25kV transformer and equipment which will remain energized at all times. The Contractor will be required to install the temporary fence around the energized substation. This fence shall meet both NESC and NEC requirements.

### 1.3 DRAWINGS AND INSTALLATION DATA

- A. Refer to **Exhibit “C”** for engineering drawings and installation data for the project supplied by the District.

### 1.4 CODES AND STANDARDS

- A. Equipment and materials used on the job shall be approved by the following industrial organizations:
  1. American Standard Associates, Inc. (ASA)
  2. American Society for Testing Materials (ASTM)
  3. National Electrical Manufacturers Association (NEMA)
  4. Underwriter's Laboratories, Inc. (UL)
  5. National Bureau of Standards (NBS)
  6. National Board of Fire Underwriters (NBFU)
  7. National Fire Protection Association (NFPA)
  8. Insulated Power Cable Engineers Association (IPCEA)

- B. Each major component of equipment shall have the manufacturer's name, catalog number, capacity, and rating on a nameplate securely affixed on the equipment in a conspicuous place.

### 1.5 EROSION AND SEDIMENTATION CONTROL

- A. The Contractor shall be responsible for construction, installation and maintenance of Erosion and Sedimentation Control structures and facilities as shown on the Drawings. Contractor shall be responsible for implementing recommended stormwater Best Management Practices (BMPs), providing a Certified Erosion and Sediment Control Lead during the duration of the project, and

## **GENERAL**

complying with all site inspection, monitoring, recordkeeping, and reporting requirements per the Department of Ecology regulations.

END OF GENERAL

## **SITE PREPARATION**

### **PART 2 - SITE PREPARATION**

#### **2.1 GENERAL**

- A. The work described in this section consists of all excavating, filling, grading, backfilling, and related items necessary to complete the site work indicated on the Drawings.
- B. Definitions
  - 1. The term "access roads" shall mean that part of the road outside the fenced enclosure of the substation extending to the designated public thoroughfare.
  - 2. The term "substation area" shall mean that part of the job site within the fenced enclosure plus the immediate adjacent area surrounding the fenced enclosure as specified or indicated on the Drawings.

#### **2.2 DEMOLITION**

- A. These Specifications provide for the demolition of the existing equipment, structures, foundations and footings, conduit and conductors, and fence, including the removal and return to the District of steel structures, wood pole material, switches, insulators, conductors, breakers, transformer, and other miscellaneous material; except that the District will remove and retain the three 15 kV regulators and four 15 kV reclosers. All concrete and other building material produced as a result of the demolition shall be disposed of by the Contractor in manner approved by the District and in accordance with the contract. All demolition work shall be done in a thorough and workmanlike manner in conformance with the Specifications and Drawings.
- B. Material
  - 1. Material to be returned to the District. Material to be returned to the District shall include 69 kV breaker, 69 kV switches and disconnects, 15 kV switches and disconnects, 69 kV arresters, 15 kV station service transformer, 15 kV CT's and PT's, all ANSI Gray porcelain and polymer insulators, steel structures, wood pole structure material, all wire and conductors, and miscellaneous hardware. All material and equipment shall be disassembled and protected, taking care that no damage results from the removal and return of the material to the District.
    - a. The Contractor shall be responsible for disconnecting the 69 kV breaker from the system and preparing it for movement; except that the District will remove the oil from the breaker. The Contractor will be responsible for movement and return of the breaker to the District, including crane and trucking services, and all permits for transportation.
    - b. The Contractor shall disconnect the 69 kV switches and disconnects, 69 kV arresters, 15 kV switches and disconnects, 15 kV station service, 15 kV CT's and PT's, and all ANSI Gray porcelain and polymer insulators from the system and return them to the District. All brown porcelain shall be properly disposed of by contractor.

## SITE PREPARATION

- c. The Contractor shall disassemble and remove steel structures, taking care not to damage the steel, galvanizing or hardware and return them to the District. All bolts, nuts and washers shall be retained with the structure they were removed from in one marked container per structure. All structural steel shall be secured with proper dunnage to avoid damage and returned to the District at one time.
  - d. The Contractor shall disassemble and remove the wood pole structures such that the crossarms remain intact and undamaged for reuse. Poles may be sectioned to facilitate removal and butts shall be removed. All wood material shall be return to the District.
  - e. The Contractor shall return all hardware, conductor, wire and cable to the District in container(s) provided by the District. Ground grid conductor and ground rods need not be in one piece but may be sectioned to facilitate removal. Ground rods may be cut 36 inches below grade. Container(s) shall be picked up by the Contractor prior to demolition and returned at the completion of demolition.
  - f. All material shall be returned to the Central Warehouse Facility, 100 Hooker Road, Sequim, WA 98382; 69 kV breaker and wood poles (and sectioned poles) shall be returned to the Port Angeles Warehouse, 1936 W. 18<sup>TH</sup> Street, Port Angeles, WA 98362. The Contractor shall give a minimum of 24 hours advanced notice to the District Representative before material is returned.
2. Contractor Demolition Material. Material that will not be returned to the District shall become the responsibility of the Contractor, including the concrete foundations and footings, control house, fence, and conduit and miscellaneous porcelain and breakage. All Contractor demolition material shall be removed from the site and disposed of in a manner approved by the District and in accordance with the contract.
- a. Concrete foundations and footings shall be removed in their entirety, either whole or in pieces.
  - b. The fence shall be removed including gates and concrete bases.
  - c. Conduit shall be removed. Brown insulators and associated hardware and breakage from the wood pole structure shall be removed.
3. Contractor demolition material shall be removed from the site and disposed of in a manner approved by the District. The Contractor shall provide documents related to the disposal of the material including but limited to location of disposed material and permits associated with the disposal if required.
4. Site preparation. The Contractor shall fill foundation, footing and pole excavations in accordance with Section III Substation Specification; 2.4.B Backfill and Fill.

END OF DEMOLITION

## **SITE PREPARATION**

### **2.3 CLEARING AND GRUBBING**

- A. Stabilized
- B. The site shall be cleared of rocks, boulders, brush, vegetation and other organic material as directed by the District.
- C. Any roots that are over one (1) inch in diameter, shall be completely removed and disposed of off site.
- D. Stones and boulders six (6) inches or greater in the longest dimension shall be removed to a depth of six (6) inches below subgrade in fill areas, on the access road, and within the substation area.
- E. Blasting, if required to remove large rocks and boulders shall be permitted only when prior approval is obtained from the District. Contractor shall be responsible for identifying and obtaining approvals and permits from regulatory agencies as required prior to blasting. Such approval shall not relieve the Contractor of any liability resulting from injury, loss of life, or damage to property.
- F. Top soil stripped from the site shall be stored at a location agreed upon by the District. No soil may be removed offsite without the written authorization of the District's Representative.
- G. Contractor shall be responsible for the disposal of all debris resulting from site preparation operations, including trees, brush, roots, and sod stripping. The Contractor shall dispose of such materials in a manner acceptable to the District. The disposal site must be stated in the Proposal and approved by the District. Burning of debris shall not be permitted.

### **2.4 SITE GRADING**

- A. Materials
  - 1. Unless otherwise specified, the Contractor shall be responsible for finding a source for all fill and backfill materials. All costs related to acquiring and transporting material shall be paid by the Contractor.
  - 2. All fill and backfill material shall be free of roots or other organic matter, refuse, ashes, cinders, frozen earth, or other unsuitable material. Only material capable of satisfactory compaction shall be used.
  - 3. Any fill within the fenced enclosures shall be free of rock and also of stones greater than six (6) inches in the longest dimension, particularly in areas where foundations or piers are to be installed.
  - 4. Any on-site borrow areas shall be graded to drain and shall present a neat appearance, as directed by the District.
- B. Erosion and Sedimentation Control
  - 1. All erosion and sedimentation control facilities shall be constructed per the Drawings and per the "Strom Water Management Manual for Western Washington".
- C. Backfill and Fill

## SITE PREPARATION

1. All backfill and fill material shall be compacted unless otherwise required by design.
2. Per the Geotechnical Engineering Report, dated July 14, 2011, prepared by Kleinfelder: “All materials on the site within the substation should be considered structural fill. Native soils are expected to be suitable for use [as backfill and/or fill]. However, the on-site soils generally contain a significant quantity of silt and are moisture sensitive...The contractor should submit samples of each of the required earthwork materials to the District for evaluation and approval prior to use.”
3. Compaction material shall be placed in layers not exceeding eight (8) inches in depth. Lift materials shall be moisture conditioned to within three percent (3%) of optimum moisture content prior to compaction, and compacted by a machine acceptable to the District’s Engineer to at least ninety-five percent (95%) of maximum dry density per ASTM D1557. Any material incapable of compaction to ninety-five percent (95%) of maximum density shall be removed and replaced with acceptable material.
4. Sod, roots, snow, ice, or frozen earth shall not be placed in fill, and fill shall not be placed on a frozen surface.
5. Watering, if necessary to obtain optimum moisture content, shall be done without additional cost to the District.
6. Contractor shall arrange for and pay for all compaction testing. One (1) compaction test shall normally be taken per 30,000 square feet (or less) for every two (2) feet of fill or as otherwise specified in the Geotechnical Engineering Report.

### D. Excavation

1. Clearing limits and/or any easements or required buffers shall be identified and marked in the field by the Contractor prior to the start of any clearing, grading, or construction by staking and flagging.
2. Excavation shall be performed by any recognized method of good practice to complete the job in the most expeditious manner. The Contractor shall take precautions to ensure no damage is done to existing facilities or equipment, or to other work.
3. All excavation is considered unclassified regardless of the nature of the material.
4. Grading around excavations shall be controlled to prevent surface water from flowing into excavated areas. Draining or pumping, as necessary, shall be required to continually maintain excavated areas free of water or mud from any source, and this material shall be discharged to approved drains or channels.
5. Subgrade material rendered unsuitable by excessive wetting shall be removed and replaced with approved material.
6. Undisturbed subgrade in cuts shall be compacted unless the Design determines that compaction is not necessary.
7. While grading on the southwest side of the property, the Contractor will be responsible for providing a barrier so that the public cannot attain access to the backside of the property.

### E. Subgrade

1. After proper compaction the graded area shall be shaped and fine-graded as shown on the Drawings. The accumulation of loose material incidental to fine grading shall be incorporated into the subgrade by means of pneumatic tire roller or other suitable available means of compaction.
2. Excavation or backfill shall be required, as necessary, to construct subgrades to the elevations ( $\pm 0.10$  ft.) shown on the Drawings.
3. The finished subgrade of the substation area shall be graded to ensure adequate drainage gradient. Rolls or low spots which may cause ponding will not be approved.

## SITE PREPARATION

### 2.5 FINISH-SURFACE PREPARATION

A. Subsequent to the application of soil sterilant by the District, a uniform layer of crushed rock shall be spread in accordance with the following requirements:

1. The area to be covered shall include the fenced area plus three (3) feet outside the fence on all sides.
2. Where indicated on the drawings, the geotextile fabric shall be installed after the installation of footings or slabs and associated conduit installation except for those footings that do not extend below the geotextile fabric, in which case the footing shall be installed after the installation of the geotextile fabric. The edges of the geotextile fabric shall be overlapped a minimum of 18 inches.
3. The geotextile fabric shall meet or exceed the following specifications for a needle-punched non-woven fabric:

| Property                                 | ASTM Test | Requirement |
|--|-----------|-------------|
| Grab Tensile Strength                    | D4632     | 165         |
| Elongation (%)                           | D4632     | 50          |
| Trapezoid Tear (lbs)                     | D4533     | 65          |
| Puncture (lbs)                           | D4833     | 90          |
| Mollen Burst (psi)                       | D3786     | 310         |
| UV Stability (% @ 500 Hours)             | D4355     | 70          |
| Permittivity (sec <sup>-1</sup> )        | D4491     | 1.1         |
| Water Flow Rate (gpm / ft <sup>2</sup> ) | D4491     | 95          |
| Permeability (cm / sec)                  | D4491     | 0.2         |
| A.O.S. (U.S. Sieve #)                    | D4751     | 80          |
| A.O.S. (mm)                              | D4751     | 0.18        |
| Weight (02 / yd <sup>2</sup> )           | D5261     | 6           |
| Thickness (mils)                         | D5199     | 70          |

4. Upon completion of the installation of the fabric, the Contractor shall install the crushed rock. The Contractor shall be responsible for loading, hauling, and installing the crushed rock.
5. The first layer of fill material, where over excavation has occurred, shall bring the substation site to subgrade elevation, which is within five-tenths of a foot of the final elevation. The fill material to be used for this first layer shall be pit-run, and it shall be six-inch-minus in size. Pit-run for the Project shall be obtained from the source stated in the Proposal. The Contractor shall haul and install the pit-run in the substation in the required quantity to achieve the compacted subgrade elevation, where over excavation has occurred. The subgrade elevation is six (6) inches below the final ground elevation. The second layer of fill material shall bring the substation to final grade elevation. The crushed rock shall be 100% fracture and uniform in quality and substantially free from wood, roots, bark, and other extraneous material and shall meet the following test requirements:

## SITE PREPARATION

|                               |            |
|-------------------------------|------------|
| % passing 1-1/2" square sieve | 100%       |
| % passing 7/8" square sieve   | 50%        |
| % passing 1/4" square sieve   | 5% maximum |

6. The portion of crushed surface retaining on a 1/4-inch square sieve shall not contain more than 0.15% wood wastes.
7. The fill material shall be compacted to 95% of the maximum density as determined by compaction control test in accordance with the Method of Test for Compaction Control of Granular Materials (WSDOT Test Method No. 606A). The moisture content of the fill material at the time of compaction shall be as specified by the Engineer. When the fill material contains less moisture than required for proper compaction with the compaction equipment being used, water shall be added in the amounts ordered by the engineer. If it becomes necessary to reduce the moisture content below the maximum limit in order to achieve the required compaction, all costs and expense involved in such drying shall be incidental to and included in other items of work involved.
8. Horizontal layers of fill material shall be placed in layers not exceeding eight (8) inches in loose depth. At all locations that are inaccessible to compaction rollers, the fill material shall be compacted in layers as required herein and shall be compacted to the required density by the use of small mechanical or vibratory compactor units.
9. The existing elevations are approximate and are shown as a convenience for the Contractor. In no way do these drawings relieve the Contractor of his responsibility to be familiar with the site. In addition, the Contractor shall not be allowed to claim any extra compensation for additional ballasting based on any inaccuracy of the elevation drawing.
10. The Contractor will be responsible for setting the subgrade and final grade elevations from the existing benchmark. The District will check the final grade after compaction, and any deviations will be corrected by the Contractor and re-compacted.
11. The Contractor to provide localized grading around swing gates to ensure gates swing into the station area only, are able to open greater than 90 degrees without obstruction, and do not have a significant gap between the bottom of the swing gate and the top of crushed rock surface.

### 2.6 DRAINAGE STRUCTURES

- A. All galvanized-steel culvert pipes shall have at each end a prefabricated, flared end section of the same gauge and quality. Concrete shall conform to the specifications listed in the concrete section of these Specifications.
- B. The outside of all culvert pipe shall be given one (1) coat of coal-tar enamel or other approved bitumastic coating applied by brush for complete covering. All pipes shall be evenly bedded throughout its entire length, not partially resting on rock or earth embankment. The flow-line gradient and elevation shall be in line with that of the natural drainage course insofar as possible.
- C. Backfill shall be thoroughly compacted in layers not exceeding eight (8) inches loose depth. Backfill shall be compacted under the pipe haunches to a width of one (1) pipe diameter on each side of the pipe and from the very bottom up to the top of the pipe, to the satisfaction of the District. The pipe shall be covered with compacted fill not less than one half (1/2) the diameter of the pipe, or a minimum of twelve (12) inches.



**SITE PREPARATION**

END OF SITE PREPARATION

## CONCRETE STRUCTURES

### PART 3 - CONCRETE STRUCTURES

#### 3.1 GENERAL

- A. An experienced concrete foreman shall supervise all concrete work.
- B. Contractor shall supply all equipment and manpower necessary to construct concrete structures, under any field or weather conditions.
- C. Contractor shall use the reference points established by the Design and shall supply all necessary lines and levels to ensure that finished concrete work is properly located, at the proper elevation, true to line and grade, and square.

#### 3.2 CONCRETE REQUIREMENTS

- A. Concrete shall have a minimum compressive strength of 4000psi at twenty-eight (28) days as noted in Drawings, and shall conform to ASTM C94. Absolute water-cement ratio shall not exceed 0.45. Slump shall not exceed four (4) inches without the approval of the District. Maximum nominal coarse aggregate size shall not exceed three quarters (3/4) of an inch. A minimum of six (6) bags of cement per yard of mix shall be used. The concrete mix design shall be submitted to the District for review and comments.
- B. The source of materials and mix design proposed for use shall be submitted to the District for approval. If the materials conform to these Specifications and are approved, no change in sources shall be made without the additional approval of the District. Mix design shall include brand name and quantity of any additives.
- C. Cement shall be Portland Cement Type II in accordance with ASTM C150, unless specified otherwise on Drawings.
- D. Fine aggregate shall be in accordance with ASTM C33, with the exception that only natural sand shall be accepted.
- E. Course aggregate shall consist of clean, durable, hard-crushed stone, gravel, or a proper combination thereof, in conformance with ASTM C33. Exception is taken to ASTM C33 in that only natural material shall be accepted.
- F. Water for mixing and curing concrete shall be potable and free from injurious amounts of any substance that may be detrimental to concrete or reinforcement.
- G. An air-entraining additive according to ASTM C260 shall be used to produce a total air content of six percent (6%) plus or minus one percent ( $\pm 1\%$ ) by volume. No other additives shall be used in concrete without the written approval of the District. No chlorides shall be used in concrete mix.
- H. Perform all work in accordance with ACI 301 and ACI 318.

## CONCRETE STRUCTURES

### 3.3 REINFORCING STEEL

- A. Reinforcing bars shall conform to the latest revision of ASTM Standard Specifications for Deformed Billet Steel Bars for Concrete Reinforcement, Designation A615, Grade 60. If requested by the District, the Contractor shall submit, at no cost to EME, laboratory reports on the reinforcing steel prepared by an approved testing laboratory.
- B. Before the reinforcing bars are placed, the surfaces of the bars and the surfaces of any metal bar supports shall be cleaned of heavy, flaky rust, loose mill scale, dirt, grease, or other foreign substances. After being placed, the reinforcing bars shall be maintained in a clean condition until they are completely embedded in the concrete.
- C. Reinforcing bars shall be accurately placed and secured in position so that they will not be displaced during the placing of the concrete, and special care shall be exercised to prevent any disturbance of the reinforcing bars in concrete that has already been placed. Precast concrete blocks may be used for supporting reinforcing bars.
- D. Reinforcement shall not be spliced unless indicated on the Drawings or with the approval of the District's Engineer. Splices shall be in accordance with ACI 318.
- E. Lateral ties shall be secured to vertical reinforcement with wire ties. Welded connections shall not be allowed.

### 3.4 ANCHOR BOLTS

- A. Anchor bolts shall be galvanized and shall be complete with galvanized nuts and washers. Anchor bolts shall be bundled and tagged with the part numbers assigned on the Drawings.
- B. Anchor bolts shall be accurately positioned. It shall be the Contractor's responsibility to accurately set the bolts initially and to maintain the required position until after the concrete has set.
- C. Prior to setting, the threads on the upper end of each anchor bolt shall be protected to prevent the adherence of concrete. When installed, the bolts shall be clean and the portions to be embedded in concrete shall be free of oil or other detrimental substances which would adversely affect the bond between the bolts and concrete. Anchor bolts shall be in position and at the specified projection height prior to the pouring of concrete.
- D. The location and dimensions of the anchor bolts shall be as exact as possible to the locations shown on the Drawings.
- E. During concrete finish and cleanup the Contractor shall remove concrete adhering to the portions of anchor bolts extending above finished concrete grade, giving particular attention to concrete at the finish grade line which would prevent base plates on the legs of station structures from seating fully on the finished concrete elevation.
- F. Any foundation which does not satisfy the specified requirements for line and grade shall be rejected. No payment shall be made for any such defective work until the Contractor has completed the necessary corrective work, to the satisfaction of the District. Contractor shall bear the full expense of all such corrective work.

## CONCRETE STRUCTURES

- G. Anchor Bolts shall be ASTM F1554 unless noted otherwise.
- H. Circuit switcher foundation anchor bolts shall be supplied and installed by contractor per Drawings

### 3.5 EXCAVATION AND BACKFILL

- A. Excavation shall be completed to the depths and dimensions indicated on the respective Drawings. Over-excavation adjacent to a bearing surface shall be filled with concrete at the time of structure pour unless otherwise directed by the Contractor's Engineer. Cost of the additional concrete shall be the responsibility of the Contractor. Over-excavation adjacent to a non-bearing surface may be backfilled in lifts and compacted to ninety percent (90%) of natural density per ASTM D1557 unless otherwise directed by the District.
- B. Excavation shall be designed to minimize the amount of disturbance to the surrounding natural terrain and vegetation. Areas inaccessible to excavation equipment shall be excavated by hand.
- C. Contractor shall perform all grading and earth moving necessary to prevent the accumulation of water in the excavations. All excavations are to be kept free of water until all foundations have been placed.
- D. Contractor shall notify the District should an obstruction be encountered which prohibits using normal techniques and tools.
- E. Backfill
  1. Concrete shall be backfilled only after it has attained seventy percent (70%) design strength.
  2. Backfilling adjacent to structures shall be done only after, in the opinion of the District, a sufficient portion of the structure has been built to resist the imposing load. Backfilling shall be performed simultaneously on all sides of structures. Extreme care should be exercised in the use of heavy equipment in areas adjacent to structures.
  3. Compaction material shall be placed in layers not exceeding six (6) inches in depth after compaction. Lift materials shall be moistened and compacted by a machine acceptable to the District.

### 3.6 DRILLED PIERS

- A. Dry drilling is the preferred method of excavation. Unless rock or obstructions are encountered, the excavation shall be completed in a continuous operation and the concrete shall be placed without undue delay.
- B. If unsuitable materials affecting required bearing value are encountered, the excavation shall be continued to whatever depth is necessary to obtain suitable material, as determined by the District.
- C. The excavation shall be protected to prevent sloughing or caving until the concrete has been placed.

## CONCRETE STRUCTURES

- D. The location and dimensions of the drilled piers shall be as exact as possible to the locations shown on the Drawings.
- E. The tops of the drilled piers shall be no less than four (4) inches or more than sixteen (16) inches above the finished crushed rock surfacing, unless otherwise authorized by the District.

### 3.7 CASING

- A. Temporary casings shall be required at locations where the soil will not stand without support or where, because of ground water conditions, sloughing of the sides of piers may seriously delay or endanger the satisfactory completion of excavation and placement of concrete.
- B. Contractor shall have available for immediate use on the job an ample supply of casing of each size which will be required for use in the piers and shall provide additional amounts, if required, to ensure orderly progress of the job.
- C. Such metal casing may be in short pieces but with jointing devices of sufficient strength that assembled sections of casing may be pulled complete as concrete is placed (or immediately thereafter). The casing shall also be of such strength and rigidity as to maintain the required excavation lines against the pressure of sloughing material from the sides of piers.
- D. All temporary casing shall be removed from piers as concrete is placed - or immediately thereafter - and in such a manner as to prevent sloughing material from dropping to the bottoms of piers or falling on top of freshly placed concrete. A sufficient head of concrete shall be maintained to prevent intrusion of soil into or on top of fresh concrete.
- E. During casing extraction, upward movement of the steel shall not exceed six (6) inches. Downward movement shall not exceed four (4) inches.
- F. The inside diameter of the casing shall not be less than the specified diameter of the drilled shaft. The length of the casing shall be sufficient to allow the construction of a good-quality shaft.

### 3.8 BOTTOM OF EXCAVATION

- A. The Contractor shall clean the bottom of the excavation so that no more than twenty-five percent (25%) of the bearing area is covered with a maximum of two (2) inches of loose, disturbed material.
- B. When shown on the Drawings, bedding material shall be three-quarter (3/4) inch minus, washed, crushed rock compacted in place to 90% maximum index density as per ASTM D698.
- C. Immediately prior to the placement of concrete, the excavation shall be cleaned of water, debris, or other materials harmful to concrete, including ice, clods, and piles of loose earth. Water in the bottoms of excavations must be removed or absorbed. On-hand equipment shall include a pump and two (2) vibrators in good working condition, hoppers and elephant trunks or concrete pump and tremie for directing the flow of concrete to the bottom of the piers, and an ample supply of sacked cement for use in drying up bottoms of drilled-pier excavations.

## CONCRETE STRUCTURES

### 3.9 FORMING

- A. Forms shall conform to the shapes, lines, and dimensions of the concrete as called for on the Drawings. Forms shall be sufficiently strong to carry the dead weight of the concrete without undue deflection or bulging, and sufficiently tight to prevent leakage of mortar. Forms shall be properly braced and tied together so as to maintain position and shape.
- B. Lumber or other forming material used in forms at exposed surfaces shall be dressed to uniform thickness and shall be free from loose knots or other defects. Joints in forms shall be horizontal or vertical. At all unexposed surfaces and for rough work, undressed lumber or slip forms may be used. Lumber reused in forms shall have nails withdrawn and surfaces to be in contact with concrete thoroughly cleaned before being used again.
- C. Forms shall not be disturbed until the concrete has hardened sufficiently to support any loads that may be imposed upon it. When stripping forms metal wedges or tools shall not be used to pry panels loose. If wedging is necessary, it shall be done with wood wedges lightly rapped to break adhesion between the concrete and form.
- D. Any misshapen concrete due to form slippage shall be replaced at the Contractor's expense.
- E. The bottom of the forms for drilled pier caps shall extend a minimum of six (6) inches below final grade.
- F. One (1)-inch chamfer shall be provided on all exposed top edges of footings.
- G. Forms shall be treated with a release agent such as form oil to facilitate removal.

### 3.10 MIXING

- A. Ready-mixed concrete in accordance with ASTM 94 is preferred on all construction. Contractor shall indicate at bid time if this condition cannot be met and shall submit an alternate mixing procedure for approval by the District.
- B. All concrete shall be sufficiently mixed to ensure complete uniformity of the batch. The volume of the batch shall not exceed the manufacturer's rating of the drum capacity. Rotating speed of the drum shall not exceed its rated speed.
- C. District shall be notified at time of bid if concrete cannot consistently be delivered and discharged within one and one-half (1 1/2) hours from introduction of water to cement. With these conditions, the District may require all water to be added at the jobsite.
- D. The mixer shall be equipped with water storage and measuring device which can be locked, and also with a suitable charging hopper.
- E. The contents of the drum shall be completely discharged before receiving materials for a new batch.
- F. Water shall not be added to the mix after initial batching without the approval of the District.

## CONCRETE STRUCTURES

### 3.11 CONCRETE PLACEMENT

- A. The concrete shall be conveyed from the mixer to the place of final deposit by methods that will prevent the separation or loss of material.
- B. Concrete shall be deposited as nearly as practical in its final position to avoid segregation due to handling or transporting.
- C. The Contractor shall not place any concrete until the form work, excavation, and embedded items are inspected by the District. Concrete shall be placed only in the presence of the District or the Districts designated representative.
- D. Concrete shall be placed in the drilled piers as soon after excavation as possible. Concrete shall be deposited continuously and as rapidly as possible until the unit being cast is complete. Construction joints shall not be allowed.
- E. No concrete shall be placed in standing or running water without permission of the Contractor's Engineer, following approval of a depositing method.
- F. Immediately prior to concrete placement, all surfaces against which concrete will set shall be free of any dried concrete, mud, or other foreign matter.
- G. Surfaces against which new concrete will be set shall also be saturated with water immediately prior to placement.
- H. When placing concrete into drilled piers, care shall be given not to pour concrete through rebar cages causing separation of cement and gravel. Care shall also be taken while using vibrators such that vibrators are not held in concrete for a length of time to cause separation of concrete or that vibrators contact forms causing breakage.
- I. A trunk or tremie shall be used to transport concrete to the foundation bottom.
- J. Any concrete retained in the truck mixer long enough to require additional water to permit satisfactory placing shall be wasted at the Contractor's expense. Concrete requiring re-tempering shall also be wasted at the Contractor's expense. Waste concrete shall be removed from the site and disposed of at the Contractor's expense.
- K. Vibration shall not be allowed if slump is greater than six (6) inches. Rodding shall be allowed near pier cap forms to prevent honeycombing. Internal vibration shall be required for concrete with slumps of four (4) inches or less.

### 3.12 FINISHING

- A. Screeding and initial finishing shall be performed before bleed water can accumulate on the surface.
- B. No further finishing shall be performed until bleed water has evaporated.
- C. Smooth, solid concrete surfaces are required throughout the work. The top surface of the concrete foundation shall be finished to conform to the detail shown on the Drawings. In general, a trowel finish on the concrete is required, with edging as necessary. Care shall be taken in the steel

## CONCRETE STRUCTURES

troweling not to bring excessive fine material to the surface. Finishing of concrete surfaces shall be performed only by skilled workmen.

- D. All exposed concrete shall be properly cured for seven (7) days by the moist curing method using wetted burlap, Kraft paper, or polyethylene sheets to prevent evaporation, or by spray application of a liquid membrane-forming compound conforming to ASTM C309, Type 1. The membrane shall be applied according to the manufacturer's recommendations. Surface defects shall be filled prior to application of membrane curing compound. All concrete surfaces on which curing compound have been applied shall be adequately protected for the duration of the curing period from any cause which would disrupt the continuity of the curing membrane. No curing compound shall be used on surfaces requiring subsequent bonding.
- E. After form removal all fins, small projections, or other irregularities shall be removed by tooling.
- F. Following form removal, foundations shall be inspected by the District's representative.
- G. Metal form ties extending from the face of exposed concrete shall be cut off at least three-fourths (3/4) inch deep in the concrete immediately after removal of forms. Holes shall be filled with a cement-sand mortar approximately the same color as the adjoining concrete. The mortar shall be mixed and placed as dry as possible and finished flush with the adjoining surface.
- H. Honeycombed areas shall be removed and patched with grout. The grout shall consist of one (1) part Portland Cement, one (1) part fine sand (passing a No. 30 sieve), and water sufficient to attain a creamy consistency. The area shall be dampened before grout is brushed on. Shallow patches shall be filled with stiff mortar and finished. Deep patches shall be of formed concrete doweled to the hardened concrete as required by the District.
- I. All vertical surfaces or exterior exposed concrete shall be hand-rubbed to a minimum of six (6) inches below finished grade. Rubbing shall be done immediately after the forms are removed (not later than three (3) days after placement). The rubbing mixture shall consist of equal parts by volume of cement and fine sand applied with a wetted wood block or carborundum stone to give a smooth, even, dense surface finish. After rubbing, no form marks or voids shall be visible.

### 3.13 HOT WEATHER

- A. All concrete work done when the air temperature is 80°F (or forecasted to rise above this temperature within twenty-four (24) hours after concrete placement) shall be in conformance with the following:
  - 1. Mixing water shall be kept cool.
  - 2. Aggregate stockpiles shall be saturated and the surfaces kept moist by intermittent sprinkling or by a continuous fog spray.
  - 3. The basic water-cement ratio shall be maintained.
  - 4. Forms, reinforcing, and subgrade surfaces shall be wetted just before concrete is placed. Wetting down of areas around the work is recommended.
  - 5. The temperature of the concrete when placed shall not exceed 80°F.
  - 6. In extremely hot (80°F and above) and windy weather, sunshades, windbreaks, fog sprays, or a combination of such items shall be used during flat-slab finishing operations.
  - 7. When approved by the District, a retarding admixture may be used for slowing down the setting time of concrete to allow for proper finishing.



## CONCRETE STRUCTURES

8. All hot weather concrete work shall be performed in accordance to ACI 305R.

### 3.14 TESTING AND LOGS

- A. Field tests of concrete being placed shall be conducted regularly. In general, as an indication of other physical properties the quality of the concrete being produced shall be judged by the compressive strength developed within a given period.
- B. Contractor, unless otherwise instructed, shall be required to make a set of compressive test specimens, each set consisting of four (4) compressive test cylinders made in accordance with ASTM C31. One set of compressive test specimens shall be made from each major pour, with a minimum of one set per truck. Each set of test cylinders shall be identified by the identification numbers of the foundations in that pour. Testing of the cylinders shall be handled by the Contractor through a qualified testing laboratory and the cost of testing shall be borne by the Contractor. Contractor shall require the laboratory to send the compressive test reports to the District. One sample shall be tested at seven (7) days and two (2) at twenty-eight (28) days. One cylinder shall be held in the event of a break test that is below the required compressive strength requirement. The Contractor shall notify the District immediately in the event of a test cylinder that does not meet the required break strength.
- C. In cases where the strength of the test cylinders for any portion of the work falls below the requirements specified herein, the District may require the Contractor to secure test specimens of the hardened concrete represented by these cylinders. Specimens shall be secured and tested in accordance with ASTM Designation C42. If the specimen test further substantiates that the concrete represented by the cylinders and specimens is below the strength requirement specified herein, the District may order such concrete removed and replaced at the expense of the Contractor.
- D. Tests shall also be performed to determine slump (ASTM C143) and air entrainment (ASTM C231).
- E. Any concrete which arrives on site not meeting the specified qualities of slump, uniformity, or air entrainment must be approved by the District before placement continues, or be rejected by the Contractor.

END OF CONCRETE STRUCTURES

## STRUCTURES AND EQUIPMENT

### PART 4 - STRUCTURAL AND EQUIPMENT INSTALLATION

#### 4.1 GENERAL

- A. The erection of structures and installation of the substation equipment shall conform to the manufacturer's recommended installation procedures. In the installation of the structures and equipment, only mechanics skilled in their various trades shall be employed. All work shall be done in a neat and workmanlike manner. Special care shall be taken to ensure that all frames, trusses, columns, guides, and other fixed metalwork are installed in their exact positions. Structures and equipment to be installed over embedded material and concrete shall be placed accurately and shall be supported in a correct position of alignment and grade. After erection and completion of any field welding the areas adjacent to field welds and any areas where paint or galvanizing has been damaged shall be thoroughly cleaned of dirt, oil, weld spatter, or loose paint and repainted with primer and top coat or cold galvanizing as appropriate. The contractor shall properly dispose of all shipping materials and dunnage including but not limited to oil containers and gas cylinders.
- B. The Contractor shall confirm nameplate data of all equipment to agree with ratings and requirements on the drawings and specifications.

#### 4.2 STRUCTURE INSTALLATION

- A. Installation shall consist of all equipment and structures, including stands, pedestals, frames, and/or other structural items required for a complete substation.
- B. All structures and equipment shall be cleaned of dirt, oil, road grime, etc., before erecting. When galvanizing has been damaged, surface shall be replaced as described in Painting, Part 18.
- C. The structures shall be assembled utilizing the identification marks as shown on drawings to ensure proper fit-up.
- D. The Contractor shall install all hardware and attachments to make complete assemblies and installations of both Contractor-furnished and District-furnished material. All fasteners shall be galvanized, unless otherwise noted.
- E. The Contractor shall provide all miscellaneous drilling, adjustments, mounting holes, touch-up painting, etc., to produce a complete steel structure system to accommodate all equipment, buses, materials, and future equipment and structures where specified.
- F. No structure shall be placed on its foundation until at least seven (7) days after placement of the foundation concrete.
- G. All base plates shall be set level and in exact position. All structures shall be installed with leveling nuts below the structure base plate. Base plates will not be placed directly on top of foundations.
- H. Connection or erection bolts shall be seated clear to the head and installed with nuts to the inside of the member.

## STRUCTURES AND EQUIPMENT

- I. The structural nuts shall be locked into place with split-type lockwashers and tightened to recommended torque values for the respective diameter and material.
- J. For low-carbon, mild-steel bolts (ASTM A307) refer to the torque table below:

| Bolt Size | Torque     | Bolt Size | Torque     |
|-----------|------------|-----------|------------|
| 1/2"-13   | 37 Ft-lbs  | 1"-8      | 235 Ft-lbs |
| 9/16"-12  | 52 Ft-lbs  | 1-1/8"-7  | 340 Ft-lbs |
| 5/8"-11   | 83 Ft-lbs  | 1-1/4"-7  | 432 Ft-lbs |
| 3/4"-10   | 104 Ft-lbs | 1-1/2"-6  | 732 Ft-lbs |
| 7/8"-9    | 160 Ft-lbs |           |            |

- 1. When AISC specification "Structural Joints Using ASTM A325 Bolts" is specified, the "turn-of-nut" method described below may be used:
  - 2. Bolts shall first be brought to a "snug-tight" condition to ensure that the parts of the joint are brought into good contact with each other. "Snug-tight" is defined as the tightness attained by the normal effort of a man using a standard socket wrench. The nuts and steel shall be marked in this position and the bolts systematically turned an additional one-half (1/2) turn for bolts up to eight diameters or eight (8) inches in length and two-thirds (2/3) turn for longer bolts. During this operation there shall be no rotation of parts not turned by the wrench.
- K. Beveled washers shall be used on sloping or beveled surfaces where required to provide a proper fit.
  - L. A reasonable amount of drifting will be allowed in assembling, but reaming for mismatched holes shall not be permitted.
  - M. All structural metals shall be handled with care to avoid bending or damaging. Pieces bent in handling may be used only if they are straightened to the satisfaction of the District.
  - N. All structures shall be assembled and aligned, and all bolts tightened and/or torqued as required by the AISC Code of Standard Practice. After final tightening and before any apparatus is mounted on the structures, the alignment shall be checked by the District. Structures must align within 1/500th of the span horizontally and 1/500th of the height from the top of the foundation to the connecting points of the supporting members of the uppermost apparatus support.
  - O. Whenever torquing is required, the fastener shall be marked with Torque Seal or an acceptable equivalent.
- 4.3 FIELD WELDING
- A. Field welded connections shall be permitted only where shown on the Drawings.
  - B. All field splice butt welds shall be full penetration welds unless otherwise specified.
  - C. Welding required for welded field splices, for steel structure adjustments, or for miscellaneous additions shall be performed by a welder qualified per AWS D1.1 Structural Welding Code -

## STRUCTURES AND EQUIPMENT

Steel or AWS D1.2 Structural Welding Code - Aluminum, and welds shall be such that they will pass a radiographic test.

- D. Any welding that is suspected to deficient shall be replaced or repaired to the Owner's satisfaction. Should in the sole opinion of the Owner the quality of the weld remain in question the Contractor shall prove the quality of the weld(s) through radiographic testing. Weld testing costs shall be borne by the Contractor.
- E. Material to be field welded shall be positioned so that welds can be made in a flat, horizontal, or vertical position whenever possible. Field welding shall be performed in an overhead position only when specifically approved by the District.
- F. Welding shall not be done when the ambient temperature is lower than 0°F. When the ambient temperature is below 40°F, the base metal shall be preheated for both tack welding and finish welding in such manner that the surfaces of the parts on which weld metal is being deposited are at or above a temperature of 72°F for at least three (3) inches both laterally and in advance of the welding. Preheat temperature shall not exceed 400°F.

### 4.4 EQUIPMENT INSTALLATION - GENERAL

- A. Installation of equipment shall consist of scheduling, receiving, unloading, reloading (if necessary), storage, placement and field assembling of equipment in accordance with the manufacturer's installation instructions.
- B. All equipment shall be cleaned of dirt, oil, road grime, and other foreign matter before installation. Refer to the Testing Section of this specification for additional requirements.
- C. District and Contractor supplied equipment installation shall be in accordance with the manufacturer's recommended procedures. The procedures shall include, but not be limited to, bushings, ground assemblies, bussing, terminals, and any other ancillary devices to form a complete installation.
- D. Installation of other high voltage equipment shall be performed in a workmanship like manner and in accordance with the manufacturer's installation procedures. Specific attention is required to rigging and moving procedure.

END OF STRUCTURES AND EQUIPMENT

## COPPER BUS

### PART 5 - BUSWORK

#### 5.1 GENERAL

- A. Buswork shall include rigid buses, strain and jumper buses, fittings, and all hardware required to form a complete system of current-carrying paths connecting the equipment.

#### 5.2 RIGID BUS INSTALLATION

- A. All rigid buses shall be copper tubular-bus conductor, ANSI Schedule 40 pipe (standard pipe size), unless otherwise noted.
- B. Tubing end plugs shall be installed at all open ends.
- C. One-fourth (1/4)-inch weep holes shall be drilled in all bus risers, bends, A-frames, and horizontal runs at the lowest practical point to drain moisture accumulation. All holes shall be reamed to remove sharp edges.
- D. All tubing bus connectors shall be bolted compression type. Bus couplers shall be installed as required within the first quarter span either side of a bus support. Bus couplers outside of the first quarter span are not approved.
- E. Rigid bus shall be installed in complete conformance with the recommendations of the manufacturer.
- F. All connections, fittings, and termination pads shall be bolted to the bus.

#### 5.3 STRAIN AND JUMPER BUS INSTALLATION

- A. Cable for the strain and jumper buses shall conform to ASTM B232. Each individual aluminum wire entering into the construction of the completed conductors shall conform to ASTM B230.
- B. Strain and jumper buses shall be installed in conformance with the Drawings and manufacturer's recommendations.
- C. Jumper and buses shall be smoothly formed, and adjacent runs shall be similarly and symmetrically shaped to provide a uniform and aesthetically pleasing appearance throughout.
- D. Stranded conductor shall be installed without twists, kinks, or "bird-caging" and shall be handled to avoid abrasions or other damage. No splices shall be allowed in overhead strain buses.
- E. All strain buses and incoming line conductors shall be sagged in conformance to values supplied.
- F. All strain and jumper bus terminal connectors shall be of the compression type.

## **COPPER BUS**

### **5.4 CLEARANCE**

- A. Buses, jumpers, insulation, connectors, and other hardware shall be installed in conformance with the applicable drawings. Clearance and spacing shall be equal to or greater than those in NEMA Standard SG-6.

### **5.5 FASTENERS**

- A. All bolts, washers, and lock washers for bus connections shall be stainless steel. All nuts shall be silicon bronze. Aluminum is not acceptable. All conductors at joints and fittings shall be clean and free of foreign matter. An oxide-inhibiting compound (Burndy "Pentrox A" or an approved equal) shall be used at all connections involving aluminum conductor and fittings.

**END OF BUSWORK**

## ELECTRICAL CONNECTIONS

### PART 6 - ELECTRICAL CONNECTIONS

#### 6.1 GENERAL

- A. Connectors shall include all bolted devices, welded devices, clamps, strain clamps, deadend fittings, terminal devices, and couplings.

#### 6.2 INSTALLATION

- A. All connectors, suspension and strain clamps, and deadend fittings shall be equal to the manufacturer's references. Cable connectors shall be of the compression type unless specifically stipulated otherwise.
- B. Welded-type connectors shall be installed by a welder qualified.
- C. Utmost care shall be exercised in installing clamps, connectors, and other bolted devices. The contact surface of the clamp or connectors and the bonding surface of the wire or tubing shall be clean and bright, and an oxide-inhibitor compound such as "Pentrox A" shall be applied. A stainless steel brush shall be the principal cleaning instrument.
- D. All bolted electrical connections, except deadend assemblies, shall be made with stainless steel hardware except the nuts which shall be silicon bronze. Anodized aluminum bolts may be used on deadend terminal connectors. Anodized aluminum bolts may not be cut off and shall be tightened with a torque wrench per the manufacturer's recommendations. Bolts shall be tightened firmly, but threads must not be over-stressed. Bolts in clamps over stranded conductor shall be tightened enough to flatten the lock washers but not enough to deform or damage the conductor. Bolts shall not extend beyond the nut more than one-half (1/2) bolt diameter.
- E. Interface pads shall be installed in all cases of mating aluminum terminal connectors to bronze or copper terminal pads. Where interface pads are not practical, these connections shall be tinned. Oxide-inhibitor compound (Burndy "Pentrox A" or an approved equal) shall be used on all aluminum surfaces.

#### 6.3 TERMINAL BLOCKS

- A. Terminal blocks will be supplied by the District in District provided switchboard control panels. A small quantity of ancillary terminal block installation may be required to provide complete substation installation. All inner switchboard panel wiring will be terminated. Contractor will be required to pull and terminate outdoor and indoor interconnection cables as per Drawings.
- B. All terminal blocks shall be rated 600 V, 30 A, UL listed type GE EB or approved equal, and shall be suitable for #14 through # 8 AWG stranded copper conductors.
- C. Terminal blocks for current transformer secondary circuits shall be of the short-circuiting type.

## **ELECTRICAL CONNECTIONS**

- D. Terminal blocks shall have marking strips, terminal screws, and divider strips. A minimum of 10 percent spare terminals shall be supplied, excluding current transformer terminal blocks where spare terminals are not required.
- E. Terminal blocks shall be arranged on each side of each relay panel with terminal block facing parallel to the panel surface.
- F. Terminal blocks shall be grouped as to service (e.g., CT leads, lighting, control, interconnecting wiring, etc.) and the "grouped" blocks shall be located in approximately the same location in each panel.
- G. Each terminal on every terminal block or device shall be properly identified with wire numbering matching the interconnecting wiring drawings.

**END OF ELECTRICAL CONNECTIONS**



## **ELECTRICAL INSULATION**

### **PART 7 - ELECTRICAL INSULATION**

#### **7.1 MATERIALS**

##### **A. Suspension Insulators**

1. Suspension insulators shall be installed per IEEE-NEMA Class 52-3 and Drawings.

##### **B. Bus and Station Post Insulators**

1. NGK-LOCKE and LAPP are the approved manufacturers for the station post insulators.
2. Bus insulators shall conform to ANSI C29.2, and station post-type insulators shall conform to ANSI C29.9 and the Technical References as noted in Drawings.

##### **C. All insulators shall be ANSI 70, gray unless otherwise specified.**

##### **D. Insulator bases and spacers shall be of malleable iron or forged steel and galvanized in conformance with ASTM A-153.**

##### **E. Upon completion of project, insulators shall be cleaned with HP Polywater. Nothing abrasive shall be used on the insulators unless Scott Bright is used. New, lint-free rags shall be used for each step.**

#### **7.2 INSTALLATION**

##### **A. All insulators and bushings shall be cleaned of oil, dirt, paper, tape, or other foreign materials. Any insulator or bushing having the surface glaze damaged in any way shall not be installed.**

##### **B. Contractor shall be responsible for furnishing and installing all miscellaneous hardware necessary for a complete insulation system. Miscellaneous hardware can include but is not limited to bolts, nuts, lock washers, eye-bolts, shackles, clevis-pieces, etc.**

**END OF ELECTRICAL INSULATION**

## SWITCHES AND FUSES

### PART 8 - DISCONNECT SWITCHES AND FUSES

#### 8.1 GENERAL

- A. All switches and disconnects shall conform to their respective sections of NEMA Standard SG-6, "Power Switching Equipment". Fuses shall conform to all applicable portions of NEMA SG-2. Where there is a discrepancy between the NEMA standards and these Specifications, these Specifications shall apply.
- B. Extra fuses shall be stored by the Contractor in the station control house.

#### 8.2 INSTALLATION

- A. Switch operator platforms or mats shall be provided for all switches as shown on the Drawings. Switch handle and platform shall be grounded.
- B. Mechanical interlocks, electrical interlocks, or key interlocks shall be completely installed as required by the Drawings. The Contractor shall be responsible for the final adjustment of the interlock schemes. Locks for securing operator mechanisms shall be supplied by the District.
- C. Switches, disconnects, and fuses shall be installed in conformity with vendor drawings and instructions which show mounting and installation requirements. The Contractor shall review vendor drawings and shall provide miscellaneous brackets, bearings, couplings, nuts, bolts, lock washers, and other necessary hardware to completely install the switches, disconnects, and fuses. Final adjustments and settings shall be made by the Contractor to produce a complete working assembly. The Contractor shall be responsible for any and all modifications to the steel structures to install a complete working disconnect switch, and/or fuse assembly. Final touch-up painting shall be applied to switch base parts where required.
- D. Switch handles and operating platforms shall be arranged and aligned to ensure the proper switching of the unit from the platform.
- E. Group operated switches shall be installed such that the blades open and close simultaneously. The switches will be manually operated until approved by the District. The Contractor shall adjust all cam, spare contacts, and limit switches in accordance with the drawings and maintenance instructions.
- F. The contractor shall not perform final piercing of disconnect switch operating rods and connections until final inspection and acceptance by the District. Contractor shall give the District 24 hours notice for final inspection and acceptance by the District on functional operation of devices and equipment.

END OF SWITCHES AND FUSES

## TRANSFORMER OIL CONTAINMENT

### PART 9 - TRANSFORMER OIL CONTAINMENT

#### 9.1 SYSTEM DESCRIPTION

- A. The transformer and regulator oil volumes are designed to be contained in an 18” deep sump lined with geotextile fabric, Agent-X oil-stopping polypropylene fabric membrane, X-Tex oil absorbent filler and 1-1/2” drain rock. The Agent-X fabric is supplied by the District in five prefabricated sections as shown in the drawings. The District also supplies Loctite 3034 adhesive and an application tool for gluing liner seams, the X-Tex oil absorbent material, and a stainless steel clamp with hardware for securing the liner to the pier footing adjacent to the regulator slab. After the sump has been excavated, it is lined with geotextile fabric. The prefabricated sections of Agent-X are trimmed to fit and, along with the geotextile fabric, is secured to the transformer and regulator foundations and the aforementioned pier footing. Seams are sealed with the Loctite 3034 adhesive as shown in the drawings. After the oil absorbent material and drain rock is installed, the oil-stopping membrane is secured to earth anchors along the perimeter of the sump, as shown in the drawings. Finally, the sump is covered with a layer of geotextile fabric and yard rock. Once the containment system is installed, area must be roped off so as to not allow heavy equipment to travel over containment area.

END OF TRANSFORMER OIL CONTAINMENT

## NAMEPLATES

### PART 10 - SUBSTATION GROUNDING

#### 10.1 GENERAL

- A. This section covers requirements for a complete grounding installation for the substation, which shall conform to these Specifications and all applicable codes. Grounding shall include a complete buried system and a grounding system for all lightning arresters, circuit breakers, circuit switcher, regulators, meter cabinets, potential transformers, power transformers, structures, fence, control building, panels, switch platform, conduit bushings, cables, and other appropriate items.

#### 10.2 INSTALLATION

- A. The buried grounding system shall be installed in conformance with the Drawings and Specifications. Below-grade connections shall utilize an approved exothermic process. Connections shall be made in conformance with the manufacturer's instructions.
- B. Grounding conductors shall be straight and free from kinks, breaks, and other damage after installation. Conductors shall be thoroughly cleaned prior to making connections. All connections shall be inspected by the District prior to burial.
- C. The ground bus shall be laid slack to the depth shown on the Drawings.
- D. All taps, junctions, and splices shall be left uncovered until inspected by the District.
- E. Ground rod placement and characteristics are as noted in Drawings.
- F. All equipment and all steel structures and electrical equipment shall be connected to the ground system. This includes but is not limited to all panels, junction boxes, and auxiliary equipment. All bolted installations shall use lock washers. Paint, rust, or other non-conducting material shall be completely removed from the contact surfaces and these surfaces coated with oxide-inhibiting compound before making ground connections. Once the connection has been made, any exposed metal shall be painted in accordance with Part 18, Painting.
- G. All ground bus bars in panels shall be grounded solidly to the ground grid with #6 or larger solid copper wire.
- H. All conduit hubs shall be solidly connected to ground grid.
- I. The grounding system on the fence and gates shall be solidly connected to the buried ground grid.
  - 1. The station fence, including the gates in any position, shall be grounded by means of a perimeter ground conductor buried three (3) feet outside the fence. The conductor shall be connected to the buried ground inside the yard. The following fence parts shall be bonded to the perimeter ground conductor:
    - a. Each corner post.
    - b. Line posts at thirty (30)-to-fifty (50)-foot intervals.

## NAMEPLATES

- c. Each driveway gatepost, which shall have a flexible ground bond to each driveway gate frame.
  - d. The gatepost on the hinged side of each man gate. The gate frame or frames shall each have a flexible ground bond to that gatepost.
2. In addition, the fence fabric, top rail, and strands of barbed wire at the top shall be grounded by means of #2 solid tinned-copper wire in the following manner:
- a. The #2 wire shall be bonded to the ground system at each post that has a ground connection to the buried ground loop outside the fence, including both sides of each corner post.
  - b. Each gate frame shall be bonded with #2 solid tinned-copper wire by connecting to the flexible ground bond with the gatepost.
  - c. The #2 wire shall be woven into the fence fabric from the top down, and it shall be clamped to the top rail and each of the barbed wire strands.
3. All metallic conduit and metallic cable shielding and sheath shall be effectively grounded at terminations in conformance with the National Electrical Code.

END OF STATION GROUNDING

## CONDUIT & FITTINGS

### PART 11 - CONDUIT & FITTINGS

#### 11.1 GENERAL

- A. Contractor shall install electrical conduit and accessories required for embedded and exposed conduit systems. Conduit accessories shall include the following: conduit fittings; conduit duct spacers conduit connectors; outlet boxes; outlet bodies; standard pipe tees for conduit drains (as required); pull boxes; junction boxes; locknuts; bond nuts; bushings; materials for sealing joints and for coating external surfaces of conduit; materials for sealing and connecting the ends of conduits terminating at outdoor boxes, panel boards, and cabinets; hanger supports; bracket supports and clamps; and all other devices required to complete the electrical conduit system.
- B. Contractor shall install four (5) feeder power cable 6" schedule 40 conduits per Drawings. Pulling rope shall be installed in empty conduits for future cable pulling.
  - 1. At riser structure end power cable conduits shall be extended above riser structure mounting brace and connected to riser structure via brace.
  - 2. Threaded grounding clamp as per noted in the BOM shall be mounted on top of each riser conduit and solidly connected to station ground grid as per Drawings.
  - 3. At end outside of substation power cable conduits shall be capped and location marked for future locating. Contractor shall give the District 48 hours notice prior to capping and burying power cable conduits.
- C. Contractor shall be responsible for installing all other materials and accessories necessary to install a complete conduit system which shall be approved by the District.

#### 11.2 MATERIAL

- A. All rigid galvanized steel (RGS) and polyvinyl chloride (PVC) conduit shall be Schedule 40 unless otherwise specified.
  - 1. Straight portions of horizontal runs of buried conduit shall be PVC conduit unless otherwise specified.
  - 2. PVC conduit joints shall be made watertight per ASTM D2855.
  - 3. All bends greater than fifty degrees (50°), including those within or at the ends of PVC runs, shall be made with RGS conduit. Adapter connectors are to be provided between PVC conduit and all RGS conduit sections. All RGS bends installed underground shall be coated with Bitumastic 50 or wrapped with PVC tape unless encased in concrete.
  - 4. RGS conduit shall be used to make entrance connections into building or equipment foundations, and vaults. The RGS conduit is to be extended a minimum of eighteen (18) inches beyond exterior walls for buried cables.
  - 5. All exposed conduit shall be RGS unless otherwise stipulated. Where it is connected to buried conduit, a PVC to RGS coupler shall be used at surface level.
- B. Flexible conduit shall not be used without approval by the District. If approved, conduit shall be steel reinforced and liquid tight.

## CONDUIT & FITTINGS

- C. Circuit breaker panels, wiring devices, junction and outlet boxes, together with associated items for attaching and making connections, shall be in conformance with the following specifications:
1. All surface-mounted or exposed outlet boxes shall be cast aluminum or cast iron, with steel or aluminum cover plates. Crouse-Hinds, Russel & Stoll, or similar approved types of outlet boxes shall be used. Sheet metal boxes are not acceptable.
  2. Junction boxes for splicing and termination points shall be located throughout the station. They shall be Hoffman type or approved equal rated NEMA 3R or 4X, supplied without knockouts for conduit entry. They shall be heavy-duty, rain-tight, drop-door, screw-cover type enclosures of the sizes required by code. Connections on the top and sides shall be made with waterproof hubs. Connections in the bottom may be made with a bushing and two (2) locknuts. Drilling through the junction boxes is not acceptable.

### 11.3 INSTALLATION

- A. All material and equipment shall be stored so as to be protected from deteriorating effects of the elements. Touch-up paint shall be provided as required.
- B. All conduits shall be installed in a neat and workmanlike manner. Where possible, the runs shall be parallel to the centerlines of structures or parallel to each other in the case of multiple runs. Underground runs shall be as direct as possible, using the least number of bends as is practical.
- C. Conduit runs, embedded or exposed, shall not contain more than the equivalent of four (4) quarter-bends (360° total) between outlet and outlet, fitting and fitting, or between outlet and fitting, including bends located immediately at the outlet or fitting. Pull boxes shall be installed, if required, to limit any run of conduit to four (4) quarter bends (360° total).
1. All outdoor conduits shall be one (1) inch minimum unless otherwise stipulated. Inside the control enclosure one-half (1/2) inch and larger electrical metallic tubing (EMT) conduit may be used. Control enclosure shall be pre-fabricated type with majority of EMT conduits installed by provider.
  2. Factory bends or bends made with a hydraulic power bender shall be used for conduit larger than one (1) inch. Minimum bend radius shall be seven (7) times the diameter of the conduit.
  3. All exposed ends of conduit shall be protected during construction to prevent the entrance of any foreign material or moisture.
  4. Burrs or sharp projections which might injure the cable shall be removed.
  5. Round, flexible, nylon-covered tapes or nylon ropes shall be used for fishing and wire-pulling in conduit.
  6. Where conduit enters a box, vault, cable trench, or any other fitting or termination, a bushing shall be provided to protect the cable from abrasions. At all points where the conduit terminates, the bushing shall be of the grounding type to provide an effective connection to ground.
  7. Entrances to breaker panels which are inside the control building shall be made with conduit runs from a cable trench or tray. The conduits shall extend through a cutout in the trench cover plates and shall be securely fastened to the trench sidewall.
  8. Conduit, conduit fittings, and conduit boxes to be embedded in concrete shall be held securely in position while the concrete is being placed. All concrete shall be cleaned from the inside of conduit boxes after the forms are removed, and the threads for attaching devices and covers shall also be cleaned.

## CONDUIT & FITTINGS

9. The ends of conduit shall be protected to prevent the entrance of any foreign material. As soon as practical after conduit rounds are completed and the forms are stripped, all conduit runs shall be swabbed to show that they are free of foreign material and have no broken fittings. The plugs or caps shall then have their threads greased and shall be replaced and left in place until the wire is installed.
10. Outdoor conduit runs must be supported at least every six (6) feet horizontally and eight (8) feet vertically. Fittings and outlets that are for conductor feed-through shall have the attached conduit supported within three (3) feet. Eighteen (18) inches shall be the distance between conduit supports and outlets that contain devices (such as receptacles) or boxes that support fixtures. Conduit runs in control buildings shall have supports a maximum of eight (8) feet horizontally and vertically.
  - a. Conduit shall be bent so that no more than four (4) inches separate the conduit and the adjacent surface.
  - b. Drilling through junction boxes is not acceptable for NEMA ratings 3 or above. Unistrut C-channel shall be used for mounting unless otherwise indicated on the drawings.
  - c. Conduit which enters manhole or pull boxes is to be mortared. End bells shall be used and mortar and end bells will be flush with the surface.
11. Contractor shall cap outside conduits.
12. After testing and commissioning are complete, the contractor shall seal the conduits.

### 11.4 UNDERGROUND CONDUIT BURIAL

- A. Underground conduit runs shall be buried below subgrade (soil grade) as follows:
  1. Control and equipment power cable circuits shall be buried twenty four (24) inches below subgrade unless indicated otherwise on the Drawings.
  2. Conduit for power cable circuits and communications shall extend six feet outside the substation fence in the direction and depths indicated on the Drawings.
  3. Conduit duct banks with multiple conduit runs shall have conduit spacers to maintain distances between conduits.
  4. Conduit trench bottom shall be smooth and filled with three (3) inches of sand to make it such.
  5. Where native material is unsuitable as bedding material, the Contractor shall provide sand for minimum coverage of (6) inches below and (6) inches above the conduit, prior to backfilling
  6. Substation feeder circuit conduits shall include RGS rigid steel sweeps as indicated on the Drawings. Buried feeder circuit conduits shall be 6-inch PVC, with a minimum coverage of (6) inches below and (6) inches above the conduit, prior to backfilling.

END OF CONDUIT AND FITTINGS



## WIRE & CABLE

### PART 12 - WIRE & CABLE (SUBSTATION CONTROL & LOW-VOLTAGE POWER CABLE)

#### 12.1 MATERIALS

- A. Wire type and size for above-grade and conduit run connections shall be determined as specified below. Sizes listed are to be used as a default size or type if not listed in the Drawings.
1. Current circuits shall have a minimum size of #10 AWG.
  2. Potential circuits shall have a minimum size of #10 AWG.
  3. Single conductors shall be tray cable rated, 600V, THHN 90°C (or equal) for circuits run entirely within a control house or cabinet.
  4. Single conductors used for metering pulse circuits only shall be a minimum of #18 AWG., 600V, shielded, tray cable rated, nineteen (19)-strand tinned copper with tinned-copper braided shield over insulation and jacketed overall.
  5. Shielded multiconductor control cable, when required, shall be insulated, shielded with an overall jacket, tray cable rated and suitable for direct burial and wet/dry locations conforming to, NEMA WC-7, WC-8, IEEE-383 and the following specifications:
    - a. Conductor - Class B stranded soft copper.
    - b. Primary Insulation - XLPE or fire retardant EP, .020" thick, 600V (min.).
    - c. Assembly - For three (3) conductors or more, fillers and polyester tape covering (ten percent (10%) minimum overlap) shall be applied to form a round cable.
    - d. Shielding - Copper tape two-thousandths inch (.002") thick shall be applied after the polyester tape; overlap shall be twenty-five percent (25%) or manufacturer's guarantee of 100% coverage.
    - e. Overall jacket - The multiconductor cable shall have a CPE or CSPE jacket applied over the cabled assembly.
    - f. Individual wire insulation color shall be per ICEA Method 1, Table E-2
    - g. Marking - The overall jacket shall be ink printed with 1) number and AWG size of conductor(s), 2) 600V, 3) stranding, and 4) manufacturer's name.
  6. Multiconductor cable for AC and DC circuits run in an outdoor conduit shall be flame resistant, tray cable rated, suitable for direct burial, and wet/dry locations conforming to, NEMA WC-7, WC-8, IEEE-383 and the following:
    - a. Conductor - Class B stranded soft copper.
    - b. Primary Insulation - XLPE or fire retardant EP, .020" thick, 600V (min.).
    - c. Assembly - For three (3) conductors or more, fillers and polyester tape covering (ten percent (10%) minimum overlap) shall be applied to form a round cable.
    - d. Overall jacket - The multiconductor cable shall have a CPE or CSPE jacket applied over the cabled assembly.
    - e. Individual wire insulation color shall be per ICEA Method 1, Table E-2
    - f. Marking - The overall jacket shall be ink printed with 1) number and AWG size of conductor(s), 2) 600V, 3) stranding, and 4) manufacturer's name.
  7. Single conductors for AC and DC circuits run in an outdoor cable trench shall be flame resistant, tray cable rated, suitable for direct burial, and wet/dry locations conforming to, NEMA WC-7, WC-8, IEEE-383 and the following:

## WIRE & CABLE

- a. Conductor - Class B stranded soft copper.
  - b. Insulation - XLPE or fire retardant EP, .020" thick, 600V (min.).
8. The following list details the size and color of most of the control circuits to be installed by the Contractor:

| Circuit             | Color  | Size |
|---------------------|--|------|
| MV Lights           | Black, White   | #12  |
| High Side Breakers: |  |      |
| AC                  | Black, White   | #12  |
| DC                  | Blue, White  | #4   |
| Ind. Lights         | Red, Orange, Blue, Brown, Green, Yellow, White                                 | #10  |
| Relays              | Black, Green, Yellow, White, Purple, Red, Blue, Brown                          | #10  |
| Transformer:        |  |      |
| High Side CT        | Black, Blue, Red 3/White   | #10  |
| Pumps & Fans        | Black, Red, White  | #8   |
| Trip Contacts       | Black, Blue, Red, White, Orange, Yellow, Green, Brown, Purple, Pink, Gray, Tan | #10  |
| Alarm Contacts      | Black, Blue, Red, Green, Orange, Yellow, White, Brown, Purple, Pink, Gray, Tan | #10  |
| Metering CT         | Black, Blue, Red, 3/White  | #10  |
| Neutral CT          | Green, White   | #10  |
| Metering PT         | Orange, Brown, Yellow, 3/Green   | #10  |
| Recloser:           |  |      |
| 120                 | Black, Red, 2/White  | #12  |
| Controls            | Black, Blue, Red, Green, White, Orange, Yellow, Brown, Gray, Tan, Purple       | #10  |
| Indicators          | Black, Blue, Red, Green, White, Orange, Yellow, Brown, Purple, Pink            | #10  |
| Diff. CTs           | Black, Orange, Blue, Brown, Red, Yellow  | #10  |
| Overcurrent CTs     | Black, Orange, Blue, Brown, Red, Yellow  | #10  |
| Station Service     | Black, Red, White  | #2   |

All DC power supply circuits shall consist of a blue conductor to the positive portion of the circuit and a white conductor for the negative position of the circuit. All 120-volt AC power supply circuits shall consist of a white and black conductor; and all 240-volt AC power supply circuits shall consist of a white, black, and red conductor. All AC power supply and AC control circuits shall include a #12 green ground conductor.

### 12.2 INSTALLATION

- A. A careful determination of the length of all wire and cable runs shall be made prior to installation in order to minimize pulling stresses and the need for splices.

## WIRE & CABLE

- B. Wire and cable shall be handled with care to avoid damage.
- C. The Contractor shall perform continuity tests on all terminated conductors of all cables to verify integrity of cables and terminations.
- D. Coding - Contractor shall use accepted NEC code practices for providing the required colors at the wire ends.
- E. All wires shall be labeled at both ends indicating the wire designation as shown with heat shrink machine printed markers. Each marking shall clearly indicate the exact individual wire designation as shown on the cable connection diagrams. Non-heat shrink markers are not permitted. Markers shall face out and will be labeled to read with minimal effort.
- F. Cables and wires in the same circuit or grouping shall be identified by circuit numbers as indicated in the cable schedule Drawing. The circuit number shall be fastened to each cable or wire grouping at each terminal, cable trench, pull box, manhole, hand hole, and junction point. (Ty-Rap cable markers, type TY551M or TY-546, manufactured by the Thomas & Betts Co., are recommended). The circuit numbers shall be legibly printed with a permanent marking pen. (Thomas & Betts Co. special nylon marking pen, Cat. #WT163M-1, black, is recommended.)
- G. Splices
  1. Cables or wires, except for lighting and receptacle cable, leads shall not be spliced.
  2. Wire for lighting circuits shall be continuous from outlet to outlet. Splices shall be made in outlet or junction boxes. At least six (6) inches of free conductor shall be left at each outlet to make splices of joints, except where it is intended to loop through sockets, receptacles, and other fixtures without splices or joints.
- H. Terminations
  1. Solderless ring-type terminal lugs and connectors shall be used for connecting #8 AWG wire and smaller stranded cable to studs.
  2. Terminations shall be made with compression-type ring-tongue terminal lugs using a compression tool provided with a ratchet or toggle mechanism that ensures complete crimping before the tool can be removed.
  3. Terminations on larger size wires shall have at least two (2) indentations.
  4. Sufficient length shall be left at all ends of wires and cables to conveniently make connections to equipment and devices. Spare conductors at the end of a multi-conductor cable shall be coiled neatly and retained in a length equal to that of the longest single conductor at each end of the multiple-conductor cable. All cables entering a terminal cabinet, switchgear compartment, distribution board, or other such device from a conduit, cable slot, or cable trench shall be clamped securely at the opening. All exposed cable or wire runs shall be bunched and tied so as to prevent movement.
  5. Cable connections to pad-mounted equipment shall have enough slack left in the cable to allow for thermal expansion and contraction. When pad-mounted equipment has a wiring compartment underneath, a full coil of cable shall be installed before the cable is terminated.
  6. When voltage drop has dictated the conductor size to be greater than #8 AWG, and the terminal blade will only accept lugs which are suitable for #9 AWG, the Contractor shall reduce the conductor to appropriate size by using a splice in a junction box or, if approved

## WIRE & CABLE

by District, by trimming to that equal of #9 and installing a heat shrink tube to overlap the jacket and insulated lug.

7. Fused circuits shall be wired such that the fuse is de-energized where lifted.
8. Where cables must pass from the cable trench/tray to instrument panels they shall be bundled in the trench/tray so they can pass through an opening in the trench cover in one group at each instrument panel rack.

### I. Cable Pulling

1. Wire and cable shall be installed in such a manner that the cable jacket receives no cuts or abrasions.
2. A clean, tight-fitting rag shall be drawn through the conduit immediately before installing the wire or cable. No wire or cable shall be installed in conduit unless it is free of all foreign material.
3. An approved lubricating material non-injurious to the insulation or jacket shall be used when necessary to prevent mechanical damage.
4. Any wire or cable that is damaged during installation shall be removed and replaced at the Contractor's expense.

END OF WIRE AND CABLE

## CONTROL BUILDING

### PART 13 - CONTROL ENCLOSURE

#### 13.1 GENERAL

- A. This section covers requirements for the installation of a pre-fabricated control enclosure which shall be supplied complete with the following: heating, , ground bus bars, lighting, general power circuits, AC and DC station power breaker panels, relay panels, SCADA/communications panel, overhead cable tray and all wiring and additional material items for a complete enclosure assembly.
- B. District will provide the batteries, charger and battery containment to Contractor for Contractor installation per Drawings.

#### 13.2 SITE PREPARATION AND FOUNDATIONS

- A. Site preparation shall be in conformance with the grading and site preparation section of these Specifications.
- B. Foundation work shall conform to the concrete section of these Specifications.
  - 1. The enclosure floor shall be no more than 12” above finished grade per Drawings.
  - 2. The enclosure shall be installed with a single step in the stoop at north entrance per Drawings

#### 13.3 INSTALLATION REQUIREMENTS

- A. Lighting and utility power systems shall be installed by pre-fabricated control enclosure vendor.
- B. AC and DC circuit breaker panels will be installed and wired to control enclosure loads by pre-engineered enclosure manufacturer. Contractor shall wire and terminate exterior or not wired circuits to the AC and DC panels per Drawings. The supporting battery system to be provided by District and installed by Contractor as required by the Drawings shall be installed in conformance with codes and applicable sections of these Specifications so that they shall be complete in every way.
  - 1. The purpose of each circuit breaker shall be labeled in simplified terms. Identification labels shall be permanently installed on or adjacent to the breakers inside the panel board box. All labels shall be machine printed.
- C. The Contractor shall make an effective connection from the station ground grid through the control enclosure to all breaker panels, all electrical equipment within the control enclosure, each relay panel, and overhead cable tray. The Contractor shall be responsible for a complete and effective ground system.

END OF CONTROL ENCLOSURE

## **INSTRUMENTATION**

### **PART 14 - INSTRUMENTATION**

#### **14.1 INSTALLATION OF INSTRUMENT CONTROL PANELS AND BATTERY SYSTEM**

- A. Contractor shall install District furnished, pre-fabricated Control Panels. Contractor shall be responsible for unloading the Control Panels at the project site and placing, leveling, and anchoring the Control Panels on the foundation. Contractor shall terminate all Control Panel inter-panel wiring and all of the external control cable wiring. Contractor shall furnish all labor, equipment, hardware, and material required for complete installation. Contractor shall install District furnished Battery System including the batteries, rack, charger, grounding and interconnections. Contractor shall be responsible for unloading the Battery System at the project site and placing, leveling, and anchoring the battery rack on the foundation. Contractor shall furnish all labor, equipment, hardware, and material required for complete installation.

#### **14.2 WIRING**

- A. Wire shall conform to the wire and cable section of these Specifications and Drawings.

**END OF INSTRUMENTATION**

## PAINING

### PART 15 - PAINTING

#### 15.1 GENERAL

- A. All field painting costs shall be borne by the Contractor. Exterior building color shall be approved by District.

#### 15.2 EQUIPMENT

- A. Surfaces of most electrical equipment (such as panels, switchgear, transformers, circuit breakers, etc.) are finished at the factory. Great care shall be exercised to prevent damage to this original finish during installation of the equipment and during construction work.
- B. If the factory finish is damaged during the course of construction, the entire surface of the damaged component shall be refinished.
- C. The refinished surface shall be equivalent in every respect to the original surface, including color, texture, and smoothness. Refinishing paint, if furnished with the equipment, may be used; otherwise, the paint shall be obtained from the equipment manufacturer.

#### 15.3 STRUCTURAL STEEL

- A. Contractor shall be responsible for repairing surface coating (paint and galvanizing) damaged in shipping and construction, and for applying the surface coating over any bare metal areas which were not painted (galvanized) during fabrication. All bare metal areas which are subject to rust shall have a protective coating applied.
- B. After field erection has been completed, the welds shall be ground smooth and the adjacent uncoated areas and any areas where the coating has been damaged shall be cleaned in conformance with SSPC-SP3, power tool cleaning.
- C. All steel requiring touch-up painting shall be prime painted and finish painted in accordance with the following:
  - 1. Surfaces shall be free of abrasive, oils, dirt, or contaminants when primed.
  - 2. Handling of coating equipment and the steel surfaces to be primed shall be done in a manner to avoid contamination during and following application of the primer coat.
  - 3. The surface temperature of the steel to be coated shall be 50°F minimum and at least 5°F above the wet-bulb air temperature reading.
  - 4. The primer thickness shall be 2.0 mils (dry). The thickness shall be monitored by wet-film thickness measurements.
  - 5. The primer shall be allowed to cure prior to application of second (or top) coating for at least the minimum time recommended by the paint manufacturer.
  - 6. Areas with dry-film thickness of less than 1.7 mils or greater than 5.0 mils shall be corrected by additional primer coating or by wire brushing and recoating.

## PAINING

7. The primer shall be of a zinc-rich inorganic type which is identical to the primer applied by the steel fabricator. The primer shall not be applied over the topcoat.
  8. Topcoating shall be applied after any corrections have been made to the primed surface and the primer is fully cured.
  9. The topcoat shall be applied to a thickness of 3.0 mils dry (primer plus topcoat = 5.0 mils dry) using the manufacturer's recommended procedures. The topcoat thickness shall be monitored by a wet-film thickness method. Areas where the dry-film thickness of the primer plus topcoat are less than 4.5 mils or greater than 8.0 mils shall be corrected.
  10. The topcoat shall be a polyamide epoxy type. It shall be identical to the topcoat applied by the steel fabricator.
  11. Touch-up painting shall be done in conformance with SSPC-PA 1 "Shop, Field, and Maintenance Painting".
- D. All steel requiring galvanizing repair shall be repaired in conformance with SSPC-PA 1 "Shop, Field, and Maintenance Painting" and ASTM A 780 "Repair of Damaged Hot-Dip Galvanized Coatings". Since different pigments exist, the appropriate pigment will be selected by the Contractor to match the existing surface.

END OF PAINTING



## PART 16 - TESTING

### 16.1 GENERAL

- A. In addition to Contractor's complete testing of the substation, Contractor shall allow up to ten (10) working days for pre-energization testing by the District and, if necessary, shall provide 120/240 volt AC and DC power, heat, and lights in the control building without additional cost to the District.

### 16.2 CONTROL AND LIGHTING SYSTEMS

- A. The inspection of the station power control and lighting systems shall be conducted by the Contractor and observed by the District. It shall include but not be limited to the following:
- B. Continuity checking of all cables, wires, and wiring to control and power boards shall be made before any other tests are made on control and station power equipment. This check shall be made by using low voltage continuity-testing apparatus. Any sensitive equipment such as galvanometers, millimeters, and millivoltmeters shall be disconnected before making this check. The wiring shall be checked against the schematics and wiring diagrams at the same time the continuity tests are being made.
- C. A ground megger test shall be made to check the insulation integrity.
- D. Contractor shall manually and electrically operate and test all switch, disconnect, and fuse assemblies to guarantee the complete and satisfactory working condition of these units.

END OF TESTING