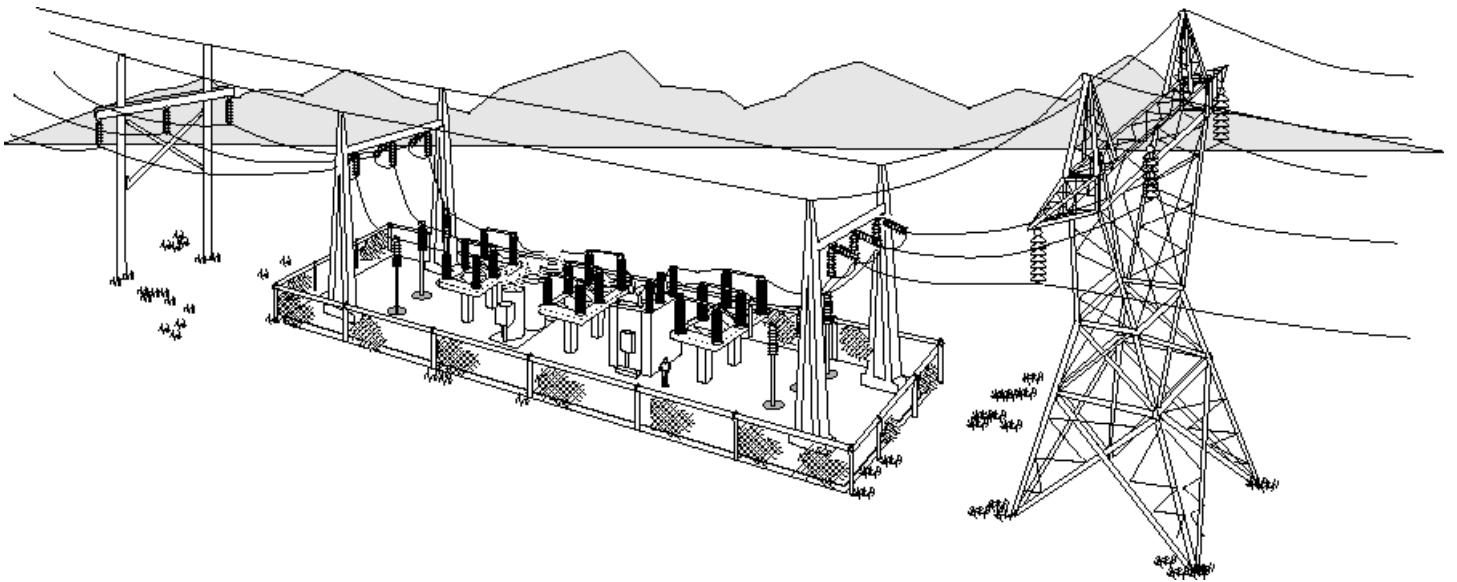




Western Area
Power Administration

CONSTRUCTION STANDARDS

STANDARD 1 GENERAL REQUIREMENTS



2026

SAFETY
A HABIT TO LIVE BY

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STANDARD 1 – GENERAL REQUIREMENTS

SECTION 1.1 – GENERAL CONDITIONS

1.1.1 STANDARDS AND PROJECT SPECIFICATIONS:

1. **GENERAL:** WAPA uses standards and project specifications for constructing substation, transmission line and other miscellaneous construction projects. The standards, project specifications, standard drawings and project drawings together completely describe the project to be constructed.
2. **STANDARDS:** The standards contain general requirements for constructing substation and transmission line projects and specify material, and quality requirements applicable to WAPA construction projects.
3. **PROJECT SPECIFICATIONS:** Project specifications are issued to describe the specific requirements for each construction project. The specifications may list requirements in addition to the Standards and may list requirements that modify or take exception to the standards.
4. **BIDDING SCHEDULE:** The Bidding Schedule is listed in Section B of the contract. If the Bidding Schedule contains a single item for the entire project, then the cost of performing work under the contract shall be included in the single item. If the Bidding Schedule contains numerous items, then the cost of performing work shall be included in the appropriate items as listed in the project specifications. If work, required by the specifications and drawings, is not listed as included in a separate item, then the cost of the work shall be included in other Bidding Schedule items as applicable.
5. **APPLICABILITY OF STANDARDS:** Use only the portions of each standard that are relevant to work described in the project specifications.
6. **CONFLICT IN REQUIREMENTS:** If a conflict occurs between project-specific written specifications or drawings and the Construction Standards, the project-specific documents shall take precedence.

1.1.2 GENERAL DEFINITIONS:

In addition to the terms and abbreviations covered in Section 1.2.4, “Reference Standards” and the “Definitions” and “Specifications and Drawings for Construction” Contract Clauses, the terms and definitions listed below apply:

“WAPA” or “Western Area Power Administration” means the Government.

“COR” means the person duly appointed by the Government Contracting Officer to serve as the Contracting Officer’s Representative.

“Approved” or “approval” means approved by the COR, except where another specific authority is designated.

“Material” or “materials”, includes items furnished by the Contractor or by WAPA, and means machinery, equipment, components, products or any other item incorporated in the work.

“Provide” or “providing” means “furnish and install” or “furnishing and installing”, including labor and material to construct or install an item complete and ready for use.

Where “provide”, “install”, “furnish”, “repair” or words of similar import are used, it shall be understood that reference to the Contractor is intended unless clearly indicated otherwise.

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“Section” means written text designated by a section number (e.g., 1.1.6) and include subsections under the referenced designation.

“PCB” or “PCBs” means polychlorinated biphenyl or polychlorinated biphenyls.

“Bidding Schedule” as used herein shall mean Section B of this solicitation.

“Removing” as used herein shall mean remove and dispose unless otherwise directed.

“Worksite” means any location where work is being performed by one or more employees.

1.1.3 COMMENCEMENT, PROSECUTION AND COMPLETION OF WORK:

1. PROSECUTION OF THE WORK: Sequence of operations, method of operation and the forces employed shall be subject to the COR's approval
2. SAFETY AND HEALTH PROGRAM: Prior to start of field construction operations at the worksite, the Contractor shall submit a Safety and Health Program as specified under Section 1.4, “Safety and Health”.
3. OUTAGE RESTRICTIONS: WAPA's substations and transmission lines are under the jurisdiction of WAPA's power operation and maintenance staff and are subject to their standard operating procedures and regulations. Provisions will be made to de-energize only those buses and circuits necessary to accomplish the work. WAPA will give outages based on system operating conditions at the time outages are requested. Time and length of outages will be at WAPA's discretion. Certain operating facilities will be released only at prescheduled times in order to maintain the continuity of commercial electrical service.
4. SUBMITTAL FORMAT AND APPROVAL REVIEW TIME: All submittals shall include the WAPA contract number, WAPA project title and the Bidding Schedule Contract Line Item Number (CLIN). The standards and project specifications list approval times for submittals. Review times apply to each separate submittal or resubmittal whether drawings or data are approved, not approved or returned for revision.

1.1.4 CONSTRUCTION PROGRAM:

1. GENERAL: Submit a construction program for approval in accordance with the contract clause titled “Schedules for Construction Contracts”. Pending approval of the program, proceed with work in accordance with the proposed construction program.
2. ESTIMATE OF EARNINGS: Construction program shall show the percentage of work for each line item or portion of work scheduled for completion each month and include an estimate of earnings by months.

Program approval shall not obligate WAPA to provide funds in any manner other than as provided in the contract clauses and special contract requirements.

3. SUBMITTALS:
 - a. Submit electronically per the Project Specifications.
 - b. Revisions: Revise construction program to keep it current; enter on program actual progress at end of each progress payment period, or at such other intervals as directed.

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4. **FORMAT AND DETAIL:** Construction program shall show in detail the Contractor's schedule of operations and shall provide for orderly performance of the work. Construction program shall show the following:
 - a. Sequence of operations.
 - b. Dates for commencing and completing work on the controlling features.
 - c. Order and delivery dates for Contractor-furnished material.
 - d. Lead times required for Government-furnished construction drawings. Lead times greater than 75-days shall be justified.
 - e. Dates Contractor-prepared drawings will be submitted for approval.
 - f. Dates and duration of required power outages.

1.1.5 CONSTRUCTION SURVEYS:

1. **GENERAL:** The Contractor shall:
 - a. Establish lines and grades from existing structures or survey control as approved by the COR for control and measurements at the site.
 - b. Establish lines and grades that control the work at the location so that they are set to the limit marks and tolerances identified in Section 1.1.5.11 "Degree of Accuracy" or as shown on the Drawings.
 - c. No payment will be made for work necessary to correct misaligned tangent or facility structures or features in either the horizontal or vertical plane.
 - d. Perform as-built survey.
 - e. The Contractor shall use the site coordinate system shown on the topography drawing. All plan distances are to be at ground (actual physical distance at the site surface) and not at grid or mapping plane distances.
2. **SUBMITTALS:**
 - a. Prior to beginning survey work, submit to the COR a proposed plan that demonstrates that the lines and grades, established by the Contractor for control of the work, will meet the requirements of the project specifications.
 - b. Submit digital survey data , computer printout and field books to the COR.
3. **PERSONNEL QUALIFICATIONS:** Survey work shall be done under the direction of a qualified surveyor or engineer approved by the COR.
4. **EQUIPMENT AND MATERIAL:** Furnish all labor, equipment, supervision, transportation, operation supplies and incidentals for the work.
5. **RECORDS:** Survey notes that show field procedures and field data shall be recorded and certified by the person in charge of the survey work.

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6. **DIGITAL SURVEY DATA:** Digital survey records utilized in conjunction with total station equipment shall be provided to the COR with a computer printout of the survey calculations showing initial and finalized data. The data shall be annotated to reflect, at each occupied station, the date and time data is collected, stations occupied, back sight, foresight, angle turned, distance measured and difference in vertical elevation.
7. **FIELD BOOKS:** If field books are utilized in conjunction with conventional equipment, the original field notes, computations and other records for the purpose of layout and quantity surveys shall be recorded in duplicating field books. Immediately upon completing and reducing the notes for a survey or portion of a survey, furnish a duplicate copy to the COR. Upon completing a field book, submit the original field survey book to the COR for filing.
8. **AS-BUILT SURVEY:** A field topographic survey of post-construction conditions including grading, ditches and drainage structures, fencing, rigid bus centerline, access roads, buildings, foundations, new communication and transmission structures, survey control, benchmarks and boundary monuments shall be provided. Deliverables shall include:
 - a. Autodesk Civil3d CAD drawing (current version) of topographic survey data.
 - b. All field books, sketches, digital photos, digital survey data reports of field survey.
 - c. Digital point file conforming to WAPA standard feature codes including identifiers Point number, Northing, Easting, Elevation, Point code (PNEZD).
9. **DIFFERING CONDITIONS:** Conditions encountered during construction that are different from those represented on the Drawings shall be brought to the attention of the COR. The Contractor shall accurately record the condition and furnish the corrected drawing to WAPA in accordance with Standard 15 Drawings Section 15.2, "As-Built Drawings".
10. **CLEANUP:** Except for permanent survey markers and material that locate proposed facilities, stakes, pins, rebar, spikes and other material shall be removed from the surface and within the top 15-inches of the topsoil as a part of final cleanup.
11. **ACCESS ROADS:** Stake and mark WAPA provided access road rights-of-way in accordance with the legal descriptions and tract plats furnished by WAPA.
12. **DEGREE OF ACCURACY:**
 - a. **Substations:** Points for cross sections shall be located to the nearest 0.1 (1/10th) of a foot horizontally and vertically. Levels shall close within 0.05 (5/100th) of a foot times the square root of the length of the circuit in miles. Final grade stakes (blue tops) for concrete shall be set to 0.01 (1/100th) of a foot. Alignment of tangents and curves shall be within 0.1 (1/10th) of a foot. Points for structures shall be set to the nearest 0.01 (1/100th) of a foot, except where operational function of special features or installations of metalwork and equipment require closer tolerances.
 - b. **Access Roads:** On land in rural areas, establish the centerline of the access road with a horizontal positional closure of 1:2500 or better. On land in residential or commercial areas, establish the centerline of the access road with a horizontal positional closure of 1:5000 or better.
 - c. **Transmission Lines:**
 - (1) **Lattice Steel Towers:**

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Survey Marks for Points of Intersection (P.I.) and Tangent Transmission Line Structures: In grassland, pasture, desert or grazing areas, the rebar is flush with the ground. In crop land, the rebar is buried 12-inches to 14-inches below ground surface. WAPA has located the center of each transmission line P.I. structure on the transmission line centerline and marked it with a No. 5 rebar (5/8 inch) affixed with an aluminum cap imprinted with the survey control number and punch mark.

WAPA has located the center of each tangent transmission line structure on the transmission line centerline and marked it with a No. 4 rebar (1/2-inch). WAPA will only provide survey crew services to re-establish transmission line P.I.

- (a) Leg Extension Determination Sheets: After contract award, the COR will provide the Contractor with electronic copies of WAPA's "Leg Extension Determination Sheet".
- (b) Horizontal and Vertical Control: After contract award, the COR will furnish the Contractor with data that may include a set of drawings titled "Schematic Control and Land Monumentation Diagram" that identifies the horizontal and vertical control network established by WAPA. Using the horizontal control at the P.I.'s furnished by WAPA:
 - 1) Stake auger points for footings and construct the transmission line towers to plus or minus 1/10th-foot of the base elevation shown on the plan and profile drawings.
 - 2) Recover structure sites and verify or re-establish the horizontal location of tangent structures sites; and ensure the centerline point of each transmission line structure site is within 0.2-foot of the true tangent line between P.I.'s and within plus or minus 1.0-foot of the correct centerline station.
 - 3) Verify that the ahead and back span lengths at recovered tangent structure sites agree with the plan and profile drawings. The results, including the magnitude of any difference, shall be given to the COR prior to foundation construction.
- (2) Single Shaft Steel, H-Frame Steel Pole, Wood Pole Single and Wood Pole H-Frame:
- (3) Steel Pole Structures, Light Duty Steel Pole Structures and Wood Pole Structures:

Survey Marks for P.I. and Tangent Transmission Line Structures: In grassland, pasture, desert or grazing areas, the rebar is flush with the ground. In crop land, the rebar is buried 12-inches to 14-inches below ground surface.

WAPA has located the center of each transmission line P.I. structure on the transmission line centerline and marked it with a No. 5 rebar (5/8-inch-diameter) affixed with an aluminum cap imprinted with the survey control number and punch mark. WAPA has located the center of each tangent transmission line structure on the transmission line centerline and marked it with a No. 4 rebar (1/2 inch-diameter). WAPA will only provide survey crew services to re-establish transmission line P.I.

- (a) Horizontal and Vertical Control: After contract award, the COR will furnish the Contractor with data that may include a set of drawings titled "Schematic Control and Land Monumentation Diagram" that identifies the horizontal and vertical control network established by WAPA. Using the horizontal control at the P.I.'s:

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- 1) Recover structure sites and verify or re-establish the horizontal location of tangent structure sites; and ensure the centerline point of each transmission line structure site is within 0.2-foot of the true tangent line between P.I.'s and within plus or minus 1.0-foot of the correct centerline station.
 - 2) Verify that the ahead and back span lengths at recovered tangent structure sites agree with the plan and profile drawings. The results, including the magnitude of any differences, shall be given to the COR prior to foundation construction.
 - 3) Stake auger points for the footings or structures and, if required, the guys for tangent and P.I. structures. Guys shall be located with an accuracy of plus or minus 1-foot (1.0). The accuracies shall be measured from angle points shown on the plan and profile drawings.
- d. Microwave Stations: In remote areas, WAPA will locate and mark tower and support centers with No 4 or No 5 rebar. WAPA will provide a reference azimuth from the tower center.
- (1) In remote areas, establish three protected reference points for the WAPA-established tower or support center. These reference points shall be established outside of the area under construction.
 - (2) Antennas shall be oriented within 1-degree, plus or minus, of the azimuth specified. Towers shall be constructed so the antenna is located within 6-inches (0.5-foot), plus or minus, of the height specified.

1.1.6 BREAKDOWN OF CONTRACT PRICES:

1. GENERAL: In addition to the requirements of the contract clause titled "Payments Under Fixed Price Construction Contracts", the Contractor shall submit a detailed breakdown of the total contract price.
2. SUBMITTALS: The price breakdown shall be submitted to the COR designated in this contract within 30-calendar days after the date of notice to proceed.
3. FORMAT AND DETAIL: The breakdown of contract costs shall be arranged by bid item with a further, more detailed division into the various kinds of work which make up the bid item. Contract costs shall be furnished for each bid item detailing the various kinds of work covered in the technical paragraphs of the specifications. The cost breakdown shall show the quantities of each type of work, the unit prices for materials, labor and equipment, as well as the total price. The Contractor shall obtain cost information from its subcontractor(s) as required, to provide the Government with a complete breakdown of the actual bid price.
4. FORMS: WAPA may furnish forms for the Contractors use in providing the cost breakdown.

SECTION 1.2 – MATERIAL

1.2.1 SECURITY REQUIREMENTS REGARDING MATERIAL AND EQUIPMENT STORAGE:

The Contractor shall maintain a 6-foot clear zone inside and outside WAPA perimeters when storing materials and equipment (e.g. insulators, conductors, poles, equipment, vegetation, etc.) at WAPA facilities.

STANDARD 1 – GENERAL REQUIREMENTS

1.2.2 GOVERNMENT-FURNISHED PROPERTY:

Government-furnished material shall be in accordance with the following:

1. **ESTIMATED DELIVERY DATES:** Estimated delivery dates are provided for developing a construction program. These delivery dates are not guaranteed, but WAPA will make reasonable efforts to secure delivery of the items within the time period shown.
2. **ESTIMATED COSTS:** Estimated costs are provided so bidders may include applicable Federal, State and local taxes and duties on Government-furnished material. These costs are not guaranteed but are WAPA's best estimates at time of bidding.
3. **POINTS OF DELIVERY:** Load and haul material from the delivery points to the work.
4. **UNLOADING OF MATERIAL:** Provide prompt unloading of material. WAPA will back charge the Contractor for demurrage charges incurred due to failure to unload trucks promptly. Report to the COR, in writing, within 24-hours after unloading, any shortage or damage to material when delivered.
5. **DRAWINGS AND DATA:** WAPA will furnish one (1) print of wiring diagrams for Government-furnished control, metering, relaying and communications equipment when the equipment is delivered.

1.2.3 CONTRACTOR-FURNISHED MATERIAL:

1. **GENERAL:** Furnish material for completing the work. Material shall be new and of current manufacture. Refer to the contract clause titled "Material and Workmanship" for additional material requirements.
2. **DRAWINGS AND DATA:** WAPA will furnish wiring diagrams of Contractor-furnished equipment 90-days after receipt of informational drawings and data as required in Standard 9 – Substation – Electrical, Section 9.1.3.

1.2.4 MATERIAL INSPECTION:

1. **GENERAL:** Submit purchase orders and advance notification as follows:
 - a. **PURCHASE ORDERS:** The Contractor shall submit purchase orders for electrical equipment and steel structures within 10-working-days of order to WAPA. The purchase orders shall describe the material and give the Bidding Schedule item number. To permit scheduling of Government inspection, purchase orders shall describe the material, state the applicable contract line item number, state the manufacturer, manufacturer location, name of contact and phone number, start date and duration of fabrication, applicable dates of testing and shipping date.
 - b. **ADVANCE NOTIFICATION:** To permit scheduling of Government inspection, provide at least 7 work-days advance notification of when Government inspection of material or witness of test is required. 7-work days advance notification shall also be given prior to shipping material.
2. **SUBSTITUTION OF MATERIAL:** Provide the type and grade of material specified from any source. If the specified material is not available, substitute material, approved in writing, may be used. Adjustment will be made in favor of WAPA if the substitute material costs less to the Contractor than the material specified.

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If the substitution involves an adjustment in WAPA's favor, then a contract change will be issued in accordance with the "Changes" clause.

3. INSPECTION OF MATERIAL: Inspect material in accordance with the "Inspection of Construction" clause.

1.2.5 REFERENCE STANDARDS:

1. GENERAL: Reference to ANSI, ASTM and other reference standards and codes shall be to the most current edition. If material is not specified by ANSI, ASTM or other standards or codes, material furnished shall be of standard commercial quality. Where types, grades or other options offered in the referenced specifications are not specified in these standards or project specifications, material furnished will be acceptable if in accordance with any one of the types, grades or options offered.
2. OBTAINING REFERENCE STANDARDS: Standards and codes published by associations or other standardizing organizations shall be obtained directly from those organizations.
3. STANDARDS ORGANIZATIONS:

AA-Aluminum Association, Inc.

AAMA-American Architectural Aluminum Manufacturers Association

AASHTO-American Association of State Highway and Transportation Officials

ACI-American Concrete Institute

AISC-American Institute of Steel Construction

AISI-American Iron and Steel Institute

AMCA-Air Movement and Control Association, Inc.

ANSI-American National Standards Institute

APA-American Plywood Association

ASCE- American Society of Civil Engineers

ASHRAE-American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.

ASME-American Society of Mechanical Engineers

ASTM-American Society for Testing and Materials

AWI-Architectural Woodwork Institute

AWPA-American Wood-Preservers' Association

AWS-American Welding Society, Inc.

AWWA-American Water Works Association

BIA-Brick Institute of America

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CFR-Consumer Product Safety Commission

CISCA-Ceilings and Interior Systems Contractors Association

EIA-Electronic Industries Association

EPA-Environmental Protection Agency

IBC-International Building Council

IEEE-Institute of Electrical and Electronic Engineers

IES-Illuminating Engineering Society

IPCEA-Insulated Cable Engineers Association

MBMA-Metal Building Manufacturers Association, Inc.

NAAMM-National Association of Architectural Metal Manufacturers

NACE-National Association of Corrosion Engineers

NEC-National Electrical Code

NEMA-National Electrical Manufacturers Association

NESC-National Electrical Safety Code, Institute of Electrical and Electronic Engineers

NFPA-National Fire Protection Association

NFOPA-National Forest Products Association

NSF-National Sanitation Foundation

OSHA-Occupational Safety and Health Administration

PCA-Portland Cement Association

PCI-Precast/Prestressed Concrete Institute

RIS-Redwood Inspection Service

SDI-Steel Deck Institute

SJI-Steel Joist Institute

SMACNA-Sheet Metal and Air-Conditioning Contractors National Association, Inc.

SSPC-Steel Structures Painting Council

TPI-Truss Plate Institute, Inc.

UBC-Uniform Building Code

UL-Underwriters' Laboratories, Inc.

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UPC-Uniform Plumbing Code-International Association of Plumbing and Mechanical Officials

WWPA-Western Wood Products Association

SECTION 1.3 – LOCAL CONDITIONS

1.3.1 RIGHTS-OF-WAY:

WAPA will furnish the right-of-way or site for the work and the right-of-way for access to the work over routes established by WAPA.

1.3.2 ACCESS TO THE WORK AND HAUL ROUTES:

1. **GENERAL:** Rights-of-way for access to the work from existing roads will be provided as specified above. Perform work on the rights-of-way necessary for access to the site. Construct and maintain haul roads, access roads, bridges and drainage structures required for construction operations.
2. **INVESTIGATIONS:** Investigate the condition and availability of public and private roads and clearances, restrictions, bridge-load limits, bond requirements and other limitations that may affect transportation and ingress and egress at the jobsite.
3. **EXISTING ROADS:** Existing roads are available subject to applicable restrictions. Meet conditions imposed upon the use of existing roads by those having jurisdiction, including seasonal environmental and other limitations or restrictions. Pay excess size and weight fees and post bonds conditioned upon repair of road damage.
4. **HAUL ROUTES:** Intra job hauling over public highways, roads and bridges shall be in accordance with applicable local regulations and shall minimize interference with local traffic. Where haul routes cross railroads, dams, public highways or roads, provide barricades, flag persons and other necessary precautions for safety of the public as required by Section 1.4, "Safety and Health".

1.3.3 USE OF LAND FOR CONSTRUCTION PURPOSES:

1. **GOVERNMENT LAND:** Government land, controlled by WAPA, may be used for field offices, storage yards, laydown yards, shops and other facilities if such use will not interfere with work of other Contractors or of the Government in the vicinity or with reservations made by WAPA for use of the land. Refer to the contract clause titled "Operations and Storage Areas" for additional requirements. The COR's approval shall be obtained prior to use of Government land.
2. **PRIVATE LAND:** If private land is used, make necessary arrangements with the owner and pay rentals or other costs.

1.3.4 PROTECTION OF EXISTING INSTALLATIONS:

1. **GENERAL:** In addition to the contract clause titled "Protection of Existing Vegetation, Structures, Equipment, Utilities and Improvements", obtain the location of buried conduit, pipe, cable, ground mat and other buried items prior to performing excavations in the existing installation. Use proper methods for protecting existing installations during excavating and backfilling operations and when installing equipment and material.

Fences on right-of-way shall be removed where necessary and replaced to the original condition or better when the work is finished.

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2. **SUBMITTALS:** Prior to starting excavation in an energized substation, submit to the COR for approval a cable location plan and print of locations. The plan shall give proposed methods of locating existing buried cable and include methods of identifying subsurface cable installations within the work area and methods of surface marking of cable locations and lines of excavation. When locating cable, wires shall not be loosened or removed from the terminals, and signals shall not be induced into the control circuit. The substation shall remain operational and the methods used for cable location shall not interfere with operation of the substation. Excavation will not be allowed until cable location has been marked on the ground and the COR has received a marked print showing the cable location.
3. **PROTECTIVE INSTALLATIONS:** Protective installations shall permit operation of existing equipment and facilities while construction work is in progress. Remove protective installations after they have served their purpose. Material furnished to provide protection shall remain the Contractor's property.

Where existing fences are removed to facilitate the work, temporary fence protection for lands adjacent to the right-of-way shall be provided at all times during the continuation of the contract. Such temporary fence protection shall be adequate to prevent public access to restricted areas. Temporary fencing constructed on the right-of-way shall be removed by the Contractor as part of the cleanup operations prior to final acceptance of the completed work.

4. **CONTRACTOR'S NONCOMPLIANCE:** If the Contractor does not provide the necessary fences and gates to adequately protect property adjacent to the right-of-way within a reasonable time after need for such protection arises, WAPA will have the work performed and back charge the Contractor.

1.3.5 RAILROADS, HIGHWAYS AND UTILITY LINES:

1. **GENERAL:** Make necessary provisions and perform work required to avoid interference with the operation or maintenance of railroads, highways and overhead utility lines, including transmission, telegraph and telephone lines, in a manner satisfactory to the owners or operators thereof and to WAPA. If required, furnish liability insurance, indemnity and other bonds and required permits.
2. **PROTECTIVE MEASURES:** Provide and maintain required watchmen, signals, guards and temporary structures in accordance with Section 1.4.2, "Public Safety".
3. **STRINGING OVER ENERGIZED POWER LINES:** When stringing transmission line conductors or overhead ground wires over energized electric power lines, notify the owners or operators thereof of the period of time required for stringing and obtain a written acknowledgment of such notice. Present the acknowledgment to the COR before stringing of the crossing span is started. Stringing operations shall conform to the applicable safety and transmission line stringing provisions of Section 1.4, "Safety and Health".

SECTION 1.4 – SAFETY AND HEALTH

1.4.1 GENERAL:

1. **GENERAL:** In addition to the contract clause titled "Accident Prevention", conduct a Safety and Health Program and take necessary precautions to protect the safety and health of employees and members of the public and to prevent damage to public and private property. Do not allow employees, whether directly employed or employed through subcontract or onsite supply contract, to work in surroundings or under working conditions which are unsanitary, hazardous or dangerous to their health or safety.

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WAPA's commitment and policy concerning occupational safety and health is printed on the inside back cover of the project specifications. This statement is incorporated into these standards and shall be incorporated into the Contractor's safety program.

2. **CONFLICT IN REQUIREMENTS:** If there is a conflict between the requirements of the standards, project specifications and applicable Federal, State or local safety, health, or industrial regulations or codes, the more stringent requirements shall prevail.
3. **COMPLIANCE WITH CODES AND STANDARDS:** Comply with the latest effective Occupational Safety and Health Administration (OSHA) Standards 29 C.F.R. 1910 and 29 C.F.R. 1926 and other applicable Federal, State and local regulations. In any State where the State OSHA's plan is accepted by the Federal Government, comply with the State OSHA regulations. Keep a copy of applicable OSHA standards at the jobsite. Certain OSHA standards have been referenced for emphasis. OSHA standards shall apply, whether referenced or not.
4. **SUPERINTENDENT QUALIFICATIONS AND RESPONSIBILITIES:**
 - a. **General:**
 - (1) **De-energized Substation Construction:** For work in a de-energized substation, the superintendent shall have a minimum of 3-years' experience as a superintendent or foreman in high-voltage substation construction.
 - (2) **Energized Substation Construction:** For work in an energized substation, the superintendent shall have a minimum of 3-years' experience as a superintendent or foreman in high-voltage substation construction, including 1-year of experience in energized substations.
 - (3) **Transmission Line Construction:** The superintendent shall have a minimum of 3 years' experience as a superintendent or foreman in high-voltage transmission line construction.
 - (4) **General Construction:** The superintendent shall have a minimum of 3-years' experience as a superintendent or foreman in the type of construction contained in the project specifications.
 - (5) **OSHA Knowledge:** The superintendent shall have demonstrated knowledge of applicable OSHA construction safety standards and have a completion certificate of 30 hour OSHA training pertaining to 1926 Safety and Health Regulations for Construction.
 - b. **Superintendent's Resume:** The superintendent's resume shall be submitted as part of the Contractor's Safety and Health Program and shall include the following:
 - (1) Work history relating to above requirements.
 - (2) Three job-related references.
 - (3) Current first aid and CPR certificates.
 - (4) Listing of safety and health training.
 - c. **Responsibilities:** The superintendent's primary responsibilities shall be to provide oversight and supervision of onsite work activities. Superintendents shall be in a non-work status during work requiring a Hot Line Order, Clearance or other critical phases of work as determined by the COR.

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5. **CONTRACTOR'S SAFETY AND HEALTH PROGRAM:** Submit one (1) electronic copy of a proposed Safety and Health Program (Program) to the COR for approval at least 10-days prior to start of construction operations. The Contractor will always keep one (1) hard copy of the approved Program onsite. Onsite construction operations shall not begin until approval of the Program. Approval of the Program, including amendments and supplements thereto, is for the purpose of determining compliance with the standards and project specifications only and shall not relieve the Contractor of the responsibility for the safety and health of persons and property. The Program shall include, but not be limited to, the following:
- a. Designation of the onsite superintendent to carry out the Program. Include superintendent's resume of qualifications and experience in the type of work to be performed and safety and hazard recognition training.
 - b. Statement of company Safety and Health Policy encompassing compliance with applicable Federal, State, and local safety standards and the safety and health requirements of the standards and project specifications.
 - c. Provision for first aid, medical care of injured employees and emergency response telephone numbers as required by OSHA 1926.50, "Medical Services and First Aid". For fieldwork involving two (2) or more employees at a work location, at least two (2) trained persons shall be available. For fixed work locations, the number of trained persons available shall be sufficient to enable emergency treatment to begin within 4-minutes of an accident.
 - d. Provision for training employees in the recognition and avoidance of unsafe conditions using methods such as new employee orientation, weekly "toolbox" meetings and job hazard analysis.
 - e. Fire protection procedures and facilities, including requirements in OSHA 1926, Subpart F, "Fire Protection and Prevention".
 - f. Health and sanitation facilities, including requirements in OSHA 1926.51, "Sanitation".
 - g. Procedures for specific sequences of work to ensure adequate activity hazard analysis of hazards and provision of protective measures (e.g., demolition, excavation, structure erection, stringing operations, grounding, working adjacent to energized electrical equipment, installation/removal of batteries banks, etc.).
 - h. Provisions for the use and furnishing of personal protective equipment.
 - i. Procedures for protecting the public.
 - j. Company policy and procedures for enforcing safety and health regulations.
 - k. Copy of the current certificate of compliance with industrial compensation insurance statutes.
 - l. Procedures as required by OSHA 1926, Subpart D, "Occupational Health and Environmental Controls".
 - m. A comprehensive daily inspection program for inspecting tools, equipment and facilities. The inspection program shall document observed hazards and the corrective actions taken.
 - n. Fall protection policy and program identifying hazards and listing equipment and procedures the Contractor is planning on using for this specific project that meets the requirements of OSHA 1926 and applicable WAPA standards. A list of Contractor approved employees, to work at height when fall protection is required, shall be provided to the COR.

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- o. Lockout/Tagout and Arc Flash Requirements: Submit a lockout/tagout program, specific to equipment and circuits being worked on, which complies with the requirements listed in OSHA 1926, Subpart K, “Electrical Standards for Construction”; OSHA 1926.966, “Substations”; ANSI/IEEE National Electric Safety Code (NESC) C2.
 - p. Provision for line-clearance tree trimming operations including requirements in OSHA 1910.266. “Logging operations” and 1910.269(r). “Electrical power generation, transmission and distribution”. Include qualifications and certification of training.
6. JOB HAZARD ANALYSIS:
- a. A Job Hazard Analysis (JHA) is a study of a job or activity to identify hazards or potential accidents associated with each step or task and develop solutions that will eliminate, modify or prevent such hazards or accidents. For simple tasks, the JHA may be a thought process for a single employee task; it may be a verbal discussion as part of a tailgate safety meeting; or it may be a verbal discussion between a Supervisor and employee when work is assigned.
 - b. For complex, high risk tasks, or as directed by the COR, a written JHA shall be prepared by the Supervisor in consultation with the employees. It also may involve second level or higher supervision, as in the case of a separate written work procedure. In all cases, the analysis shall include those participating in the task and a signature or initials of all participants shall be required.
 - c. The JHA shall consist of the following: date; identification of Employee Group(s); location and directions to the worksite; narrative description of work to be accomplished; list of identified hazards and how to minimize or eliminate, including specific personal protective equipment; appropriate apparel; special instructions or limitations; list of all special equipment and tools; and sequence of steps or, when required, a detailed step-by-step work procedure.
7. JOINT WAPA AND CONTRACTOR SAFETY MEETINGS:
- a. Commencement of Construction: Prior to beginning onsite construction, a preconstruction safety meeting will be conducted with the Contractor's supervisory personnel and WAPA for review of the Contractor's Safety and Health Program.
 - b. Management Safety Awareness Meeting: After commencement of construction, the Contractor's management, subcontractor's management and WAPA's management shall conduct a management safety awareness meeting, including the Contractor's supervisors and work force. This meeting shall be for the purpose of demonstrating to project personnel that the Contractor and WAPA are totally committed to providing a safe workplace.

Additional meetings will be required as necessary to ensure a majority of employees have participated.
 - c. Periodic Joint Safety Meetings: Periodic joint safety meetings with the Contractor's supervisory personnel and WAPA will be conducted throughout the contract.
8. FAILURE TO COMPLY: Failure to implement, monitor and enforce the Safety and Health Program and the requirements of the standards and project specifications may result in the Contracting Officer's directed removal of the job superintendent or may result in suspension of work as provided by the contract clause entitled “Accident Prevention” or both. WAPA's failure to order discontinuance of the Contractor's operations shall not relieve the Contractor of responsibility for the safety and health of personnel and property.

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9. ACCIDENT RECORDS AND REPORTING: Maintain and furnish accurate records and reports to WAPA as directed by the COR. Verbal notifications are required immediately, and written reports are required within 48-hours on job-related deaths, occupational diseases, traumatic injuries to employees or the public and property damage caused by an accident as follows:
- a. Personal Injury/Illness:
 - (1) Job-Related Injuries/Illnesses: Job-related injuries/illnesses to Contractor employees shall be reported to the COR. Injuries/illnesses shall be posted to the OSHA 300 Log and OSHA Form 301 and shall be available for review by the COR.
 - (2) Public Injury: Injuries to the public arising out of this contract shall be reported to the COR.
 - b. Equipment and Motor Vehicle Accidents: Work site equipment and motor vehicle accidents, regardless of extent of injury or cost, shall be reported to the COR.
 - c. Property Damage: Property damage or loss in excess of \$1,000 resulting from any accident shall be reported to the COR. Damage to Government or public property, regardless of cost, shall be reported to the COR.
- When requested by the COR, participate in any investigation of accidents or incidents, including near-miss-type incidents.
10. TESTING AND DATA: Prior to onsite use, furnish the COR with copies of certifications, test records and technical data as follows:
- a. Load performance tests in accordance with Section 1.4.11, "Lifting Devices".
 - b. Annual inspections for cranes and aerial lifts shall be performed by a qualified, independent party, accredited by the Crane Certification Association of America or the manufacturer. Crane annual inspection records shall be in accordance with OSHA 1926 Subpart CC, "Cranes and Derricks in Construction" and annual inspection reports of aerial lift equipment in accordance with ANSI A92. Electronic copies of the reports and any deficiencies corrected for repairs made since the inspection was performed shall be provided to the COR. Copies of the reports and certifications shall also be maintained in the lifting device.
 - c. Brake performance test in accordance with Section 1.4.10 "Equipment".
 - d. Test results of protective ground leads in accordance with Section 1.4.14 "Grounds, Bonds and Other Protective Devices".
 - e. Safety Data Sheets (SDS) for each paint, oil, epoxy, insulating medium, curing compound, herbicide and other hazardous material.
 - f. The manufacturer's load rating for each hoist and grip.
 - g. Certification of fabricated mobile lifting devices and field-fabricated rigging devices in accordance with Section 1.4.11 "Lifting Devices".
 - h. Medical Examiner's certificate in accordance with Section 1.4.3 "Employee Requirements".
 - i. Data for excavation protective system in accordance with Section 1.4.5 "Excavation".

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11. **SILICA CONTROL REQUIREMENTS:** WAPA construction Contractors are required to comply fully with the Silica Control Requirements of 29 CFR 1926.1153. When cutting, breaking, drilling or otherwise abrading silica-bearing materials such as concrete, brick, stone or masonry, the Contractor shall use a control method listed in Table 1 of 29 CFR 1926.1153 or other method as approved by the COR. When performing any activity listed in Table 1, the Contractor shall also ensure that their work process does not produce any visible emissions of silica-bearing dust.

When using Portland cement, powdered grout or mortar or other powdered silica-bearing materials, the contractor shall handle them in a way that does not produce visible emissions of dust. Any such materials that are inadvertently spilled shall be cleaned up using wet methods or vacuums equipped with high-efficiency particulate filters. The Contractor shall not permit dry sweeping of silica-bearing materials.

If the Contractor will perform abrasive blasting, the WAPA Regional Occupational Safety and Health Manager must review and approve the specific blasting media that will be used. The use of any abrasive blasting media containing more than 1-percent free silica is prohibited.

1.4.2 PUBLIC SAFETY:

1. **ROADS:** Roads subject to interference by the work shall be kept open without unreasonable delays or suitable detours shall be provided and maintained. Protection of the public shall be provided as required by OSHA 1926, Subpart G, "Signs, Signals and Barricades" and by the public agency having law enforcement jurisdiction for the roadway.
2. **RAILROADS:** Provide, erect and maintain barricades, flasher lights, flag persons, danger signals and signs where access roads and haul routes cross railroads.

1.4.3 EMPLOYEE REQUIREMENTS:

1. **GENERAL:** Employees shall be qualified to perform their assigned duties. Employees shall not work while their ability or alertness is impaired because of fatigue, illness, medications, drugs or alcohol or any other reason that may expose them or others to injury.

Wearing a headset, headphone or other listening device, other than a hearing aid or instrument for the improvement of defective human hearing, hearing protection worn as the hazard exists or for communication purposes is not permitted while on a WAPA jobsite.

2. **TRAINING:** Ensure that each employee entering the worksite has experience, training and, where required, the certification, skills and knowledge necessary to safely perform their assigned tasks. In addition, ensure each employee receives initial worksite safety orientation and continued safety and health training addressing the hazards associated with the work and the measures necessary to control or eliminate the hazards.
3. **PHYSICAL EXAMINATION:** Each employee who operates the following listed equipment shall be given and pass a Department of Transportation (DOT 49 C.F.R. 391.43) physical examination once every 24-months:
 - a. Cranes.
 - b. Aerial lift equipment.
 - c. Other vehicles as required by Federal and State laws and regulations.

A copy of the Medical Examiner's certificate shall be furnished to the COR prior to the employee operating the listed equipment. The certificate shall state that the physical examination met the requirements of DOT 49 C.F.R. 391.43.

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4. OPERATORS: Employees operating motor vehicles and other equipment shall be licensed in accordance with applicable Federal and State laws and regulations.

Provide the COR with assurance of competency of employees operating cranes, aerial lift equipment, heavy equipment and other motor vehicles by documentation of their experience, training and/or licensing. Qualified operators must meet ASME B30.5 (OSHA Ref. 29 C.F.R. 1926 Subpart CC, "Cranes and Derricks in Construction").

1.4.4 PERSONAL PROTECTIVE EQUIPMENT:

1. GENERAL: Identify the need for personal protective equipment in work activities and require wearing of appropriate personal protective equipment in accordance with OSHA requirements and the following requirements.
2. MINIMUM WEARING APPAREL: Employees shall wear, as a minimum, full-length pants, short sleeve or T-shirt and above-the-ankle leather work boots.
3. HARD HATS: Employees entering the area where construction work is in progress, with the exception of the parking area and the interior of shops and offices, shall wear hard hats. Provide hard hats for visitors entering hard hat areas. "Hard Hat Area" signs shall be furnished and erected.
4. HIGH-VISIBILITY CLOTHING: Personnel working on the ground on or near public thoroughfares, personnel working in areas open to big game hunting and flag persons shall wear safety color fluorescent clothing with a reflective area of at least 400 square inches above the waist.
5. FALL PROTECTION SYSTEMS: All employees working at elevated locations more than 4-feet above a lower level shall use a personal fall protection system, work-positioning equipment or fall restraint system, as appropriate.

Fall arrest systems shall be provided exclusively through the use of a self-retracting lanyard (SRL) in conjunction with a full-body harness. Refer to the specific manufacturer's application and use guidelines for all equipment.

- a. Substations, Transmission Lines, and Microwave Towers: Positioning straps and fall protection systems shall be worn and used in accordance with OSHA 1926.954(b) during construction of electric transmission and distribution lines, substations and microwave towers. Using bushings on substation equipment for anchorage or climbing will not be allowed. Using step bolts and ladder rungs as an anchor point will not be allowed.
- b. Aerial Devices: Transitioning to a structure will only be allowed if the aerial device has a door or ladder designed for that purpose. Personnel transferring to or from an aerial lift shall be protected from falling at all times.
6. SCAFFOLDING: Scaffolding shall be in accordance with OSHA 1926, Subpart L, "Scaffolding". Scaffolds shall be used in lieu of ladders for long-term work procedures.
7. LADDERS: Ladders shall be in accordance with OSHA 1926, Subpart X, "Stairways and Ladders", and the following:
 - a. Suspended Ladders: Provide positive fall protection when climbing, moving or working on suspended ladders.

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- b. Ladders of Conductive Material: Ladders with side rails constructed of conductive material shall not be used in substations or on transmission lines.
 - c. Ladder Stability: Ladders, except stepladders, shall be held or tied off when being climbed, when being worked from or when a worker is getting on or off at an elevated position.
 - d. Ladder Rungs: Ladder rungs shall have skid-resistant surfaces and shall be maintained as such.
8. RESPIRATORY PROTECTION: Provide a respirator program that meets the requirements of OSHA 1926.103, "Respiratory Protection" and OSHA 1910.134, "Respiratory Protection". Employees exposed to airborne contaminants shall wear respirators. Examples of contaminants include, but are not limited to, asbestos, fumes released by welding and cutting on galvanized steel and fiberglass insulation.
- A copy of the program required by OSHA 1910.134(b)(1) through 1910.134(b)(11) shall be submitted prior to use of chemicals or processes requiring respiratory protection, such as sandblasting, etc.
9. CHEMICAL PROTECTION EQUIPMENT: When exposed to chemicals or hazardous materials, employees shall wear personal protective equipment such as full face shield, chemical splash goggles, impermeable gloves and boots, disposable coveralls or impermeable clothing, respirators and any other items recommended by the SDS or label instructions. If impermeable clothing required for chemical application becomes contaminated on the inside, it shall be disposed of and not returned to service.
10. PROTECTIVE CHAPS: When using chain saws, protective chain saw chaps shall be worn. Chaps shall be constructed of four (4) layers of Kevlar or ballistic nylon.
11. FOOT PROTECTION DURING CHAIN SAW USE: Use boots made with material (such as layered Kevlar) capable of meeting ASTM standard F1818 (Standard Specification for Foot Protection for Chain Saw Users or equivalent testing standard to ISO 17249 or EN 381-3).

1.4.5 EXCAVATION:

- 1. BURIED UTILITIES: Prior to excavation, examine the area and determine the location of buried utilities as required by OSHA 1926.651, "General Requirements", subparagraph (b). Utilities shall be identified with a marker denoting the type of service.
- 2. METHOD OF CABLE LOCATION: Prior to starting excavation in an energized substation, submit a plan to the COR, for approval giving proposed methods of locating existing buried cable. The plan shall include methods of identifying subsurface cable locations within the work area and methods of surface marking of cable locations and lines of excavation. When locating control cable, wires shall not be loosened or removed from the terminals and signals shall not be induced into the control circuit. The substation shall remain operational and methods used for cable location shall not interfere with operation of the substation. Excavation will not be allowed until cable location has been marked on the ground and the COR has received a marked print showing the cable location.

Hand dig to confirm the location and identities of the cable. Before digging in an existing substation, review as built drawings, cable trenches, any equipment not shown on the Drawings and terminal box inlets to identify any cables that may not be shown on a drawing.

For work in an energized substation, have a cable locator onsite. Cable and magnetic locator equal to Model MAC 51B, as manufactured by Schonstedt Instrument Company, 1775 Wiehle Avenue, Reston, Virginia, 22090, telephone 703-471-1050.

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3. **UNATTENDED EXCAVATION:** Protection of unattended excavations shall be as required by OSHA 1926, 501(b)(7)(ii).
4. **EQUIPMENT ACCESS:** Precautions shall be taken to prevent slides or cave ins when excavations or trenches are made in locations adjacent to backfilled excavations, or where excavations are subjected to vibrations from adjacent traffic, the operation of equipment, or any other source. A spotter shall assist operators of trucks and equipment when adjacent to excavations as required by OSHA 1926.601, "Motor Vehicles".
5. **EMPLOYEE PROTECTION:** Protection of employees entering excavations shall be as required by OSHA 1926.651, "General Requirements" and OSHA 1926.652, "Requirements for Protective Systems". Select the protective system appropriate for the excavation and submit data relevant to selection of the protective system, including soil classification, qualifications for competent person and any other data listed in OSHA 1926.652, "Requirements for Protective Systems".

1.4.6 EXPLOSIVES AND BLASTING:

1. **GENERAL:** Transportation, handling, storage, and use of explosives shall comply with OSHA 1926, Subpart U, "Blasting and the Use of Explosives". Blasting will be permitted only after adequate provisions have been made for the protection of persons, the work, and public or private property. Blasting shall be done between sunrise and sunset. Repair blasting damage to the work and public or private property.
2. **BLASTING PLANS:**
 - a. **General:** Submit the blasting plan to the COR for approval. No blasting activity shall begin prior to approval of the blasting plan and submission of individual shot plans.
 - b. **Blasting Plan:** Plan shall detail the Contractor's proposals for compliance with this section and shall detail the general concepts proposed to achieve the desired excavations using individual shot plans. In addition, the plan shall address proposed methods for controlling fly rock, for blasting warnings and for use of electrical blasting systems. Provide data to support the adequacy of the proposed efforts regarding the safety of structures and slopes and to assure that an adequate foundation is obtained.
 - c. **Shot Plans:** Shot plans shall detail, including sketches, the drilling and blasting procedures; the number, location, diameter and inclination of drill holes; the amount, type and distribution of explosive per hole and delay; and pounds of explosive per square foot for pre-splitting and smooth blasting.
3. **EXPLOSIVES:** Explosive logs shall be available for review by the COR.
4. **DRILLING DUST CONTROL:** When drilling control the dust within safe hygienic limits as required by OSHA 1926.1153(a), "Respirable Crystalline Silica".
5. **VIBRATION AND DAMAGE CONTROL:** Blasting in the vicinity of buildings, structures and other facilities susceptible to vibration or air blast damage shall be carefully planned and controlled to eliminate possibility of damage to such facilities and structures. Include in blasting plan provisions for control to eliminate vibration and air blast damage.
6. **BLASTER CERTIFICATION:** Blasters shall be qualified as required by OSHA 1926.901, "Blaster's Qualifications". In States having jurisdiction for enforcement and requirements for formal certification or licensing blasters and explosives purchasers, comply fully with those requirements. The blasting plan shall contain documentation of the blaster's certifications, qualifications and experience.

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1.4.7 MATERIAL HANDLING AND STORAGE:

1. **GENERAL:** Material handling and storage shall be as required by OSHA 1926, Subpart H, “Materials Handling, Storage, Use, and Disposal” and OSHA 1926, Subpart V, “Power Transmission and Distribution”. Stack heavy material on adequate lagging to prevent shifting. Cylindrical-shaped material such as poles and pipe shall be handled with extra caution to prevent unplanned movement.
2. **CRITICAL LIFTS:** The Contractor shall prepare a written plan for critical lifts. All personnel involved with the lift shall review and sign the Critical Lift Plan.

A critical lift is defined as a lift requiring detailed planning and additional safety precautions, including:

- a. Lifts being made under a hotline order next to energized conductors.
- b. Lifts made when the load is 75-percent or more than the rated capacity of the crane or hoisting device.
- c. When crane supported personal platforms are being used.
- d. Any lift the operator or COR believes critical.

The plan shall include, but is not be limited to:

- (1) Exact size and weight of the load, including the crane and rigging components.
- (2) Exact information about the sequence of the lift.
- (3) Rigging plans with lift points and hardware requirements.

1.4.8 STRUCTURE ERECTION:

1. **GENERAL:** Procedures for erecting structures shall be made a part of the Safety and Health Program. The structure erection plan shall include, but not be limited to, the following subjects: assembly, lifting, shoring, size and type of hoisting equipment, operator qualifications, crane signal/communication, connecting rigging, guying, moving equipment, and protection for adjacent energized power facilities.

Structure and building assembly and erection shall be conducted with a minimum exposure to employees from overhead loads and work activities. No one shall be permitted under the load while it is being hoisted into position, except as required to secure the load being set. No one shall be allowed to ride the hook, line or load.

2. **COMMUNICATION:** A 2-way radio device shall be used to relay information between the spotter and the crane operator when vision is obstructed.
3. **TEMPORARY STRUCTURE SUPPORT:** Structures shall have adequate temporary guy cables or other structural support during erection procedures. Temporary structure support shall be approved by a registered Professional Engineer. Temporary guys or structural supports shall remain in place until the permanent guys or structural supports are in place.
4. **TOOLS:** Tools and material shall not be thrown or dropped from structures. Handlines and tool bags shall be used.

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1.4.9 ELECTRICAL MINIMUM APPROACH DISTANCE:

1. GENERAL: Equipment, conductive objects and personnel shall not be brought closer to energized high-voltage facilities than the distances listed in the applicable parts of OSHA 1910 and 1926 as listed below. Adequate means of preventing violations of the electrical minimum approach distances shall be used, such as spotters and equipment stops.

Cranes and Derricks shall comply with 1926 Subpart CC, "Cranes and Derricks in Construction". A notice of the electrical minimum approach distance limitations required by the Standards shall be permanently posted in the operator's cab of such equipment.

Other equipment, conductive objects or personnel, shall not be brought closer to energized facilities than the electrical minimum approach distances established by OSHA 1926.958(b), "Materials, Handling and Storage". The less stringent equipment clearance distances established by OSHA 1926.960, "Working On or Near Exposed Energized Parts", Table V-5 and Table V-6, may only be used after the Contractor has completed and submitted WAPA's Electrical Clearance Variance form and has received the signed form in return from the COR.

1.4.10 EQUIPMENT:

1. GENERAL: Equipment shall be designed, manufactured, maintained and operated as required by OSHA 1926 and the requirements contained in this section. Equipment shall be used only for the manufacturer's intended purpose.
 - a. Riding on Equipment: Riding on equipment is prohibited unless a safe place to ride is provided. A safe place to ride is defined as a permanently affixed seat with passenger restraint device. Getting on or off equipment while in motion is prohibited.
 - b. Brakes: When directed by the COR and when otherwise required, carry out a braking performance test on onsite equipment. Test shall be conducted in the presence of the COR and recorded on the form prescribed by the COR.
2. ROLLOVER PROTECTIVE STRUCTURES AND SEAT BELTS: Equipment defined by OSHA 1926.1000, "Rollover Protective Structures (ROPS) for Material Handling Equipment", shall be equipped with rollover protective structures (ROPS) meeting the performance requirements of OSHA 1926.1001, "Minimum Performance Criteria for Rollover Protective Structures for Designated Scrapers, Loaders, Dozers, Graders and Crawler Tractors". Equipment defined by OSHA 1926.602, "Material Handling Equipment", shall be equipped with seat belts in accordance with the requirements of that section. Agricultural, industrial tractors and off-road utility vehicles shall be equipped with the ROPS and seat belts, regardless of date of manufacture. Seat belts shall be worn when operating equipment that is required to be equipped with seat belts.

1.4.11 LIFTING DEVICES:

1. GENERAL: Lifting devices shall be designed and manufactured or fabricated for their intended use and shall conform to applicable ANSI standards; OSHA 1926, Subpart CC, "Cranes and Derricks in Construction"; OSHA 1926 Subpart H "Material Handling, Storage, Use and Disposal"; OSHA 1926 Subpart O "Motor Vehicles"; and the requirements of this section.
2. MOBILE CRANES: Crawler, truck and wheel-mounted cranes shall conform to applicable requirements for design, inspection, construction, testing, maintenance and operation as prescribed in ANSI B30. The exception in the last sentence of B30.15-0.1 shall not apply. Submit annual inspection records to the COR in accordance with ANSI B30.

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3. **AERIAL WORK DEVICES:** Aerial work devices used to raise, shift and lower personnel shall conform to applicable requirements for design, inspection, construction, testing, maintenance and operation as prescribed by ANSI A92, regardless of date of manufacture. Submit annual inspection records to the COR in accordance with the applicable ANSI standard.
4. **FORKLIFTS AS ELEVATED PLATFORMS:** Forklifts used as elevated platforms will be subject to approval of the COR for each application. Forklifts and platforms will conform to B56.1. The Contractor shall submit and receive approval of a plan addressing OSHA requirements 1926.451(c)(2)(iv) and (v), 1926.602(c)(1)(viii) thru 1926.502(d).
5. **WORK PLATFORMS:** Work platforms suspended from crane load lines will be subject to the approval of the COR for each application. The design, use and testing of the work platforms shall be in accordance with OSHA 1926 Subpart CC, "Cranes and Derricks in Construction".
6. **FABRICATED MOBILE LIFTING DEVICES:** Fabricated mobile lifting devices such as truck mounted A frames, gin poles and similar equipment shall be designed, constructed, and certified based on the determinations of a registered Professional Engineer competent in this field. A written contract specific certification shall be provided to the COR. Design capacity shall be posted at the operator's station.
7. **LOAD PERFORMANCE TEST:** Prior to initial use and following modification, alteration or repair of any component, load test mobile cranes and fabricated mobile lifting devices at the jobsite and in the presence of the COR. Provide test results on forms supplied by WAPA. Load test shall involve lifting, swinging and brake holding a load of 100-percent of the load chart rating for a specific configuration and load radius. Configuration, load radius and test weight shall be chosen to prove the machine's capability and load chart accuracy for its anticipated use. Configuration shall provide a boom angle of at least 30-degrees above the horizontal.
8. **REPAIRS:** Repairs shall be in strict compliance with manufacturer's instructions. The manufacturer or a registered Professional Engineer shall certify repairs to structural load carrying parts competent in structural analysis. Submit certification to the COR.
9. **RIGGING:**
 - a. **General:** The handling, use and inspection of rigging shall be in accordance with OSHA 1926.251, "Rigging Equipment for Material Handling".
 - b. **Rigging Selection and Analysis:** Analyze the requirements and select the rigging equipment appropriate for the load based upon thorough analysis of load data, rated capacities and manufacturer's recommendations. A copy of the analysis and selection of equipment shall be submitted to the COR.
 - c. **Field-Fabricated Devices:** The design of field-fabricated rigging equipment and devices shall be certified by a registered Professional Engineer.
10. **UNKNOWN LOADS:** When lifting an unknown load or a load that cannot be calculated, a load indicating device shall be used.

1.4.12 CONDUCTOR OR OVERHEAD GROUND WIRE SUSPENDED WORK CARTS:

The use of work carts suspended from conductors or overhead ground wires will be subject to the approval of the COR for each application. A detailed work procedure shall be submitted for approval by the COR that, as a minimum, addresses the following:

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1. DESIGN: Work cart design or modifications shall be certified by a registered Professional Engineer or the manufacturer. Cart capacity will be clearly displayed on the cart exterior. Cart design shall be such that no single component failure will separate cart from conductor or overhead ground wires.
2. HOISTING AND INSTALLING: Method of hoisting and installing the cart on the conductor and procedure for powering the cart along the conductor.
3. EXISTING FACILITIES: Prior to working on existing facilities, evaluate the condition of existing structures, conductors, suspension hardware and overhead ground wires. Fall protection procedures will be used.

The use of work carts will be approved only when less hazardous methods of performing the work are not feasible.

1.4.13 AVIATION:

1. GENERAL: Helicopter, fixed wing and/or unmanned aerial vehicle (UAV) operations shall conform to applicable FAA standards contained in 14 C.F.R. 91, 133 and 135 and OSHA 1926.551, "Helicopters". The Contractor and/or Subcontractor shall select an aviation provider from the "Accepted Operator List" located on the Department of Energy (DOE) Office of Aviation Management (OAM) website.
https://powerpedia.energy.gov/wiki/CAS_Accepted_Operators_List.

The aviation Contractor shall maintain "accepted" status throughout the performance period of the contract and immediately notify the COR of any aviation-related violations and/or accidents or incidents that may be in conflict with its current DOE-accepted aviation status. If there is a conflict with the aviation providers listed, WAPA aviation may review alternate provider options, contact the COR immediately.

2. PROGRAM REQUIREMENTS: Program submittals shall include the following:
 - a. Aviation operator certifying credentials of pilot for the work to be performed addressing the following:
 - (1) Evidence of experience in class load, make and model of aircraft, including currency of training in aircraft make and model. Training must have included emergency procedures, weight and balance computations, performance charts and training in the approved flight manual.
 - (2) If the pilot is not experienced in class load, make and model, provide onsite training and supervision by the chief pilot until the pilot has demonstrated that they can perform the work safely. Minimum training period shall be at least ten (10) flying hours.
 - b. The aviation operator certifying compliance with 14 C.F.R. 91, Subpart E, and possession of current:
 - (1) Airworthiness Certificate.
 - (2) Aircraft Registration.
 - (3) Current Weight and Balance.
 - (4) Operator's Manual.

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- c. JHA's shall be submitted for procedures addressing the following concerns:
 - (1) Emergency procedures.
 - (2) Communications between pilot and ground.
 - (3) Hazards involved in rigging components between the helicopter and any external loads (e.g., "weak link") in Class C loads, etc.
 - (4) Hazards involving aircraft flight attitudes.
 - (5) Hazards for load combinations that require hot-line crossings.
 - (6) Static electricity discharge.
 - (7) Refueling procedures and control of fuel planning.
 - (8) An evaluation of the selection of the wire stringing direction that has considered direction of prevailing winds, relationship to adjacent lines, terrain or other hazard factors.
- d. In addition, a JHA shall be performed and procedures established and submitted for those tasks identified as high risk or of a recurring nature (e.g., installing spacers, travelers, marker balls, conductor repair, etc., from the helicopter skid); Class B loads (e.g., hanging ladders, travelers, steel tower erection, concrete placement, etc.); and/or Class C loads (e.g., sockline and overhead ground wire stringing, center phase pass through, "needle" stringing for center phase, tower catch off of sockline or overhead ground wire, etc.). These are examples of tasks requiring development and submittal of a job hazard analysis.
- e. External Load Operations:
 - (1) A spotter shall be utilized during stringing operations to observe and warn the pilot of impending hazards during tower threading operations.

1.4.14 GROUNDS, BONDS AND OTHER PROTECTIVE DEVICES:

- 1. GENERAL: Electrical circuits, equipment and conductors; construction equipment; and other conductive apparatus used in proximity of energized facilities shall be considered an electrical hazard to personnel and shall be considered energized until grounded in an approved manner. No work shall be performed on energized equipment and circuits.
- 2. DEFINITIONS: The following definitions of terms apply to the protection of personnel from electrical shock:
 - a. Approved Ground: Approved grounds shall be as follows:
 - (1) A station ground mat.
 - (2) An installed structure or electrical equipment ground.
 - (3) 5/8-inch-diameter copperweld or galvanized rod driven or screwed to a depth of at least 5-feet. If a rod cannot be installed to a depth of 5-feet, install additional rods such that a total of at least 5-feet of rod is buried. Bond these rods together with grounding cables of adequate size based on maximum fault current.

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- (4) In parallel conditions, or when energized lines are being crossed, ground rods shall be driven until the total resistance, between the grounding system and remote earth, falls below 50-ohms. If the grounding system does not result in less than 50-ohms, ground rods shall be driven until the reduction in worksite resistance is less than 10-ohms. Ground impedance shall be measured in accordance with IEEE Standard 81.
- b. Hot-Stick: A hot-stick is a nonconductive tool designed, certified and approved by the manufacturer for the installation of protective ground leads in accordance with OSHA 1926.951, "Tools and Protective Equipment". Wood hot-sticks shall not be used.
 - c. Protective Ground Leads: Protective ground leads (protective ground cable assemblies) are those utilized for grounding electrical apparatus and construction equipment. Protective ground leads shall be a minimum No. 1/0 AWG extra-flexible copper or equivalent. Some areas of work may require protective ground leads with greater current-carrying capacity than No. 1/0 AWG due to available fault current.
 - d. Protective Ground Lead Connector: A protective ground lead connector is one designed for installation with an insulated hot-stick. A hot-stick may be an integral part of the connector, or the connector may be designed for use with a universal or utility-type hot-stick. Connectors shall be the self-cleaning clamp type and shall have a current-carrying capacity equal to the capacity of the protective ground lead.
 - e. Grounding: Grounding is electrically connecting a conductive object to an approved ground with a protective ground lead.
 - f. Bonding: Bonding is electrically connecting a conductive object to other conductive objects with a protective ground lead.
 - g. Drag-Chain Ground Lead: A drag-chain ground lead is a steel, or steel alloy chain securely bolted to the chassis of rubber tired mobile construction equipment. Chain shall have links at least 1-inch in length, and the overall chain length shall be sufficient to provide 1-foot of ground contact when the equipment is not moving. A drag chain is allowable only when no other ground lead is feasible and equipment grounding is required.
 - h. Three-Phase Grounded Short: 3-phase grounded short means bonding three (3) phases of an electrical circuit and connecting to a common approved ground.
 - i. Barricades: A barricade is a highly visible physical obstruction intended to warn and limit access to a hazardous area. Construct barricades of high-visibility, weather-resistant material such as yellow 1 1/2-inch plastic tape or yellow synthetic fiber rope. Support barricades to avoid displacement and to maintain a height of approximately 42-inches above walking surface. Locate barricades in such a manner that persons obeying the barricade are restricted from contacting conductive objects within the barricade.
 - j. Barriers: A barrier is a physical obstruction which is intended to prevent contact with energized lines or equipment and to physically prevent access to other hazardous areas. Barriers are intended to physically prevent children and livestock from entering an area and make the existence of a hazard apparent to other persons. Fence-type barriers shall be at least 48-inches high and supported to prevent displacement.

Supports shall be constructed and located so as to not enhance climbing. If constructed of conductive material, the barrier shall be connected to an approved ground with a protective ground lead. Signs shall be placed on the barrier and shall be 10-inches by 14-inches in size, visible from any direction, and read "Danger High Voltage".

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- k. **Grounded Travelers:** Grounded travelers are stringing sheaves or blocks used to make electrical ground connection to conductors and conductive pulling lines. They shall be designed and constructed for this purpose. Western requires the use of grounded travelers that incorporate a separate spring-tensioned sheave to provide the contact surface. Grounded travelers shall not be used or considered as a personal protective ground.
 - l. **Isolation Platform:** An isolation platform is a working or walking surface used to prevent personnel from contacting two conductive objects or a conductive object and the ground simultaneously. Isolation platforms shall be constructed of plastic or fiberglass, shall be at least 5-inches in height, have 9-square-feet of working surface, and shall be able to support dynamic loads up to 4,000 pounds. Wood platforms will not be allowed. Isolation platforms shall be maintained free of dirt, dust, and contamination. When used on wet or soft ground, additional supports shall be provided to ensure the entire platform stays above the ground surface.
 - m. **Electrical Insulating Boots:** Electrical insulating boots shall not be used as a primary means of electrical protection unless other methods of performing the work are not feasible and they have been approved by the COR. If used as secondary protection, boots shall be dielectric rubber boots with an electrical insulation value equal to or greater than 18-kV as tested in accordance with ANSI Z41.4. A program shall be developed and implemented requiring daily inspection of the boots, the testing of the insulating property of the boots on a regular basis, boot replacement criteria, and the instruction of workers on the care and use of the boots.
 - n. **Grounded Work Mat:** A grounded work mat is a working or walking surface used to eliminate step potentials in a work area. The mat may be constructed of woven wire fencing or concrete reinforcing mesh and shall be grounded to an approved ground within 10-feet of the mat. Access to the mat shall be accomplished with an isolation platform and barriers or barricades as required shall be installed.
 - o. **Work Site GPR Monitoring System:** A work site safety warning system that is installed at each work site, connected to the work site ground, which monitors the ground potential rise at the work site and provides an audible and visual alarm when the GPR has reached potentially hazardous levels.
3. **TESTING AND CERTIFICATION:**
- a. **Protective Ground Leads:** Each protective ground lead shall have a permanent identification tag with unique identification number, certified wire size, and test date. Each protective ground lead shall be tested complete with connectors, in accordance with ASTM F 2249. Protective ground leads shall be retested and recertified annually. A protective ground lead without an identification tag to relate it to the annual certification of that protective ground lead shall not be used. No protective ground lead shall be longer than 36 feet, unless approved by COR. Test results shall be submitted to the COR for approval prior to use of the grounds. When using the DC test method, the Contractor shall submit testing information in the format shown below in the Personal Protective Grounds Test Report. When using the AC test method, the Contractor shall submit testing information in accordance with the test set manufacturers recommendations.

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Personal Protective Grounds Test Report

Project Title _____

Contract No. _____

Test Equipment _____

CABLE ID	CABLE SIZE	CABLE CONDITION	CABLE LENGTH		MEASURED RESISTANCE (mΩ)	ASTM 2249 RESISTANCE (mΩ)	PASS/FAIL
			FT	IN			

Tester's Signature _____

Test Temperature _____

Test Date _____

- b. Grounded Travelers: Grounded travelers with a separate spring-tensioned sheave shall be designed, installed and tested to provide 1-ohm or less resistance between the moving conductor and the protective ground lead connection. Tests shall be performed at the worksite in the presence of a WAPA Representative before initial use of grounded travelers. Periodic retesting shall be performed as requested by the COR.
4. INSTALLATION AND REMOVAL OF PROTECTIVE GROUND LEADS: Installation and removal of protective ground leads shall be in accordance with OSHA 1926.962, "Grounding for Protection of Employees". While applying or removing the hot end of the personal protective grounds, workers shall not be in contact with the ground cable.

When two (2) or more sets of grounds are specified to be used, all cables shall be the same size and approximate length. These grounds shall be placed as close together as possible to minimize coupling and be bound or twisted together to maximize the current carrying capacity of the cable set. Protective ground leads shall be constructed with commercial connectors installed in accordance with manufacturer's instructions.

1.4.15 CLEARANCES, HOT LINE ORDERS AND SPECIAL WORK PERMITS:

1. GENERAL: Secure information concerning which facilities are energized at or near each worksite. Take precautions for the safety of personnel, and keep employees fully informed of the work situation and safe work limits. Information concerning WAPA facilities or other facilities under the operational control of WAPA shall be obtained from the COR.
2. DEFINITIONS:
 - a. Clearance: Clearance is a procedure whereby energized electrical facilities are de energized; and switches, disconnects and circuit breakers are tagged or locked to prevent re-energization.
 - b. Hot Line Order: Hot Line Order is a procedure whereby adjacent electrical facilities may remain energized during Contractor operations, but provides that if any circuit breaker connected to the facility opens under fault conditions, it will not be reclosed until employees and equipment working in the area are determined to be in the clear.
 - c. Special Work Permit: Written permit issued by WAPA's Representative, indicating the limits of the work areas, restrictions and conditions pertinent to the work. It is issued to the

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Contractor's authorized representative for Contractor activities on or near facilities under the operational control of WAPA. The Contractor's authorized representative shall be the superintendent or other supervisors designated by the superintendent in writing.

3. PROCEDURES TO OBTAIN CLEARANCES AND HOT LINE ORDERS:

- a. Clearance and Hot Line Order requests shall be made in writing to the COR at least 45 calendar days prior to the anticipated work. Special Work Permit requests shall be made in writing at least 45-calendar days prior to the anticipated work. Request shall include the plan of operation indicating the Contractor's authorized representative under whose direction the work will be performed, the work to be done, sequence of operations, time to start work, duration of work, number of employees and their classifications, safety precautions to be taken, type and location of barricades, warning signs, protective grounds and description of equipment to be used in performing the work.
- b. Following approval of the Contractor's plan of operation, and after obtaining a Clearance or Hot Line Order, WAPA's inspector will issue a Special Work Permit to the Contractor's authorized representative.

4. SPECIAL WORK PERMIT PROCEDURES:

- a. Special Work Permit will indicate the limits of the work area, restrictions, and conditions pertinent to the work including Clearance or Hot Line Order, or both issued by WAPA. Both the Contractor's authorized representative and WAPA's Representative shall sign the Special Work Permit, and each retains a copy. The Contractor's authorized representative shall remain onsite when work is being performed under a Clearance or Hot Line Order.
- b. Review the Special Work Permit and limits of the work area with employees before proceeding with the work and as frequently thereafter as necessary to ensure that employees are knowledgeable of the work program and the required safety precautions.
- c. After receipt of a Special Work Permit for a Clearance and prior to commencement of any work, install 3-phase grounded shorts in the following sequence.
 - (1) Using a hot-stick of sufficient length to maintain the electrical minimum approach distance contained in Table V-1 of OSHA 1926, Subpart V, "Power Transmission and Distribution", test the circuit to ascertain it is de-energized. The voltage detector shall be able to measure and display primary and induced voltages and shall be equal to model number VDAH300 manufactured by The White Rubber Corporation, 835 Cleveland Road, P.O. Box 230, Ravenna, Ohio, 44266.
 - (2) Install the protective ground leads by first attaching the leads to the approved ground.
 - (3) Attach the protective ground leads to the de-energized circuit with a hot-stick maintaining electrical minimum approach distances contained in Table V-1 until ground leads are attached. This electrical minimum approach distance requirement shall be maintained between parts of the workman's body and the protective ground lead being attached.
 - (4) Document location of protective ground leads on the Special Work Permit.

Additional grounding may be required depending on type and location of work being performed.

5. PROCEDURES FOR RELEASE OF A SPECIAL WORK PERMIT: After the work has been completed, advise WAPA's inspector and the following will occur:

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- a. WAPA's inspector will check to determine that the equipment installed or modified is satisfactory for normal service, energization or is in safe condition for the action to be released.
 - b. Remove protective ground leads, bonds and other protective devices in the reverse procedure specified in Section 4(3) above.
 - c. The Contractor's authorized representative holding the Special Work Permit shall sign both copies of the release of the Special Work Permit certifying that personnel and equipment are in the clear and will remain in the clear and that protective ground leads, bonds and protective devices have been removed.
6. TRANSFER OF RESPONSIBILITY FOR SPECIAL WORK PERMIT: If necessary, to transfer responsibility for work under a Special Work Permit from one (1) Contractor's authorized representative to another, the following shall occur:
- a. A new Special Work Permit will be issued to the Contractor's new authorized representative by WAPA's Representative with an explanation of the limits of the work defined thereon.
 - b. WAPA's Representative and the Contractor's new authorized representative will review the location and integrity of protective ground leads, bonds and other protective devices.
 - c. The old Special Work Permit will then be released.

1.4.16 SUBSTATION SAFETY:

1. GENERAL: In addition to the requirements contained in OSHA 1926, Subpart V, "Power Transmission and Distribution" and other applicable OSHA requirements, the requirements contained in this section apply.
2. SUPERVISION AND AUTHORIZATION: Work shall be performed under the immediate supervision of the Contractor's superintendent. No work shall be performed in or near an energized facility that is under the operational control of WAPA until authorization to proceed and a Special Work Permit is obtained from WAPA's inspector, when appropriate.

Provide documentation of obtaining protection and permission before performing any work on or near any electrical facility under the operational control of a non-WAPA agency or utility.

3. RESTRICTED AREAS: Areas of the substation other than de-energized areas and access ways specifically designated by WAPA's Representative shall be considered restricted areas and shall be barricaded. The Contractor's employees shall not enter a restricted area.
4. ELECTRICAL EQUIPMENT CONTAINING SF6:
 - a. General: The SF6 insulating gas in electrical equipment poses a potential health problem to exposed employees. In its pure state, SF6 gas is about 5-times heavier than air and is a simple asphyxiate. Electrical arcing can cause SF6 gas to separate into chemical components. When the arc is removed, the chemical components will recombine to form SF6 gas but may leave extremely hazardous by products. It is imperative to avoid skin contact with, inhalation of, and ingestion of these by products. The solid portions of these by products are usually in the form of a white or gray powder which may be found on the interior of gas confinement areas of the equipment.
 - b. Instructions and Standards: Prior to opening the SF6 gas containment areas of the equipment, employees shall be informed of the pertinent sections of the SDS for SF6 gas

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and the manufacturer's instructions for equipment disassembly. Manufacturer's instructions on opening up the electrical equipment containing SF6 gas shall be followed to prevent accidents from sudden release of high-pressure gas. Comply with OSHA 1926.21, "Safety, Training and Education", subparagraph (b)(6), for confined space entry where employees must enter the electrical equipment.

- c. Protective Equipment: Because of the danger to employees of SF6 by products, do not open any piece of electrical equipment containing SF6 gas which has been exposed to electrical arcing unless the employees involved are protected with the equipment listed below. The protective equipment as specified in the MSDS and as listed below shall be worn until a thorough examination reveals that no SF6 by products are present.
 - (1) Either self-contained breathing apparatus or airline respirators supplying breathing quality air.
 - (2) Chemical safety goggles if eyes are not protected by the above mask.
 - (3) Impermeable gloves.
 - (4) Disposable coveralls.
- d. Portable Eye Wash/Shower: A portable eye wash capable of 15-minutes of flushing at .4 gpm shall be located within 20-feet for emergency decontamination of employees.
- e. Disposal of SF6 By Products: Disposal of SF6 by products shall be in accordance with Federal, State and local regulations. Certificates of disposal shall be provided to the COR.

5. ADDITIONAL REQUIREMENTS:

- a. Control Panels: Work on energized control panels shall be in accordance with OSHA 1926.966, "Substations", and shall include the use of accident prevention tags.
- b. Substation Fences: Obtain the COR's approval prior to removing substation fencing. Temporary protection for removed fences and controlled access to the substation shall be in accordance with OSHA 1926.966, "Substations".

1.4.17 TRANSMISSION LINE SAFETY:

- 1. GENERAL: In addition to the requirements contained in OSHA 1926, Subpart V, "Power Transmission and Distribution", and other applicable OSHA requirements, the requirements contained in this section apply.
- 2. SUPERVISION AND AUTHORIZATION: Work shall be performed under the general supervision of the Contractor's superintendent. No work shall be performed in or near an energized facility that is under the operational control of WAPA until authorization to proceed and a Special Work Permit is obtained from WAPA's Representative, when appropriate.

Provide documentation of obtaining protection and permission before performing any work on or near any electrical facility under the operational control of a non-WAPA agency or utility.

- 3. INDUCTION FROM PARALLEL ENERGIZED LINES: Anytime work is performed on a de energized transmission line that parallels an energized line, a Work Site GPR Monitoring System shall be installed. Acceptable work site monitoring systems are: The GroundHound Site Safety Warning System GPR Monitor, Delta Step and Touch Monitor or equivalent.

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4. **STRINGING PLAN:** Procedures for stringing, including sagging and clipping operations, shall be made a part of the Safety and Health Program. The plan shall consist of a description of the stringing method proposed and include: The type of stringing equipment to be used; grounding and bonding devices and procedures; barrier and barricade design as applicable; isolation platform design and use; utility, highway, railway and waterway crossing methods including guard structure design; clearances required; and locations and procedures for stringing adjacent to energized lines.
5. **CONDUCTOR AND OVERHEAD GROUND WIRE STRINGING:** Overhead ground wire and conductive pulling lines shall be considered the same as conductor in terms of required safety precautions during installation or removal. Stringing operations shall be in accordance with OSHA 1926.964, "Overhead lines and live-line barehand work" and the following additional requirements:
 - a. **Equipment and Pulling Operations:**
 - (1) Pulling machines (tuggers), braking machines (tensioners) and reel jacks shall be in accordance with OSHA 1926.955, "Overhead lines and live-line barehand work" and the following additional requirements. Stringing equipment and catch off points shall be firmly anchored against displacement. Reels shall be firmly attached to the reel jacks, and the reel jacks shall be anchored to prevent displacement or overturning in the event of a fouled reel or brake lockup.
 - (2) The practice of rigging to an existing structure, not specifically designed for the load magnitude and direction of force, shall not be allowed without first completing a technical analysis by a Structural Engineer.
 - (3) Operators of pulling and braking machines shall be totally protected from contact with bullwheels, cable drums and tension line snap back.
 - (4) A designated person, in direct voice communication with the pulling machine operator, shall watch the attachment between the pulling line and the conductor as it travels through each stringing block.
 - (5) If a conductor should catch under any firm object, the pulling shall stop, and the tension shall be slacked off prior to attempting to free the conductor.
 - (6) No person shall be allowed on any structure through which a conductor is being pulled (in continuous motion).
 - (7) A barricade shall be used to enclose the area between the tensioner and reel setup. Entering the area will be permitted only with the knowledge of the tension and pulling machine operators and when pulling is stopped and undesired tension released.
 - b. **Grounding and Bonding:**
 - (1) General: Comply with OSHA 1926.962, "Grounding for Protection of Employees" and 1926.964, "Overhead Lines and Live-line Barehand Work". The following additional requirements apply to stringing work:
 - (2) Pulling equipment, reels and tensioning equipment shall be grounded to an approved ground. Equipment that can be touched simultaneously at a worksite shall be bonded together and grounded to a single approved ground.
 - (3) A moving-type ground (traveling ground) shall be installed and attached to an approved ground at the tensioning setup or bonded to the tensioner.

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- (4) During construction operations grounded travelers shall be installed for each conductor and ground wire at the first structure away from the tensioner and puller and at intervals not more than 2-miles apart. A 3-phase grounded short shall be maintained on the last suspension structure on each end of each isolated line section and shall remain in place until aerial work is complete. These shall be progressively removed as part of the final aerial cleanup.
- (5) When splicing, making up jumpers and working around unspliced conductors on sequential pulls, employees shall not contact two (2) conductors simultaneously until both conductors are bonded together.
- (6) Dead end structure jumpers shall be left off (open) to isolate line sections and grounds shall not be left in place on these structures. Jumpers may be installed when aerial cleanup is completed on adjacent line sections.
- (7) Clipping work shall be performed between 3-phase grounded shorts.
- (8) Insulated aerial lifts shall not be utilized as primary employee protection from sources of electrical hazard. When grounding is required, insulated aerial lifts shall be bonded and grounded the same as non-insulated aerial lifts.
- (9) Grounding and Bonding for Stringing Over Energized Line Crossings: Comply with subsection (a) above and the following:
 - (a) Conductive pulling lines and conductors shall be grounded at each structure adjacent to energized line crossings. This shall be accomplished with grounded travelers during stringing operations. Prior to removal of grounded travelers for conductor clipping, protective ground leads shall be installed. These protective ground leads shall remain until clipping is completed for that line section.
 - (b) Conductor clipping shall be completed on structures adjacent to energized crossings, prior to clipping the remaining structures in that line section.
 - (c) Employees shall not contact two (2) conductors simultaneously until both conductors are grounded to a common point, unless protective ground leads are installed and conductor clipping is completed on structures adjacent to energized line crossings.
 - (d) Aerial lifts shall be grounded and bonded to the structure or conductor, as appropriate, until conductor clipping is completed on structures adjacent to energized crossings.
- (10) Grounding and Bonding for Stringing Adjacent to Energized Lines: Comply with Sections (a) and (b) above and the following:
 - (a) Protective ground leads shall be placed at each structure during aerial work on conductors at that structure.
 - (b) Aerial lifts shall be grounded and bonded to the structure or conductor as appropriate for aerial work.

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- (c) When splicing, making up jumpers and working around unspliced conductors on sequential pulls, employees shall not contact two (2) conductors simultaneously until both conductors are bonded together and grounded to a common point.
- c. Crossing Energized Lines, Highways, Railroads and Telephone Lines: The owner, utility or authority having jurisdiction shall be notified in advance of making such crossings and necessary permits obtained. The following safety precautions and procedures shall be followed:
 - (1) Prior to stringing over or under an existing power line, inform the owner or utility company and request the existing line be de-energized. Secure Hot Line Orders and/or Clearances from the respective utilities on non-WAPA lines. WAPA shall be kept fully informed, in writing, of such Hot Line Orders and Clearances or denials of such requests prior to the work being performed.
 - (2) Protective guard structures shall be designed and installed at crossings to ensure that adequate clearance is continually maintained between the pulling lines or conductors and the facility being crossed. Clearances of guard structures, pulling lines and conductors from energized lines shall be at least 5-feet but never less than the distance in Table V 6 of OSHA 1926, Subpart V, "Electric Power Transmission and Distribution", for the voltage being crossed.

The protective guard structures shall be installed with the following minimum distances.

TYPE OF ROAD	*MINIMUM DISTANCE FROM EDGE OF ROAD
Gravel road	9-feet
Paved two lane road (county and State)	15-feet
Multilane road	30-feet
Railroad	As required by railroad agency

*If the agency in charge of the road to be crossed determines that greater minimum distances are needed, their minimum distance controls shall be used.

The protective guard structures shall not be removed until the adjacent transmission line structures are clipped in.

- (3) Ropes utilized as lead lines at energized crossings shall be nonconductive and shall be kept clean and dry to protect their dielectric strength.
- (4) Crossings shall be attended when wire is being pulled. Each attendant shall be provided a means of direct communication with the pulling and tensioning machine operator.
- (5) Equipment at the pulling and tensioning sites, catch off points, conductor tails and splice areas shall be enclosed by a barricade with access to equipment or conductor accomplished by isolation platforms. When work procedures require contact with a conductor or anything bonded to the conductor, employees shall work from isolation platforms or grounded work mats. If left unattended, the barricades shall be replaced with barriers and access points closed. The above requirements apply until after conductor clipping is completed on the structures adjacent to the energized line crossing.

STANDARD 1 – GENERAL REQUIREMENTS

- d. Stringing Adjacent to Energized Lines: For stringing operations adjacent to energized lines, comply with OSHA 1926.964, “Overhead Lines and Live-line Barehand Work”, subparagraph (b), and the following additional requirements:
 - (1) Requirements for stringing operations adjacent to energized lines shall apply until stringing operations have progressed beyond the adjacent energized line and the conductor being strung is isolated by open jumpers.
 - (2) Equipment at the pulling and tensioning sites, catch off points, conductor tails and splice areas shall be enclosed by a barricade with access to equipment or conductor accomplished by isolation platforms. When work procedures require contact with a conductor or anything bonded to the conductor, employees shall work from isolation platforms or grounded work mats. If left unattended, the barricades shall be replaced with barriers and access points closed.
 - (3) Aerial lifts used for splicing or clipping shall be barricaded, and an isolation platform used for access to the equipment.
 - (4) Barrier and barricade placement shall be a minimum of 10-feet away from grounds, grounded equipment and conductors.
 - (5) Guy and guy anchors shall be grounded to the worksite ground.

1.4.18 REMOVAL OR UPGRADING OF EXISTING TRANSMISSION LINE:

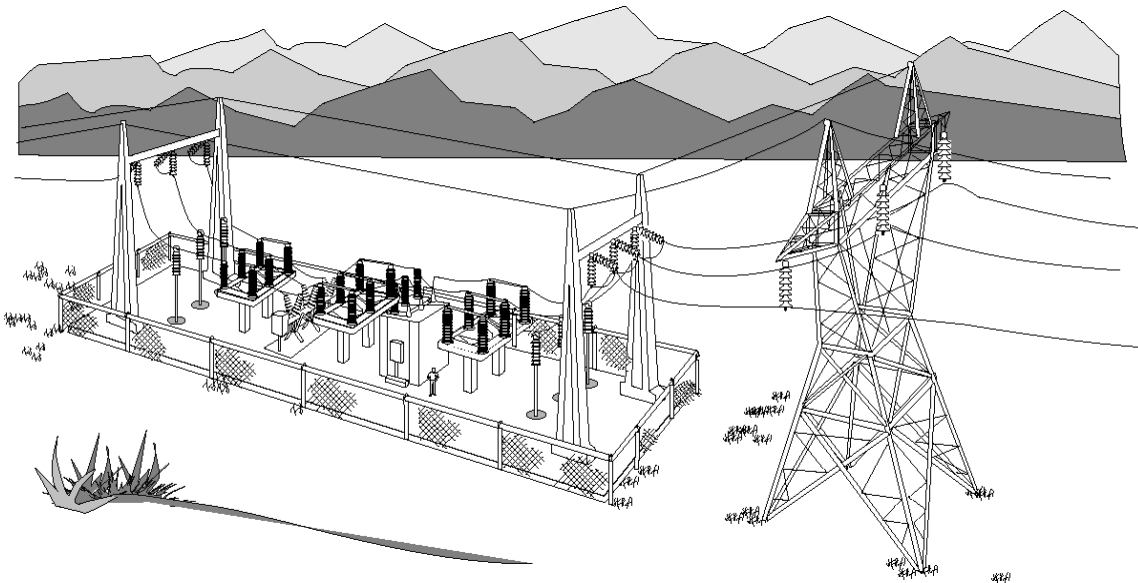
- 1. GENERAL: Prior to removal or upgrading of the existing transmission line, submit for approval a detailed removal plan. Plan shall include at least the following: method, equipment and safety precautions to be used in removing the line with specific attention given to condition of existing poles for climbing, including both shell rot and structural integrity; parallel energized facilities, other hot line crossings and railroad and road crossings; method or procedure for releasing the tension on the conductor to prevent structural failure; and procedures for cross arm, pole and anchor removal. Removal of existing conductor and overhead ground wire requires the same grounding and safety precautions as installing new conductor and overhead ground wire. Requirements contained in Section 1.4.17, “Transmission Line Safety”.



Western Area
Power Administration

CONSTRUCTION STANDARDS

STANDARD 2 SITEWORK



2026

SAFETY
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SECTION 2.1 – GENERAL

2.1.1 CONTRACTOR-FURNISHED DRAWINGS AND DATA:

1. GENERAL: Use United States standard units of measurement and English words, signs and symbols.

Data and drawings shall be thoroughly checked for accuracy and completeness before submittal. WAPA will not check details and intermediate dimensions.

WAPA will return one (1) copy of each drawing and data sheet marked to indicate required changes and approved or not approved. Change the details which WAPA determines necessary to make the finished construction conform to these specifications.

WAPA's review time is specified in the project specifications in the "Commencement, Prosecution and Completion of Work" paragraph of Division 1 "General Requirements". WAPA approval shall not relieve the Contractor from meeting the specifications requirements nor the responsibility for drawing correctness. Fabrication or material placement prior to approval will be at the Contractor's risk.

2. COMPACTING EARTH MATERIAL: Submit the following to the COR:
 - a. Name and qualifications of a testing laboratory at least 20-calendar-days prior to start of compaction operations. The testing laboratory shall meet the requirements of ASTM D 3740.
 - b. Compaction test reports immediately after completion. Reports shall specify location by elevation and horizontal coordinates for each test taken. Testing requirements are provided in Section 2.7.1, "Compacting Earth Material".
3. APPROVAL DRAWINGS FOR CATTLE GUARDS: Prior to providing the cattle guards, submit for approval the following drawings and data to the COR:
 - a. Complete details covering the cattle guards to be furnished including length, width and size of the foundation, framework, anchor bolts, end wings and other items as appropriate.
 - b. Concrete compressive strength and type of reinforcement.
 - c. Type of finish for metal products.
 - d. Certifications and/or calculations showing that the foundation and framework are designed for the truck loading. Certifications and/or calculations shall include design loadings, foundation reactions, soil bearing pressure and other appropriate design parameters.
4. GRAVEL SURFACING: Prior to placing, the Contractor shall certify material gradation with test data representing the gravel surfacing to be used. After placing, the Contractor shall certify in place density and compaction with tests obtained from locations as determined by the COR. The in place density test results shall be furnished to the COR within 7-days after completion of the tests. One (1) test per 250-cubic-yards of material, or fraction thereof, shall be performed for gradation, Atterberg Limits Tests, and density testing. The gradation analysis and the Atterberg Limits Tests shall be performed either at the batch plant or on the site, as directed by the COR.

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5. SOIL-APPLIED HERBICIDE: Submit the following:
- a. Herbicide Applicator's References: At least 30-calendar-days prior to the date of intended application, submit to the COR the Environmental Specialist of a list of references. The list of references shall include clients (with telephone numbers) previously worked for during the past 2-years.
 - b. Herbicide Applicator's Certification/License: At least 30-calendar-days prior to the date of intended application, submit to the COR one (1) copy of the herbicide applicator's certification/license number for the State in which herbicides will be applied.
 - c. Herbicide Application Plan: At least 30-calendar-days prior to the date of intended application, submit to the COR and the Environmental Specialist of a written Herbicide Application Plan. The plan shall specify the following:
 - (1) Planned date of application.
 - (2) Herbicide products to be applied and planned application rates (pounds of active ingredient per acre or quantity of product per acre). Spray marking dye name and manufacturer.
 - (3) Method of application (equipment to be used to apply herbicide).
 - (4) Herbicide manufacturer's product specimen label (include directions for use of material, use precautions and storage and disposal directions).
 - (5) Material Safety Data Sheets (SDS).
 - (6) Safety procedures that will be followed (including safety equipment and clothing).
 - d. Final Report: Within 7-calendar-days after each application, submit to the COR and the Environmental Specialist of a written report which provides the record keeping information required by Federal and State regulations. The report shall include the following:
 - (1) A synopsis of the services provided.
 - (2) Date of application.
 - (3) Place (facility) and size of area (square feet or acreage) treated.
 - (4) Name and manufacturer of herbicide applied, together with the EPA pesticide registration number and product lot number from the labels. Include name and manufacturer of spray marking dye.
 - (5) Method of application (equipment used, carrier).
 - (6) Weather conditions at time of application (wind speed, wind direction, temperature, rainfall and humidity).
 - (7) Quantity/rate of herbicide applied pounds of active ingredient per acre or quantity of product per acre.
 - (8) Problems that occurred such as any health effects and noncompliance with environmental and health/safety laws or regulations.

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- (9) Other information/data as required by applicable local, Federal and State regulations.
6. **SEEDING:** Submit an electronic copy of the following to the COR prior to seeding:
- a. **Seed Certification:** For each seed type include botanical name; common name; percentage in mixture by weight; and percentage of purity, germination and weed seed. Include all other data required by State seed regulations. Data for germination tests shall be dated no earlier than 3-months prior to seed delivery at jobsite.
 - b. **Fertilizer Certification:** Certificate of inspection required by State seed regulations and manufacturer's or vendor's certified analysis of fertilizer material.
7. **ASPHALT PAVING:** The following shall be submitted to the COR for approval at least 30-days prior to placement of asphalt paving:
- a. **Testing Laboratory:** Submit name and qualifications of testing laboratory.
 - b. **Mix Design:** Submit mix designs in accordance with the local state Department of Transportation (DOT) certified mixes.
 - c. **Asphalt Cement:** Submit manufacturer's certification that asphalt cement grade specified meets the requirements of ASTM D 3381.
 - d. **Performance Grade Asphalt:** Submit mix design in accordance with the local state DOT certified mix.
 - e. **Aggregate for Paving Courses:** Submit certification showing that fine and coarse aggregates meet the requirements of ASTM D 692 and ASTM D 1073.
 - f. Submit certification showing that the gravel base meets the requirements of ASTM D 2940.
 - g. Submit batch certificate, including batch weight and time of batching to the COR when each load of asphalt is delivered.

SECTION 2.2 – DEMOLITION

2.2.1 REMOVING BURIED ITEMS, FENCING AND GRAVEL SURFACING AND CUTTING OFF FOUNDATIONS:

- 1. **CUTTING OFF FOUNDATIONS:** Cut off foundations 30-inches minimum below the ground surface.
- 2. **EXCAVATION:** Excavate as required for removal and cutting off operations.
- 3. **FENCE AND GATE REMOVAL:**
 - a. **Chain Link Fence:** Remove existing chain link fence in accordance with the Standard 1 – General Requirements, Section 1.4.16 “Substation Safety”. It is a standard 7 foot-high chain link fence with a guard of three strands of barbed wire. The fence posts are set in concrete.
 - b. Disconnect ground cable risers from the fence and bury a minimum of 18-inches below finished grade.
 - c. Remove warning and safety signs and reinstall as directed by the COR.

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- d. Barbed Wire Fence: Existing barbed wire fence consists of three (3) or four (4) strands of barbed wire supported on wood or steel posts.

Posts and concrete footings shall be completely removed. If fenceposts are reused, concrete or earth material adhering to the posts shall be removed prior to reinstallation.

4. REFILL: Remove loosened and disturbed earth material from the excavation resulting from removal or cutting off operations. Refill the excavation to the adjacent ground surface or subgrade with earth material approved by the COR. Compact the earth material in accordance with Section 2.8.1, "Placing and Compacting Backfill". Replacement of gravel surfacing shall be in accordance with Section 2.11.2, "Replacing and Protecting Gravel Surfacing". Refill for barbed wire fencepost holes need not be compacted but shall be mounded to allow for settlement.
5. EXISTING FACILITIES TO REMAIN: During removal or cutting off operations, take necessary precautions not to loosen or damage existing facilities that are to remain in place. Existing facilities that are loosened or damaged as a result of the Contractor's operations shall be replaced or repaired as approved by the COR.
6. MATERIAL DISPOSAL: Dispose of removed concrete, spalls, metalwork, fence, wood poles, guys and anchors that are not reused, and other debris in accordance with Standard 13 – Environmental Quality Protection, Section 13.8 "Disposal of Waste Material".

2.2.2 REMOVING AND STORING STRUCTURES:

1. GENERAL: Removed material shall become the Contractor's property and shall be promptly removed from the right-of-way by the Contractor.
2. STEEL STRUCTURE REMOVAL: Remove and store structures in accordance with Standard 4 – Substation Metalwork and Transmission Line Lattice Towers, Section 4.1.13 "Relocating, Modifying, and Storing Steel Structures and Towers".
3. WOOD POLE REMOVAL: Completely remove wood poles. Completely remove guys and anchors or cut off the guys and anchors 30-inches below ground surface in cultivated areas and 12-inches below ground surface in uncultivated areas.

SECTION 2.3 – CLEARING AND GRUBBING FOR FACILITY SITES AND ACCESS ROADS

2.3.1 CLEARING AND GRUBBING:

1. CLEARING: Brush, trees, rubbish and other objectionable matter shall be cleared. Trees designated by the COR shall be protected from damage. Clear to a minimum of 3-feet outside of the cut and fill slope lines, but not past the right-of-way.
2. GRUBBING: Ground surfaces under embankments and ground surfaces of excavations to be used for embankments or backfill material shall be cleared of stumps, roots and vegetation matter. Stumps shall be removed, and roots grubbed to a depth of 18-inches below ground surface.
3. REFILL: Refill holes resulting from stump and associated root removal with earth material approved by the COR.

Compact the earth material in accordance with 2.8.1, "Placing and Compacting Backfill".

4. MATERIAL DISPOSAL: Burning or burying material on the right-of-way is not permitted. Disposal of cleared and grubbed material shall be in accordance with Standard 13 – Environmental Quality Protection, Section 13.8 "Disposal of Waste Material".

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5. **TIMBER UTILIZATION:** In accordance with the Government's policy for maximum utilization of timber, the Contractor shall utilize merchantable timber for its intended beneficial use.

SECTION 2.4 – CLEARING FOR TRANSMISSION LINE RIGHT-OF-WAYS AND ACCESS ROADS

2.4.1 CLEARING, GENERAL:

1. **GENERAL:** Clearing shall be performed so as to minimize marring and scarring the countryside and preserve the natural beauty to the maximum extent possible. Except for danger trees, no clearing shall be performed outside the limits of the right-of-way.
2. **DEFINITIONS:**
 - a. **Trees:** encompasses all woody vegetation, including shrubs and brush.
 - b. **Shelter Belt:** Refers to a row or grove of trees and/or shrubs that has been intentionally planted. Their purpose is often to provide protection from wind and snow or to prevent soil erosion.
 - c. **Danger Tree:** A tree that is located within or near an easement or permit area and poses a risk to the facility. This includes any tree that presents an immediate hazard or has the potential to grow, bend, swing, or fall into the minimum safe distance of a conductor or structure. Factors that could classify trees as a "danger tree" include leaning towards the right-of-way or having structural defects.
3. **TREE REMOVAL:**
 - a. Tree trimming and removal shall be strictly limited to achieve the following objectives:
 - (1) **Access Route Clearance:** To clear and maintain access roads, including paths through shelter belts that intersect with the right-of-way.
 - (2) **Facility and Structure Access:** To ensure unobstructed land access for personnel and equipment to all transmission structures.
 - (3) **Electrical Safety Clearances:** To maintain the mandated safe distance between vegetation and electrical conductors, mitigating the risk of electrical faults or outages.
 - (4) **Hazard Prevention:** To prevent damage to structures by proactively removing or trimming trees identified as "danger trees," which pose a significant risk of falling.
 - b. All vegetation management activities will be performed in accordance with industry best practices and applicable safety regulations to ensure the reliability of the electrical service and the safety of the public.
 - c. In instances where proper pruning would necessitate the removal of a major portion of a tree, the entire tree shall be removed and cut off at the ground surface. All felling and removal operations must be executed with professional care and precision to protect and preserve all vegetation designated to remain, thereby minimizing impact on the surrounding environment
4. **PINE NEEDLES:** Excessive amounts of pine needles left by clearing of trees, as determined by the COR, shall be removed from the right-of-way and disposed of in a location to prevent harm to grazing domestic animals.

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2.4.2 CLEARING CRITERIA:

1. **ACCESS CLEARING:** Clear a 15 foot-wide strip for access to structure sites located in timbered areas. Trees shall be cleared to the minimum extent required to provide suitable access for construction equipment. Within the boundaries of the right-of-way, trees removed for access shall be cut flush with the ground surface to permit vehicular travel without damage. Stumps and root systems may remain in the traveled surface unless otherwise designated to be removed by the COR.
2. **STRUCTURE VICINITY CLEARING:** Trees adjacent to transmission line structures shall be removed to permit vehicular access and/or to minimize the possibility of structure damage due to falling trees. Except for danger trees, tree removal shall not extend beyond a 20 foot radius from any transmission structure member.
3. **CONDUCTOR-TO-TREE CLEARANCE CLEARING:** Remove trees to provide the vertical tree-to-conductor clearance over the width specified in the project specifications. From this width to the right-of-way edges, the elevation at the top of the trees will be allowed to increase at the rate of 1-foot for each foot increase in distance from the transmission line centerline. Table 2-1 provides the necessary tree-to-conductor clearance criteria for tree removal based on the distance from the nearest point on a tree to the conductor. If the distance is less than or equal to the distances specified for the voltage shown in table 2-1 below, the tree must be removed.

TABLE 2-1 TRANSMISSION LINE DANGER TREE REMOVAL REQUIREMENTS – per WAPA Order 450.3C

LINE VOLTAGE	MINIMUM DISTANCE BETWEEN CONDUCTOR AND VEGETATION (FT)
69-kV and below	20'
115-kV	21'
138-kV	22'
161-kV	22'
230-kV	23'
345-kV	26'
500-kV	29'

2.4.3 CLEARED MATERIAL DISPOSAL:

Cleared material shall be disposed of in accordance with Standard 13 – Environmental Quality Protection, Section 13.8 “Disposal of Waste Material”.

2.4.4 QUALIFICATIONS FOR TREE TRIMMERS:

Certified personnel shall perform or supervise work involving tree trimming/felling activities. Certification shall ensure that an individual is knowledgeable and competent in performing the work. For work involving tree removal near energized equipment, certification shall include successful completion of a line clearance tree felling and trimming training program. For work involving tree removal absent of electrical hazards, certification shall include successful completion of a tree felling and trimming training program. Certification training shall include hands-on competency testing under the direction of an expert in the field. Submit qualifications certification of training to the COR.

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SECTION 2.5 – EXCAVATION

2.5.1 EXCAVATION, GENERAL:

The Bidding Schedule items which contain excavation include segregating, loading, transporting and temporarily stockpiling excavated material as needed; work and material necessary to maintain excavations during construction; and removing temporary construction when no longer required.

1. **EXCAVATION SURFACES:** Excavated surfaces, except surfaces of auger excavation, upon or against which concrete is to be placed, shall be finished to the dimensions required, moistened with water and tamped or rolled to form firm and compact foundations for placing concrete structures. Special preparation of surfaces of auger excavations is not required. Auger excavations for structures shall be performed with earth augering equipment. Undercuts for bells shall be made in undisturbed material or compacted embankments.

Where concrete is to be placed upon or against rock surfaces, the excavations shall be sufficient to provide the dimensions of concrete shown on the Drawings or as specified in the Project Specifications; required dimensions being exceeded only as approved by the COR.

2. **OVER EXCAVATION:** Over excavation and associated additional concrete, gravel fill, sand fill and compacted backfill shall be at the Contractor's expense.

If material is excavated or loosened beyond the excavation lines, remove loosened material and fill over excavation as follows:

- a. With concrete where concrete structures or concrete backfill are required to be placed upon or against excavated surfaces.
- b. With gravel fill where structures are required to be placed on gravel fill.
- c. With sand fill where structures are required to be placed on sand fill.
- d. With selected material approved by the COR for other over excavations.

Selected material and gravel fill placed in over excavations shall be compacted in accordance with Section 2.7.1, "Compacting Earth Material". Concrete, gravel fill and sand fill shall conform, respectively, to Standard - 3 Concrete and to Section 2.8.2, "Gravel fills and Sand fills".

Where additional excavation is prescribed by the COR to remove unsuitable material, excavation, compacted backfill, gravel fill, sand fill and concrete shall be in accordance with the applicable sections of these standards and be paid for in accordance with the contract clause titled "Changes".

2.5.2 GRADING FOR TRANSMISSION LINE TOWER SITES AND LINE CLEARANCE:

1. **DRAINAGE AND LINE CLEARANCE:** Perform grading, as shown on Drawing 41 2017 and as directed by the COR, to provide adequate drainage around structure and tower sites and sufficient clearance under conductors. Spread excavated material around the site from which excavated. Pile topsoil separately and replace after work completion.
2. **STRIPPING:** Strip embankment areas to a depth of 6-inches. Stripped material, or as much as may be required, shall be used for the upper 6-inches of embankment slopes. Spread remaining stripped material where directed by the COR.

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3. **EMBANKMENTS:** Construct embankments to the lines and grades shown on the Drawings or prescribed by the COR. No embankment shall be made of frozen material or placed on frozen surfaces. Embankment material shall be suitable material, as determined by the COR, obtained from required excavations or from borrow and of an acceptable gradation of material to provide compacted embankments in accordance with Section 2.7.1 “Compacting Earth Material”.

2.5.3 STRIPPING:

Refer to Project Specifications, Drawings and site-specific Geotechnical Engineering Report for requirements regarding stripping; unless noted otherwise in referenced documents, strip areas to a minimum depth of 6-inches. Stripped material, or as much as may be required, shall be used for the upper 6-inches of embankment slopes and excavated areas to be seeded. Remaining stripped material shall be wasted in accordance with Section 2.5.8, “Disposal of Excavated Material”. When necessary, stripped material shall be temporarily stockpiled prior to final placement.

Except as provided above for embankment slopes and excavated areas that are to be seeded, stripped material shall not be used for backfill or constructing compacted embankments.

2.5.4 EXCAVATION FOR FACILITY SITES AND ACCESS ROADS:

Suitable material excavated during the regrading operations may be used for embankments and backfill. This excavated material shall not be used for gravel fills or gravel surfacing unless it is processed to meet applicable requirements of Sections 2.8.2, “Gravel fills and Sand fills” or 2.11.1, “Gravel Surfacing”.

Grade to the lines, grades and dimensions shown on the Drawings. Drainage ditches shall be clear of obstructions and diverge sufficiently at the lower ends to prevent erosion.

2.5.5 EXCAVATION FOR SPREAD FOOTING AND MAT FOUNDATIONS:

1. **GENERAL:** Excavate for concrete foundations, slabs, buildings, cable entry boxes, gravel fills, structures, poles, fences, cattle guards, pull boxes, concrete vaults, removing concrete foundations, or any other items requiring excavation to construct the facilities in the project specifications.
2. **EXCAVATIONS:** Excavations shall provide for concrete foundations and structure embedments as provided in the project specifications and as shown on Drawing 41 2017. Protect the excavation to maintain a clean subgrade until the foundation is placed. Remove sand, mud, silt and other objectionable material which may accumulate in the excavation before placing concrete.
3. **EXCAVATION STABILIZATION:** Reference 2.5.10 Controlled Low Strength Materials (Flowable Fill).

2.5.6 EXCAVATION FOR DRILLED SHAFT FOUNDATIONS:

1. **GENERAL:** At least 30 days prior to starting drilled shaft work, submit a Drilled Shaft Construction Plan including the following to the COR:
 - a. Proposed drilled shaft construction sequence.
 - b. Proposed Drilling, hole cleaning, and hole preparation method.

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- (1) Discuss potential drilling difficulties and means and methods that will be used to remove obstructions from the excavation. Provide specific shaft drilling procedures to counter issues associated with ground water, if anticipated. Demonstrate an understanding of the subsurface conditions at the site by referencing available subsurface data.
 - c. Proposed Drilled Shaft Excavation and Construction Methods
 - (1) Include proposed excavation method(s) used to ensure shaft stability during and after excavation. If casing is required, provide casing dimensions and procedures for installing and removing the temporary casing. If temporary casing is used, a detailed description of the method used to set and maintain the proper anchor bolt cage alignment during casing removal must be included. Include plan for disposal of excavated material.
 - d. Proposed lifting and rigging methods for the anchor bolt assembly and reinforcing cage installation.
2. EXCAVATIONS: Drill holes according to the approved Drilled Shaft Construction Plan. Excavate or construct fill to final grade elevation(s) prior to drilling.
 - a. If obstructions such as boulders are encountered during drilling, remove/bypass the obstructions according to the approved Drilled Shaft Construction Plan. If the approved methods are insufficient, submit an alternative plan for approval.
 - b. Remove sand, mud, silt and other objectionable material which may accumulate in the excavation before placing concrete.
 - c. Set reinforcement and place concrete immediately after excavation is complete. If concrete is not placed within 4 hours of completion and acceptance of excavation, completely cover the hole and provide a barrier in accordance with OSHA regulations. Remove sand, mud, silt and other objectionable material which may accumulate in the excavation on the same day concrete is placed and reinspect.
 3. EXCAVATION STABILIZATION: Use wet construction methods in accordance with 2.5.11 or 2.5.12, casing construction methods in accordance with 2.5.13, or both when dry methods are not effective.
 4. CONSTRUCTION TOLERANCES:
 - a. Transmission Line Structures (Except H-frames):
 - (1) Axial Alignment:
 - (2) Shaft Diameter:
 - (3) Horizontal Location:
 - b. Substation Structures and H-frames:

2.5.7 EXCAVATION FOR TRENCHES:

1. GENERAL: Excavate for cables, conduits, drains, culverts, duct banks, utilities, grounding systems, buried fiber optic cables and any other items requiring trenches to construct the facilities in the project specifications.

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2. EXCAVATION:

- a. Ground Cable, Conduit and Insulated Cable: Excavation for electrical ground cable and conduit shall be to depths of not less than 18-inches in common material as measured from the subgrade elevation under gravel surfacing to bottom of the trenches. If rock is encountered prior to obtaining the 18 inch depth, excavation shall extend 6-inches into rock or the amount required to obtain an overall trench depth of 18-inches, whichever is less.

Excavation for insulated electrical cable shall be made to lines and depths shown on Drawing 31 1006.

- b. Culvert and Pipe Trenches: Excavation shall be to depths and grades shown on the Drawings. Culvert and pipe trenches shall be finished so that the pipe will be fully supported by unexcavated ground under the bottom quarter of the circumference. Excavation shall accommodate bells, flared end sections, couplings, fittings and valves.

Where rock or other unsuitable material in the bottom of a trench might cause unequal settlement or provide unequal bearing for the culvert or pipe, the trench shall be over excavated to a depth of 6-inches if in rock and to depths sufficient to remove the other unsuitable material. The over excavated areas shall be backfilled and compacted in accordance with Section 2.8.1, "Placing and Compacting Backfill". Backfill material shall be shaped to fit the curvature of the culvert or pipe under the bottom quarter of its circumference.

2.5.8 EXCAVATION FROM BORROW:

1. OFF-GOVERNMENT PROPERTY AND RIGHTS-OF-WAY: Make arrangements for obtaining borrow material, off-Government property and rights-of-way, including transporting and stockpiling material prior to placement.
2. ON-GOVERNMENT PROPERTY: The COR will designate location of borrow pits in the borrow site from which material shall be obtained. Strip borrow pits of topsoil to a depth of approximately 6-inches. Stripped topsoil shall be stockpiled and, upon completion of borrow excavation, spread to a uniform depth of 6-inches over areas of borrow pits from which removed. Before replacing topsoil, excavated surfaces shall be reasonably smooth and uniformly sloped as approved by the COR. Bring sides of borrow pits to stable slopes with slope intersection shaped to carry the natural contour of adjacent undisturbed terrain into the pit to give a natural appearance.

Surface of borrow pits shall be left reasonably smooth as approved by the COR. When necessary, as determined by the COR, borrow pits shall be drained by open ditches to prevent accumulation of standing water. Drainage shall be controlled as prescribed in Standard 13 - Environmental Requirements - Section 13.16 - "Prevention of Water Pollution".

3. MATERIAL: Borrow material shall be suitable material, as determined by the COR, and be an acceptable gradation to provide compacted embankments in accordance with Section 2.6.1, "Constructing and Compacting Embankments", and shall have a minimum PI of 3 and a maximum PI of 15. Borrow material shall contain sufficient clay to prevent excessive caving of auger-type excavations performed in the substation embankments.

2.5.9 DISPOSAL OF EXCAVATED MATERIAL:

1. GENERAL: Suitable material from excavations, as determined by the geotechnical report or COR, shall be used for required earthwork. The excess material shall be disposed of in accordance with Standard 13 – Environmental Quality Protection, Section 13.9 "Disposal of Waste Material".

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2. **TRANSMISSION LINE STRUCTURE SITES:** Suitable excavated material shall be used for backfill at the site from which excavated. Except in cultivated fields, excess excavated material shall be spread evenly around or adjacent to the site as directed by the COR. In cultivated fields, excess excavated material shall be removed from the transmission line and access road right-of-ways. The Contractor shall dispose of in accordance with Standard 13 – Environmental Quality Protection, Section 13.9 “Disposal of Waste Material”.

2.5.10 UNWATERING EXCAVATIONS:

1. **INFORMATION ON WATER LEVEL:** Available information on water level is shown on the geologic logs of subsurface exploration. However, water levels encountered at time of construction may vary considerably from water levels shown.
2. **CONCRETE PLACEMENT:** During concrete placement, water level shall be kept below top of concrete. When the COR determines that unwatering is impractical, place concrete under water in accordance with ACI 304R.
3. **WATER POLLUTION PREVENTION:** Unwatering excavations shall be in accordance with Standard 13 – Environmental Requirements - Section 13.17 - “Prevention of Water Pollution”.

2.5.11 CONTROLLED LOW STRENGTH MATERIAL (FLOWABLE FILL) FOR EXCAVATIONS:

1. **INFORMATION ON CONTROLLED LOW STRENGTH MATERIAL:** Controlled low strength material (CLSM) is a self-consolidating cementitious material composed of cement, pozzolans, fine aggregate, water and admixtures, used primarily as a backfill, as an alternative to compacted fill. Terms used to describe this material include flowable fill, controlled density fill, flowable mortar, plastic soil-cement and soil-cement slurry.
2. **CRITERIA FOR USAGE:** CLSM may be used for earth stabilization during foundation and structure excavation where soils are not adequately self-supporting, must be approved by the COR prior to use. The mixture shall be in accordance to ACI 229R and designed as such to ensure excavatability.
3. **MIX PROPORTIONS:** The Contractor shall submit mix proportions for CLSM. Materials shall meet applicable ACI 229R, and documentation of the test results shall be submitted to the COR. If fly ash is unavailable a suitable replacement must be submitted to the COR.
4. **EXCAVATABILITY:** To ensure excavatability of the flowable fill, the 28-day unconfined compressive strength shall be between 50-psi (hand excavated) and 100-psi (machine excavated), depending on method of excavation as determined by the contractor. Determine compressive strength in accordance with ASTM D4832.

2.5.12 SLURRY DRILLING FLUIDS:

A slurry may be used as a wet drilling method if approved in the Drilled Shaft Construction plan. Premix the slurry outside of the shaft excavation and use according to the manufacturer's instructions and recommendations.

1. **Mineral Slurry:** Use sodium bentonite and attapulgite in potable water.
2. **Polymer Slurry:** Use a slurry appropriate for the site soil types and water chemistry.

Concrete placed under water shall be in accordance with ACI 304R.

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2.5.13 CASING AUGER EXCAVATIONS:

Casing of an excavation may be used as a wet drilling method if approved in the Drilled Shaft Construction plan

1. **CONCRETE PLACEMENT:** Casing shall be withdrawn as concrete is deposited, with the casing removed after concrete placement is finished. Concrete placement shall be maintained at a sufficient height within the casing to prevent earth infusion into the concrete or reduction in diameter by earth pressure on the fresh concrete.

Concrete placed under water shall be in accordance with ACI 304R.

2.5.14 TRIAL AUGERING:

1. **GENERAL:** Trial augering includes auger excavations that are attempted and cannot be completed due to encountering unsatisfactory material.
2. **AUGERING OPERATIONS:** If unsatisfactory materials encountered during augering that prevents excavating to required depths, then non-auger type foundations shall be substituted for the intended auger type. The substituted foundation shall be approved by the COR.
3. **BACKFILL:** Fill trial holes with flowable backfill in accordance with 2.5.11.

SECTION 2.6 – EMBANKMENTS

2.6.1 CONSTRUCTING AND COMPACTING EMBANKMENTS:

1. **GENERAL:** Embankments shall not be constructed in an area where clearing, grubbing and stripping are required until that work has been completed. Maintain embankments to the proper elevations, dimensions and slopes until final acceptance of all work.
2. **PREPARING FOUNDATION MATERIAL UNDER EMBANKMENTS:** After completing clearing, grubbing and stripping and before the first layer of embankment is placed, the foundation material, other than rock surfaces, shall be scarified to a 6 inch minimum depth. The layer of scarified material shall be compacted in accordance Section 2.7.1, "Compacting Earth Material".
3. **PLACING MATERIAL:** Embankment material shall be suitable material, as determined by the COR, obtained from required substation site excavation. If sufficient suitable material is not available from required substation site excavation, additional suitable material shall be obtained from borrow areas as specified in, Section 2.5.7, "Excavation from Borrow". Embankment material obtained from borrow shall contain sufficient clay to prevent excessive caving of auger type excavations.

Stripped material shall not be used for constructing embankments, except for the upper 6-inches of material placed on embankment slopes to be seeded.

Excavation operations for the compacted embankments shall result in an acceptable gradation of material to provide for stability when compacted. Distribution of material shall result in material being homogeneous and free from lenses, pockets or streaks. Stones placed in compacted embankments shall not exceed 5 inches. Stones larger than 5 inches found in otherwise approved material shall be removed prior to compacting operations. Material used in constructing embankments shall be clean and free from vegetation, stumps, roots, pieces of timber and other foreign material. Material shall not be placed in embankments when either the material or the surface on which it will be placed is frozen. Embankments shall be placed, moistened and compacted in accordance with Section 2.7.1, "Compacting Earth Material".

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SECTION 2.7 – COMPACTION

2.7.1 COMPACTING EARTH MATERIAL:

1. GENERAL: Where compacting earth material is required, material shall be deposited in horizontal layers and compacted as specified, except that the density and moisture requirements for surfacing shall be in accordance with Section 2.11 – Surfacing.

Excavating, placing, moistening and compacting operations shall result in material being uniformly compacted throughout the required section and homogeneous, free of lenses, pockets, streaks or laminations.

2. TESTING:

- a. Testing Laboratory: An approved testing laboratory shall be employed by the Contractor to perform compaction tests. The testing laboratory shall meet the requirements of ASTM D 3740.
- b. Tests: Perform a minimum of one successful test for every 1,000-cubic-yards, or fraction thereof, of embankment and for every 100-cubic-yards, or fraction thereof, of backfill. Material samples for testing shall be obtained from locations as determined by the COR. A successful test is a test showing that the material has been compacted to the specified density and moisture. If a test is not successful, the Contractor shall perform additional tests and additional work as required in order to ensure that the specified density and moisture are achieved.

3. COMPACTING CLAYEY AND SILTY MATERIAL:

- a. General: Thickness of horizontal layers after compaction shall not be more than 6-inches. Excavating and placing operations shall result in material, when compacted, being blended sufficiently to secure the highest practicable density, impermeability and shear strength.
- b. Moisture Content: Prior to and during compacting operations, material shall have a moisture content within plus or minus 2-percentage points of optimum moisture. Moisture content shall be uniform throughout each layer.
- c. If the moisture content is not within 2-percentage points of optimum, the compacting operations shall not proceed, except with the specific approval of the COR, until the material has been wetted or allowed to dry to obtain optimum moisture content within the tolerances. No adjustment in price will be made on account of wetting or drying the material or on account of delays occasioned thereby.
- d. Compaction: When the material has been conditioned, it shall be compacted by rollers or by hand or power tampers. Where hand or power tampers are used in confined areas, they shall be equipped with suitably shaped heads to obtain the required density.
- e. Soil Density: The density (dry) of the soil fraction in the compacted material shall not be less than 95-percent of the laboratory standard maximum soil density (dry) as determined by ASTM D 698, Method A, compaction test for the material being compacted. The standard maximum soil density is the dry weight per cubic foot of the soil compacted at optimum moisture content by laboratory procedure

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4. COMPACTING COHESIONLESS MATERIAL:

- a. General: Thickness of horizontal layers after compaction shall not be more than 6-inches if compaction is by tampers or rollers; not more than 12-inches if compaction is by treads of crawler-type tractors, surface vibrators or similar equipment; and not more than the penetrating depth of the vibrator if compaction is by internal vibrators. Water shall be added as required to obtain the specified density.
- b. Relative Density: Relative density of the compacted material shall not be less than 70 percent as determined by ASTM D 4253 and ASTM D 4254.

SECTION 2.8 – BACKFILL

2.8.1 PLACING AND COMPACTING BACKFILL:

1. GENERAL: Place and compact backfill for excavations listed in Section 2.5.5, “Excavation for Foundations and Structures”, 2.5.6, “Excavations for Trenches” and other work requiring backfill. Surface of compacted backfill shall slope away from a building a minimum of 4-inches in 10-feet.
2. MATERIAL:
 - a. General: Obtain backfill material from required excavations. If sufficient suitable material is not available from required excavations, obtain additional material from borrow areas as specified in Section 2.5.7, “Excavation from Borrow”. Type of backfill material and amount shall be approved by the COR.
 - b. Backfill Near Electrical Conduit: Backfill within 2-inches of buried electrical conduit shall be sand or equally fine earth material. Sand backfill for buried insulated electrical cable is specified in Section 2.8.3, “Sand Backfill and Lumber Protection for Buried Insulated Electrical Cables”.
 - c. Backfill Around PVC Piping: Material passing a 3/8 inch sieve shall be used around PVC piping to a height of 6-inches above the pipes.
 - d. Backfill Around Building Piping: Material passing a 3/4 inch sieve shall be used around building piping, to a height of 12-inches above the pipes.
 - e. Other Backfill: Other backfill material shall not contain stones larger than 3-inches in diameter, vegetation, stumps, roots, pieces of timber and other foreign material.
3. PLACING: Manner of depositing backfill material shall be approved by the COR. Material shall not be placed when either the material or the surface on which it will be placed is frozen. Stripped material shall not be used for backfill.

Backfill shall be placed and compacted about corrugated metal pipe culverts, concrete pipe culverts, corrugated metal pipe drains and High Density Polyethylene (HDPE) pipe drains and culverts in accordance with this section and Sections 2.9.1, “Corrugated Metal Pipes”, 2.9.4, “Concrete Pipe Culverts” and 2.9.8, “High Density Polyethylene Pipe Drains and Culverts”.

Sloping backfill shall be placed and compacted adjacent to transmission line structure foundations and poles to an elevation approximately 6-inches above the original ground surface and uniformly sloped away.

4. COMPACTING: Backfill shall be compacted in accordance with Section 2.7.1, “Compacting Earth Material”.

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2.8.2 GRAVEL FILLS AND SAND FILLS:

1. MATERIAL:

- a. Gravel fills: Gravel fill shall be composed of clean crushed rock that is hard, dense, durable rock particles, with three fractured sides and range from 3/16-inch to 3/4-inch.
- b. Sand fills: ASTM C 33 for fine aggregate.
- c. Sheet Polyethylene: 6-mils thick.

2. PLACING:

- a. General: Before gravel fill or sand fill is placed, the subgrade shall be leveled to a uniform cross section free from depressions and soft spots. Gravel fill or sand fill shall be placed to the lines and grades shown on the Drawings.
- b. Building Piping: Building piping to be buried shall be laid prior to placing gravel fill.
- c. Building Floor Slabs: A layer of sheet polyethylene shall be placed over the gravel fill beneath the building floor slab. Prior to placing the sheet polyethylene, the surfaces of gravel fill shall be prepared to prevent damage to the covering. Sheet polyethylene shall be lapped 6-inches at ends and edges.
- d. Building and Concrete Foundations: Gravel fills for service building and for concrete foundations shall be deposited and compacted as specified in Section 2.7.1, "Compacting Earth Material".
- e. Sand fills: Sand fills in service building cable entry box, and in cable trenches and pull boxes shall not be compacted.

2.8.3 SAND BACKFILL AND LUMBER PROTECTION FOR BURIED INSULATED ELECTRICAL CABLES AND CONDUITS:

1. MATERIAL:

- a. Sand: ASTM C 33 for fine aggregate.
- b. Lumber: Lumber shall be 2-inches by 8-inches, constructed of noncombustible recycled plastic, mold resistant and equal to: Trex Deck Boards.

2. PLACING BACKFILL AND LUMBER COVERS:

- a. Sand Backfill: The bottom portion of trenches for buried insulated electrical cables shall be backfilled with sand to provide 2-inches of sand both below and above the cables and a minimum of 2-inches of sand between the sides of the trench and the closest cable. Where there is more than one (1) cable in a trench, the cables may be grouped together and need not be separated by sand.
- b. Lumber: Plastic lumber shall be placed lengthwise over the sand backfill to provide a continuous cover above the cables and conduits without spaces between ends of lumber.
- c. Soil Backfill: Backfill trench above the lumber with soil and compact in accordance with Section 2.7.1, "Compacting Earth Material".

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SECTION 2.9 – SITE DRAINAGE

2.9.1 GENERAL SECURITY REQUIREMENTS:

All perimeter drainage culverts, drop inlets, drains and manhole covers shall have measures (i.e., grills, rebar, locks) to prevent unauthorized entrance. Culvert passages shall be reduced to no more than 96 square-inch openings at any point. Refer to Project Specifications or details on Drawings for requirements.

2.9.2 HIGH DENSITY POLYETHYLENE PIPE DRAINS AND CULVERTS:

1. GENERAL: HDPE corrugated, and smooth-lined pipe drains include a flared-end section at inlets and culverts include a flared-end section at each pipe end. Pipes shall be of sizes, types and dimensions shown on the Drawings.
2. MATERIAL:
 - a. HDPE corrugated and smooth-lined pipe sections including all related materials for construction of drains, culverts, side road pipes, storm sewers, stubs and all related connections and fittings: ASTM F 2306, Type S with full circular cross section, outer corrugated pipe wall and smooth inner wall.
 - b. HDPE connections and joints to new or existing pipes, storm sewer manholes, inlets, headwalls, flared-end sections and other appurtenances required to complete the work: ASTM F 2306.
3. HAULING AND HANDLING:
 - a. General: Haul and handle pipe with care to avoid damage. Rope, cable, or chain slings shall not be used for handling the pipe. Canvas slings not less than 12-inches in width may be used.
 - b. Pipe that is damaged shall be replaced with new pipe. Damaged pipe shall be removed from the work site.
4. INSTALLATION:
 - a. General: Installation of HDPE pipe drains and culverts shall be in accordance with ASTM D 2321 "Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications".
 - b. HDPE pipe shall be laid at the locations and to the grades shown on the Drawings, starting at the downstream end. Trenches shall be excavated in accordance with Section 2.5.6, "Excavation for Trenches"; minimum width of trench shall be (1.25 x pipe outside diameter) plus 12-inches. Accessories and fastenings shall be drawn tight. Pipe shall be laid so that the departure from and return to established alignment and grade shall not exceed 1/8-inch per foot of pipe, but with not more than a 1-inch total departure. Pipe shall be placed so as to be fully supported over the bottom quarter of the circumference.
 - c. High Groundwater: Install a soil filter fabric as required and provide restraint against flotation.
 - d. Joints: Joints shall be installed such that connections between adjacent pipe sections form a continuous line free from irregularities in the flow line.

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- e. Bedding and sides: ASTM D 2321 Class I or Class II material, minimum of 6-inches of 1 1/2-inches maximum granular size loosely compacted below pipe. Upon completion of joint and accessory installations, same material shall be placed and tamped about sides of pipe, extending to 6-inches above top of pipe.
- f. Final Backfill: Backfill shall be placed above bedding materials noted above and shall be placed and compacted in accordance with Section 2.8.1, "Placing and Compacting Backfill".

Equipment travel over the pipe drains and culverts shall not be permitted until final backfill has been placed and compacted to the depth recommended by the pipe manufacturer, but not less than 24-inches above the top of the pipe drain or culvert.

2.9.3 CONCRETE PIPE CULVERTS:

1. MATERIAL:

- a. Concrete Pipe: Reinforced concrete pipe shall conform to ASTM C 76, minimum Class III, with either A or B wall thickness. Pipe shall have either tongue-and-groove ends for packing with mortar or ends designed for use with rubber gaskets conforming to ASTM C 443.
- b. Flared-End Sections: Shall be steel, cast-in-place concrete or precast concrete.
 - (1) Steel end sections shall be galvanized-steel, flared-end sections by Armco Drainage and Metal Products, Inc., P.O. Box 800, Middletown, OH 45043; or equal.
 - (2) Cast-in-place concrete and precast concrete end sections shall be about 2-feet long, flare out to a width of about 2-feet and have sidewalls formed to direct the water flow into the pipe drain. Wall and floor sections shall not be less than 2-inches thick for precast concrete and 4-inches thick for cast-in-place concrete.
- c. Mortar: Mortar for pipe joints and connections to other drainage structures shall be composed of one (1) part by volume of Portland cement and two (2) parts of sand. Portland cement shall conform to ASTM C 150, Type IA or IIA. Sand shall conform to ASTM C 144.

Hydrated lime may be added to the mixture of sand and cement in an amount equal to 5 percent of the volume of cement used. Hydrated lime shall conform to ASTM C 207, Type N. The quantity of water in the mixture shall be sufficient to produce a stiff workable mortar but shall not exceed 7-gallons of water per sack of cement.

2. INSTALLATION:

- a. General: Trenches shall be excavated in accordance with Section 2.5.7, "Excavation for Trenches". Holes for couplings shall be excavated and the pipe bedded so as to be fully supported over the bottom quarter of the circumference and so as to have uniform bearing for the full length of the pipe, except at joints.
- b. Joints: Joints shall be made in accordance with the instructions of the pipe manufacturer. Rubber gaskets shall be protected from the sun and heat prior to installation and show no sign of deterioration.
- c. Backfill: As each section of pipe is laid, backfill material shall be placed and tamped to a depth of 1-foot over the top of the pipe and the remaining backfill placed and compacted in accordance with Section 2.8.1, "Placing and Compacting Backfill".
- d. Connections: Connection between the pipe and the flared-end section shall be reasonably watertight and the method of coupling approved by the COR.

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2.9.4 CORRUGATED METAL PIPES:

1. GENERAL: Corrugated metal pipe drains include a flared-end section at inlets and corrugated metal pipe culverts include a flared-end section at each pipe end.
2. MATERIAL:
 - a. Corrugated Steel Pipe and Coupling Bands: ASTM A 929, zinc coated (galvanized), 16 gage minimum thickness, or approved equal.
 - b. Flared-End Sections: ASTM A 929, zinc coated (galvanized).

2.9.5 CONCRETE TRENCH DRAINS:

1. MATERIAL:
 - a. Concrete: Concrete material and reinforcement shall be in accordance with Standard 3 – Concrete.
 - b. Drain Line:
 - (1) Pipe: PVC sewer pipe and fittings, ASTM D 3034.
 - (2) Pipe Joints and Fittings: ASTM D 2855.
 - c. Miscellaneous Metalwork:
 - (1) Trench Grate and Frame: Equal to Catalog No. R-4000 series, heavy-duty trench frame with grated cover as manufactured by Neenah Foundry Company. Specific catalog reference (or equivalent) shall be based on the size requirements of the grates and frames as shown on the Drawings. Ductile Iron grates shall be used in place of Gray Iron in those areas that receive loads exceeding 16,000 pounds. Metalwork for trench grates and frames shall be grounded in accordance with Standard 9 – Substation Electrical, Section 9.4.1 “Grounding System”.
2. FABRICATION: The quality of fabrication shall be in accordance with Standard 4 – Substation Metalwork and Transmission Line Lattice Structures, Section 4.1.5 “Quality Control”.
3. INSTALLATION: Trench grate and frame shall be installed in those locations and as dimensioned as shown on the Drawings. Material shall be embedded in concrete, set accurately in position and held firmly in place until concrete has set.

2.9.6 PRECAST CONCRETE DROP INLETS:

1. GENERAL: Top of concrete elevations for the drop inlets shall be flush with the adjacent finish grade, unless otherwise shown.
2. MATERIAL: Concrete and reinforcement shall be manufacturer's standard. Precast concrete drop inlets, appurtenant metalwork, reinforcement and other required accessories shall be equal to:
 - a. Miscellaneous Metalwork:

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- (1) Drop Inlet Grate and Frame: Equal to Catalog No. R-2000 series, frame with grated cover as manufactured by Neenah Foundry Company. Specific catalog reference (or equivalent) shall be based on the size requirements of the grates and frames as shown on the Drawings. Weight of grate shall not exceed 135-pounds. Metalwork for grates and frames shall be grounded in accordance with the “Grounding System” paragraph of the “Electrical” Division.
 - (2) Ladder Safety Post: Ladder-mounted, retractable, galvanized safety post as manufactured by Bilco Company, P.O. Box 1203, New Haven, CT 06505; or equal.
 - (3) Ladder Rungs: Nonslip galvanized safety rungs, “Rugged Round Rung” as manufactured by Safe-Walk, Inc., P.O. Box 212, Leola, PA 17540; or equal.
- b. Grout: Grout shall be “nonshrink” and be in accordance with ASTM C 1107 latest revision. Accelerating admixtures, including calcium chloride, shall not be used. Clean surfaces to be grouted, and remove all loose material, dirt, grease and other foreign substances. Grout shall be mixed and placed in accordance with the manufacturer's recommendations. Water shall not be added to increase grout flowability that has been decreased due to delays.
3. FABRICATION: The quality of fabrication of miscellaneous metalwork shall be in accordance with Standard 4 – Substation Metalwork and Transmission Line Lattice Structures, Section 4.1.5 “Quality Control”.
- Galvanizing shall be in accordance with Standard 4 – Substation Metalwork and Transmission Line Lattice Structures, Section 4.1.10 “Galvanizing and Painting”.
4. INSPECTION: Precast concrete drop inlets may be inspected at the place of manufacture or precasting. Notify the COR 2-weeks prior to precasting and furnish location and date of precasting. No precasting shall be performed unless a WAPA inspector is present or has waived the right for inspection.

2.9.7 ROCK WATER CROSSING:

1. LAYOUT, SLOPE AND LOCATION: The COR will designate the exact location for construction of the water crossing. The water crossing length shall be sufficient to cross the drainage channel at the high-water elevation. The water crossing width shall be equal to the roadway width plus a minimum of 6-feet on either side of the roadway. The water crossing will require grading of the stream banks, so approach slopes are not greater than 12-percent.

Water may be present in the stream crossing, and the depth will fluctuate with seasonal water flow. Crossings shall comply with Standard 13 – Environmental Requirements - Section 13.16 “Prevention of Water Pollution”.

Drawing 01 2005 shows the general shapes and dimensions to which all material is to be placed. It is not intended that special equipment be used to obtain the shapes and dimensions shown, but the shapes and dimensions should be achieved as nearly as practical through careful dumping procedures, travel over the material with haul equipment and hand methods where necessary.

2. MATERIAL: Rock for the water crossing shall consist of hard, dense, durable, crushed rock fragments or graded stream channel rock.
 - a. Rock material for the lower 18-inch layer of the water crossing and for the upstream and downstream sides of the crossing, on either side of the roadway, shall be reasonably well graded from a minimum of 4-inches to a maximum of 12-inches.

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- b. Rock surfacing material for the upper 6 inch layer of the water crossing shall be reasonably well graded from a minimum of 2-inches to a maximum of 4-inches and shall be placed over the 4-inch to 12-inch rock material as shown on the Drawing.
- c. PLACEMENT: The stream bed shall be excavated, graded, and shaped prior to receiving the rock and rock surfacing material, as shown on Drawing 01 2005.

The rock and rock surfacing material shall be dumped and distributed, either by mechanical or hand methods, in such a manner as to achieve, as nearly as practical, the thickness and cross section shown on the Drawing.

The rock material, when in place, shall be stable and so arranged that no large voids exist between the rocks. Rock surfacing shall be compacted by equipment traveling over the surface.

2.9.8 RIPRAP:

1. MATERIAL:

- a. Riprap: Rock shall be hard, dense and durable. Either quarried rock fragments or rounded cobbles and boulders may be used. Rock shall be reasonably well graded from a maximum size of 18-inches to a minimum size of 6-inches unless otherwise stated in project specifications. "Reasonably well-graded" means that there should be a reasonably good distribution of sizes of particles from the coarsest to the finest and without a major deficiency of any size or group of sizes.
- b. Sand and Gravel Bedding: Bedding shall be either a sand and gravel mixture or sand and crushed rock, reasonably well graded to a maximum size of 1 1/2-inches.

- 2. PLACING: Riprap shall be bedded in a continuous layer of sand and gravel. Riprap need not be hand placed but may be dumped and smoothed by moving rocks into position so as to ensure the in place material is stable and without tendency to slide and that there are no large unfilled spaces within the riprap. Inclusion of earth, sand or rock dust in excess of 5-percent, by volume, is not permitted.

2.9.9 GRAVEL BLANKETS:

- 1. MATERIAL: Gravel for the blankets shall be pit-run, free-draining, gravelly material containing stones reasonably well-graded from a minimum size of 2-inches to a maximum size of 4-inches. The material shall be free from vegetation, pieces of timber or other foreign matter.
- 2. PLACING: Distribute and grade material evenly over the required areas. Compaction will not be required.

SECTION 2.10 – FENCING

2.10.1 CHAIN LINK FENCE:

1. GENERAL:

- a. Standard and high-security chain link fence with gates, guard of three strands of barbed wire and security razor/concertina type wire are shown on Drawings 31 2000, 31 2001 and 31 2038. Ground the fence and gate in accordance with Project Specifications, Project Drawings and Standard Drawing 31 1501.

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- b. Standard chain link fence includes standard chain link fence with gates and guard of three (3) strands of barbed wire; refer to Project Specifications for applicable requirements.
 - c. High-security chain link fence includes high security chain link fence with gates, one (1) spool of security razor/concertina type wire on top of the fence in addition to the guard of three (3) strands of barbed wire and may include three spools of security razor/concertina type wire stacked inside and immediately adjacent to the fence at ground level; refer to Project Specifications for applicable requirements.
 - d. Openings in the substation fence shall be protected in accordance with the Standard 1 – General Requirements, Section 1.4.16 “Substation Safety”.
2. MATERIAL: Match material in the existing fence as far as practicable with respect to type, size and gage. Ferrous material shall be zinc-coated.
- a. Standard Chain Link Fence Fabric: ASTM A 392, 2 inch mesh, 11 gage nominal wire diameter after coating, and 7-feet high.
 - b. High Security Chain Link Fence Fabric: ASTM A 392, 1-inch mesh, 9-gage nominal wire diameter after class 1 (1.20 oz/sf) zinc coating, and 7-feet high.
 - c. Security Razor/Concertina Type Wire: Provide in accordance with the manufacturer’s recommendations. Material shall be classified as medium security, shall be constructed of stainless steel and shall be resistant to cutting with normal cutters. The single coil located on top of the fence shall be 24-inches in diameter. The three (3) coils located at ground level shall be 30-inches in diameter. All coils shall protect the entire perimeter of the fence, with the exception that the three (3) ground level coils are not required at the gate, as shown on the Drawings. The single coil on top of the fence shall be securely attached to the top and bottom barbed wire strands at an 18-inch maximum spacing, with a maximum gap of 2-inches between the bottom of coil and the top of chain link fence and such that they will withstand 200-pounds (minimum) of pull load without becoming detached. The ground level coils shall be securely attached to the chain link fabric and each other, at an 18-inch maximum spacing, and such that they will withstand 200-pounds (minimum) of pull load without becoming detached.
 - d. Bottom Tension Wire for use with High Security Chain Link Fence Fabric: ASTM A 392, 9 gage nominal wire diameter after class 1 (1.20 oz/sf) zinc coating.
 - e. Galvanized Steel Ties for use with High Security Chain Link Fence Fabric: ASTM F 626, 9 gage nominal wire diameter after class 1 (1.20 oz/sf) zinc coating.
 - f. Fence Posts, Top Rails and Braces: ASTM F 1083, Schedule 40 steel pipe. Options shall be as shown on Drawing 31 2000.
 - g. Gates and Accessories: Except as shown on the Drawings, gates and accessories shall be in accordance with ASTM F 900. Gates shall be swing-type with zinc-coated, round tubular frames. The zinc coating shall have an average weight of not less than 1.8-ounces per square foot of coated surface area. Gate fabric shall be the same as the fence fabric.

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Each gate leaf shall be equipped with one pair of hinges that will allow a full gate opening between gate posts. Hinges shall allow the gate to be easily opened and closed by one (1) person, and to swing a full 180-degrees without twisting or binding. Forked latch may be provided for the single gate less than 10 feet wide. Unless otherwise noted on the Drawings, latch for double gate shall be of the “Double Gate Leaf Keeper” type or the plunger bar type of full gate height and arranged to engage the center stop. The latch shall have provisions for padlocking. The locking device shall be constructed so that the center drop rod or plunger bar cannot be raised when locked. Gate latch for gate shall be as shown on Drawing 31 2001.

Gate hinges, latches, stops, keepers and other accessories shall be zinc-coated, steel, ductile iron or malleable iron except that wire ties, clip bolts and nuts may be of aluminum alloy. Minimum weight of the zinc coating shall be 1.2-ounces per square foot of surface. Barbed wire guard at the gate top shall be as shown on the Drawings.

- h. Chain Link Fence Accessories: Except as shown on the Drawings, fence accessories shall be in accordance with ASTM F 626. Post caps, rail ends and barbed wire support arms shall be zinc-coated, steel, malleable iron or ductile iron except that post caps and rail ends may be of cast iron. Rail sleeves, wire ties and clips, clip bolts, nuts, brace bands, tension bands, reinforcing wire and tension bars shall be zinc-coated, steel except that clip bolts, and nuts may be of aluminum alloy. Two (2) 12 1/2 gage twisted, barbles, zinc-coated strands may be substituted for the 7 gage bottom reinforcing wire.
- i. Zinc-Coated Barbed Wire: 12 gage wire with 14 gage, 4 point barbs, zinc-coated.

3. ERECTION:

- a. General: Brush, weeds and other obstacles which interfere with proper fence erection shall be cleared and removed. Smooth ground irregularities (finished grade) and erect fence so that bottom of fabric is from 1-inch to 2-inches (maximum) above finished grade at all locations.
- b. Fence Posts: Perform all required excavating, backfilling and compacting of backfill for fence posts. Posts shall be plumb, in alignment, and set in concrete as shown on the Drawings. Cement quantity shall be not less than 5 1/2-bags per cubic yard of concrete. Placing, curing and protection of concrete shall be in accordance with Standard 3 – Concrete.
- c. Damaged Galvanizing: Damaged areas of galvanizing shall be repaired in accordance with ASTM A 780.

2.10.2 BARBED WIRE FENCE:

1. MATERIAL:

- a. Line Posts: Painted steel, heavy duty, T shaped with steel anchors, 7-feet 0-inches in length, 1 3/8-inches by 1 3/8-inches in cross section, and of 1/8 inch-thick material.
- b. Gate, Corner and Braced Panel Posts: Well-seasoned cedar or wood pressure treated with preservative. Pressure-treated posts shall be Douglas Fir, Western Larch, Lodgepole Pine or Southern Yellow Pine. Gate posts shall be at least 7-inches diameter at the top. Corner and braced panel posts shall be 4-inches minimum diameter at top. Corner and braced panel posts shall be 8-feet 0-inches in length.
- c. Barbed Wire: Galvanized, 12 1/2 gage wire with 4-point barbs.

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- d. Stays and Fasteners: ASTM Specifications A121 and A702.
 - e. Nails and Staples: Nails shall be bright, round nails. Staples shall be No. 9 gage galvanized-wire staples, not less than 1 1/2-inches long, and either U or L shaped with ringed shanks.
 - f. Gates: Galvanized-steel tubular gate as shown Drawing 41 9024. Set gates level and to swing in the direction as directed by the COR.
2. ERECTION: Remove brush and obstacles and level ground surface as required to erect fencing. Conduct all operations as directed by the COR. Existing fencing shall be connected to new fencing by placing a corner post at each junction and fastening the existing and new fence wire to the post. Finished fencing shall be in alignment, taut, solid at all points and thoroughly braced.

Set gate, corner and braced panel posts in 4 foot-deep post holes filled with concrete. Concrete shall contain not less than 5 1/2 bags of Portland cement per cubic yard of concrete.

Drive steel line posts not less than 3-feet 0-inches below ground surface.

Space barbed wire strands 8-inches center-to-center, with first strand 16-inches above ground. Wire shall be drawn tight and fastened securely to each post. Staples shall be driven diagonally to the grain of timber posts in a manner to hold wire securely without causing bends or nicks in the wire. Use wire stays to fasten barbed wire to steel posts.

Braced panels in line with fence and corner panels shall have panel posts spaced 8-feet 0-inches center-to-center with 4 inch by 4 inch horizontal wood bracing and cross-wire bracing similar to the gate braced panel shown on Drawing 41 9024.

Barbed wire shall be placed on the side of the posts which is away from the substation site. At grade changes where stresses tend to pull posts from the ground, fencing shall be anchored as directed by the COR. Anchors shall consist of a double strand of No. 8 gage wire connecting each barbed wire strand to a "deadman" weighing not less than 100-pounds and buried in the ground not less than 2-feet.

2.10.3 CATTLE GUARDS:

- 1. DESIGN REQUIREMENTS: Design to support an AASHTO HS20 truck loading, with an allowable average soil pressure not to exceed 1,000-pounds per square foot. The horizontal framework members shall be spaced so as to prevent livestock from walking across the framework. The perimeter of the framework shall be supported by a continuous, reinforced concrete foundation. The framework shall be protected by a reinforced concrete header which is to be a part of the continuous foundation. To facilitate cleaning underneath, provide removable sections which shall fit flush with the surface of the framework. The end wings shall be sloping 45-degrees from end of the steel framework and tie in securely to the adjacent fence.
- 2. MATERIAL:
 - a. Framework and 45-Degree End Wings: The framework and 45-degree end wings shall be constructed from standard commercial quality steel members (channels, pipe, light-gauge rails or other suitable shapes) and galvanized. Galvanizing shall be in accordance with Standard 4 – Substation Metalwork and Transmission Line Lattice Towers, Section 4.1.10 "Galvanizing and Painting". Painting shall be in accordance with the "Standard 12 – Painting.
 - b. Concrete Foundation and Header: Reinforced concrete.

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- c. Anchor Bolts: Anchor bolts, nuts and washers shall be standard commercial quality, suitable for intended conditions of use.
- 3. CONSTRUCTION: Perform the required sitework in accordance with Section 2.5, “Excavation” and Section 2.8.1, “Placing and Compacting Backfill”. Provide, place, cure and finish concrete in accordance with the applicable sections of Standard 3 – Concrete. Fabricate, galvanize and erect steel and other metalwork in accordance with Standard 4 – Substation Metalwork and Transmission Line Lattice Towers.

2.10.4 PERMANENT GATES IN EXISTING BARBED WIRE FENCES FOR TRANSMISSION LINE ACCESS ROADS:

- 1. MATERIAL: Material shall be in accordance with the details shown on the Drawings and the following:
 - a. Barbed Wire Gates: As shown on Drawing 41 9002.
 - b. Electric Barbed Wire Gates: As shown on Drawing 41 9003.
 - c. Prefabricated Tubular Steel Gates: As shown on Drawing 41 9024.
- 2. INSTALLATION: Install gates in existing fences where directed by the COR.

2.10.5 FENCE GROUNDS FOR TRANSMISSION LINES:

- 1. MATERIAL: As shown on Drawing 41 1011.
- 2. INSTALLATION:
 - a. General: Install fence grounds in accordance with Drawing 41 1011. Drive grounding rods to a depth of not less than 5-feet. Fasten fence wires securely to grounding rods with U bolt clamps.
 - b. Nonelectric Fences on Wood or Concrete Posts and Electric Fences: Ground with one (1) grounding rod at hinge end of gates and one for each 1/8-mile of fence.
 - c. Nonelectric Fences on Metal Posts: Ground with one grounding rod for each 1/4-mile of fence.
 - d. Metallic Gates: Bond electrically to fence in accordance with Drawing 41 9024.
 - e. Fences Crossing Under Line: Ground with one (1) grounding rod on each side of right-of-way.

SECTION 2.11 – SURFACING

2.11.1 GRAVEL SURFACING:

- 1. MATERIAL: Gravel surfacing material shall conform to the requirements by relevant State Department of Transportation standards for Type I, Gradation B, surface-course material, ASTM D 1241, with the following exceptions:
 - a. 100-percent shall pass the 1 1/2 inch screen.
 - b. 75 90-percent shall pass the 1 inch screen.
 - c. Minimum of 8-percent shall pass the No. 200 sieve in lieu of the minimum percentage shown in Table 1.

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- d. Fraction passing the No. 40 sieve shall have a maximum liquid limit of 35 and plasticity index range from 4 to 9 in lieu of the limits specified for fine aggregate. Liquid limit and plasticity index testing shall be in accordance with ASTM D 4318, Method A (Wet Preparation).
 - e. Minimum of 50-percent of material retained on the No. 4 screen shall have a minimum of one (1) fractured face.
2. PLACING: Prior to placing, the subgrade shall be free from depressions and soft spots and conform to grades shown on the Drawings. Gravel surfacing shall not be placed until the subgrade has been approved by the COR. Gravel surfacing thickness shall be greater than or equal to the thickness shown on the Drawings after being compacted.

Place, moisten, compact and test gravel surfacing in accordance with Section 2.7.1, "Compacting Earth Material", with the following exceptions:

- a. For gravel surfacing with more than 50-percent of the material passing the No. 4 screen, the density shall not be less than 90-percent.
- b. For gravel surfacing with 50-percent or more of the material retained on the No. 4 screen, the density shall not be less than 85-percent.
- c. Prior to and during compaction operations, the material shall have a moisture content of plus or minus 3-percent of optimum moisture.

Surfaces of gravel surfacing shall be free from corrugations and waves.

2.11.2 ROAD BASE:

1. MATERIAL: Road base material shall conform to the requirements of the relevant State Department of Transportation . Or the following gradation:
- a. 100-percent shall pass the 1 1/2 inch screen.
 - b. 90- 100-percent shall pass the 1 inch screen.
 - c. 60- 85-percent shall pass the 1/2-inch screen.
 - d. 35- 55-percent shall pass the No. 4 sieve.
 - e. 25- 50-percent shall pass the No. 8 sieve.
 - f. 10- 30-percent shall pass the No. 30 sieve.
 - g. 3- 15-percent shall pass the No. 200 sieve.
 - h. Fraction passing the No. 40 sieve (for fine aggregate) shall have a maximum Liquid Limit of 25 (AASHTO T-89), and Plasticity Index range from 0 to 3 (AASHTO T-90). In lieu of AASHTO standards, Liquid limit and Plasticity Index testing may be in accordance with ASTM D 4318, Method A (Wet Preparation).
 - i. Minimum of 50-percent of material retained on the No. 4 screen shall have a minimum of one (1) fractured face.

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2. PLACING: Prior to placing, the subgrade shall be free from depressions and soft spots and conform to grades shown on the Drawings. Road base shall not be placed until the subgrade has been approved by the COR. Road base thickness shall be greater than or equal to the thickness shown on the Drawings after being compacted.

Place, moisten, compact and test road base in accordance with Section 2.7.1, "Compacting Earth Material", with the following exceptions:

- a. For road base with more than 50-percent of the material passing the No. 4 screen, the density shall not be less than 90-percent.
- b. For road base with 50-percent or more of the material retained on the No. 4 screen, the density shall not be less than 85-percent.
- c. Prior to and during compaction operations, the material shall have a moisture content of plus or minus 3-percent of optimum moisture.

Surfaces of road base shall be free from corrugations and waves.

2.11.3 WASHED CRUSHED ROCK:

1. MATERIAL: Washed crushed rock material, shall conform to AASHTO #57 of the thickness specified, shall be used as finished grade material placed over road base. Washed crushed rock material shall conform to the following requirements:
 - a. 100-percent shall pass the 1 1/2 inch screen.
 - b. 95-100 percent shall pass the 1 inch screen.
 - c. 25-60 percent shall pass the 1/2 inch screen.
 - d. 0-10 percent shall pass the #4 screen.
 - e. 0-4 percent shall pass the #8 screen.
 - f. Washed crushed rock shall have a minimum of three (3) fractured faces.
2. PLACING: Prior to placing the washed crushed rock, the road base shall be free from depressions and soft spots and conform to grades shown on the Drawings. Washed crushed rock shall not be placed until the road base has been approved by the COR. Washed crushed rock thickness shall be greater than or equal to the specified thickness after being compacted.

Place, moisten, compact and test washed crushed rock in accordance with Section 2.7.1, "Compacting Earth Material". Final surfaces of washed crushed rock shall be free from corrugations and waves.

2.11.4 REPLACING AND PROTECTING GRAVEL SURFACING:

1. GENERAL: Replace existing gravel surfacing from removed areas. Add gravel surfacing required due to removing or cutting off existing concrete foundations, removing existing drains and removing existing chain link fence. Existing gravel surfacing may be excavated separately in required excavation areas and reused if excessive amounts of earth, organic matter and other deleterious material is removed prior to reuse.

Before gravel surfacing is replaced or added, grade subgrade to conform to the required elevations and compact loose and disturbed material. Fill depressions in the subgrade with backfill material and compact in accordance with Section 2.8.1, "Placing and Compacting Backfill". Do not use gravel surfacing material for filling depressions.

Provide additional gravel surfacing in accordance with Section 2.11.1, "Gravel Surfacing". Gravel surfacing shall be the same thickness as the existing adjacent gravel surfacing.

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2. PROTECTING GRAVEL SURFACING: Protect existing gravel surfacing and subgrade in areas where equipment will operate. Use planking or other suitable material designed to spread the equipment loads to prevent damage.

Repair damage to existing gravel surfacing and subgrade where such damage is due to the Contractor's operations. Grade and compact damaged subgrade areas as described in subsection 1 above before replacing gravel surfacing. Damaged gravel surfacing shall be restored to match the adjacent undamaged gravel surfacing and be the same thickness.

2.11.5 SOIL-APPLIED HERBICIDE:

1. GENERAL: Provide a broad spectrum, nonselective, soil-applied herbicide and submittals in accordance with Section 2.1.1.5 "Soil-Applied Herbicide".
2. HERBICIDE APPLICATOR'S QUALIFICATIONS: The applicator shall be a dedicated industrial (noncrop) applicator with 2-years' experience applying commercial bare-ground, residual herbicides. Herbicide contractor shall be currently certified to apply herbicides for industrial (noncrop) weed control or rights-of-way.
3. REGULATIONS: Regulations and procedures are provided Standard 13 – Environmental Quality Protection – Section 13.12 "Pesticides".
4. MATERIAL:
 - a. General: Soil-applied herbicides shall be of broad spectrum, nonselective type with a high residual soil activity. Herbicides shall be nonstaining and nonvolatile if applied in the vicinity of nontarget plants such as landscaping or field crops. Legible labels shall be maintained on all containers.
 - b. Storage: Herbicides shall not be stored on Government property without prior written approval from the COR. If the COR allows storage of herbicides, it shall be for no more than a 2 week period and in strict accordance with the storing of hazardous waste requirements of the applicable State Health and Safety Code and the COR's instructions.
5. APPLICATION:
 - a. General: Apply in strict accordance with the herbicide manufacturer's instructions and all Federal, State and local codes and regulations. Soil-applied herbicide shall not be applied until the gravel surfacing has been placed.
 - b. Weather Conditions: Apply herbicides only during periods of favorable weather conditions so that a major rainstorm, or rapid snow melt, does not occur and create surface runoff. If favorable weather conditions cannot be ensured, temporarily block drainage pipes through the substation fence, or other effective means as approved by the COR, to contain herbicide runoff inside the substation. Do not apply herbicide when winds could cause drifting of sprayed herbicide.
 - c. Protective Equipment: The Contractor shall determine if personal protective equipment and other health and safety related equipment is required for performing the work covered by this section. The Contractor shall furnish all required equipment and ensure his employees use it. The Contractor shall provide all required medical monitoring, health physicals and record keeping.

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6. DAMAGE: Existing vegetation such as landscape plants, gardens and field crops which, in the opinion of the COR, are damaged by the application of the soil-applied herbicide shall be replaced by the Contractor at his expense.
7. RELEASE OF HAZARDOUS SUBSTANCES: If a reportable release of hazardous substance occurs at the worksite, the Contractor shall immediately notify the COR and all environmental agencies, as required by law. The Contractor shall be responsible for the cleanup.
8. WARRANTY: If vegetation occurs in the gravel surfaced area within 1-year following final acceptance of the work, the Contractor shall return and reapply herbicide as directed by the COR.

SECTION 2.12 – LANDSCAPING

2.12.1 SEEDING:

1. GENERAL: Seeding operations shall be undertaken only after the seeded areas will not be disturbed by other Contractor operations.
2. MATERIAL:

Percent pure live seed shall be determined by the following formula:

$$\text{Percent pure live seed} = \frac{\text{Percent of purity} \times \text{percent of germination}}{100}$$

Seed and seeding mixtures shall be free of prohibited noxious weed seed, quack grass (*Agropyron repens*) and Johnson grass (*Sorghum halepense*); not exceed the limits for restricted noxious weed seed; and not contain more than 4-percent of other weed seed. Prohibited and restricted noxious weeds are those classified by the State Seed Department.

Seed containers shall be sealed and labeled to comply with State seed laws and regulations or in accordance with U.S. Department of Agriculture Rules and Regulations under the Federal Seed Act, if shipped in Interstate Commerce. For Montana, North Dakota and South Dakota seed shall have been grown in the North American continent above 41-degrees North latitude. Seeds shall be a standard grade adapted to State conditions.

Different grass species shall be separately packaged and labeled so they can be uniformly and thoroughly mixed after receipt at the jobsite.

If regrading is required, WAPA will test the soil in areas to be seeded after grading is complete. Based on the soil analysis, WAPA will determine the recommended fertilizer analysis and spread rate for fertilizer to be used.

- a. Mulching Material: Dry hay or straw free from noxious weeds or foreign matter detrimental to plant life.
 - b. Protective Cover: Light, pervious burlap; jute matting; or standard commercial erosion net material which will protect against erosion and rapid moisture evaporation without preventing germination of seed or growth of grass.
 - c. Water: Free of matter harmful to plant growth.
3. PREPARATION:
 - a. Remove foreign material, stones, plants and debris from areas to be seeded.

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- b. Protect existing underground improvements from damage.
- c. Cultivate soil to a depth of 3-inches. Repeat cultivation in areas where equipment has compacted soil. The topsoil surface shall be relatively smooth with no ruts, furrows or depressions that may cause erosion.

4. APPLICATION:

- a. Fertilizing during seeding is acceptable provided the equipment is designed to evenly distribute fertilizer at the rate specified.
- b. Seeding: Provide uniform stands of grass on seeded areas. Reseed bare areas to obtain uniform stands.

Do not use wet seed or seed which is moldy or otherwise damaged. Do not sow immediately following rain, when ground is too dry or during windy periods. Do not seed area in excess of that which can be mulched on same day.

- (1) Drill Seeding: Regulate drill to uniformly distribute seed and cover with soil to a depth not to exceed 1/2 inch. Dry fertilizer may be applied simultaneously with the drilling of seed if the drill is equipped with an attachment which will evenly distribute fertilizer at the rate specified.
- (2) Hydroseeding: Prepare slurry mixture immediately prior to application. Do not use slurry mixtures prepared more than 1-hour prior to application. Maintain uniform mixture of seed, fertilizer and water. Cover seed with soil to a depth not to exceed 1/2-inch.
- (3) Mechanical or Hand Broadcasting: Method is acceptable for areas inaccessible to large equipment provided wind velocities permit uniform distribution of material. Cover seed with soil to a depth not to exceed 1/2-inch.
- (4) Mulching: Apply mulch to seeded areas and crimp into soil within 24-hours after seeding.
- (5) Slope Protection: For slopes steeper than 2:1, apply protective cover. Roll cover down over slopes without stretching or pulling. Bury top end of each section in narrow 6 inch trench.

Overlap 12-inches minimum from top roll over bottom roll. Overlap 4-inches minimum over adjacent section. Lightly dress slopes with topsoil to ensure close contact between cover and soil. In ditches, unroll cover in direction of flow. Overlap ends of strips 6-inches minimum with upstream section on top.

- (6) Maintenance: Water, mow and apply weed control chemicals until date of final acceptance of work. The Contractor shall obtain uniform stands of grass on all seeded areas, reseeding bare areas as often as necessary to obtain uniform stands. Water to ensure uniform seed germination. Apply water slowly so that surface of soil will not puddle. Reseed and maintain damaged areas showing root growth failure, deterioration, bare spots and eroded areas. Provide additional topsoil, where necessary, including areas affected by erosion.

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SECTION 2.13 – ASPHALT PAVING

2.13.1 GENERAL:

1. QUALITY ASSURANCE:
 - a. Material and Producer: Supply source of asphalt paving material shall be approved by the COR before delivery.
 - b. Testing Laboratory: Shall meet the qualifications of ASTM D 3666.
2. MATERIAL:
 - a. Aggregate for Paving Courses: ASTM D 1073 for fine aggregate and ASTM D 692 for coarse aggregate; maximum nominal diameter 3/4-inch.
 - b. Gravel Base: ASTM D 2940.
 - c. Tack Coat: ASTM D 2397 for emulsified asphalt CSS 1H grade.
3. MIX DESIGN: Conform to current state DOT material specifications for asphalt concrete, providing a job mix formula (JMF) approved in the last 12-months. Utilize an asphalt binder specific to the project location and designed according to AASHTO M 320. For each JMF proposed, submit a production certification conforming to the state DOT specifications and conforming to design parameters (1), (2), or (3) below:
 - a. Marshall Series: (AASHTO T 245):
 - (1) Minimum Stability, lbs.: 2,200.
 - (2) No. of Blows: 75.
 - (3) Flow, .01 in.: 8 to 14.
 - (4) Air Voids %: 3.0- to 5.0-percent range, 4-percent target.
 - (5) Minimum VMA %: 14 (bulk specific gravity of aggregate).
 - b. Hveem Stabilometer (AASHTO T 246 and AASHTO T 247):
 - (1) Minimum Stabilometer Value: 35.
 - (2) Maximum Swell (inches): 0.030.
 - (3) Air Voids, %: 3.0- to 5.0-percent range, 4-percent target.
 - c. Volumetric hot asphalt concrete pavement (AASHTO M 323, AASHTO R 35 AND AASHTO T 312):
 - (1) Gyratory compaction level (AASHTO T 312): Ninit: 7 (<91.5%Gmm), Ndes: 75 (96% Gmm), Nmax 115 (<98% Gmm).
 - (2) Volumetric properties at 0.3 to 3 million ESAL:
 - (a) VMA: 13.0 – 16.0.
 - (b) VFA: 65.0 – 78.0.
 - (c) Dust-to-binder ratio: 0.8 – 1.6.
 - (d) Minimum tensile strength ratio (AASHTO T 283): 0.80.

Submit the maximum specific gravity of the mix as determined by AASHTO T 209.
4. BATCHING AND MIXING:

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- a. Comply with AASHTO M 156 for material storage, control, mixing and plant equipment and operation.
 - b. Aggregates: Deliver dry aggregate to mixer at recommended temperature to suit penetration grade and viscosity characteristics of asphalt, ambient temperature and mixture work ability.
 - c. Transporting: Provide covers over mixture when transporting during rainy or cold weather. Coat truck beds and other equipment coming into contact with the mix with an approved release agent to prevent asphalt mixture to adhering to the beds. Do not use a petroleum derived coating or other material that alters the characteristic of the mix. Mix temperature shall be maintained according to the JMF and binder manufacturer.
5. TESTING: An approved testing laboratory shall be employed by the Contractor to perform asphalt paving tests. Obtain test samples in accordance with ASTM D 979. Perform tests as follows:
 - a. Bitumen Extraction: ASTM D 2172. One test per 500-tons or fraction thereof.
 - b. Gradation Analysis: ASTM C 117 and ASTM C 136. One (1) test per 500-tons or fraction thereof.
 - c. Marshall Series ASTM D 1559 or Hveem Stabilometer ASTM D 1560: One(1) test per 1,000 tons or fraction thereof.
 - d. Density: ASTM D 2950. Perform tests at a frequency to establish a roller pattern, correlate compacted density to nuclear testing device and supplement Contractor quality control system.
 - e. Bulk Specific Gravity and Compacted Density: ASTM D 2726. Two (2) tests per 500-tons. Any fraction thereof will require one (1) test.
6. PREPARATION OF SUBGRADE: Subgrade shall be compacted to a density of 95-percent of maximum dry density in accordance with Section 2.7.1 "Compacting Earth Material". Before final rolling, shape entire section and compact subgrade to provide grades, elevations and cross section indicated on the Drawings. Compact areas adjacent to structures and other areas not accessible to rollers with mechanical or hand tamping devices.
7. PLACING OF GRAVEL BASE:
 - a. Place untreated aggregate base when the air temperature in the shade is 30-degrees Fahrenheit and rising.
 - b. Spread untreated aggregate base material over prepared subgrade to compacted depth and grades shown on the Drawings.
 - c. Compact and moisten untreated aggregate base at optimum moisture content, ± 1.5 -percent to achieve a minimum density of 95-percent of maximum laboratory density in accordance with ASTM D 1557.

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8. CONDITIONING OF ADJOINING SURFACES:

Construct structures adjacent to proposed asphalt pavement prior to placement of pavement. Surfaces in contact with the asphalt pavement, including adjoining asphalt lifts, shall receive a uniform application of tack coat prior to placing asphalt pavement. Tack coat must be completely cured prior to placing asphalt course.

9. SPREADING AND COMPACTING ASPHALT PAVING:

a. General: Place the asphalt concrete mix with a paver with the following features:

- (1) Self-contained, power-propelled units with adjustable vibratory screeds with full-width screw augers.
- (2) Heated for the full width of the screed.
- (3) Equipped with a receiving hopper having sufficient capacity to ensure a uniform spreading operation.
- (4) Equipped with automatic feed controls, which are properly adjusted to maintain a uniform depth of material ahead of the screed.
- (5) Operable at forward speeds consistent with satisfactory asphalt concrete mix lay down.
- (6) Capable of producing a smooth-finished surface without segregating, tearing, shoving or gouging.
- (7) Equipped with automatic screed controls with sensors capable of sensing grade from an outside reference line, sensing the transverse slope of the screed and providing the automatic signals that operate the screed to maintain grade and transverse slope

Control horizontal alignment using a reference line. Automatically control the grade and slope from reference lines, a ski and slope control device or dual skis. In areas where mechanical spreading and finishing is impractical, place and finish the asphalt concrete mix with alternate equipment to produce a uniform surface closely matching the surface obtained when using a mechanical paver. Compact the asphalt concrete mix with alternate equipment to obtain the required compaction along forms, curbs, headers, walls and other places inaccessible to rollers. Place the asphalt concrete mix as continuously as possible. Do not pass rollers over an unprotected edge of freshly laid asphalt concrete mix.

- b. Weather: Construct paving courses when air temperature in the shade is 40-degrees Fahrenheit and rising, the underlying base is dry and unfrozen, the weather is not rainy and precipitation is not in the immediate weather forecast.
- c. Protection: Protect buildings and other facilities from asphalt splatter. Dispose all excess or rejected asphalt material legally offsite.
- d. Compaction: Asphalt paving shall be compacted to a minimum of 91.0-percent of theoretical maximum specific gravity in accordance with ASTM D 2041.

Do not allow traffic on newly paved areas until surface has cooled to the maximum surface temperature allowing traffic as per the JMF and binder manufacturer recommendation.

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Ensure surface of completed pavement is true to lines, profiles and elevations indicated and is free from depressions, tears, streaks, shoving and segregation.

10. TOLERANCES: After placement, asphalt paving shall be within the following tolerances:

- a. Thickness of Asphalt Paving Courses: $\pm 1/4$ -inch.
- b. Smoothness of Asphalt Paving Courses: Free from depressions exceeding 1/4-inch when measured with a 10 foot straight-edge.

11. PAVEMENT MARKING MATERIAL: Material used shall be equal to the local state DOT standard requirements. Color shall be white or yellow.

Paint stripes for parking lanes shall be 4-inches wide and sprayed or brushed at locations shown on the Drawings. Provide handicap symbols in accordance with the International Symbol System. Spray or brush stripes at crosswalks and stop signs. Apply a single coat at 54-square feet per gallon for symbols. Apply two (2) coats at a rate of 107-square feet per gallon for striping. Surface of pavement shall be thoroughly cleaned and dust free before painting. Follow paint manufacturer's recommendations for waiting period to install paint markings over a new bituminous surface.

2.13.2 ASPHALT PAVING RECYCLING:

1. GENERAL: Dispose of existing asphalt paving in accordance with Standard 13 – Environmental Quality Protection, Section 13.8 "Disposal of Waste Material". Recycled asphalt paving shall meet the requirements in Section 2.13.1, "Asphalt Paving, General".
2. HOT MIX RECYCLING: In accordance with Asphalt Institute Manual Series No. MS 20.
3. COLD MIX RECYCLING: In accordance with Asphalt Institute Manual Series No. MS 21.

2.13.3 GEOTEXTILE FABRIC:

1. GENERAL: This work consists of furnishing all material, equipment and labor necessary for the installation of geotextiles.
2. MATERIAL:
 - a. Woven fabric with fibers (threads and yarns) used in the manufacture of geotextile shall consist of synthetic polymers composed of a minimum of 85-percent by weight polypropylenes, polyesters, polyamides, polyethylene, polyolefins or polyvinylidene-chlorides. They shall be formed into a stable network of filaments or yarns retaining dimensional stability relative to each other. The geo-textile shall be free of defects and conform to the certain physical requirements. The geotextile shall be free of any chemical treatment or coating that significantly reduces its porosity. Fibers shall contain stabilizers and/or inhibitors to enhance resistance to ultraviolet light.
 - b. Woven fabrics formed by the uniform and regular interweaving of the threads or yarns in two (2) directions. Woven fabrics shall be manufactured from monofilament yarn formed into a uniform pattern with distinct and measurable openings, retaining their position relative to each other. The edges of fabric shall be selvaged or otherwise finished to prevent the outer yarn from unraveling.

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3. PHYSICAL REQUIREMENTS FOR CLASS 1 WOVEN GEOTEXTILE:

Property (equal to Geotex 200ST)	Test Method	Class I
Tensile Strength	ASTM D-4632	200 lbs
Elongation @ Break	ASTM D-4632	15%
CBR Puncture	ASTM D-6241	700 lbs
Trapezoidal Tear	ASTM D-4533	75 lbs
Apparent Opening Size	ASTM D-4751	40 US Sieve
Permittivity	ASTM D-4491	0.05 Sec-1
Water Flow Rate	ASTM D-4491	4 g/min/sf
UV Resistance @ 500-Hours	ASTM D-4355	70%

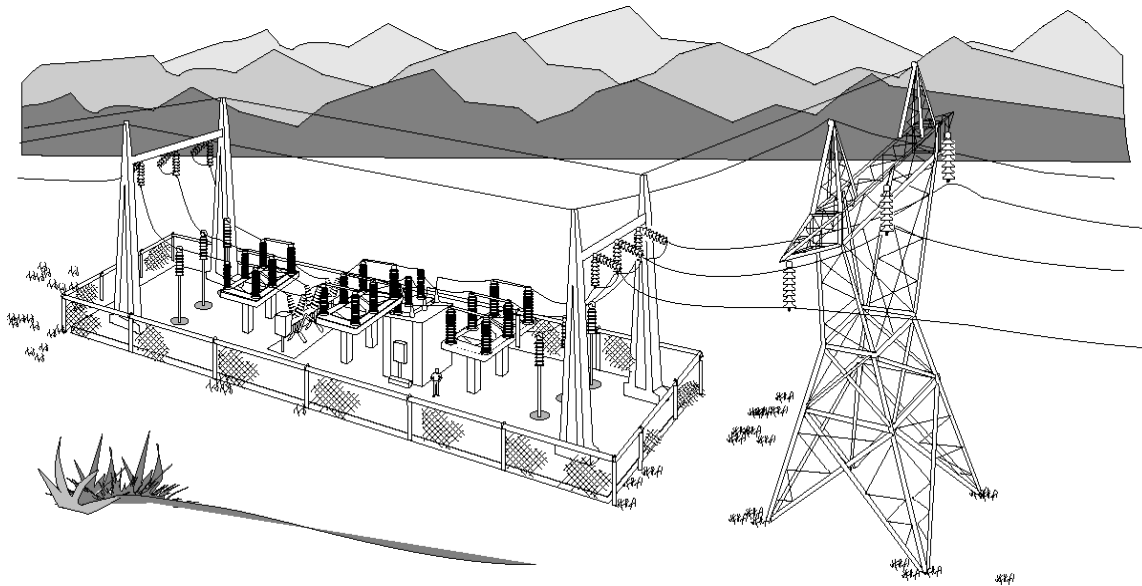
4. SURFACE PREPARATION: The surface on which the geotextile is to be placed shall be graded to the neat lines and grades as shown on the Drawings. It shall be reasonably smooth and free of loose rock and clods, holes, depressions, projections, muddy conditions and standing or flowing water (unless otherwise specified in drawings).
5. PLACEMENT: Place geotextile fabric according to manufactures recommendations.



Western Area
Power Administration

CONSTRUCTION STANDARDS

STANDARD 3 CONCRETE



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SAFETY
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SECTION 3.1 – CONCRETE REQUIREMENTS

3.1.1 GENERAL CONCRETE REQUIREMENTS AND CONTRACTOR-FURNISHED TESTS AND DATA

1. GENERAL: Provide concrete in accordance with ACI 301, ACI 318 and this Section.
 - a. Concrete shall meet 80-percent of design strength and cure a minimum of 4-days after placement before structures may be placed. Placed structures shall not be loaded until additional strength criteria in 3.1.1.1.(2) and 3.1.1.1.(3) is met.
 - b. Concrete shall meet 28-day compressive strength and cure a minimum of 7-days after placement prior to loading foundation with equipment.
 - c. For transmission lines and substation wire tension loaded structures, concrete backfill and reinforced concrete shall meet 28-day compressive strength and cure a minimum of 14-days before stringing conductors and overhead ground wires.
2. CONTRACTOR-FURNISHED TESTS AND DATA:
 - a. Testing Laboratory: Submit name and qualifications of testing laboratory to the COR for approval at least 10-days prior to placing concrete.
 - b. Mix Design: Submit each mix design to the COR for review at least 10-days prior to use.
 - (1) Pre-placement meeting: Conduct a meeting prior to placing concrete to determine site specific haul time based on the mix design. Haul time limits shall be approved by the COR. Delivery and placement outside of the haul time limit will be rejected. If a specific haul time is not provided, concrete delivery will be limited to 90-minutes from the introduction of water into the mix to discharge.
 - c. Cement: Submit manufacturer's certification that cement meets the requirements of ASTM C 150 at least 10-days prior to use.
 - d. Aggregate: Submit data showing that sand and coarse aggregate meet the requirements of ASTM C 33 and ASTM 1778. Aggregates must have been tested within 1-year prior to use. Submit data, including source location and potential reactivity test results, prior to obtaining aggregate.
 - e. Fly Ash: Submit test data conforming to ASTM C 311 to the COR at least 10-days prior to use.
 - f. Admixtures and Curing Compound: Submit brand name and manufacturer for admixtures and curing compound to the COR at least 10-days prior to use. Submission of manufacturer's test data and certification of compliance with these specifications may be required.
 - g. Batch Certificate: Submit batch certificate, including batch weights or volumes and time of batching, with each batch of concrete delivered. Submit to the COR at the jobsite.
 - h. Test Reports: Submit reports for slump, air-entrainment and compression tests to the COR immediately after completion. Reports shall specify location of concrete placement for each batch of concrete from which tests were taken.
 - i. Void Forming Material: Submit an electronic copy of the manufacturer's installation instructions to the COR prior to use.

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- j. “Nonshrink” Grout: Submit report from testing laboratory verifying performance requirements shown in Table 1 of ASTM C 1107.
- 3. TESTING: An approved testing laboratory, meeting the requirements of ASTM E 329, shall be employed by the Contractor to perform concrete tests. The field personnel performing concrete tests shall be ACI certified. Collect samples for each test from the same batch of concrete at the point of discharge, in accordance with ASTM C172. Include the unit weight and concrete temperature with the test report. Perform the tests for each mix design as follows:
 - a. Slump Test: ASTM C 143.
 - b. Air-Entrainment Test: ASTM C 231.
 - c. Compression Test Cylinders: ASTM C 31, a minimum of three (3) cylinders for each compression test.
 - d. Compression Tests: ASTM C 39. Test one (1) cylinder at 7-days and a minimum of one (1) cylinder at 28-days until the mix strength requirements are met.
 - e. Test for Potential Reactivity of Sand and Coarse Aggregate: ASTM C 295 and ASTM C 1778 and all additional investigations that may be required to evaluate any adverse properties that are discovered by the test performed.
 - f. Test Frequency: Perform a minimum of one (1) slump, air-entrainment and compression test per week or one (1) per 50-cubic yards of concrete placed or as directed by the COR.
 - g. Acceptance Criteria for Compression Tests: ACI 318.
- 4. MATERIAL:
 - a. Cementitious Materials:
 - (1) Portland Cement: ASTM C 150.
 - (a) Meet equivalent alkali requirements of ASTM C 150 – Table 2.
 - 1) Low-Alkali limitation for Portland cement may be waived when tests of concrete aggregate source show that low-alkali cement is not required.
 - (b) Meet the false set requirements of ASTM C 150 – Table 4.
 - (2) Blended hydraulic cement: ASTM C 595, Type IP or IS.
 - (a) If the cement will be used with alkali-reactive aggregate, it must meet the mortar expansion requirements of ASTM C 595 – Tables 3 and 4.
 - (3) Supplementary Cementitious Materials (SCM):
 - (a) Fly Ash: ASTM C 618 with the following additional requirements:
 - 1) Maximum percent of sulfur trioxide is 4.0-percent for Class F.
 - 2) Maximum percent loss on ignition is 2.5-percent for Class F.
 - 3) For Class F fly ash with Type II cement, the “R” factor shall be less than 2.5.

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- 4) Determine calcium and ferric oxide contents in accordance with ASTM C 114.
 - 5) Class N “Pozzolan” may be used in accordance with ASTM C989. When this material is used, an exception to 40 CFR Part 24 must be obtained and approved by COR.
- (b) Slag Cement: ASTM C 989, Grade 100 or 120.
- b. Water: ASTM C 94.
- c. Aggregate Materials:
- (1) Fine Aggregate: ASTM C33.
 - (a) Percent material passing No. 200 sieve: Less than 3-percent.
 - (2) Coarse Aggregate: ASTM C33.
 - (a) Gradings for either size No. 467 (1 ½-inch to No. 4 United States standard sieve), size No. 57 (1-inch to No. 4), or size No. 67 (¾-inch to No. 4).
 - (3) Alkali Silica Reaction (ASR) Mitigation: Test fine and coarse aggregates in accordance with ASTM C 1260 for potential deleterious ASR.
 - (a) Typically readings should be taken 14-days after zero reading. However, if it is determined based on preliminary aggregate survey or local experience that slow or late reacting aggregates are a possibility continue readings for 28-days after zero readings.
 - (b) Acceptance criteria specified below are based on 14-day readings if aggregates are not late reacting and are based on 28-day readings for late reacting aggregates.
 - (c) Expansion is not greater than 0.10-percent:
 - 1) Aggregates are acceptable.
 - (d) Expansion is greater than 0.10-percent, but less than 0.20-percent:
 - 1) Aggregates are acceptable if petrographic examination shows expansion is not due to ASR.
 - 2) Otherwise, test aggregates according to ASTM C 1567 using components (e.g. coarse aggregate, fine aggregate, cementitious materials and ASR inhibiting admixtures) in proportions proposed for mixture design and retest.

For mixes using lithium admixtures use test procedure COE CRD-C 662 (U.S. Army Corps of Engineers Standard Test Method for use of Lithium to Mitigate ASR.)

Expansion of proposed mixture design test specimens, tested in accordance with ASTM C 1567 does not exceed 0.10 percent:

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Aggregates are acceptable.

Expansion of proposed mixture design test specimens is greater than 0.10-percent:

Aggregates are not acceptable unless adjustments to mixture design can reduce expansion to less than 0.10-percent or testing by ASTM C 1293 indicates aggregates will not experience deleterious expansion.

Expansion is greater than 0.20-percent:

Test aggregates according to ASTM C 1567 using components (e.g. coarse aggregate, fine aggregate, cementitious materials and ASR inhibiting admixtures) in the proportions proposed for the mixture design and retest.

For mixes using lithium admixtures, use test procedure COE CRD-C 662.

Expansion of the proposed mixture design test specimens, tested in accordance with ASTM C 1567 does not exceed 0.10-percent:

Aggregates are acceptable.

Expansion of the proposed mixture design test specimens is greater than 0.10-percent:

Aggregates are not acceptable unless adjustments to the mixture design can reduce the expansion to less than 0.10-percent or testing by ASTM C 1293 indicates the aggregates will not experience deleterious expansion.

(e) ASTM C 1293 test results may be substituted for ASTM C 1260 test results:

- 1) Average ASTM C 1293 concrete prism expansion less than 0.04-percent at 1-year:

Aggregates are acceptable.

- 2) Average ASTM C 1293 concrete prism expansion greater than 0.04-percent at 1-year:

Aggregates are not acceptable.

d. Air-Entraining Admixture: ASTM C 260.

e. Water-Reducing and Retarding Admixtures: ASTM C 494.

(1) Accelerating Admixtures including Types C, E and calcium chloride, shall not be used.

f. Plasticizing Admixtures: ASTM C 1017 Type I and Type II.

g. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed bars.

h. Anchor Bolts or Threaded Rods with Nuts, Washers and Lock Washers: ASTM F 1554 Grade 36 or 55, ASTM A 307 or ASTM A 36 anchor bolts or threaded rods; ASTM A 563 heavy hex nuts; washers and lockwashers in accordance with Standard 4. ASTM A615

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Grade 75 modified for transmission line structures. All components shall be hot-dip galvanized after fabrication unless otherwise stated in project specifications.

- i. Steel Embedments: In accordance with Standard 4, hot-dip galvanized after fabrication.
 - j. Fiberglass Reinforcing Bars: “Mateenbar60” by Mateenbar Composite Reinforcements, LLC., Concord NC; or equal.
 - k. Fabric: ASTM A1064, electrically welded wire fabric.
 - l. Wax-Base Curing Compound: ASTM C 309, Type 2, Class A.
 - m. Clear Resin-Base Curing Compound with Fugitive Dye: ASTM C 309, Type 1-D, Class B.
 - n. Clear Resin-Base Curing Compound Without Fugitive Dye: ASTM C 309, Type 1, Class B.
 - o. Polyethylene Film: ASTM C 171, 4-mils thick.
 - p. Void Forming Material: Chemically treated void forming material equal to “Sure-Void” forms by VoidForm Products, Inc., in Englewood, Colorado.
5. MIX DESIGN: Mix design shall comply with ACI 211.1 and the following:
- a. Slump: Slump shall meet the following, unless otherwise specified, at the point of placement (i.e. at pump truck discharge point if a pump truck is used):
 - (1) Drilled shaft foundations: 5-to 7-inches.
 - (2) Other structural concrete: 2- to 5-inches.
 - b. Cement content shall be considered equivalent to total cementitious materials content, by weight, when considering fly ash replacement as noted in 3.1.1.5.(3).
 - c. FLY ASH: Fly ash shall be used to partially replace cement. Weight of fly ash shall not exceed 20-percent of the total cementitious material required, (e.g., fly ash weight/(fly ash weight + cement weight)) x 100 must be equal to or less than 20. Slag cement may be used in lieu of fly ash in accordance with ACI 233R with COR approval. Complete a test of the cement and fly ash combination in accordance with ASTM C1012 and submit test results documenting sulfate resistance to the COR. Exceptions to fly ash or slag cement use are listed in Standard 13 – Environmental Quality Protection.
 - d. AIR-ENTRAINMENT: Air-entraining admixture(s) shall be used in such amount as will affect the entrainment of air from 4-to 7-percent, by volume, of concrete at the point of placement (i.e. at pump truck discharge point if a pump truck is used).. Except as stated for building slabs-on-ground, see standard Drawing 01 2006-1, -2, -3.
 - e. Optional minimum cement content alternative to performance based mix design. If performance base mix design is not specified, the mix design shall conform to the following:
 - (1) Minimum Cement Content for 3,000-psi Concrete:

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Maximum Size Aggregate	Minimum Cement Content Without Water-Reducing Admixture	Minimum Cement Content with Water-Reducing Admixture
1 1/2-inch	525-lb/yd ³	510 lb/yd ³
1-inch	575-lb/yd ³	555 lb/yd ³
3/4-inch	610-lb/yd ³	595 lb/yd ³

(2) Minimum Cement Content for 4,000-psi Concrete:

Maximum Size Aggregate	Minimum Cement Content Without Water-Reducing Admixture	Minimum Cement Content with Water-Reducing Admixture
1 1/2-inch	565-lb/yd ³	535-lb/yd ³
1-inch	620-lb/yd ³	585-lb/yd ³
3/4-inch	660-lb/yd ³	625-lb/yd ³

(3) Minimum Cement Content for 4,500 psi Concrete:

Maximum Size Aggregate	Minimum Cement Content Without Water-Reducing Admixture	Minimum Cement Content with Water-Reducing Admixture
1 1/2-inch	595-lb/yd ³	540-lb/yd ³
1-inch	650-lb/yd ³	590-lb/yd ³
3/4-inch	675-lb/yd ³	625-lb/yd ³

(4) Minimum Cement Content for 5,000-psi Concrete:

Maximum Size Aggregate	Minimum Cement Content Without Water-Reducing Admixture	Minimum Cement Content with Water-Reducing Admixture
1 1/2-inch	625-lb/yd ³	550-lb/yd ³
1-inch	675-lb/yd ³	600-lb/yd ³
3/4-inch	700-lb/yd ³	625-lb/yd ³

3.1.2 BATCHING AND MIXING:

1. GENERAL: Concrete shall be batched and mixed in accordance with one (1) of the following:
 - a. Ready-Mixed Concrete: ASTM C 94.
 - b. Concrete Made by Volumetric Mixing and Continuous Batching: ASTM C 685.
2. MIXING REQUIREMENTS: Mixing time shall be sufficient to thoroughly mix concrete. Addition of water shall not be permitted without a signed document in the batch ticket. Truck mixers, if used, shall be in good mechanical condition, including the mixing fins, so that the concrete, when placed, will be uniform throughout.
3. CERTIFICATION: Each batch of concrete delivered shall be accompanied by a written certificate containing the batch ticket information required by either ASTM C 94 or ASTM C 685.

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3.1.3 REINFORCEMENT, ANCHOR BOLTS AND EMBEDMENTS:

1. GENERAL: Place reinforcing bars and fabric, anchor bolts and embedments in concrete where shown on the Drawings and in accordance with the Drilled Shaft Construction Plan, see section 2.5.6 "Excavation For Drilled Shaft Foundations". Reinforcement, anchor bolts and embedments shall be accurately placed and secured into position before concrete is placed as required in ACI 318 and ACI 301. "Stabbing" and/or wet-setting of reinforcement, anchor bolts or embedments into wet concrete during placement is a code violation and is not acceptable in any circumstance. Violation of this provision will result in rejection.

Welding or tack-welding of reinforcing bars and anchor bolts made from reinforcing bars shall not be permitted, except at locations shown on the Drawings. Clean reinforcement and anchor bolts of heavy, flaky rust, loose mill scale, dirt; grease, and other foreign substances prior to use in reinforced concrete.

Place reinforcing bars and fabric, anchor bolts and embedment's to meet the following tolerances:

- a. Amount of concrete cover protecting reinforcement shall not deviate from that specified on Drawing 01 2004 1 -2 by more than 1/2-inch if the specified cover is more than 2 1/2-inches, nor by more than 1/4-inch if the cover specified is 2 1/2-inches or less.
 - b. Spacing of reinforcing bars shall not deviate from the required spacing by more than 1-inch. Vertical bars shall be equally spaced unless otherwise shown on the Drawings.
 - c. Unless otherwise shown on the Drawings, reinforcement shall be placed so that there will be a clear distance of at least 1-inch between the reinforcement and anchor bolts, form ties or other embedded metalwork.
 - d. Spacing of anchor bolts shall not deviate from the specified spacing by more than 1/8-inch.
 - e. Placement of anchor bolts and embedments shall not deviate from the specified location by more than 1/8-inch.
 - f. Anchor bolt templates shall have an unobstructed opening through the center to allow the use of a tremie or drop chute for concrete placement.
2. REINFORCEMENT SUPPORTS: Where portions of reinforcement supports will be exposed, reinforcement supports shall be galvanized or corrosion-resistant material, except that concrete supports will not be permitted.
 3. BAR-PLACING DIAGRAMMS, BAR LISTS AND BAR-BENDING DIAGRAMMS: WAPA will not furnish supplemental bar-placing diagrams, bar lists and bar-bending diagrams. Supplemental diagrams and bar lists of this type required to facilitate the fabrication and placement of reinforcement shall be provided by the Contractor. Cost of preparing supplemental diagrams and bar lists, if provided, shall be at the Contractor's expense. Bar-placing diagrams, bar lists and bar-bending diagrams prepared by the Contractor shall conform to the requirements shown on Drawing 01 2004 1 -2
 4. FIBERGLASS REINFORCING BARS: Fiberglass reinforcing bars shall be bent in the factory. Fiberglass reinforcing bars cut in the field shall be sealed in accordance with the manufacturer's instructions.

3.1.4 FORMS, PREPARATION, PLACING AND FINISHING:

1. FORMS:

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- a. All forms shall be sufficiently tight to prevent mortar loss from concrete and maintained rigidly in position until concrete has hardened sufficiently to prevent damage by form removal.
 - b. Forms for exposed or specified portions of augered foundations shall be held rigidly in position at all times during construction. Prior to use of sonotube-type or light-gage sheet metal forms, the Contractor shall submit properly designed strengthening and bracing schemes to the COR for review and approval. The proposed design shall be prepared, stamped and signed by a registered professional civil or structural engineer, licensed in the state where the project is located. The proposed design shall ensure that the forms will not fail under load from wet concrete, are held rigidly in place at all times and shall not rely on rebar or anchor bolt cages for bracing. NOTE: It is not acceptable to use these types of forms without written prior approval from the COR.
 - c. All bolsters used shall be submitted for approval.
2. VOID FORMING MATERIAL: Install void forming material in accordance with the manufacturer's installation instructions. Prior to installation, submit an electronic copy of the manufacturer's instructions to the COR. Exercise care in placing void forming material and protect the material against damage during subsequent construction operations.
3. PREPARATION:
- a. Foundation Surfaces: Foundation surfaces upon or against which concrete will be placed shall be free from standing water, mud and debris. Concrete required to be extended into rock shall be placed in direct contact with the rock for a depth not less than shown on the Drawings. Earth foundations shall be free from frost and ice when concrete is placed upon or against them. Surfaces of absorptive foundations against which concrete will be placed shall be moistened thoroughly so that moisture shall not be drawn from freshly placed concrete.
 - b. Construction Joint Surfaces: Surfaces of construction joints shall be clean, rough and surface dry when covered with fresh concrete. Clean by removing laitance, loose and defective concrete, coatings, sand, curing compound if used, and other foreign material. Surfaces of construction joints shall be wet sandblasted, washed thoroughly and thoroughly surface dried prior to placing adjoining concrete. A mortar layer shall not be used on concrete construction joints.
4. PLACING:
- a. Place concrete in accordance with ACI 301. Place concrete in hot or cold weather in accordance with ACI 305R or ACI 306R, respectively.
 - b. Prevent segregation of concrete ingredients and slump loss in excess of 2-inches.
 - c. Freefall concrete is permitted as long as the concrete does not contact any reinforcement, forms or side walls to the full depth of excavation. Drop chutes consisting of a smooth tube may be used to direct freefall concrete for shaft foundations. Aluminum chutes, pipes or buckets shall not be used.
 - d. Do not retemper concrete that has developed an initial set.
 - e. Conveying and placing of concrete shall be in accordance with ACI 304R.
 - f. Concrete shall not be placed in layers exceeding 20-inches deep, except in shaft foundations. Each layer shall be consolidated by mechanical internal-vibrating equipment

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supplemented by hand spading, rodding and tamping to work concrete into all angles and narrow places.

- g. Vibrators shall be applied vertically and at uniformly spaced points not farther apart than the visible effectiveness of the machine. The vibrator shall not be inserted into lower courses that have begun to set. Vibrators shall not be used to transport concrete inside forms. The use of form vibrators or form tamping will not be permitted.
 - h. All concrete shall be mechanically vibrated. In the case of drilled shaft foundations, the top 6-feet of concrete shall be mechanically vibrated.
 - i. Vibrate concrete until consolidated to maximum practicable density. Concrete shall be free of pockets of aggregate “Honeycombs”.
 - j. Concrete temperature during placement shall be between 50-degrees Fahrenheit and 90-degrees Fahrenheit.
 - k. Ensure that reinforcement, inserts, embedded parts and formed joints are not disturbed during concrete placement.
 - l. Maintain minimum concrete cover around reinforcement.
 - m. Place concrete continuously between predetermined construction and control joints.
 - n. Place concrete under water in accordance with ACI 304R.
5. FINISHING: Finish surfaces in accordance with ACI 301.
- a. BUILDING CONCRETE: After the concrete has been placed, struck off, consolidated and leveled, provide the following finishes:
 - (1) Smooth Troweled Finish: For floors as walking surfaces, control room subfloor, top of foundation wall at exterior door thresholds or surfaces which will be left exposed.
 - (2) Broom Finish: For equipment and entry slabs; and treads and landings of concrete stairs, perpendicular to tread direction.
 - (3) Sloping Floors: Maintain level floor at walls and pitch surface uniformly to low point as shown on the Drawings.
 - (4) Exposed, Unformed Surfaces at Metalwork: Finish surfaces to be in contact with cable entry covers so that metalwork does not rock.
 - (5) Concrete Floor Hardener: Apply a minimum of two (2) coats in accordance with manufacturer's instructions. Cure concrete as required for application of floor hardener. Concrete surfaces shall be clean, dry and free of contaminants. Apply to all interior concrete slabs, including the subfloor for the access flooring system. Concrete floor hardener shall be equal to Sikagard-300 HD WB Chemical Floor Hardener by Sika Corporation.
 - b. FOUNDATIONS:
 - (1) Rough Form Finish: For all concrete surfaces not exposed to view.
 - (2) Smooth Form Finish: For all concrete surfaces exposed to view and where other finishes are not specified.

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- (3) Surfaces of cast-in-place concrete upon which cable trench covers rest shall be brought to level, uniform surfaces and given a steel-trowel finish such that the trench covers will lie flat without rocking.
- (4) Exposed, unformed surfaces of other concrete shall be brought to level, uniform surfaces and worked with suitable tools to a reasonably smooth wood-float, broom or steel-trowel finish as directed or specified.
- (5) Concrete in tops of foundations in which stub angles are embedded shall be sloped to provide drainage away from the stub angles.

3.1.5 JOINTS AND EDGES IN CONCRETE:

Refer to Standard Drawing 01 2004 1 -2 and -3 for joints related to building slabs-on-ground.

- 1. CONSTRUCTION JOINTS: Location of construction joints shall be as shown on the Drawings or as directed by the COR. Bond is required at a construction joint regardless if reinforcement is continuous across the joint. Construction joints shall be constructed in accordance with Section 3.1.4, "Forms, Preparation, Placing and Finishing".
- 2. EXPANSION JOINTS:
 - a. General: Construct expansion joints as shown on the Drawings. Joints shall be clean of laitance, coatings and other detrimental material.
 - b. Joint Filler: Place preformed bituminous joint filler in all expansion joints. Joint filler shall cover the entire surface of the concrete at the joint and be laid against the completed side of the joint and held rigidly in place while concrete is placed on the other side of the joint. Joints in joint filler shall be tight-fitting butt joints.
 - c. Dowel Bars: Install dowel bars in concrete at expansion joints as shown on the Drawings. Hold dowels firmly in place while concrete is placed on one (1) side of the joint. Exposed end of each dowel bar shall be coated with grease and fitted with an expansion cap to prevent bond before concrete is placed on the other side of the joint.
 - d. Material:
 - (1) Preformed Bituminous Joint Filler: ASTM D 994, 1/4-inch thick, unless noted otherwise on the Drawings.
 - (2) Dowel Bars: ASTM A36.
 - (3) Expansion Caps: Either metal or paper caps.
- 3. TOOLED EDGES: Top edges of cast-in-place cable trenches, cable entry boxes, expansion joints, concrete foundations and other edges of concrete where directed by the COR shall be finished neatly with an edging tool. Radius of curvature of tooled edges shall not be greater than 1/4-inch.
- 4. CHAMFERED EDGES: Chamfer edges of permanently exposed cast-in-place concrete surfaces in accordance with Drawing 01 2004 -1, -2 and buildings drawings.
- 5. CONTROL JOINTS: Saw cut joints to a depth of 1-inch, unless noted otherwise on the Drawings.

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3.1.6 PROTECTION AND CURING:

1. PROTECTION: Protect concrete against damage until final acceptance as follows:
 - a. Temperature Protection: Protect concrete against freezing temperatures by keeping it at a temperature not lower than 50-degrees Fahrenheit for at least 72-hours after it is placed. Water-cured concrete shall be protected against freezing temperatures for duration of the curing period, and a temperature of not less than 50-degrees Fahrenheit shall be maintained for 72-hours following discontinuance of water curing. Where artificial heat is employed, take special care to vent heaters and prevent concrete from drying.
 - b. Construction Activity Protection: Concrete and concrete curing compound shall be protected against construction activities by covering with plywood, sand or other suitable material. After danger of damage has ended, remove protective coverings and dispose of waste material in accordance with Standard 13 – Environmental Quality Protection, Section 13.8 “Disposal of Waste Material”.
2. CURING CONCRETE FOUNDATIONS:
 - a. Surfaces of construction joints, and surfaces on which grouting mortar is placed, shall be cured with water or wax-base curing compound or by covering with polyethylene film.
 - b. Other concrete shall be cured with water or wax-based curing compound, resin-based curing compound or by covering with polyethylene film.
 - c. If concrete is cured with curing compound, all surfaces of concrete upon which equipment or metalwork will be grouted in place shall be cleaned thoroughly of curing compound by wet sandblasting.
3. CURING BUILDING CONCRETE: Cure concrete in buildings with water, curing compound or by covering with polyethylene film. If concrete is cured with curing compound, all surfaces of concrete upon where concrete finish is applied shall be cleaned thoroughly of curing compound by wet sandblasting.
4. WATER CURING: Concrete shall be kept continuously moist for at least 14-days after being placed by sprinkling or spraying or by other methods approved by the COR. Water temperature shall be within plus or minus 20-degrees Fahrenheit of the concrete temperature.
5. CURING COMPOUND:
 - a. General: Apply curing compound promptly after form removal. Formed surfaces shall be saturated with a fine spray of water until they will absorb no more water. Apply compound as soon as free moisture on the surface has disappeared. On unformed surfaces, apply compound immediately after bleeding water or shine disappears, leaving a dull appearance.
 - b. Application: Apply curing compound per manufacturer’s instructions.
6. POLYETHYLENE FILM: When concrete has hardened sufficiently to prevent damage, thoroughly moisten by spraying lightly with water and then completely cover with a clear polyethylene film to provide an airtight, water-retaining film over the entire concrete surface for at least 14-days. Edges of polyethylene strips shall be lapped to affect a seal to adjacent strips and, at extreme edge of the curing area, held tightly against concrete surface. Secure polyethylene film to withstand wind and prevent circulation of air inside the film.

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3.1.7 CONCRETE REPAIR:

1. GENERAL: Remove and replace concrete that is damaged or defective; concrete that is honeycombed or fractured; and concrete that must be excavated and built up to bring the surfaces to prescribed lines. Correct surface imperfections and irregularities. Repair damaged or defective concrete and correct surface imperfections and irregularities as soon as practicable after form removal and before curing compound is applied.
2. MATERIAL: Repair with concrete, dry pack, cement mortar, epoxy-bonded concrete or epoxy-bonded epoxy mortar, as applicable for type of repair involved, in accordance with the United States Bureau of Reclamation's "Guide to Concrete Repair".

3.1.8 CONCRETE CONSTRUCTION TOLERANCES:

1. GENERAL: Tolerances are allowable variations from specified lines, grades and dimensions and allowable surface irregularities. Allowable variations from specified lines, grades and dimensions are listed below.

Finish concrete and set and maintain concrete forms within the listed tolerances. Concrete work that exceeds the tolerances shall be repaired or removed and replaced.

Plus or minus variations indicate a permitted actual position up or down and in or out from the specified position. Variations not designated as plus or minus indicate the maximum deviation permitted between designated successive points on the completed element of construction.

2. FOUNDATIONS, FOOTINGS AND STRUCTURES:

- a. Variation in length and width dimensions from those specified, except for building foundation walls: -1/2-inch and +2-inches. Variation in length and width of building foundation walls: -1/4-inch and +1/4-inch.
- b. Horizontal misplacement or eccentricity: 2-percent of foundation width in the direction of misplacement but not more than 2-inches.
- c. Reduction in thickness from that specified (excluding shafts): 5-percent of specified thickness but not more than 2-inches.
- d. Variation in Drilled Shaft Diameter: -0-inches
- e. Variation from specified elevation for top of concrete, except building foundations: $\pm 1/2$ -inch. Variation from specified elevation for top of concrete building foundations: $\pm 1/4$ -inch.

3. ANCHOR RODS/BOLTS: Variation in dimensions for anchor rods or anchor bolts, shall not exceed the following tolerances:

- a. Center to center of any two (2) anchor rods within an anchor group: 1/8-inch.
- b. Center to center of adjacent anchor rod groups: 1/4-inch.
- c. Elevation of the tops of anchor rods: $\pm 1/4$ -inch.
- d. Accumulated variation in dimension between centers of anchor rod groups along the column line through multiple anchor rod groups:
 - (1) 1/4-inch per 100-feet.
 - (2) Not to exceed 1-inch total.

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- e. Center of any anchor rod group to the column line through that group: 1/4-inch.
- 4. VARIATION FROM PLUMB FOR AUGERS AND PIERS:
 - a. $\pm 1.5\%$ of shaft length.
- 5. VARIATION FROM PLUMB OR SPECIFIED BATTER FOR LINES AND SURFACES OF STEMS AND WALLS:
 - a. When overall height of line or surface is:
 - (1) 10-Feet or Less: $\pm 1/4$ -inch.
 - (2) More Than 10-Feet: $\pm 3/8$ -inch.
 - b. For any two intermediate points on the line or surface separated by:
 - (1) 10-Feet: 1/4-inch.
 - (2) 20-Feet or More: 3/8-inch.
- 6. VARIATION FROM LEVEL OR SPECIFIED GRADES FOR FOUNDATION SLABS AND GRADE BEAMS:
 - a. When overall length of line or surface is:
 - (1) 10-Feet or Less: $\pm 1/4$ -inch.
 - (2) 10-to 20-Feet: $\pm 3/8$ -inch.
 - (3) More Than 20-Feet: $\pm 3/4$ -inch.
 - b. For any two (2) intermediate points on the line or surface separated by:
 - (1) 10-Feet: 1/4-inch.
 - (2) 20-Feet or More: 3/8-inch.
- 7. VARIATION FROM LEVEL OR SPECIFIED GRADES FOR BUILDING SLABS AND TOP OF BUILDING FOUNDATION: $\pm 1/4$ -inch.
- 8. VARIATION IN CROSS-SECTIONAL DIMENSIONS OF GRADE BEAMS AND STEMS FROM THOSE SPECIFIED AND IN THICKNESSES OF SLABS AND WALLS FROM THOSE SPECIFIED: -1/4-inch and +1/2-inch.
- 9. VARIATION FROM SPECIFIED GRADE OR ALIGNMENT FOR CABLE TRENCHES:
 - a. When overall length is:
 - (1) 10 Feet or Less: $\pm 1/4$ -inch.
 - (2) 10 to 20 Feet: $\pm 3/8$ -inch.
 - (3) More Than 20 Feet: $\pm 3/4$ -inch.
 - b. For any two (2) intermediate points separated by:
 - (1) 10-Feet: 1/4-inch.
 - (2) 20-Feet or More: 3/8-inch.

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10. VARIATION OF OVERALL HORIZONTAL BUILDING DIMENSIONS AT FLOOR LEVEL FROM SPECIFIED POSITION IN PLAN: $\pm 1/4$ -inch per 100-foot length with maximum for entire length of ± 1 -inch.
11. VARIATION OF FLOOR OPENINGS:
 - a. Variation in location from specified position in plan of sleeves and other floor openings: $\pm 1/2$ -inch.
 - b. Variation in size from those specified for sleeves and other floor openings: $\pm 1/4$ -inch.
12. CONCRETE BACKFILL FOR DIRECT-EMBEDDED STEEL POLE:
 - a. Concrete Projection: 18-inches ± 3 -inches.
 - b. Concrete Cover for Fabric: 3-inches -0-inches and +1-inch.
13. REPAIR OF CONCRETE NOT WITHIN TOLERANCES: Repair hardened concrete which is not within specified tolerances in accordance with Section 3.1.7, "Concrete Repair". Repair to bring concrete within tolerances shall be done only after consultation with the COR regarding the method of repair. Notify the COR of the time repair will be performed.

Repair concrete exposed to view to ensure a concrete surface with a uniform appearance. Grinding of exposed concrete surfaces shall be limited in depth so that no aggregate particles are exposed more than $1/16$ -inch in cross section at the finished surface. Where grinding has caused or will cause exposure of aggregate particles greater than $1/16$ -inch in cross section at the finished surface, repair by excavating and replacing concrete.
14. PREVENTION OF REPEATED FAILURE TO MEET TOLERANCES: When concrete placements result in hardened concrete that does not meet specified tolerances, submit to the COR an outline of all preventative actions, such as modifications to forms, modified procedure for setting screens and different finishing techniques to be implemented to avoid repeated failures. WAPA may delay concrete placements until the Contractor implements approved preventative actions.

3.1.9 DRILLING AND GROUTING ANCHOR BARS:

Dimensions and locations of anchor bars and drill holes shall be as shown on the Drawings.

Anchor bars shall be reinforcing bars as shown on the drawings. Reinforcing bars and water used in the grout shall be in accordance with Section 3.1, "Concrete Requirements".

Grout shall be "nonshrink" and be in accordance with ASTM C 1107. Accelerating admixtures that include calcium chloride, shall not be used. The grout shall not cause corrosion of the anchor bar.

Clean drill holes of loose material and clean anchor bars of flaky rust, loose mill scale, dirt, grease and other foreign substances prior to grouting.

Grout shall be mixed and placed in accordance with the manufacturer's recommendations. Water shall not be added to increase grout flowability that has been decreased due to delays. A fresh batch of grout shall be used if grout flowability is not suitable for anchor bar placement.

Insert the anchor bar in the hole and fill the hole with grout. The Contractor shall demonstrate to WAPA's Representative that the drill hole is completely filled with grout and that the anchor bar is either centered in the hole or has a minimum of $3/4$ -inches of grout around it for its entire length. Installation shall be per manufacturer's recommendations.

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3.1.10 GROUTING MORTAR:

1. GROUTING MORTAR: Grouting mortar shall be composed of cement, water and sand. Cement, water and sand shall be as specified in Section 3.1, "Concrete Requirements", except use sand passing a No. 16 screen when clearances prevent use of the specified grading. Mix grouting mortar in proportion of 1 part Portland cement to 2½-parts sand, by weight, and to approved consistency.
2. PREPARATION AND PLACING:
 - a. Preparation: Before placing mortar, roughen base concrete surfaces and remove laitance, loose and defective concrete, curing compound and other foreign material. After cleaning, thoroughly wash with water.
 - b. Placing: Place mortar so as to completely fill spaces adjacent to equipment and metalwork as shown on the Drawings. Remove shims and grout the remaining spaces.
 - c. Curing: Cure exposed surfaces of mortar for 72-hours by keeping covered with moist burlap or dampened sand.

Do not apply loads to the mortar sooner than 72-hours after placement. Apply loads only after the mortar has attained a compressive strength of 3,000-psi. Time required for the mortars used to attain this strength will be determined by the COR. Care shall be taken when applying loads on hardened mortar. The Contractor shall be responsible for any damage to mortar resulting from impact loads when positioning equipment or metalwork.

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SECTION 3.2 – SUBSTATION CONCRETE CONSTRUCTION

3.2.1 CONTRACTOR-FURNISHED DRAWINGS AND DATA:

1. GENERAL: Use United States standard units of measurement and English words, signs and symbols. Drawings shall be thoroughly checked for accuracy and completeness before submittal. WAPA will not review details and intermediate dimensions.

WAPA will provide comments to the Drawings and data. The Contractor shall change the details which WAPA determines necessary to make the finished construction conform to these specifications.

WAPA's review time is specified in the Division 1 – General Requirements, paragraph "Commencement, Prosecution, and Completion of Work". WAPA review shall not relieve the Contractor from meeting the specifications requirements nor the responsibility for drawing and data correctness. Precasting, fabrication and installation of precast concrete cable trench, precast pull boxes and precast concrete vaults prior to drawing and data review will be at the Contractor's risk.

2. DRAWINGS AND DATA FOR DESIGN OF ELECTRICAL EQUIPMENT FOUNDATIONS: Submit an electronic copy of the following to the COR:
 - a. Equipment outline drawings, dimensions and weights.
 - b. Base type, dimensions and mounting details.
 - c. Location, types, sizes and projections of required embedded anchor bolts.
 - d. Location and size of required openings in the floors for conduits.
 - e. Impact loading for the oil-type circuit breaker.
 - f. Orientation of all equipment and a complete anchor bolt setting plan.
 - g. Size and location of jacking pads for transformer.
 - h. Pole spacing for circuit breaker.
 - i. Seismic qualification report, including seismic outline drawing, in accordance with IEEE 693 for equipment specifications requiring a seismic qualification report.
 - j. Overall equipment cabinet dimensions, including height above equipment base and weights.
3. APPROVAL DRAWINGS FOR PRECAST CABLE TRENCH: Prior to precasting, submit the following to the COR:
 - a. Complete details of the precast concrete cable trench, vehicular crossing, special sections, appurtenant metalwork, covers and grounding cables.
 - b. Marking and position of each piece.
 - c. A complete bill of material.
 - d. Controlling dimensions and appropriate substation reference lines.
 - e. Size, type and grade of reinforcement and concrete strength.

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4. APPROVAL DRAWINGS FOR PRECAST CONCRETE PULL BOXES: Prior to precasting, submit for review an electronic copy of the following drawings and data to the COR:
 - a. Complete details of the precast concrete pull box, appurtenant metalwork and grounding cables.
 - b. Marking and position of each piece.
 - c. A complete bill of material.
 - d. Controlling dimensions and appropriate substation reference lines.
 - e. Size, type and grade of reinforcement and concrete strength.
 - f. Certifications and/or calculations showing that the pull boxes are designed for the adjacent surcharge loading.
5. FINAL DRAWINGS FOR PRECAST CABLE TRENCHES AND PRECAST PULL BOXES: Prior to material shipment, furnish final drawings. The Drawings shall show changes and revisions made up to the time material is shipped. Forward an electronic copy of the Drawings to the COR.

3.2.2 PRECAST CONCRETE CABLE TRENCH:

1. MATERIAL: Concrete and reinforcement shall be manufacturer's standard. Precast concrete cable trench, special sections, appurtenant metalwork, reinforcement and other required accessories shall be equal to:
 - a. "Trenwa" precast cable trench by Trenwa Inc., Fort Thomas, Kentucky; or
 - b. "Fibercrete Trench System" by Concast, Inc., Zumbrota, Minnesota.
2. TRENCH COVERS:
 - a. Aluminum and steel covers: Provide covers in accordance with the requirements shown on the cable trench drawings and Standard 4 - Substation Metalwork and Transmission Line Lattice Structures, Section 4.2 "Miscellaneous Metalwork". Ground covers in accordance with Standard 9 – Substation Electrical, Section 9.2.1 "Grounding System".
 - b. Concrete or polymer concrete covers: Weight shall not exceed 85-pounds each. Furnish required special tools for removing concrete covers. If concrete covers are used, provide brackets or clips inside trench walls just underneath the cover to support No. 4 AWG copper ground wire. Connect ground cables to grounding grid.
3. INSPECTION: Precast concrete cable trench may be inspected at the place of manufacture or precasting.

3.2.3 OIL DETENTION STRUCTURE:

1. MATERIAL:
 - a. Concrete: Concrete material and reinforcement shall be in accordance with the Section 3.1, "Concrete Requirements".
 - b. Miscellaneous Metalwork:
 - (1) Structural Steel: ASTM A 36/A 36M.

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- (2) Structural Steel Tubing: ASTM A 500, Grade B.
- (3) Expansion Anchors: Unless otherwise indicated on the Drawings, expansions anchors shall be Hilti Kwik Bolt II, or equal, with a minimum diameter of 5/8-inch and a minimum embedment length of 7-inches.
- (4) Arc-Welding Electrodes: Use matching weld metal in accordance with AWS D1.1, except that the minimum tensile strength for Group I filler metal shall be 70-ksi.
- (5) Bolts and Nuts: Bolts: ASTM A 307. Nuts: ASTM A 563, Grade A.
- (6) Aluminum Covers and Aluminum Hold-Down Angles: Material, fabrication and installation shall be in accordance with Standard 4 – Substation Metalwork and Transmission Line Lattice Structures, Section 4.2.1, “Aluminum Covers”.
- (7) Ladder Safety Post: Ladder-mounted, retractable, galvanized safety post as manufactured by Bilco Company, P.O. Box 1203, New Haven, Connecticut 06505; or equal.
- (8) Ladder Rungs: Nonslip safety rungs, submit to COR for approval.

c. Drain Line:

- (1) Pipe: PVC sewer pipe and fittings, ASTM D 3034 or schedule 40 carbon steel pipes ASTM F1083.
- (2) Pipe Joints and Fittings: ASTM D 2855.
- (3) Shutoff Valve: Gate-type valve, 6-inch cast iron, 150-pounds, bronze trim, and 2-inch-square wrench nut in accordance with AWWA C500-86. Provide valve box, cover and handwheel.
- (4) Waterstop: Standard commercial quality PVC-type waterstop.
- (5) Seep Ring: Standard commercial quality.

2. FABRICATION: The quality of metalwork fabrication shall be in accordance with Standard 4 – Substation Metalwork and Transmission Line Lattice Structures, Section 4.1.5 “Quality Control”.

Shearing and cutting by torch or electrical arc shall be finished neatly on material exposed to view. After fabrication, material shall be straight and true and free from kinks, twists and warps. If straightening is necessary, no metal damage shall result. Ladders shall be fabricated with standard butt-welding fittings and joints equal in appearance to joints made with shaped nipples. Welds on ladders shall be ground smooth.

Hot-dipped galvanizing shall be in accordance with the provisions of ASTM A 123 and A 153.

3. INSTALLATION: Install construction and control joints where shown on the Drawings. Install embedded and nonembedded metalwork for frames, ladders, grating, hold-down devices, expansion anchors, bolts, nuts and accessory material.

Embedded metalwork shall be set accurately in position and supported rigidly to prevent displacement during concrete placement. The Contractor shall drill, or drill and tap holes, in metalwork as required for installation.

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Galvanized material shall be hauled and handled with care to avoid damage to the galvanized coating. Rope, cable or chain slings shall not be used for handling the material, but canvas slings not less than 12-inches in width may be used.

Damage to galvanized coatings shall be repaired in accordance with ASTM A 780, except that the coating thickness shall be a minimum of 3.0-mils. Material that is damaged beyond repair shall be replaced. Damaged material shall be removed from the worksite.

The PVC drain line shall be installed in accordance with the pipe manufacturer's instructions, a copy of which shall be furnished to the COR.

Excavation and compacted backfill shall be in accordance with the applicable sections of Standard 2 – Sitework.

3.2.4 PRECAST CONCRETE PULL BOXES:

1. GENERAL: Pull boxes shall have removable provisions for conduit entry. The minimum inside dimensions shall be as shown on the drawings.

Structural design shall include a surcharge truck loading of AASHTO HS20 a maximum of 2-feet from the pull box.

Pull boxes shall be installed on a 6-inch-thick layer of compacted gravel fill and have a top of concrete projection of approximately 6-inches above finish grade.

2. MATERIAL:
 - a. Concrete and reinforcement shall be manufacturer's standard. Precast concrete pull box, covers, pulling hooks and other required accessories shall be submitted for approval by COR.
 - b. Sign material shall be aluminum and shall be UV resistant with a minimum operating temperature range from -40-degrees to 140-degrees Fahrenheit.
3. PULL BOX COVERS: Covers shall be aluminum or galvanized steel, designed for sidewalk class traffic and of a size and weight permitting removal by one (1) person. Weights shall not exceed 85-pounds each. Covers shall be secured to pull boxes by "Hex-Head"-type bolts and supplied with all hardware necessary for securing and removing, including lifting handles, if required.

Covers shall be grounded as shown on the electrical drawings.

Paint aluminum covers in contact with concrete with commercial grade bituminous paint to produce a 5-mil minimum thickness.

4. PULL BOX LADDERS: Pull boxes with inside depths exceeding 48 inches shall be furnished with ladder and shall have a "Danger – Permit Required Confined Space" sign permanently attached to the lid. Pull box ladders shall be firmly affixed to pull box walls and shall be equal to Model PS2-PF, as manufactured by M. A. Industries, Peachtree City, Georgia.

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5. SIGNAGE: Pull box danger signs shall be permanently affixed to the pull box cover with four (4) galvanized or stainless steel bolts. Signs shall meet OSHA safety color standards for indicating hazards. Minimum sign dimensions shall be 7-inches by 10-inches. Sign shall include the following text:

DANGER
PERMIT REQUIRED
CONFINED SPACE
DO NOT ENTER

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SECTION 3.3 – TRANSMISSION LINE CONCRETE CONSTRUCTION

3.3.1 LATTICE TOWER FOOTINGS:

1. GENERAL: Type of footing to be constructed at each tower site shall be as directed by the COR, based on the most economical footing meeting the criteria shown on the “Design, Selection and Quantities” drawings and will be determined by the COR during work progress. WAPA reserves the right to change footing type where conditions during work progress reveal that another footing type is more suitable.

Towers with transverse frames require two (2) footings for each transverse frame with steel stub tees embedded in reinforced concrete. Other towers each require four (4) footings with steel stub angles embedded in reinforced concrete. Place footings for each tower in a tangent section of line so that the tower cross arm axis is perpendicular to the alignment. Unless otherwise directed by the COR, place footings for each angle tower so that the tower cross arm axis will bisect the interior angle formed by intersection of adjacent line sections.

Footings with a tapered circular section may be constructed with a constant circular section provided the largest diameter of tapered section is used and there is no additional cost to WAPA.

2. STUB ANGLES: Place stub angles in accordance with Standard 4 - Substation Metalwork and Transmission Line Lattice Structures, Section 4.1.12 “Erection”. Vertical reinforcement bars and stubs shall be bonded electrically by reinforcement bars welded to both as shown on the Drawings.
3. FRAME STUB TEES: Attach stub tees to the frames prior to placement of concrete in footings. Attach stub tees to the leg tees using connection holes or erection holes as shown on the Drawings. Hold stub tees and frames by a suitable device to prevent displacement during concrete placement. Vertical reinforcement bars and stub tees shall be bonded electrically by reinforcement bars welded to both as shown on the Drawings. Allow concrete cure at least 7-days before removing erection bolts and completing the stub tee to frame connection shown on the Drawings.

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SECTION 3.4 – COMMUNICATION FACILITIES CONCRETE CONSTRUCTION

3.4.1 COMMUNICATION FACILITIES FOUNDATIONS:

1. GENERAL: Design and construct reinforced concrete foundations required for microwave tower or microwave monopole, waveguide supports and climbing ladder.

3.4.2 CONTRACTOR-FURNISHED DRAWINGS AND DATA:

1. GENERAL: Before beginning concrete construction, furnish approval and final approval drawings and data for all Contractor-designed foundations. These drawings and data must be approved prior to any construction. Refer to the contract clause titled “Specifications and Drawings for Construction” for additional requirements.
2. CHANGES: Make all changes in Contractor-furnished drawings, designs or construction details which WAPA determines necessary to make the finished construction conform to these specifications. Revise the drawings to reflect all changes.
3. UNITS OF MEASUREMENT: Units of measurement shall be in United States Standard units; and all wording, signs, symbols and other designations shall be in English.
4. DESIGN CALCULATIONS AND DATA: Submit, for approval, an electronic copy of the following design calculations and data for each Contractor-designed foundation:
 - a. Soil-loading properties, based on the geological investigation included in these specifications, used for complete foundation design calculations.
 - b. All forces transmitted from the tower or monopole to the foundation.
 - c. Concrete dimensions.
 - d. Reinforcement size, spacing and location.
 - e. Size and locations of embedded material.
5. APPROVAL DRAWINGS: Submit an electronic copy of drawings showing the following information for each Contractor-designed foundation:
 - a. Dimensions.
 - b. Description, yield strength, size, quantity and location of the steel reinforcement.
 - c. 28-day strength of concrete.
 - d. Size, description, quantity and location of embedded anchors and other embedded metalwork.
 - e. WAPA specifications number, bid item number and revision dates.
 - f. WAPA job title.
6. FINAL APPROVAL DRAWINGS: Prior to concrete placement, furnish an electronic copy of all drawings listed in subparagraph 5, above. The Drawings shall show all changes and revisions, with revision dates, made up to the time of concrete placement.

STANDARD 3 – CONCRETE

7. FINAL AS-BUILT DRAWINGS: Before final payment is made under the contract, deliver to WAPA an electronic copy of all drawings listed in subparagraph 5. above, with all revisions found necessary to correct errors or reflect changes made during field construction.

3.4.3 DESIGN REQUIREMENTS:

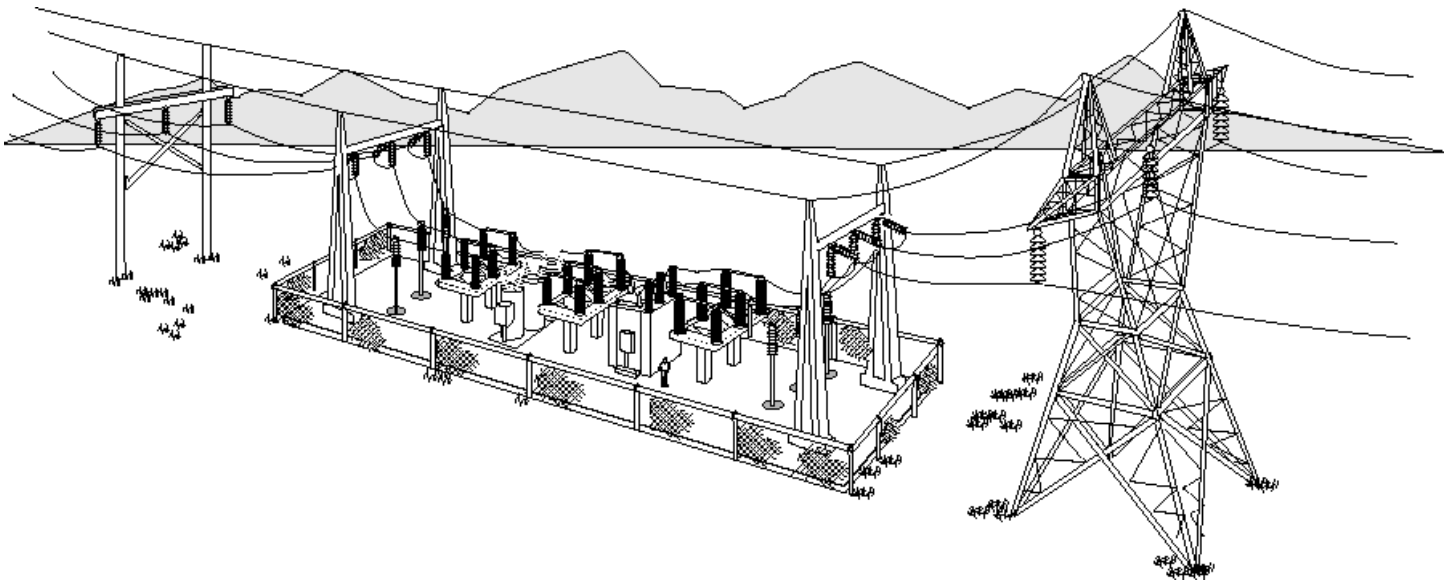
1. GENERAL: The design and drawing of the foundations shall be supervised and certified by a registered Professional Engineer competent in structural analysis and foundation design.
2. DESIGN LOADINGS: Design the concrete foundations to be reliable and serviceable and to resist without permanent distortion or displacement all loading conditions determined by the structural analysis specified in subparagraph c, below.
3. STRUCTURAL ANALYSIS AND DESIGN:
 - a. GENERAL: Design concrete tower foundations to withstand the maximum of all loads transmitted to them from the tower or monopole, including overload factors. The tower foundations shall be designed to carry these maximum loads multiplied by 1.15, without exceeding the ultimate strength of the foundation. Design foundations for ultimate strength in accordance with the assumptions and requirements as given in "Building Code Requirements for Reinforced Concrete", ACI 318.
 - b. UPLIFT: Foundations in uplift shall be designed with an overload factor of 2. The computed unit stresses under full design loads, including overload factors, shall not exceed the following:
 - (1) For Concrete: 85-percent of its 28-day strength.
 - (2) For Reinforcement: Specified yield strength of the steel.
 - c. DETAILS OF DESIGN: All self-supporting tower foundations shall be suitable for the structure type, loading and soil conditions. Top of foundations shall be a minimum of 2-inches and a maximum of 15-inches above final grade. Anchor bolts outside of reinforcement will not be permitted.



Western Area
Power Administration

CONSTRUCTION STANDARDS

STANDARD 4 SUBSTATION METALWORK AND TRANSMISSION LINE LATTICE STRUCTURES



2026

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SECTION 4.1 – METAL STRUCTURES

4.1.1 CONTRACTOR-FURNISHED DATA AND DRAWINGS:

1. **GENERAL:** Drawings shall be new originals. Copies of Specification Drawings or Government-Furnished Fabrication Drawings are not acceptable. Use United States standard units of measurement and English words, signs and symbols.

Thoroughly check data and drawings for accuracy and completeness before submitting. WAPA will not check details and intermediate dimensions.

Submit drawings as they are completed and checked for one (1) or several structures rather than delaying to include drawings for the complete specifications requirement in one (1) submittal.

WAPA will electronically return the Approval Drawing(s) and data sheet(s) marked to indicate required changes. Contractor shall change the details which WAPA determines necessary to make the finished construction conform to the specifications.

WAPA's review time is specified in the project specifications in the "Commencement, Prosecution and Completion of Work" paragraph of Division 1, "General Requirements". WAPA approval shall not relieve the Contractor from meeting the specifications requirements nor the responsibility for drawing correctness. Fabrication prior to drawing approval will be at the Contractor's risk.

2. **APPROVAL DRAWINGS FOR STEEL STRUCTURES, ALUMINUM STRUCTURES, AND MODIFICATION STEEL:** Prior to fabrication, submit electronic Approval Drawings for the steel structures, aluminum structures, or modification steel to the COR. Approval Drawings shall be standard PDF or electronic CAD ".dwg" (refer to Specifications for compatible AutoCAD version) format.

Approval drawings for steel structures listed in the metalwork requirements of the Project Specifications are not required, provided the bills of materials on the Government Furnished Fabrication Drawings show the total black weight of the required steel to be furnished for each structure. If these bills of materials are incorrect or absent, new bills of materials shall be submitted for approval. The Approval Drawings to be furnished shall include:

- a. Shop detail drawings of anchor bolts and embedded material, including a complete bill of materials for all structures.
- b. Shop detail drawings of members and connections. Members shall be detailed in place where practical. Drawings consisting totally of individual members are not acceptable.
- c. Erection drawings, showing the following:
 - (1) Marking and position of each member, size, type, location, and any approved field weld requirements. For each bolted joint, show the number and length of bolts and number and size of ring fills or filler plates.
 - (2) A complete bill of materials, including bolts, nuts, and washers. List all material for one (1) structure or the portion shown on the Approval Drawing. Show the number of pieces required, description of each piece (including size, length, and weight), and mark number on which the shop detail of each piece can be found. Total weight of one (1) complete structure, tower body or leg extension shall be noted. Calculate weights in accordance with AISC 303 "Code of Standard Practice for Steel Buildings and Bridges", except that weights for nonrectangular plates used to fabricate tubular

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shapes are to be based on actual detailed dimensions shown on the final shop drawings.

- d. Function and stub setting drawing for lattice structures and towers.
 - e. Controlling dimensions of each structure, tower body or leg extension.
 - f. WAPA specifications number.
 - g. WAPA job title and reference drawing number.
 - h. Structure type as shown on Government-furnished drawings (e.g. BP1, 3BT6, (EU)SS3).
 - i. Type and grade of material (ASTM specification) and finish (i.e., none, galvanized, dulled galvanized, or painted-over-galvanized).
 - j. For shop and field welds, show joint details, filler metal requirements, and material.
 - k. Any changes between drawing submittals shall be clearly documented and submitted as a revision for review.
3. **FINAL DRAWINGS FOR STEEL STRUCTURES, ALUMINUM STRUCTURES, AND MODIFICATION STEEL:** Prior to material shipment, submit Final Drawings to the COR. The Final Drawings shall show changes and revisions made up to the time material is shipped. Final Drawings shall be standard PDF and electronic CAD “.dwg” (refer to Specifications for compatible AutoCAD version) format.
4. **WELDING:** Submit the following to the COR:
- a. Prior to fabrication, submit all weld procedures not prequalified in accordance with AWS D1.1, “Structural Welding Code – Steel” or AWS D1.2, “Structural Welding Code – Aluminum.”
 - b. Prior to fabrication, submit a test and evaluation procedure describing the method to be used for verifying penetration of partial penetration welds.
 - c. Inspect welds and perform tests in accordance with AWS D1.1, AWS D1.2, or procedures approved by the COR. Repair and reexamine defective welds in accordance with AWS D1.1 or AWS D1.2. Document and notify the COR of any defects and subsequent weld repairs.
5. **CONNECTION BOLTS:** Submit certified copies of test reports for bolts and nuts to the COR within 20-days of material shipment.
6. **MILL TEST REPORTS:** Submit certified copies of test reports of structural steel and aluminum to the COR within 20-days of material shipment.
- Certified mill test reports for steel shapes and plates shall show customer’s order, mill order and WAPA specifications number. Mill certification shall show the weights of steel furnished for each size and heat number represented by the tests.
7. **DULLING SURFACE TREATMENT FOR GALVANIZING:** Submit the following for approval to the COR:
- a. Chemical composition of treatment

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- b. Application procedure
- c. Upon request, one (1) set of three (3) galvanized samples prior to dulling and one (1) set of three (3) samples after dulling. Dulled samples shall represent the reflectance specified in the project specifications. Each sample shall be a steel panel, 3-inches by 6-inches by 1/4-inch-thick and have the respective percent of reflectance stamped into the metal.

If approved, samples shall constitute comparison standards for dulled galvanized-steel inspection.

4.1.2 MATERIAL:

1. STRUCTURAL STEEL:

- a. Unless otherwise indicated on the Specification or Government Furnished Fabrication Drawings, steel shall be in accordance with ASTM A36.
- b. Structural Steel Tubing: ASTM A500, Grade B.
- c. Actual material yield strengths shall not exceed the design yield strength by more than 15 ksi, unless an alternate Welding Procedure Specification (WPS) is submitted, approved by the COR, and followed during fabrication.
- d. Material shall have a minimum longitudinal impact strength of 15-foot-pounds at minus 20-degrees Fahrenheit as determined by the Charpy "V" Notch Impact test in accordance with ASTM A370 and A673.
- e. Silicon, Phosphorous, Carbon, and Manganese content of structural steel shall be within the limits of ASTM A385.

2. STRUCTURAL ALUMINUM:

- a. Unless otherwise indicated on the Specification Drawings, alloy shall be 6061-T6 or -T651 in accordance with ASTM B209.
- b. Aluminum Tubing: Alloy 6061-T6 in accordance with ASTM B221.

3. CONNECTION BOLTS AND NUTS FOR LATTICE STRUCTURES AND TOWERS:

- a. Connection Bolts: ASTM A394 Type 1 or ASTM F3125 Grade A325 Type 1. Bolts and heavy hex nuts shall conform to requirements shown on Drawing 41 2001.
- b. Nuts: ASTM A563 Grade DH or other suitable grade specified in ASTM A563 Table X1.1.
- c. Step Bolts: ASTM A394, Type 0 and conform to the requirements shown on Drawing 41 2001.
- d. Step Bolts with Fall Protection Eye:
 - (1) 5/8 Inch: Buckingham Manufacturing Co. Part No. 3058, or equal.
 - (2) 3/4 Inch: Buckingham Manufacturing Co. Part No. 3075, or equal.

4. CONNECTION BOLTS AND NUTS FOR STEEL STRUCTURES, EXCEPT LATTICE STRUCTURES AND TOWERS:

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- a. Connection Bolts: ASTM F3125 Grade A325 Type 1.
 - b. Nuts: ASTM A563 Grade DH or other suitable grade specified in ASTM A563 Table X1.1.
5. CONNECTION BOLTS AND NUTS FOR ALUMINUM STRUCTURES:
- a. Connection Bolts: ASTM F468 aluminum or ASTM F593 (Group 2) 316 stainless steel.
 - b. Nuts: ASTM F467 aluminum or ASTM F594 (Group 2) 316 stainless steel.
6. WASHERS: ASTM F436 Type 1 for steel structures and Alcala 2024-T4 aluminum or ASTM A240 316 stainless steel for aluminum structures.
7. LOCKNUTS: Provide locknuts for connection bolts and anchor bolts.
- a. Palnuts (regular), Type MF No. 1 (regular, square), or equal.
 - b. In lieu of separate locknuts, self-locking heavy hex nuts for use with ASTM F3125 Grade A325 structural bolts, conforming to ASTM A194 Grade 2H or ASTM A563 Grade DH, may be used. Self-locking heavy hex nuts shall be Anco style self-locking nuts with stainless steel ratchet pin or equal.
8. GRATING: NAAMM MBG531 Type W, 1-piece serrated-steel grating. Two (2) standard sections of grating may be welded together to form a 1-piece unit. End banding bars are required. Furnish grating with manufacturer's standard hold-down clips.
9. EXPANSION ANCHORS: As indicated on the Specification Drawings.
10. ADHESIVE ANCHORS: As indicated on the Specification Drawings.
11. EYEBOLTS: Forged steel ASTM A668, Class C, and conform to the requirements shown on Drawing 31 2003.
12. STEEL PIPE: ASTM A53, Grade B.
13. ARC-WELDING ELECTRODES: Use filler metals for matching strength in accordance with AWS D1.1 for steel and AWS D1.2 for aluminum. The minimum tensile strength for steel Group I filler metal shall be 70-ksi.
14. HEADED SHEAR CONNECTORS: Low-carbon steel studs, 3/4-inch diameter, and 3-inches long after welding. Heads shall be 1 1/4-inch diameter and 3/8-inch thick. Shear connectors shall be equipped with appropriate ceramic arc shields. Shields on the shear connector ends shall be flux-filled for automatic welding application.
15. STEEL CABLE: ASTM A586, Class A, galvanized-steel structural strand.
16. STEEL CABLE HARDWARE: Galvanized with the same or higher strength rating than the steel cable and of the type as shown on the Specification Drawings.

4.1.3 DESIGN DETAILS FOR GOVERNMENT FURNISHED FABRICATION DRAWINGS:

- 1. MEMBER SIZES: Sizes shall be as shown on the Government Furnished Fabrication Drawings. Substitutions shall not be made without written approval. Approval will be given where the Contractor furnishes satisfactory proof of the nonavailability of the originally indicated size.

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2. DETAILS: Check the Government Furnished Fabrication Drawings carefully, particularly with respect to possible exceptions from the Contractor's standard notations and practice. The Contractor shall have complete responsibility for proper fit of members. Otherwise, details shall be as shown on the Government Furnished Fabrication Drawings.
3. BOLTS, NUTS AND RING FILLS: Bolts, nuts, and ring fills shall be the quantities, types and sizes called for in the material lists, provided that either MF or palnut locknuts may be furnished. The quantities of the various connection bolt lengths shall be adjusted, if necessary, as a result of the shop assembly.
4. FORGED HANGERS: Hangers may be fabricated from welded components, provided welds are complete penetration and ultrasonically tested in accordance with AWS D1.1.

4.1.4 DESIGN DETAILS FOR CONTRACTOR-FURNISHED DRAWINGS:

1. GENERAL: Member sizes, details and setting dimensions for anchor bolts and embedded material shall be as shown on the Specification Drawings. Connection details shown on the Specification Drawings may be varied slightly, provided the changes are in accordance with the specifications.
2. DOUBLE-ANGLE MEMBERS: Connect members as follows:
 - a. Tension members at 3-foot maximum intervals with stitch bolts and ring fills.
 - b. Compression members with stitch bolts and ring fills spaced so that the L/r ratio for one (1) angle is not greater than the L/r ratio of the double-angle member (maximum of 2 feet).
 - c. With stitch bolts at a minimum of two (2) locations between panel points.
 - d. With one (1) stitch bolt on the inner gage line when connected legs are 4-inches and smaller.
 - e. With two (2) stitch bolts and one (1) filler plate (one (1) bolt on each gage line) when connected legs are larger than 4-inches.
3. LONG TENSION MEMBERS: Members carrying tension only or designated on the Specification Drawings for draw shall be detailed shorter than theoretically required length. Members 10-feet or less in length shall be detailed 1/8-inch short. Unspliced members more than 10-feet in length shall be detailed short by an amount equal to 1/16-inch for each 10-feet of length, or major fraction thereof, plus 1/16-inch (maximum of 1/4-inch). Spliced members shall be detailed short an additional 1/16-inch for each lap splice or 1/8-inch for each butt splice.
4. LATTICE STRUCTURES AND TOWERS:
 - a. Splices: Splice locations and details shall be as shown on the Specification Drawings. Splices shall be at or directly above the panel points. The splice angle thickness shall be the heavier member unless otherwise shown on the Specification Drawing. Grind splice angles at the heel to fit fillets of outside angles. Do not use fillers between splice angles and main members of splices. Use a minimum of six (6) bolts (three (3) in each leg) in splices unless otherwise shown on the Specification Drawings.
 - b. Connections: Bolt connections using a minimum number of gusset plates. If the elimination of gusset plates would increase the joint eccentricity beyond a reasonable amount, use gusset plates. Clip corners of web members to eliminate or reduce eccentricity. Where gusset plates are used, connect compression web members to main members with at least

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one (1) bolt. Where fills are required at two (2) or more adjacent holes, use a single-plate fill instead of ring fills.

Unless otherwise shown on the Specification Drawings, the following conditions shall be met:

- (1) Stressed web members shall be connected by at least two (2) bolts.
 - (2) Secondary members may have one (1) bolt connection placed on the inner gage line. Where possible, without impairing the strength of main members, two (2) bolts shall be used at one end.
 - (3) Diagonal tension web members may be connected entirely on a gusset to avoid the use of fills.
 - (4) Diagonals shall be one (1) piece and connected at the point of intersection by one (1) or more bolts.
 - (5) Reinforce stressed members where the outstanding leg is blocked out.
 - (6) Gusset plates for stressed members shall be at least 1/16-inch thicker than the connected web member.
 - (7) Provide ring fills at the intersection of diagonal members when the distance between the two (2) members, at intersection, exceeds 1/16-inch per foot of length of one (1) of the members.
 - (8) Ends of outstanding legs of web member angles 2 1/2-inches and over shall be cut at 45-degrees where practicable.
- c. Connection Bolts: Connection bolt lengths shall be as shown on Drawing 41 2001. Threads may be in the shear plane for ASTM A394 Type 1 and ASTM F3125 Grade A325 bolts. Connection bolts shall be the same type and grade for the complete structure or tower, unless shown on the Specification Drawings. Provide locknuts for bolts. Provide beveled washers for bolts in sloped flanges. Provide bolts, nuts, locknuts, and beveled washers in quantity sufficient to compensate for normal field losses (2-percent maximum).
- d. Bolt Spacing: Unless otherwise shown on the Specification Drawings or authorized by the COR, the minimum center-to-center hole spacing shall be as shown in Table 4-1. Where practical, spacing shall not be less than 3-diameters. Wherever possible, distance from bolt center to face of member shall permit socket wrench use.

TABLE 4-1 – BOLT HOLE SPACINGS (Inches)

BOLT DIAMETER	MINIMUM EDGE DISTANCE		MINIMUM CENTER TO CENTER
	ROLLED OR FLAME-CUT* EDGE	SHEARED EDGE	
5/8	3/4	7/8	1 1/2
3/4	1	1 1/8	1 7/8
7/8	1 1/4	1 3/8	2 1/4

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*Where flame cuts are made by mechanically guided torch.

5. Edge Distance: Unless otherwise shown on the Specification Drawings or authorized by the COR, distance between member edge and bolt hole center shall not be less than shown in Table 4-1. In detailing the gage lines, make allowance for mill tolerances in the width of legs or flanges to ensure meeting the specified minimum edge distance.
6. Step Bolts and Eyebolts: Provide step bolts and eyebolts as shown on the Specification Drawings. Space step bolts approximately 15-inches apart, with a maximum spacing of 17-inches. Provide holes for step bolts on the inner gage line of leg angle and space to avoid climbing interference with outstanding leg of the structure web members.
7. GUYS AND GUY ANCHORS:

- a. Determine optimum guy size and arrangement best suited for the structure required. Locate guys to provide the following minimum electrical clearances:

VOLTAGE (kV)	CLEARANCE (IN)
34.5	30
69	42
115	60
138	60
161	66
230	91
345	115
500	152

- b. Consider guys as elastic members in structure analyses. Modulus of elasticity for design of guy material shall be 23,000-ksi. Under maximum design loading, guy tensions shall not exceed 65-percent of the minimum rated breaking strength.
 - c. Guy hardware and structure attachments shall be capable of supporting the minimum rated breaking strength of attached guys. Steel hardware shall be galvanized or galvanized and dulled in accordance with Section 5.1.9, "Galvanizing" and 5.1.10, "Dulled Galvanizing".
 - d. Guys and guy vangs shall not interfere with installation of maintenance provisions.
 - e. Determine number and type of guy anchors. Guy anchors shall develop the minimum rated breaking strength of attached guys. No more than two (2) guys shall be attached to any one (1) anchor.
 - f. Minimum guy anchor spacing shall be 8-feet.
8. WELDED STRUCTURES:
 - a. Weld shop connections and bolt field connections.
 - b. Connection bolt lengths shall be determined by the Contractor. Provide locknuts for bolts. Provide beveled washers for bolts in sloped flanges. Provide enough bolts, nuts, locknuts and washers to compensate for normal field losses (2-percent maximum).
 - c. Unless otherwise shown on the Specification Drawings or authorized by the COR, the minimum center-to-center hole spacing and distance between member edge and bolt hole center shall be in accordance with AISC 360 "Specification for Structural Steel Buildings".

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4.1.5 QUALITY CONTROL:

1. **GENERAL:** The Contractor shall have defined quality control methods and functions available for review and approval, upon request. Maintain permanent records for mill test reports, welding procedures, certifications for welding operators, welders, and tack welders, and visual and nondestructive test reports.

Component parts and welds shall be inspected to determine conformance to contract requirements, Final Drawings, codes, standards and procedures, including dimensional compliance, quality of welds, weld contour, weld size and overall workmanship.

2. **WORKMANSHIP AND DEFECTIVE MATERIAL:** Work shall be equal to best modern practice in the manufacture and fabrication of material. Details of design, fabrication, and erection not covered by the Specification Drawings or the specifications shall conform to AISC Steel Construction Manual for steel and to AA Aluminum Design Manual for aluminum. The Contractor shall be responsible for correct fitting of parts and replacing defective material discovered during erection.
3. **INSPECTION AND TESTS:** Inspection of material will be made in accordance with Standard 1 – General Requirements, Section 1.2.4 “Material Inspection”. WAPA inspection of material at the mill will be waived.

Certified mill test reports for steel and aluminum shapes and plates shall show customer's order, mill order, and WAPA specifications number. Mill certification shall show the weights of steel and aluminum furnished for each size and heat number represented by the tests. No material shall be shipped until certified copies of reports have been submitted to the COR.

4.1.6 FABRICATION:

1. **GENERAL:** Plates shall be edge planed or flame cut with mechanically guided torches and ground smooth. The surface roughness of plate edges shall be in accordance with AWS D1.1 for steel and AWS D1.2 for aluminum.
2. **STRAIGHTENING MATERIAL:** Before being laid out or worked in any manner, structural material shall be straight, free from sharp kinks and bends and clean of rust and dirt. If straightening is necessary, no metal damage shall result.
3. **SHEARING AND CUTTING:** Shearing and cutting shall be finished neatly on material exposed to view. Copes and re-entrant cuts shall be filleted before cutting.
4. **HOLES:** Holes in steel less than 13/16-inch thick may be punched to full size unless otherwise shown on the Specification Drawings. Holes shown on the Specification Drawings as drilled holes and holes in steel 13/16-inch thick or more shall be drilled or subpunched and reamed. Holes shall be clean cut and without torn or ragged edges. Burrs resulting from reaming or drilling shall be removed with a tool making a 1/16-inch bevel. Holes shall be cylindrical and perpendicular to the member. Place holes in plates prior to bending unless holes will be deformed during the forming process.
5. **PUNCHING:** For punching to full size, the punch diameter shall be the nominal hole diameter; and the die diameter shall not be more than 1/16-inch larger than the punch diameter. For subpunching, the punch diameter shall be 1/4-inch smaller than the nominal hole diameter and the die diameter shall not be more than 3/32-inch larger than the punch diameter. For reamed work, subpunching and reaming shall not result in a punched surface in the hole periphery.

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6. REAMING AND DRILLING: For reamed or drilled holes, the finished hole diameter shall be as shown on the Specification Drawings.
7. PUNCHING, REAMING AND DRILLING ACCURACY: Holes shall be spaced accurately in accordance with the Specification Drawings and located on the gage lines. The maximum allowable variation in hole spacing is 1/32-inch.
8. BASE PLATES: Base plates shall be straight, true and square cut. Grind torch-cut edges straight and smooth.
9. COMPRESSION JOINTS: Compression joint surfaces depending on contact bearing shall be faced to have full contact bearing when aligned and welded.
10. COLD FORMING: The Contractor shall have documented, detailed procedures describing cold forming. Methods shall produce bends without an undue amount of cracking. Cracking or opening of surface laminations shall be investigated and repairs performed, inspected and recorded. Plates displaying gross cracks, laminations or lamellar tears shall be rejected. The radius of any inside corner shall be the greater of three (3) times the specified wall thickness or as specified in ASTM A6 Appendix X4 for steel and AA Aluminum Design Manual for aluminum.
11. DIMENSIONAL TOLERANCES FOR STEEL: Steel member and plate tolerances shall be in accordance with AISC 303 "Code of Standard Practice for Steel Buildings and Bridges" and as follows:
 - a. Built-Up Square and Rectangular Member Shape Tolerances: Fabricate to meet the tolerances of square and rectangular tubing.
 - b. Eight and Twelve Sided Member Shape Tolerances:
 - (1) Cross Section:

Width Across Flats	Tolerance
36-inches or less	-1/8-inch, +1/4-inch
Greater than 36-inches	-1/4-inch, +1/2-inch
 - (2) Circumference: Dimension shall be -0-inches.
 - (3) Maximum Variation from Straightness: Variation shall not exceed 1/8-inch per 10-feet of length.
12. DIMENSIONAL TOLERANCES FOR ALUMINUM: Aluminum member and plate tolerances shall be in accordance with AA "Code of Standard Practice for Fabricating and Erecting Structural Aluminum."
13. WELDING FOR STEEL: Welding shall be performed in accordance with the latest revision of AWS D1.1. Headed shear connectors for stub angles shall be welded with automatically timed stud welding equipment. Welds shall be as shown on the Final Drawings and made to minimize residual stresses. No stress-relieving treatment is required. Welding procedures, welding operators, welders and tack welders shall be qualified in accordance with AWS D1.1.
14. LONGITUDINAL SEAM WELDS: Longitudinal seam welds may be used to fabricate structural members. Complete joint penetration is required within 6-inches of base plates and flange connection plates. The remaining seam welds shall have 80-percent minimum penetration through the material thickness. The use of permanent backing material is not permitted. Welding

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procedure specifications and supporting procedure qualification records, if applicable, for partial penetration seam welds shall be submitted to the COR and approved prior to fabrication.

15. **WELDING FOR ALUMINUM:** Welding shall be performed in accordance with AWS D1.2. Welds shall be as shown on the Final Drawings and made to minimize residual stresses. Welding procedures, welding operators, welders and tack welders shall be qualified in accordance with AWS D1.2.

4.1.7 NONDESTRUCTIVE AND METALLOGRAPHIC WELD TESTS:

1. **GENERAL:** Inspect and test welds in accordance with AWS D1.1 for steel and AWS D1.2 for aluminum, or in accordance with procedures approved by the COR.

Repair and reexamine defective welds in accordance with AWS D1.1 for steel and AWS D1.2 for aluminum. Document and notify the COR of any defects and subsequent weld repairs.

2. **VISUAL INSPECTION:** All welds shall be visually inspected in accordance with AWS D1.1 for steel and AWS D1.2 for aluminum.
3. **ULTRASONIC AND RADIOGRAPHIC TESTS FOR COMPLETE PENETRATION WELDS:** Perform ultrasonic or radiographic tests in accordance with AWS D1.1 for steel and AWS D1.2 for aluminum. Test the entire length of complete joint penetration shop and field welds. Tests shall be performed after galvanizing for complete joint penetration welds used at T-joints, as defined by AWS D1.1, where the thicker plate is more than three (3) times the thickness of the thinner plate. Otherwise, tests can be before galvanizing.
4. **ULTRASONIC AND METALLOGRAPHIC TESTS FOR PARTIAL PENETRATION WELDS:** Perform either ultrasonic or metallographic tests for partial penetration welds.
 - a. **Ultrasonic Tests:** Perform ultrasonic tests in accordance with AWS D1.1 for steel and AWS D1.2 for aluminum or procedures approved by the COR. Test a minimum of 10-percent of each length of partial penetration weld at random intervals, with no test length exceeding 12-inches.
 - b. **Metallographic Tests:** Perform metallographic examination, using an accredited test lab approved by WAPA. For each tubular piece mark, remove a weld sample from the first tubular section and from every tenth section thereafter. Remove samples by core drilling and plug the holes with full penetration welds without permanent backing material. The test procedure shall include a sample report form for documenting the test results, which shall include:
 - (1) WAPA contract number.
 - (2) Structure type and piece mark number.
 - (3) Material thickness.
 - (4) Name, location, email address and telephone number of test lab.
 - (5) A sketch showing location of removed weld samples.
 - (6) Actual weld penetration of samples.
 - c. **MAGNETIC PARTICLE AND DYE PENETRANT:** Magnetic particle or dye penetrant weld testing is required where cracking is suspected. Perform magnetic particle tests in accordance with ASTM E709. Perform dye penetrant tests in accordance with ASTM E165. The acceptance standards for the tests shall be in accordance with AWS D1.1 and AWS D1.2.

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4.1.8 MARKING:

Anchor bolts and embedded material shall be marked with the designation shown on the Specification Drawings. Other individual pieces shall be marked with the designation shown on the approved erection drawings. Markings shall be stamped into the metal before galvanizing or painting. The numerals or letters shall be 1/2-inch minimum height, clearly legible after galvanizing or painting and circled or bracketed with black paint. Anchor bolts may be identified by tagging. In designating members, use as few designations as possible; and each member of identical size and detail shall have the same designation regardless of its position in the structure or tower. Mating parts shall be match marked.

4.1.9 SHOP ASSEMBLY:

1. **GENERAL:** Structures shall be shop-assembled to the extent necessary to assure correct fit of parts, adequate bolt lengths and proper field erection. One (1) lattice tower of each type and height, including every combination of leg extensions, shall be shop-assembled to the extent necessary to assure correct fit of parts, adequate bolt lengths and proper field erection.
2. **ASSEMBLY:** Reaming of misaligned holes is not permitted. A reasonable amount of drifting is allowed. "A reasonable amount of drifting" is defined as drifting without causing hole elongation or deformation of members. Galvanizing damaged during the course of "a reasonable amount of drifting" shall be repaired in accordance with Section 4.1.10, "Galvanizing and Painting". Shop-assembled parts shall be dismantled for shipment.

Bolts used in shop assembly shall be of the lengths called for on the Approval or Government Furnished Fabrication Drawings. Where the indicated length is too short to permit acceptable assembly, provide the next longer bolt increment. If assembly is from Approval Drawings, the Final Drawings shall be revised to show the actual bolt lengths. If assembly is from Government Furnished Fabrication Drawings, provide marked prints showing changes to the COR.

4.1.10 GALVANIZING AND PAINTING:

1. **CLEANING:** After shopwork completion, material shall be clean of rust, loose scale, dirt, oil, grease and other foreign substances. Clean all welding flux residue (slag) from welded areas.
2. **PLATE AND SHAPE GALVANIZING:** After fabrication and cleaning, galvanize plates and shapes in accordance with ASTM A123. Double dipping or progressive dipping of closed-member shapes will not be permitted. Where member lengths of open shapes prevent dipping in one operation, care shall be exercised to prevent warping. Finished compression members shall not have lateral variations greater than 1/1000 the axial length between the points which are to be laterally supported. Holes shall be free of excess spelter after galvanizing.
3. **VENT AND DRAIN HOLES:** Vent and drain holes for closed-member shapes are shown on the Specification Drawings. Vent and drain holes shown on the Specification Drawings are typical to facilitate the galvanizing process and may be changed to comply with the Contractor's shop practice, provided the changes are shown on the Approval Drawings and do not affect the integrity of the structure.
4. **HARDWARE GALVANIZING:** Bolts, nuts, washers and locknuts shall be galvanized in accordance with ASTM A153. Excess spelter shall be removed by centrifugal spinning. Cadmium-plated hardware is not permitted on structural steel.
5. **STRAIGHTENING AFTER GALVANIZING:** Plates and shapes which have been warped by the galvanizing process shall be straightened by rerolling or pressing. Material shall not be

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hammered or otherwise straightened in a manner that will damage the galvanizing. Any material the COR determines has been harmfully bent or warped shall be rejected.

6. **GALVANIZING REPAIR:** Material with damaged galvanizing shall be redipped unless the damage is local and can be repaired. If the galvanized coating becomes damaged after being dipped twice, the material shall be rejected. Where repair is authorized, the damaged area shall be repaired in accordance with ASTM A780. The coating thickness shall be a minimum of 5-mils.
 - a. **Zinc Rich Paint:** When utilizing paints containing zinc dust, surfaces shall be cooled to ambient temperature, dry, and free from rust, mill scale, paint, dirt and other contaminants. Surfaces may be cleaned by wire brush or equivalent cleaning methods (grinding is not permitted). Zinc paint shall be applied with a brush (spray painting is not permitted). The minimum required dry paint thickness is 5-mils. Zinc rich paint shall have a minimum of 94-percent zinc dust by weight.
7. **DULLING SURFACE TREATMENT:** Exposed surfaces of steel structures, including connection and anchor bolts, nuts, washers, locknuts and visible portions of embedded material shall be given an approved dulling treatment to provide a gray or blackish gray coloration. Treatment shall dull the shine and reflectance of surfaces and provide a generally uniform appearance over each surface and between separately galvanized and treated members. The dulling shall be accomplished by treatment and rinsing of all surfaces. Soft or water-soluble surface deposits resulting from the treatment shall be removed by rinsing. Treatment shall have a life of at least 1-year and not be detrimental to the service life of the protective zinc coating. Dulled surfaces shall be free of white rust (zinc oxide).

Aluminum surfaces shall be treated by means other than painting, to provide a coloration of aged, naturally-weathered and dulled aluminum. Treatment shall dull shine and reflectance of surfaces and provide a generally uniform appearance. Soft or water-soluble surface deposits resulting from treatment shall be removed by rinsing or other effective means. Treatment shall have a life of at least 1-year and not be detrimental to the aluminum.

The finished steel and aluminum shall maintain a reflectance no greater than that specified in the project specifications, plus or minus 3-percent. Reflectance shall be measured utilizing any reflectometer calibrated against “Neutral Matte Finish” color standards obtainable from Munsell Color, a division of X-Rite Incorporated, 4300 44th Street SE, Grand Rapids, Michigan 49512. The reflectometer used shall have a margin of error no greater than plus or minus 3-percent.

8. **PAINTING:** Surfaces of steel structures to be painted shall be prime painted in the shop in accordance with the Standard 12 – Painting.

4.1.11 HANDLING AND TRANSPORTING:

Structures and components shall be transported and handled to avoid bending or damage. Bent pieces may be used only if they are straightened without damage to the material or galvanizing. Material with damaged galvanizing shall be redipped unless the damage is local and can be repaired in accordance with Section 4.1.10, “Galvanizing and Painting”. Pieces bent beyond repair shall be replaced.

During storage, prevent ground or surface water contact by placing steel and aluminum on timber blocking.

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4.1.12 ERECTION:

Install anchor bolts and embedded material in accordance with the Specification Drawings. Install or erect other material in accordance with the Final Drawings or Government Furnished Fabrication Drawings. Erection and installation shall be in accordance with AISC 303 "Code of Standard Practice for Steel Buildings and Bridges". No structure shall be erected on foundations until backfill has been placed and compacted and the requirements of Standard 3 have been met. Set anchor bolts and embedded material accurately to the grade and alignment designated on the Specification Drawings. Set equipment bases and base plates level and in exact position. Where shown on the Specification Drawings, equipment bases and base plates shall be given full and even bearing by grouting in place. Remove shims and grout the remaining spaces. Grout shall be in accordance with Standard 3 – Concrete, Section 3.1.10 "Grouting Mortar".

Place stub angles in foundations as shown on the Specification Drawings, and support in proper position by means of a rigid frame or equivalent suitable device to ensure placement of stubs within tolerances specified below. Hold stub angles rigidly to prevent displacement during concrete placement. Difference in elevation between identical parts of any two (2) stub angles shall not exceed 1/1000 of the horizontal distance between stubs. Actual elevation of any stub angle shall not differ from computed elevation by more than 0.02-foot. Stub angles shall be located horizontally so that each is within 1/1000 of the correct distance shown on the Specification Drawings. Heel and side batter of the stub angles shall not differ from the correct batter by more than 1/16-inch per foot of exposed stub. The twist of each stub angle shall be within 0.5-degrees of the correct orientation.

Connection bolts shall be entered to the head. Nuts for ASTM A394 bolts shall be torqued to 70- to 100-pound-feet for 5/8-inch bolts, 125- to 165-pound-feet for 3/4-inch bolts and 180- to 230-pound-feet for 7/8-inch bolts. Nuts for ASTM F3125 Grade A325 bolts shall be tightened in accordance with AISC 348-20 "Specification for Structural Joints Using High-Strength Bolts". Nuts shall be locked in place. Tighten Type MF locknut sufficiently to flatten its concave face to full contact against the nut. Tighten push-nut locknut one-third turn beyond contact with the nut. Wrenches which may deform the nuts or damage the galvanizing are not permitted.

A reasonable amount of drifting, as defined in Section 4.1.9, "Shop Assembly", is allowed in assembling. Reaming for correction of mismatched holes is not permitted.

Field welding shall conform to the requirements of Section 4.1.6, "Fabrication". Perform ultrasonic tests for the field welds specified in Section 4.1.7, "Nondestructive and Metallographic Weld Tests". Inspect other field welds in accordance with Section 4.1.7, "Nondestructive and Metallographic Weld Tests". Clean field welds by sandblasting or power grinding.

Remove corrosive and foreign material deposited on the structures prior to erection.

Field welded areas of galvanized structures shall be coated with paint containing zinc dust in accordance with the requirements of Section 4.1.10, "Galvanizing and Painting".

Field-installed stud bolts shall be welded with automatically timed stud welding equipment. Surfaces within 2-inches of field weld locations shall be free from paint or other material that would prevent proper welding or produce objectionable fumes while welding.

The finish painting system shall be applied in the field in accordance with the Standard 12 – Painting.

Erecting errors and omissions, including tightening of loose bolts, nuts and locknuts, shall be corrected by the Contractor.

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Install switch operating platforms in the proper position with respect to the switch control rod or pipe and ground platform as shown on Drawing 31 1075. Platforms shall not be installed until after the switches are installed.

Install equipment cabinet platforms to provide access for routine operation and maintenance. The platform top shall not be above the cabinet bottom. Platforms shall be grounded as shown on Drawing 31 1075.

4.1.13 RELOCATING, MODIFYING AND STORING STRUCTURES AND TOWERS:

1. **GENERAL:** Dismantle, handle, transport, re-erect, modify and bundle structures as required. Avoid bending and galvanizing damage to members. Repair damaged galvanizing in accordance with Section 4.1.10, "Galvanizing and Painting". Members damaged beyond repair or lost shall be replaced.
2. **RELOCATING STRUCTURES:** Structures to be relocated shall be dismantled as required to prevent structural damage. Anchor bolts or embedded material shall not be salvaged.

Re-erect structures in accordance with Section 4.1.12, "Erection". Replace removed, loosened or lost bolts with new bolts, nuts and locknuts of the same size and type required by the Final Drawings. Plumb structures after re-erection. The cost of loosening and retightening bolts required to accomplish this, whether due to relocation operations or to an existing out-of-plumb condition, shall be included in the applicable Bidding Schedule item.

3. **MODIFYING STRUCTURES:** Field-drill new holes as shown on the Specification Drawings to complete the modification work. Operations in removing, replacing, and modifying members shall ensure the integrity of the structure at all times. Members removed and not required in the modified structure become the Contractor's property and shall be promptly removed from the worksite.
4. **STORING STRUCTURES:** Structures to be stored shall be completely dismantled and stored above ground on timber blocking. Anchor bolts, stub angles or embedded material shall not be salvaged.

Pack undamaged bolts, nuts, washers and ring fills separately by size in wood boxes or kegs. Replace damaged bolts, nuts, washers and ring fills with new ones of the same size and type. Provide new locknuts. Store structures as a unit. Consolidate and steel band identical steel members in small bundles convenient for handling. Identify banded bundles with weatherproof tags which indicate the piece marks and member quantities. Prepare and deliver a master list of bundles to the COR.

5. **STRUCTURE SIGNS:**
 - a. **LATTICE STEEL STRUCTURE NUMBER SIGNS:** The structure number signs, with the structure numbers as designated on the plan and profile drawings, shall be attached to the structures on the ahead and back span face of structure. The structure number signs shall be fabricated and attached to the structures in accordance with Drawing 41 9007.
 - b. **AERIAL PATROL MILE MARKER SIGNS:** The first structure of each mile section of line shall be identified with two (2) aerial patrol mile marker signs, one (1) on the ahead and one (1) on the back span face of the wood pole structure or mounting plate of the steel pole/lattice steel structure. Signs shall be fabricated and attached in accordance with Drawing 41 9005.

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6. AERIAL PATROL WARNING SIGNS: Aerial patrol warning signs, located as designated on the plan and profile drawings and described in the “Line Markers” paragraph of the “Conductor, Overhead Ground Wire and Accessories” Section, shall be fabricated and mounted in accordance with Drawing 41 9005.
7. DANGER SIGNS: Mount two (2) danger signs on each lattice-type steel structure in accordance with Drawing 41 9005.

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SECTION 4.2 – MISCELLANEOUS METALWORK

4.2.1 ALUMINUM COVERS:

1. MATERIAL: Aluminum alloy 6061-T6. Covers shall be 1/4-inch-thick floor plate with a raised, 4-way pattern.
2. FABRICATION: Plates shall be straight, true, and free from warps and twists. If straightening is necessary, no metal damage shall result. Finish neatly material exposed to view. Grind sharp and rough edges of covers smooth. Perform welding in accordance with AWS D1.201.
3. INSTALLATION: Install aluminum covers accurately in position and alignment. Finish the surfaces of concrete to be in contact with the covers level so that covers will lie flat and will not rock.

Paint aluminum cover and hold-down angle surfaces in contact with concrete with commercial grade bituminous paint to produce a 5-mil minimum thickness.

4.2.2 STEEL COVERS:

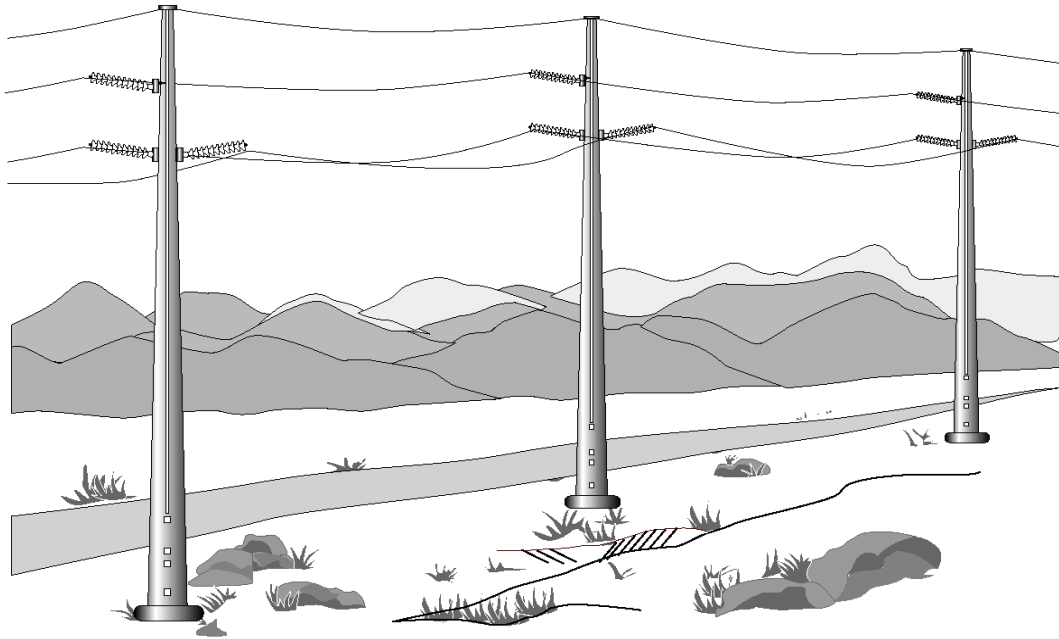
1. MATERIAL: ASTM A36. Covers shall be 3/16-inch-thick floor plate with a raised, 4-way pattern.
2. FABRICATION: Plates shall be straight, true, and free from warps and twists. If straightening is necessary, no metal damage shall result. Finish neatly material exposed to view. Grind sharp and rough edges of covers smooth. Galvanize the covers. Perform welding in accordance with AWS D1.1.
3. INSTALLATION: Install steel covers accurately in position and alignment. Finish the surfaces of concrete to be in contact with the covers level so that covers will lie flat and will not rock.



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SECTION 5.1 – TRANSMISSION LINE STEEL POLE STRUCTURES

5.1.1 CONTRACTOR-FURNISHED DATA AND DRAWINGS:

1. GENERAL: Use United States standard units of measurement and English words, signs and symbols. Submit data and drawings for all structures. Include design calculations for all structure components. Drawings shall be new originals. Reproductions of the specification drawings are not acceptable.

Thoroughly check data and drawings for accuracy and completeness before submitting. WAPA will not check details and intermediate dimensions.

WAPA will electronically return the design data sheets and drawings and indicate required changes in the reply email. Contractor shall change the designs and details, which WAPA determines necessary to make the finished structures conform to these specifications.

WAPA's review time is specified in the Project Specifications. WAPA approval shall not relieve the Contractor from meeting the specification requirements nor the responsibility for design and drawing correctness. Fabrication prior to design data and drawing approval will be at the Contractor's risk.

2. DESIGN DATA: Accuracy and correctness of the structure design, based on the loads indicated on the Drawings, is the Contractor's responsibility. Prior to fabrication, submit for approval, the following design data for each type and height of structure:
 - a. All design data pages shall show or reference the following:
 - (1) WAPA project title.
 - (2) Specific WAPA structure number(s)
 - (3) Specific WAPA structure type(s) and height(s)
 - b. General dimensions and weight.
 - c. Computer analyses for each load case showing ultimate moment capacities, total ultimate shears, moments, axial loads and rotations at ground line and point of base fixity. Computer analyses and basis of design for base plates, splices, flange plates, joints, points where plate size changes, arm connections, and other critical points for the controlling load case(s).
 - d. PLS-Pole® model backup file.
 - e. Maximum deflection at top of structure for each load case shown on the Drawings.
 - f. Anchor bolt size and spacing. Anchor bolt circle limitations are specified in the Project Specifications.
 - g. Camber requirements.
 - h. Guy locations, ultimate load, size and capacity.
 - i. Guy anchor type and capacity.
 - j. Guy hardware and anchor catalog data sheets.

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3. **MILL TEST REPORTS:** Submit certified copies of test reports of structural steel, bolts, nuts and the chemical analyses and coating test of the galvanizing within 20-days of material shipment.

Certified mill test reports for steel shapes and plates shall show customer's order, mill order and WAPA specifications number. Mill certification shall show the weights of steel furnished for each size and heat number represented by the tests.

4. **WELDING SUBMITTALS:**

- a. Prior to fabrication, submit all weld procedures which are not prequalified in accordance with AWS D1.1, "Structural Welding Code – Steel."
- b. Prior to fabrication, submit Fabricator's standard weld and evaluation procedures.
- c. Submit weld test reports within 20-working days after tests are performed.

5. **DULLING TREATMENT SUBMITTALS:**

- a. Chemical composition of dulling treatment.
- b. Application procedure.
- c. Upon request, submit one (1) set of three (3) galvanized samples prior to dulling and one (1) set of three (3) samples after dulling. Dulled samples shall represent the reflectance specified in the project specifications. Each sample shall be a dulled-galvanized steel panel, 3-inches by 6-inches by 1/4-inch-thick and have the respective percent of reflectance stamped into the metal.
- d. Approved samples shall constitute comparison standards for dulled-galvanized steel inspection.

6. **PAINTING SUBMITTALS:**

- a. Paints: Manufacturer's technical information including color chips, paint label analysis, surface preparation, spread rates, thinning instructions, coverage of paint, recommended number of coats and application instructions.
- b. Material Safety Data Sheets (MSDS) for each paint, oil, epoxy and other hazardous material.

7. **POLYURETHANE COATING SUBMITTALS:**

- a. Manufacturer's technical information and data sheets including color, surface preparation, thickness, recommended application instructions, and safety information.

8. **APPROVAL DRAWINGS:** Prior to fabrication, submit detail drawings covering each type and height of structure for approval. Submittals shall include:

- a. Erection Drawings Showing the Following:
 - (1) Dimensions.
 - (2) For Each Structure Component: Mark number, position, size, weight, material and location.
 - (3) For Each Bolted Connection: Quantity, type (grade), size and length of bolts.

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- (4) A complete bill of materials, including hardware and weights, listing all material for one (1) structure or the portion shown thereon. Show the number of pieces required, description of each piece, including size and length and drawing number on which the shop detail of each piece can be found. Total weight of one (1) complete structure shall be noted. Calculate weights in accordance with AISC 303 "Code of Standard Practice for Steel Buildings and Bridges," except that weights for nonrectangular plates used to fabricate pole shafts and davit arms are to be based on actual detailed dimensions shown on the final shop drawings.
 - (5) Weight, center of gravity, lifting lug locations or lifting method and lifting point of each major structure component (pole shaft section, arm assembly, bolt cage, etc.).
 - (6) Slip joint location(s) and design length. The drawings shall also provide the slip joint tolerances and required jacking forces (minimum and maximum).
 - (7) Camber requirements. Camber orientation shall reference direction of transmission line.
 - (8) Embedment depth for direct-embedded structures.
 - (9) Anchor bolt setting plan, size and quantity. Setting plan shall reference direction of transmission line and camber.
 - (10) Plan view showing orientation of each structure in relation to centerline of transmission line.
 - (11) Location, edge preparation details and material for each field weld.
 - (12) Method for permanently restraining slip-joints after installation for H-frame structures if approved by WAPA.
 - (13) Guy pretension loads.
 - (14) Guy locations, arrangements and attachment details.
 - (15) Guy anchors and installation details.
 - (16) Structure number sign and identification plate locations.
 - (17) Plan and elevation views for each structure type showing exact location of fixed climbing rung sections, clips for removable climbing rung sections, belt loops, hand loops, ladder brackets and ring clips.
 - (18) Splice designs and attachment details for fixed climbing rung sections.
 - (19) All instructions required for the field installation, including minimum jacking forces and connection bolt tightening.
- b. Shop Detail Drawings Showing the Following:
- (1) All structure components and connections.
 - (2) Anchor bolts.
 - (3) Location, edge preparation details and material for each shop weld.

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- (4) Ground plate locations in accordance with Drawing 41 1015.
 - (5) Locations for structure signs in accordance with Drawings 41 9027-1, 41 9027-2, 41 9027-3 and 41 9028, or as specified in the project specifications.
 - (6) Details of fixed and removable climbing rung sections, rungs, clips for removable climbing rung sections, attachments for fixed climbing rung sections, belt loops, hand loops, ladder brackets, ring clips, the attaching welds and work rings.
- c. All drawings shall show the following:
- (1) WAPA specifications number and project title.
 - (2) Specific WAPA structure number(s).
 - (3) Specific WAPA structure type(s) and height(s) shown or referenced on each drawing.
 - (4) Type and grade of material (ASTM specification) and structure finish (i.e., galvanized, dulled galvanized, metallized, weathering steel or painted-over-galvanized).
 - (5) Any changes between drawing submittals shall be clearly documented and submitted as a revision for review.
- d. Erection and Shop Detail Drawings may be combined into a single submittal drawing set at the Fabricators' discretion. However, all required information shall be clearly shown in the submitted approval drawings.
9. FINAL DRAWINGS: Prior to material shipment and before final payment, furnish final drawings and bill of materials required in Section 5.1.1.7 above.
10. SUBMITTAL REQUIREMENTS: Submit samples and electronic versions of data and drawings to the COR and Civil Engineer for approval as follows:
- a. Design Data: Submit all design data in one (1) complete submittal package, including calculations for all structure and anchor bolt components.
 - b. Mill Test Reports.
 - c. Welding Submittals.
 - d. Dulling Treatment Submittals: Submit electronic copy of photo(s) comparing a galvanized piece to a dulled piece showing reduced reflectance. Forward the samples to the COR.
 - e. Painting Submittals: Forward one (1) set of color chips and one (1) electronic copy of manufacturer's technical information and MSDS to the COR.
 - f. Polyurethane Coating Submittals: Forward one (1) electronic copy of manufacturer's technical information and data sheets to the COR.
 - g. Approval Drawings: Submit all approval drawings in one (1) complete submittal package. Anchor bolt cage assembly approval drawings may be submitted separately from structure approval drawings. For projects with ten (10) or more unique structure designs, submit structure approval drawings in scheduled phases or groups as agreed upon with the COR.
 - h. Final Drawings.

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5.1.2 DESIGN REQUIREMENTS:

1. GENERAL: Transmission line steel poles and anchor bolts shall be designed in accordance with ASCE/SEI 48-19. Base plates, flange plates, arm connections, slip joints, and other pole components may be designed using published theories accepted by industry as good engineering practice and verified by testing. Design so that ultimate stresses do not exceed the material yield stress. Design yield strength for structural steel plates shall not exceed 65-ksi. Check material stresses for each load case shown on the Drawings.
2. DESIGN GUIDES:
 - a. ASCE/SEI 48-19, "Design of Steel Transmission Pole Structures"
 - b. AISC "Steel Construction Manual"
 - c. AWS D1.1, "Structural Welding Code – Steel"
 - d. NESC 2023: National Electric Safety Code
3. SPECIFIC REQUIREMENTS:
 - a. Steel Pole Structures:
 - (1) Pole shafts shall be closed shapes and tapered consistent with strength requirements.
 - (2) Davit arms and crossarms shall be closed shapes and shall provide the electrical clearances shown on the Drawings.
 - (3) Brackets and braces may be open or closed shapes and shall provide the electrical clearances shown on the Drawings.
 - (4) Structural steel shall not be less than 3/16-inch thick, except for structure identification plates.
 - (5) Design direct-embedded structures assuming pole shaft fixity at a point 5-feet below ground line.
 - (6) Design anchor-bolted structures assuming a 1-degree rotation in the direction causing the worst case loading at the base plate.
 - (7) Apply wind pressure to structure in the direction of the greatest wire attachment force resultant.
 - (8) Perform second-order, geometrically-nonlinear, elastic analyses to accommodate stresses from structure deflection, secondary bending, and guy loads. Weights of all arm connections and components shall be considered in the second-order analyses.
 - (9) If required in the project specifications, camber single-shaft self-supporting structures with line angles and/or unbalanced tensions so that the structure axes are vertically plumb after conductors are strung. Camber less than 6-inches is not required. The bottom pole shaft section of direct-embedded structures shall not be cambered. If camber is required, WAPA will furnish camber loads within 30-days after contract award.

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- (10) Structure designs shall account for the weight and projected wind area of all maintenance provisions.
- (11) Thickness of flange plates shall be designed assuming loads are transferred directly by point loads through bolts and not by bearing between the flange plates.
- (12) Guyed structure design shall accommodate the possibility that one (1) or more guys will be moved, in line, a maximum of 5-feet closer to or further from the structure than shown on the guying arrangement plans.
- (13) Sections joined by slip joints shall have a minimum lap of 1.5-times the largest inside diameter of the female section and meet the requirements of Section 5.1.5, "Quality Control". Use complete penetration welds in the female splice area, accounting for any over slip. Shims shall not be used in slip joints.
 - (a) For any slip joints located between phases, the over-slip tolerance length for the designed slip joint shall be added to the pole length between the phases.
- (14) Non-compact sections shall not be used for the inner section at slip joints for the length of the slip, including over slip. Members shall be designed such that the result of equation $w/t \leq \sqrt{F_y/E}$ is less than 1.41 for 12-sided shapes, 1.53 for 8-sided shapes, and 1.26 for 16-sided shapes. Calculate "w" in accordance with Chapter 5 of ASCE 48-19.
- (15) H-frame structures shall use flange plate connections if more than one section is used to achieve design height. If slip joint connections are approved for H-frame structures, the slip joints shall be permanently restrained from movement after installation.
- (16) Bottom pole shaft sections for direct-embedded structures shall extend a sufficient distance above ground line so that bottom jacking lugs, normally 1-inch-diameter heavy hex nuts, are a minimum of 3-feet above ground line to allow installation of jacking devices above top of concrete. Minimum projection above ground line shall be 7-feet plus the maximum overlap length for the bottom slip joint.
- (17) All structures shall be capped at the top and arm ends.

Pole caps for galvanized structures with pole top aerial patrol mile marker signs and/or warning signs shall be minimum 1/4-inch thick and shall be attached to pole tops by a minimum of four 5/8-inch-diameter bolts in a symmetrical pattern.

Pole caps for weathering steel structures shall be welded to pole tops.
- (18) Pole shaft base sections for weathering-steel and metallized structures shall be hermetically sealed.
- (19) Direct-embedded galvanized pole shafts shall have two 1-inch-diameter vent holes 2-feet above ground line.
- (20) Direct embedded pole shafts shall be coated with polyurethane coating in accordance with Section 5.1.14, "Polyurethane Coating".
- (21) Base plates for anchor-bolted structures shall not overhang the concrete foundations.
- (22) Anchor bolt templates shall be designed by the Fabricator to have sufficient strength to maintain the anchor bolts in the designed bolt circle. Intermediate and bottom

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anchor bolt templates shall be round and extend no more than 3-inches from the bolt circle.

- (23) Structure sections and complete structures shall have approved lifting method to prevent slippage of slings and ensure safe lifting and handling.
- (24) Structure number signs and identification plates shall not interfere with installation of removable or fixed climbing rung sections.
- (25) Location and spacing of holes shall be within tolerances specified in Section 5.1.5, "Quality Control."
- (26) Contractor shall determine details not shown on the Drawings based on the intended use and fabricator's recommendations.

b. Guys and Guy Anchors:

- (1) Determine optimum guy size and arrangement best suited for the structure required. Locate guys to provide the following minimum electrical clearances:

VOLTAGE (kV)	CLEARANCE (IN)
34.5	30
69	42
115	60
138	60
161	66
230	91
345	115
500	152

- (2) Consider guys as elastic members in structure analyses. Modulus of elasticity for design of guy material shall be 23,000-ksi. Under maximum design loading, guy tensions shall not exceed 65-percent of the minimum rated breaking strength.
- (3) Guy hardware and structure attachments shall be capable of supporting the minimum rated breaking strength of attached guys. Steel hardware shall be galvanized or galvanized and dulled in accordance with Section 5.1.9, "Galvanizing" and 5.1.10, "Dulled Galvanizing".
- (4) Guys and guy vangs shall not interfere with installation of maintenance provisions.
- (5) Determine number and type of guy anchors. Guy anchors shall develop the minimum rated breaking strength of attached guys. No more than two (2) guys shall be attached to any one (1) anchor.
- (6) Minimum guy anchor spacing shall be 8-feet.

c. Maintenance Provisions:

- (1) Dimensions and details for maintenance provisions shall be as shown on Drawings 43 2203, 43 2206, 43 2207, 43 2208, 43 2209, 43 2210, 43 2214 and 41 2701 unless otherwise specified in the project specifications.

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- (2) Welds to attach maintenance provisions to structures shall be designed for a minimum 5,000-pounds factored vertical load.
- (3) Direct Embed Structures: Minimum height above ground line for bottom clip for removable climbing rung sections shall be 27-inches to allow sufficient space above top of concrete to install bottom removable climbing rung sections. Maximum height above ground line for bottom clip for removable climbing rung sections shall be 48-inches unless approved otherwise.
- (4) Base Plated Structures: Minimum height above base plate for bottom clip for removable climbing rung sections shall be 7-inches to allow sufficient space above top of base plate to install bottom removable climbing rung sections. Maximum height above base plate for bottom clip for removable climbing rung sections shall be 30-inches unless approved otherwise.
- (5) Rungs for fixed and inclined climbing rung sections shall be secured with nuts and locknuts and shall have a 3 1/2-inch minimum thread length as shown on Drawing 43 2210.
- (6) Removable climbing rung sections shall be identical.
- (7) Expansion anchors to attach clips for removable climbing rung sections to concrete foundations shall develop a minimum tensile strength of 5,000-pounds.
- (8) Fixed climbing rung sections shall be spliced together to form a continuous center support for the full height of the structure. Splices shall be designed to ensure full structural continuity of the center support. Small gaps in the center support across slip joints are acceptable. Splices shall provide smooth transitions with the center support and afford minimum interference with the gripping surface for the hands. Sharp edges or lateral projections on splices shall not be permitted.
- (9) Top or bottom cantilevered extensions of fixed climbing rung sections shall not extend more than 27-inches beyond the nearest clip.

4. EMBEDMENT DESIGN FOR DIRECT-EMBEDDED STRUCTURES:

- a. Auger Diameter: Auger diameter shall be pole shaft base diameter plus a minimum of 12-inches, unless otherwise specified in the project specifications.
- b. Embedment Depth: Structure embedment depth, "E", shall be as listed in the project specifications.

Rock is defined as a massive or stratified cemented formational material having a standard penetration test (SPT) "N" value of 100 or more throughout the entire embedment depth.

If rock is encountered, at the Contractor's option, structure embedment depths may be reduced to the overburden depth plus "Keyed into Rock" depth listed in the project specifications. Bottom of pole shafts that are cut off to reduce embedment depth shall be repaired in accordance with Section 5.1.16.3.

5.1.3 GROUNDING REQUIREMENTS:

1. GENERAL: All connections on all structures shall provide for electrical continuity across the connections and an electrical path shall be provided from every part of the structure to the ground. Grounding requirements will vary with the type of material and structure finish and shall be in accordance with Drawing 41 1015 and this section.

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2. GALVANIZED, DULLED GALVANIZED AND METALLIZED STRUCTURES:

- a. Pigtail jumpers and ground plates are not required on galvanized, dulled galvanized or metallized structures that are direct-embedded with concrete backfill or installed on concrete foundations.
- b. Pigtail jumpers and ground plates are required 2-feet above ground line on galvanized, dulled galvanized and metallized pole shafts that are direct-embedded with native backfill.

3. WEATHERING-STEEL STRUCTURES:

- a. Weathering-steel structures shall have pigtail jumpers and ground plates welded on either side of all slip joints and bolted connections, including davit arm and post insulator connections, 2-feet above ground line for direct-embedded structures, and 6-inches above base plates on anchor-bolted structures in accordance with Drawing 41 1015.
- b. After installing fixed and inclined climbing rung sections and fall protection anchors with bolts, nuts and locknuts or lock washers, the rung section mounting plates shall be field-welded to the attachments on the pole shafts in accordance with Drawings 41 1015 and 43 2210. Welding shall be sufficient to provide electrical continuity between the climbing rung sections and the pole shaft. Preferred welding rod series is E8018-C3. Other acceptable series are E8018-C1 and E8018-C2.

4. PAINTED-OVER-GALVANIZED STRUCTURES: Pigtail jumpers and ground plates are required 2-feet above ground line on all pole shafts of painted-over-galvanized structures that are direct-embedded with native backfill. Pigtail jumpers and ground plates are not required at other locations on painted-over-galvanized structures provided the following surfaces of the structures are not painted, (i.e., masked, or otherwise protected from paint, to ensure the electrical continuity of the structure):

- a. Faying surfaces shall not be painted, including:
 - (1) Areas Inside Slip Joints: Outside surfaces of male (bottom) sections and inside surfaces of female (top) sections.
 - (2) Arm Connections: Outside surfaces of arm connection vangs and inside surfaces of arm connection brackets.
 - (3) Attachment Plates for Fixed Climbing Rung Sections: Outside surfaces of attachments for fixed climbing rung sections and faying surfaces of rung section mounting plates.
 - (4) Interior surfaces of clips for removable climbing rung sections.
 - (5) Post Insulator Mounting Brackets: Exterior surfaces of mounting brackets.
- b. Overhead ground wire attachment plates shall not be painted.
- c. Portions of direct-embedded galvanized pole shafts that will be below ground line shall not be painted.
- d. If any of the above surfaces are painted, either the grounding requirements for weathering-steel structures shall apply or paint shall be removed prior to structure installation.

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5.1.4 MATERIAL:

1. POLE SHAFTS, DAVIT ARMS AND CROSSARMS:

- a. Galvanized, Dulled Galvanized, Metallized or Painted Steel: ASTM A572 Grade 65 or ASTM A871 Grade 65. Actual material yield strength shall not exceed 80 ksi, unless an alternate Welding Procedure Specification (WPS) is submitted, approved by the COR, and followed during fabrication.
 - (1) Silicon, Phosphorous, Carbon, and Manganese content of pole shaft material shall be within the limits of ASTM A385.
 - (2) Galvanize, galvanize and dull, metallize or paint material after fabrication in accordance with Sections 5.1.9, "Galvanizing", 5.1.10, "Dulled Galvanizing", 5.1.11, "Metallizing" or 5.1.13, "Painting".
- b. Weathering Steel: ASTM A871 Grade 65. Actual material yield strength shall not exceed 80 ksi, unless an alternate WPS is submitted, approved by the COR, and followed during fabrication.
- c. Structural Tubing:
 - (1) Galvanized, Dulled Galvanized, Metallized or Painted Steel: ASTM A500 Grade B.
 - (2) Weathering Steel: ASTM A847 Grade 50.
- d. Material shall have a minimum longitudinal impact strength of 15-foot-pounds at minus 20- degrees Fahrenheit as determined by the Charpy "V" Notch Impact test in accordance with ASTM A370 and A673.

2. BASE PLATES, FLANGE PLATES, ARM MOUNTING BRACKETS AND CONNECTION PLATES:

- a. Galvanized, Dulled Galvanized, Metallized or Painted Steel: ASTM A572, ASTM A588, ASTM A633 or ASTM A871.
- b. Weathering Steel: ASTM A871.
- c. Material shall have a minimum longitudinal impact strength of 15-foot-pounds at minus 20- degrees Fahrenheit as determined by the Charpy "V" Notch Impact test in accordance with ASTM A370 and A673.
- d. Actual material yield strengths shall not exceed the design yield strength by more than 15 ksi, unless an alternate WPS is submitted, approved by the COR, and followed during fabrication.

3. X-BRACES AND MISCELLANEOUS STRUCTURAL STEEL:

- a. Galvanized, Dulled Galvanized, Metallized or Painted Steel: ASTM A36, ASTM A242, ASTM A572, ASTM A588, ASTM A633 or ASTM A871.
- b. Weathering steel: ASTM A242, ASTM A588 or ASTM A871.
- c. Actual material yield strengths for any welded steel shall not exceed the design yield strength by more than 15 ksi, unless an alternate WPS is submitted, approved by the COR, and followed during fabrication.

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- d. Material shall have a minimum longitudinal impact strength of 15-foot-pounds at minus 20- degrees Fahrenheit as determined by the Charpy “V” Notch Impact test in accordance with ASTM A370 and A673.
4. CONNECTION BOLTS, NUTS, LOCKNUTS AND LOCK WASHERS:
- a. Galvanized, Dulled Galvanized, or Painted Steel:
 - (1) Bolts: ASTM F3125 Grade A325 Type 1, ASTM A354 Grade BC Modified or ASTM A394 Type 1.
 - (2) Nuts: ASTM A563 Grade DH or other suitable grade specified in ASTM A563 Table X1.1.
 - (3) Locknuts:
 - (a) Palnuts (regular) or Type MF No. 1 (regular or square).
 - (b) In lieu of separate locknuts, self-locking heavy hex nuts for use with ASTM F3125 Grade A325 Type 1 structural bolts, conforming to ASTM A194 Grade 2H or ASTM A563 Grade DH may be used. Self-locking heavy hex nuts shall be Anco style self-locking nuts with stainless steel ratchet pin or equal.
 - (4) Lock washers: ASTM F436.
 - (5) Galvanize or galvanize and dull material after fabrication in accordance with Sections 5.1.9, “Galvanizing” and 5.1.10, “Dulled Galvanizing”. Material for painted structures shall be galvanized, then painted in accordance with Section 5.1.13, “Painting”, except locknuts and lock washers do not require painting.
 - b. Weathering Steel:
 - (1) Bolts: ASTM F3125 Grade A325 Type 3, ASTM A354 Grade BC Modified or ASTM A394 Type 3.
 - (2) Nuts: ASTM A563 Grade C3 or other suitable grade specified in ASTM A563 Table X1.1.
 - (3) Locknuts: Locknuts shall be galvanized in accordance with Section 5.1.9, “Galvanizing”, then prime-coated to match weathering-steel finish.
 - (a) Palnuts (regular) or Type MF No. 1 (regular or square).
 - (b) In lieu of separate locknuts, self-locking heavy hex nuts for use with ASTM F3125 Grade A325 Type 3 structural bolts, conforming to ASTM A194 Grade 2H or ASTM A563 Grade DH3 may be used. Self-locking heavy hex nuts shall be Anco style self-locking nuts with stainless steel ratchet pin or equal.
 - (4) Lock washers: ASTM F436. Lock washers shall be galvanized in accordance with Section 5.1.9, “Galvanizing”.
5. ANCHOR BOLTS, NUTS AND WASHERS:

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- a. Anchor Bolts: ASTM A615 Grade 75 Modified. Anchor bolt material shall have a minimum longitudinal impact strength of 15 foot-pounds at minus 208F as determined by the Charpy "V" Notch Impact Test in accordance with ASTM A370 and A673.
 - b. Nuts and Locknuts: ASTM A563 Grade DH or Heavy Hex Lock Nuts, conforming to ASTM A194 Grade 2H or ASTM A563 Grade DH, equal to Anco style self-locking nuts with stainless steel ratchet pin.
 - c. Washers: ASTM F436 Type 1.
 - d. Galvanize nuts, washers and anchor bolts for the thread length plus 12-inches in accordance with Section 5.1.9, "Galvanizing".
6. GROUND PLATES:
- a. Galvanized, Dulled Galvanized, Metallized, or Painted over Galvanized Structures Backfilled with Native Soils: ASTM A36, ASTM A572, or ASTM A633 galvanized, metallized, or stainless steel conforming to an applicable ASTM standard suitable for the intended use. Stainless steel threaded inserts welded to the pole shafts may be substituted for the ground plates shown on Drawing 41 1015.
 - b. Weathering-Steel Structures: Stainless steel conforming to an applicable ASTM standard suitable for the intended use.
7. U-BOLTS AND CHAIN LINKS: ASTM A36, galvanized.
8. ARC-WELDING ELECTRODES: Arc-welding electrodes shall be in accordance with AWS D1.1.
9. PAINT SYSTEM: Paint system shall be chemical, corrosion and abrasion resistant and shall produce the color and finish specified in the project specifications. All paint system components shall be from the same manufacturer. Paint system shall be approved by the COR and the Civil Engineer.
10. POLYURETHANE COATING: CorroCote II Classic as manufactured by Madison Chemical Industries, Inc., 490 McGeachie Drive, Milton, Ontario, Canada L9T 3Y5, or approved equal.
11. GUYS: ASTM A475 Class B, or A586 Class B, galvanized.
12. GUY HARDWARE: Hardware shall be galvanized and of the type and manufacturer's rated strength as shown on the Contractor-furnished data and drawings. Hardware shall conform to an applicable ASTM standard suitable for the intended use.
13. STEEL GUY ANCHORS AND RODS: Anchors and rods shall be galvanized and of the type and manufacturer's rated strength as shown on the Contractor-furnished data and drawings. Rods for disk and plate-type anchors shall be coated with an approved corrosion-preventive, nonconductive material.
14. CONCRETE GUY ANCHORS: Concrete requirements shall be in accordance with Construction Standard 3 – Concrete.
15. FIXED AND REMOVABLE CLIMBING RUNG SECTIONS:
- a. Structural Tubing:
 - (1) Galvanized, Dulled Galvanized, Metallized or Painted Steel: ASTM A500 Grade B or C.

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- (2) Weathering Steel: ASTM A847.
- b. Rungs:
 - (1) Galvanized, Dulled Galvanized, Metallized or Painted Steel Structures: ASTM F3125 Grade A325 Type 1, ASTM A354 Grade BC or ASTM A394 Type 1. Galvanize, galvanize and dull, or metallize rungs after fabrication in accordance with Sections 5.1.9, “Galvanizing”, 5.1.10, “Dulled Galvanizing”, or 5.1.11, “Metallizing”. Rungs for painted structures shall be galvanized or metallized but shall not be painted to protect the knurling.
 - (2) Weathering Steel: ASTM F3125 Grade A325 Type 3, ASTM A354 Grade BC Modified or ASTM A394 Type 3.
 - (3) Rungs shall be corrugated, knurled, dimpled or otherwise treated to minimize slipping. Coating with skid-resistant material is not acceptable.
- 16. ATTACHMENTS FOR FIXED CLIMBING RUNG SECTIONS, CLIPS FOR REMOVABLE CLIMBING RUNG SECTIONS, BELT LOOPS, HAND LOOPS, LADDER BRACKETS AND RING CLIPS:
 - a. Galvanized, Dulled Galvanized, Metallized or Painted steel: ASTM A36.
 - b. Weathering steel: ASTM A242, ASTM A588, or ASTM A871.
- 17. FALL PROTECTION ANCHORAGE PLATES:
 - a. Galvanized, Dulled Galvanized, Metallized or Painted Steel: ASTM A572.
 - b. Weathering Steel: ASTM A242, ASTM A588 or ASTM A871.
- 18. WORK RINGS: ASTM A36. Galvanize material after fabrication in accordance with Section 5.1.9, “Galvanizing”.
- 19. STRUCTURE IDENTIFICATION PLATES:
 - a. Galvanized, Dulled Galvanized, Metallized or Painted Steel: ASTM A36.
 - b. Weathering Steel: ASTM A242, ASTM A588, or ASTM A871.
 - c. Minimum plate thickness shall be 1/8-inch.

5.1.5 QUALITY CONTROL:

1. GENERAL: Contractor shall have defined quality control methods and functions available for review and approval. Maintain permanent records on mill test reports, weld procedures, welding operators, qualifications for welders and tack welders, inspector test results and visual and nondestructive test records.

Structure components and welds shall be inspected to determine conformance to contract requirements, drawings, codes and standards and procedures, including dimensional compliance, quality of welds, weld contour, weld size and overall workmanship.

2. WORKMANSHIP AND DEFECTIVE MATERIAL: Work shall be equal to best modern practice in the manufacture and fabrication of material. Design details, fabrication and erection not covered

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by the Drawings or these specifications shall conform to AISC “Steel Construction Manual” and ASCE/SEI 48-19, “Design of Steel Transmission Pole Structures”. Contractor shall be responsible for correct fitting of parts and shall replace defective material discovered during erection.

3. INSPECTION AND TESTS: Inspection of material will be made in accordance with Construction Standard 1 – General Requirements, Section 1.2.4, “Material Inspection”. WAPA inspection of material at the mill will be waived.
4. DIMENSIONAL TOLERANCES: Allowable variations from specified dimensions are as follows:
 - a. Overall Length of Structure: -12-inches and +24-inches.
 - b. Length of Component Pole Shaft Sections: ± 3 -inches.
 - c. Structure Cross Section:
 - (1) Diameters 36-inches or less: $-1/8$ -inch and $+1/4$ -inch.
 - (2) Diameters greater than 36-inches: $-1/4$ -inch and $+1/2$ -inch.
 - (3) Circumference of all sections: -0-inch.
 - d. Vertical Spacing Between Conductor Attachment Points and Ground Wire Attachment Points: ± 1 -inch.
 - e. Straightness of Structure: $1/8$ -inch in 10-feet of length.
 - f. Location of Drilled Holes: $\pm 1/16$ -inch.
 - g. Hole Spacing on Same Connection: $\pm 1/16$ -inch (noncumulative).
 - h. Maximum Difference Between Interior Width of Arm Brackets and Exterior Width of Arm Mounting Boxes or Vangs: $1/4$ -inch per side.
 - i. Maximum Gap Between Mating Flange Plates Before Installing Bolts: $1/2$ -inch.
 - j. Length of Davit Arm: ± 1 -inch.
 - k. Length of Crossarm: $\pm 1/4$ -inch
 - l. Length of Overlap of Slip Joint:
 - (1) Under slip: -10% but not less than 1.5 times the largest inside diameter of the female section. The minimum slip joint length shall be capable of developing the full required capacity of the connection.
 - (2) Over slip: +6-inches.
 - m. Variance in Longitudinal Location of Insulator Attachment at End of Davit Arm or Crossarm, Arm Alignment: ± 2 -inches per 10-feet of arm length or 1-degree from theoretical location.
 - n. Camber: ± 1 -inch per 16-inches of specified camber.
 - o. Structure Identification Plate Location: 6-feet ± 1 -foot above ground line.

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- p. Vertical Location of Guy Attachment Points with Respect to Insulator and Ground Wire Attachment Points: ± 1 -inch.
- q. Variation in Vertical Distance Between Insulator Attachments and Horizontal Planes of Hand Loops, Belt Loops and Ring Clips: ± 3 -inches.
- r. Variation in Vertical Positioning of Hand Loops, Belt Loops or Ring Clips Located in the Same Horizontal Plane: $\pm 1/4$ -inch.
- s. Horizontal Spacing of Hand Loops, Ladder Brackets, Belt Loops and Ring Clips: $\pm 1/2$ -inch.
- t. Clear dimensions from pole face (excluding maintenance provision clips): -0-inch and $+1/2$ -inch.
- u. Bend Radii: $\pm 1/16$ -inch.
- v. Dimensions for Ring Clips and Clips for Removable Climbing Rung Sections: $\pm 1/16$ -inch.
- w. Dimensions for Fixed and Removable Climbing Rung Sections, Attachments for Fixed and Inclined Climbing Rung Sections, Hand Loops, Ladder Brackets and Belt Loops: $\pm 1/4$ -inch.
- x. Vertical Spacing of Rungs for Fixed and Removable Climbing Rung Sections, and Vertical Spacing Between Top Rung of Top Removable Climbing Rung Sections and Bottom Rung of Bottom Fixed Climbing Rung Sections: 12-inches $\pm 1/2$ -inch.
- y. Work Rings:
 - (1) Dimensions noted on Drawing 43 2203 > 3 -inches: $\pm 1/8$ -inch.
 - (2) Dimensions noted on Drawing 43 2203 ≤ 3 -inches: $\pm 1/16$ -inch.

Tolerances not listed above shall be in accordance with applicable codes and standards.

5.1.6 FABRICATION:

1. GENERAL: Plates shall be edge-planed or flame-cut with mechanically guided torches. Surface roughness of plate edges shall be in accordance with AWS D1.1.
2. STRAIGHTENING MATERIAL: Before being laid out or worked in any manner, structural material shall be straight, free from sharp kinks and bends and clean of rust and dirt. Straightening operations shall not damage the metal.
3. SHEARING AND CUTTING: Shearing and cutting shall be neatly finished on material exposed to view. Copes and re-entrant cuts shall be filleted before cutting.
4. HOLES:
 - (1) General: Holes in steel less than $13/16$ -inch-thick may be punched to full size unless otherwise shown on the Drawings. Holes shown on the Drawings as drilled holes and holes in steel $13/16$ -inch-thick or greater shall be drilled or subpunched and reamed. Holes shall be clean-cut and without torn or ragged edges. Burrs resulting from reaming or drilling shall be removed with a tool making a $1/16$ -inch chamfer. Holes shall be cylindrical and perpendicular to the member. Place holes in plates prior to bending unless holes will be deformed during the forming process.

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- (2) Punching: For hole punching to full size, the punch diameter shall be the nominal hole diameter and the die diameter shall not be more than 1/16-inch larger than the punch diameter. For subpunching, the punch diameter shall be 1/4-inch smaller than the nominal hole diameter and the die diameter shall not be more than 3/32-inch larger than the punch diameter. Subpunched and reamed holes shall not have a punched surface in the hole periphery.
 - (3) Reaming and Drilling: Finished hole diameters for reamed or drilled holes shall be as shown on the Drawings and 1/16-inch larger than the nominal diameter of the bolts that will be used at each hole location.
- 5. EDGE DISTANCES AND BOLT SPACING: Edge distances and bolt spacing shall be in accordance with AISC “Steel Construction Manual” unless otherwise shown on the Drawings.
- 6. POLE SHAFT-TO-BASE PLATE AND POLE SHAFT-TO-FLANGE PLATE CONNECTIONS: Welds to attach pole shafts to base plates and flange plates shall be complete penetration with backing bars or complete joint penetration with back gouging.
- 7. CROSSARM-TO-ARM BRACKET AND DAVIT ARM-TO-ARM BRACKET CONNECTIONS: Welds to attach crossarms and davit arms to arm brackets and flange plates shall be complete penetration with backing bars. Complete joint penetration with back gouging is allowable if the fit-up permits.
- 8. COLD FORMING: Fabricator shall have documented, detailed procedures describing cold forming methods to produce bends without cracking. Cracking or opening of surface laminations shall be investigated and repaired. Repairs shall be inspected and recorded. Plates with cracks, laminations or lamellar tears shall be rejected. Minimum inside radii of bends shall be equal to or greater than specified by ASTM A6 Appendix X4.
- 9. SLIP JOINTS: Visual indicators on the pole sections shall be provided for when minimum, design, and maximum slip occur for identification during field installation.
- 10. WELDING:
 - a. General: Welding shall be performed in accordance with the latest revision of AWS D1.1. Welds shall be as shown on the shop drawings and made to minimize residual stresses. Weld procedures, welders, welding operators and tack welders shall be qualified in accordance with AWS D1.1.
 - b. Longitudinal Seam Welds: Complete joint penetration is required within 6-inches of base plates, flange plates, arm brackets, and for the outer section of splice joints equal to the maximum lap dimension. The remaining seam welds shall have 80-percent minimum penetration through the material thickness. The use of permanent backing material is not permitted.
 - c. Vangs shall be welded all around to seal the joints. Gaps shall not be permitted.

5.1.7 NONDESTRUCTIVE AND METALLOGRAPHIC WELD TESTS:

- 1. GENERAL: Inspect welds and perform tests in accordance with AWS D1.1 or in accordance with procedures approved by the Civil Engineer. Repair and reexamine defective welds in accordance with AWS D1.1. Document and notify the Civil Engineer of any defects and subsequent weld repairs.
- 2. VISUAL INSPECTION: All welds shall be visually inspected in accordance with AWS D1.1.

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3. **ULTRASONIC AND RADIOGRAPHIC TESTS FOR COMPLETE PENETRATION WELDS:** Perform ultrasonic or radiographic tests on the entire length of each complete joint penetration shop and field weld in accordance with AWS D1.1. Perform tests after galvanizing for complete joint penetration welds used at T-joints, as defined by AWS D1.1. Otherwise, tests can be performed before galvanizing.
4. **ULTRASONIC AND METALLOGRAPHIC TESTS FOR PARTIAL PENETRATION WELDS:** Perform either ultrasonic or metallographic tests for partial penetration welds.
 - a. **Ultrasonic Tests:** Perform ultrasonic tests in accordance with AWS D1.1 or procedures approved by WAPA. Test a minimum of 10-percent of each length of partial penetration weld at random intervals, with no test length exceeding 12-inches.
 - b. **Metallographic Tests:** Perform metallographic tests using a test lab approved by WAPA. For each tubular piece mark number, remove a weld sample from the first tubular section and from every tenth section thereafter. Remove samples by core drilling and plug the holes with complete penetration welds without permanent backing material. Test procedure shall include a sample report form for documenting test results which shall include the following:
 - (1) WAPA contract number.
 - (2) Structure type and piece mark number.
 - (3) Material thickness.
 - (4) Name, location, email address and telephone number of test lab.
 - (5) A sketch showing location of removed weld samples.
 - (6) Actual weld penetration of samples.
5. **MAGNETIC PARTICLE AND DYE PENETRANT TESTS:** Magnetic particle or dye penetrant weld tests is required where cracking is suspected. Perform magnetic particle tests in accordance with ASTM E709. Perform dye penetrant tests in accordance with ASTM E165. Acceptance standards for the tests shall be in accordance with AWS D1.1.

5.1.8 MARKING:

1. **STRUCTURE COMPONENTS:**
 - a. Mark structure components with the designations shown on final erection drawings. Stamp or weld markings into the steel before painting, galvanizing, or metallizing. The markings shall be 1/2-inch minimum height and clearly legible after painting, galvanizing or metallizing. Mating pole shaft sections shall be match marked to ensure correct orientation and camber.
 - b. Stamp the total weight of individual pole shaft and arm sections at the base of each section.
2. **STRUCTURE IDENTIFICATION PLATE:** Identify each structure with an identification plate located approximately 6-feet above ground line.
 - a. Stamp the following information into the plates using numerals and letters not less than 1/2-inch high:
 - (1) Structure Number (i.e. 17/2).
 - (2) Structure designation (type and height, i.e. 292S-60).
 - (3) Complete structure weight in pounds.
 - (4) Ultimate ground line or base moment capacity in kip-feet.
 - (5) Manufacturer's name.
 - (6) Month and year of fabrication.

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- b. Plates shall be welded all-around to the pole shafts before painting, galvanizing or metallizing. The numerals and letters shall be clearly legible after painting, galvanizing, or metallizing.
3. ANCHOR BOLT CAGE TEMPLATE: Mark top of each anchor cage assembly with structure designation and structure number. The top template shall be marked with V-notch or other permanent indicator along structure transverse axis.

5.1.9 GALVANIZING:

1. CLEANING: After shopwork completion, clean material of rust, loose scale, dirt, oil, grease and other foreign substances. Clean all slag from welded areas.
2. PLATE AND SHAPE GALVANIZING: After fabrication and cleaning, galvanize plates and shapes in accordance with ASTM A123. Double dipping or progressive dipping of closed-member shapes shall not be permitted. After galvanizing, pole shaft sections shall not have lateral variations greater than 1/1000 the axial length of the section. Holes shall be free of excess spelter after galvanizing.
3. HARDWARE GALVANIZING: Galvanize bolts, nuts, washers, locknuts and lock washers in accordance with ASTM A153. Remove excess spelter by centrifugal spinning.
4. STRAIGHTENING AFTER GALVANIZING: Plates and shapes which have been warped by the galvanizing process shall be straightened by rerolling or pressing. Material shall not be hammered or straightened in a manner that will damage the galvanizing. Any material the COR determines has been harmfully bent or warped shall be rejected.
5. GALVANIZING REPAIR: Material with damaged galvanizing shall be redipped unless the damage is local and can be repaired. If the galvanized coating becomes damaged after being dipped twice, the material shall be rejected. Where repair is authorized, the damaged area shall be repaired in accordance with ASTM A780, except the minimum coating thickness shall be 5-mils.
 - a. Zinc Rich Paint: When utilizing paints containing zinc dust, surfaces shall be cooled to ambient temperature, dry, and free from rust, mill scale, paint, dirt and other contaminants. Surfaces may be cleaned by wire brush or equivalent cleaning methods (grinding is not permitted). Zinc paint shall be applied with a brush (spray painting is not permitted). The minimum required dry paint thickness is 5-mils. Zinc rich paint shall have a minimum of 94-percent zinc dust by weight.

5.1.10 DULLED GALVANIZING:

1. DULLING TREATMENT: Exposed surfaces of galvanized steel structures, including connection and anchor bolts, nuts, washers, locknuts, lock washers and visible portions of embedded material shall be given an approved dulling treatment to provide a gray or blackish-gray coloration. Treatment shall dull the shine and reflectance of surfaces and provide a uniform appearance for all treated surfaces. Soft or water-soluble surface deposits resulting from the treatment shall be removed by rinsing. Treatment shall have a life of at least 1-year and not be detrimental to the service life of the protective zinc coating. Dulled surfaces shall be free of white rust (zinc oxide).
2. REFLECTANCE: Finished steel shall maintain a reflectance no greater than that specified in the project specifications, plus or minus 3-percent. Reflectance shall be measured utilizing any reflectometer calibrated against "Neutral Matte Finish" color standards obtainable from Munsell Color, a division of X-Rite Incorporated. The reflectometer shall have a margin of error no greater than plus or minus 3-percent.

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5.1.11 METALLIZING:

1. GENERAL: Metallizing shall be in accordance with the manufacturer's recommendations and ASCE/SEI 48-19. Structures shall be metallized with zinc and have a minimum coating thickness of 5-mils. Zinc shall have a minimum purity of 99.9-percent.
2. SURFACE PREPARATION: After fabrication, blast clean steel in accordance with Steel Structures Painting Council Surface Preparation Specification SSPC-SP 5, "White Metal Blast Cleaning".
3. ANCHOR-BOLTED STRUCTURES AND DIRECT-EMBEDDED STRUCTURES WITH CONCRETE BACKFILL: Base plates on galvanized, dulled galvanized or painted-over-galvanized anchor-bolts structures may be metallized if the overall width exceeds the width of the galvanizing tank. If any portions of pole shafts above ground line are metallized, the entire structure above ground line shall be metallized so that all visible surfaces match.
4. WEATHERING STEEL DIRECT-EMBEDDED STRUCTURES WITH CONCRETE BACKFILL: Bottom 2-feet of weathering-steel pole shafts shall be metallized prior to applying polyurethane coating.

5.1.12 WEATHERING-STEEL FINISH:

After fabrication, blast clean steel in accordance with Steel Structures Painting Council Surface Preparation Specifications as follows:

1. DIRECT-EMBEDDED STRUCTURES WITH CONCRETE BACKFILL:
 - a. Top of Structure to 3-Feet Above Bottom of Structure: SSPC-SP 7, "Brush-Off Blast Cleaning".
 - b. Bottom 3-Feet of Structure: SSPC-SP 6, "Commercial Blast Cleaning".
2. ANCHOR-BOLTED STRUCTURES: SSPC-SP 7, "Brush-Off Blast Cleaning".

5.1.13 PAINTING:

1. GENERAL: Provide material and equipment, clean surfaces and apply paint to all structure components, except as noted below, in accordance with the manufacturer's instructions and this paragraph. Prevent dust or other contamination on wet, newly painted surfaces and do not move components until paint is thoroughly dry. Painted surfaces shall have uniform texture and color-matched appearance.

Repair paint on steel pole structures which is damaged or removed due to ground plate installation, welding, transport to worksites, storage at the work sites, installation or any other Contractor's operation. Re-clean exposed surfaces and reapply paint as necessary to restore damaged and bare surfaces to the specified condition. Painting materials shall be handled, used, stored and disposed of according to Federal, State and local regulations.

2. SURFACE PREPARATION AND APPLICATION: Surface preparation and application shall be in accordance with manufacturer's recommendations.
3. SURFACES NOT TO BE PAINTED: The following areas of the structures shall be masked or otherwise protected from paint to ensure the electrical continuity of the structures:

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- a. Areas inside slip joints: Outside surfaces of male (bottom) sections and inside surfaces of female (top) sections.
- b. Arm connections: Outside surfaces of arm connection vangs and inside surfaces of arm brackets.
- c. Fixed climbing rung sections: Step bolts, outside surfaces of attachments for fixed climbing rung sections and faying surfaces of connection plates for fixed climbing rung sections.
- d. Post insulator mounting brackets: Exterior surfaces of mounting brackets.
- e. Removable climbing rung sections and interior surfaces of ring clips for removable climbing rung sections.
- f. Overhead ground wire attachment plates.
- g. Portions of galvanized pole shafts below ground line.
- h. Ground plates and work rings.

If any of the above surfaces are painted, grounding requirements for weathering-steel structures in Section 5.1.3, "Grounding Requirements" shall apply.

5.1.14 POLYURETHANE COATING:

- 1. GENERAL: Minimum coating thickness and surface preparation shall be in accordance with manufacturer's recommendations. Top edge of coating shall be feathered, in lieu of masked, to prevent flaking.

Take precautions to prevent blistering of polyurethane coating. Damaged or blistered coating shall be repaired in accordance with manufacturer's recommendations prior to structure installation.

Polyurethane coating shall not be applied to ground plates.

- 2. DIRECT-EMBEDDED STRUCTURES WITH CONCRETE BACKFILL:

- a. Coat bottom 2-feet of direct-embedded weathering-steel pole shafts with polyurethane coating after metallizing.
- b. Polyurethane coating is not required for galvanized, dulled galvanized, metallized or painted-over-galvanized structures.

5.1.15 HANDLING AND TRANSPORTING:

- 1. GENERAL: Handle and transport steel structures and components to avoid bending or damage. Notify Fabricator and WAPA COR of any bent or damaged pieces for repair or replacement recommendations. Material with damaged galvanizing, metallizing, paint or polyurethane coating shall be replaced or repaired in accordance with Sections 5.1.9, "Galvanizing", 5.1.13, "Painting" or 5.1.14, "Polyurethane Coating".
- 2. MATERIAL HANDLING AND PACKAGING:
 - a. Provide 6-inch minimum height wood blocking material so that unloaded materials will not be in direct contact with the ground and will remain stable, unable to roll.

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- b. Bundle all identical fixed climbing rung sections together and tag with size and count.
 - c. Box all loose hardware and label by count and description. Bolts of different lengths shall be packaged separately.
3. **INVOICE OR PACKING LIST:** Shipping invoices shall be accompanied by an invoice or packing list or checklist of all parts in each shipment. Parts shall be identifiable by structure designation and structure number. Invoices and packing lists shall also be emailed to the COR.
4. **NOTIFICATION:** Notification shall be given to the COR and personnel that will accept delivery 2-weeks prior to delivery and again 48-hours prior to delivery. Furnish a detailed list 20-days advance of each delivery of all material that will be delivered with each shipment including quantities, weights, name of common carrier, bill of lading number, expected time of arrival and any other pertinent information.
5. **UNLOADING:** Offloading contractor shall provide sufficient manpower, a minimum of one (1) helper, to safely and efficiently unload, and not rely on help from Government representatives.

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5.1.16 INSTALLATION:

1. GENERAL:

- a. Installation shall be in accordance with the Fabricator's recommendations and AISC 303 "Code of Standard Practice for Steel Buildings and Bridges".
- b. All slip joints shall be jacked together using hydraulic jacking devices in accordance with fabricator's recommendations.
 - (1) The installed slip joint length shall be in accordance with the specified tolerances.
- c. Lubricants other than soapy water shall not be used in slip joint assembly.
- d. Secure all slip joints by positive mechanical means before lifting or installing structures.
- e. Provided dimensional tolerances listed in Section 5.1.5, "Quality Control" are not exceeded, spaces in bolted connections greater than or equal to 1/8-inch shall be filled with galvanized washers or ring fills before installing bolts. Assembled connections shall be in accordance with the following:
 - (1) Arm Brackets-to-Arm Boxes or Vangs: Spaces shall be equal on both sides of the connections, (i.e., use the same number of washers or ring fills on each side of the connection to fill the spaces).
 - (2) Flange plate connections: Straightness of assembled structure shall be within 1/8-inch in 10-feet of length.
- f. Lift structures by slings attached at lifting points as shown on erection drawings.
- g. Raking of structures shall not be permitted unless approved by WAPA.
- h. Remove all corrosive and foreign material, including chalk and grease marks, from structures and internally threaded portions of ground plates, including material deposited on the structures prior to and during installation.
- i. Correct installation errors and omissions, including retightening of nuts and retightening or retensioning of guys.

2. ANCHOR-BOLTED STRUCTURES:

- a. Install anchor bolts in accordance with the final erection drawings. Set anchor bolts accurately to the grade and alignment designated on the Drawings.
- b. Reinforced concrete foundations shall meet 28-day compressive strength and cure a minimum of 7-days before installing structures and 14-days before stringing wires.
- c. Set base plates level and in exact position.

3. DIRECT-EMBEDDED STRUCTURES:

- a. Structure embedment depth shall be as listed in the project specifications and shown on the Drawings, unless rock is encountered.

Rock is defined as a massive or stratified cemented formational material having a standard penetration test (SPT) "N" value of 100 or more throughout the entire embedment depth.

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If rock is encountered, structure embedment depths may be reduced to the overburden depth plus “Keyed into Rock” depth listed in the project specifications.

- b. If a structure embedment depth is reduced due to rock, cut off the bottom of the pole shaft a length equal to the reduction in embedment depth and reweld the bearing plate to the pole shaft bottom. Repair damaged galvanizing, metallizing or polyurethane coating in accordance with Sections 5.1.9, “Galvanizing” or 5.1.14, “Polyurethane Coating”.
- c. Verify structure alignment prior to concrete backfill placement to ensure correct orientation with respect to line angle and camber.
- d. After setting and aligning structures, temporarily guy or hold structures to prevent displacement during concrete backfill placement and for a minimum of 3-days thereafter.
- e. Concrete backfill shall meet 28-day compressive strength and cure a minimum of 7-days before placing the next section and a minimum of 14-days before stringing wires.

4. GUYS AND ANCHORS:

- a. Install guys and anchors in accordance with manufacturer’s recommendations. Compact backfill for guy anchor excavations in accordance with Standard 2 – Sitework, Section 2.7, “Compaction”. Pretension guys as shown on the final erection drawings.
- b. Perform load tests on up to 10-percent of guy anchors to verify manufacturer’s rated strength and installation methods. Anchors shall hold maximum load listed in design data for 5-minutes. Maximum allowable movement shall be 2-inches or 10-percent of helix or disk diameter, whichever is less. Number of tests and specific anchors to be tested shall be at the discretion of the COR.
- c. If it is necessary to relocate guy anchors out-of-line, or more than 5-feet from their initially approved location, prior to installation resubmit revised design data and drawings for each affected structure in accordance with Section 5.1.1, “Contractor-Furnished Data and Drawings”. Minimum anchor spacing shall be 8-feet for relocated anchors.

5. MAINTENANCE PROVISIONS:

- a. Permanently install fixed and inclined climbing rung sections and fall protection anchorage plates on structures with bolts, nuts and locknuts or lock washers. Install fall protection anchorage plates every two (2) feet, on every other step bolt, alternating left and right, in accordance with Drawing 41 2701, unless ladders are provided with a fall protection anchorage point permanently attached.
- b. For weathering-steel structures, fixed and inclined climbing rung sections shall be grounded after installation in accordance with Drawings 41 1015, 43 2210 and Section 5.1.3, “Grounding Requirements”. After installing fixed and inclined climbing rung sections and fall protection anchorage plates with bolts, nuts and locknuts, spot weld the rung section mounting plates to the attachments on the pole shafts. Welding shall be sufficient to provide electrical continuity between the climbing rung sections and the pole shafts. Preferred welding rod series is E8018-C3. Other acceptable series are E8018-C1 and E8018-C2.
- c. Prior to structure delivery, trial fit work rings into every ring clip on every structure to ensure acceptable assembly. Acceptable assembly is defined as when the work rings protrude 1-inch $\pm$ 1/2-inch from the bottom of the ring clips and can be installed without interference from adjacent work rings.

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- d. Trial fit removable climbing rung sections into clips on every structure.
 - e. After inspection by the COR, remove all work rings and removable climbing rung sections, and deliver for storage.
6. **STRUCTURE ORIENTATION:** Install tangent structures so that the transverse structure axes are perpendicular to the centerline of transmission line and install angle structures so the transverse structure axes are perpendicular to the line angle bisectors, except structures listed in the “Special Structure Orientation” section in the “Transmission Line Steel Pole Structures” Division of the project specifications.
7. **FIELD WELDING:** Field welding is only permitted when authorized by the COR and the backside of the weld is accessible for coating repair. Field welding, including welding procedures and welders, shall be in accordance with Section 5.1.6, “Fabrication”. Perform nondestructive weld tests and inspect field welds in accordance with Section 5.1.7, “Nondestructive and Metallographic Weld Tests”. Clean field welds by sandblasting or power grinding.

Repair damaged paint, galvanizing, metallizing, or polyurethane coating in accordance with the Sections 5.1.9, “Galvanizing”, 5.1.13, “Painting” or 5.1.14, “Polyurethane Coating”.

8. **DIRECT-EMBEDDED H-FRAME STRUCTURES:** If ground line elevations vary by 5-feet or less at direct-embedded H-frame legs, install structures vertically plumb so that the center conductor attachment is a distance “H”, height portion of structure designation, above ground line. If ground line elevations vary by more than 5-feet, submit revised design data in accordance with Section 5.1.1, “Contractor-Furnished Data and Drawings”.

Concrete backfill projections shall extend a minimum of 18-inches above ground line for both legs of H-frame structures when concrete backfill is specified.

9. **TEMPORARY GUYING REQUIREMENTS:** If conductors or overhead ground wires are temporarily dead-ended on self-supporting structures, the structures shall be guyed to remain plumb until final conductors and ground wires are strung at some future date. Variation from plumb shall not exceed 3-inches at top of structure in any horizontal direction after initial stringing.
10. **VIBRATION CONTROL:** Before insulators, conductors or overhead ground wires are installed, members shall be restrained or dampened by hanging weights or insulators or in accordance with the manufacturer’s recommendations, if necessary, to prevent fatigue crack initiation and propagation due to fluctuating loads.
11. **INSTALLATION TOLERANCES:** Allowable variations from specified dimensions and locations for installed structures are as follows:
- a. Centerline Location: Within 3-inches of theoretical centerline location.
 - b. Embedment Depth, “E”: -6-and +24-inches, where rock is not encountered; -3-inches and +12-inches, where rock is encountered.
 - c. Installed Height, “H”, Distance from Ground Line or Base Plate to Bottom Insulator Attachment: ± 12 inches.
 - d. Installed Position Prior to Stringing:
 - (1) Uncambered Structures: Variation from plumb shall not exceed 6-inches at top of structure in any horizontal direction.

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- (2) Cambered Structures: Variation from specified camber shall not exceed 6-inches at top of structure in any horizontal direction.
- (3) Variation in Longitudinal Location of Conductor Attachments at End of Davit Arm, Arm Alignment: ± 2 -inches per 10-feet of arm length from theoretical location.

5.1.17 STRUCTURE SIGNS:

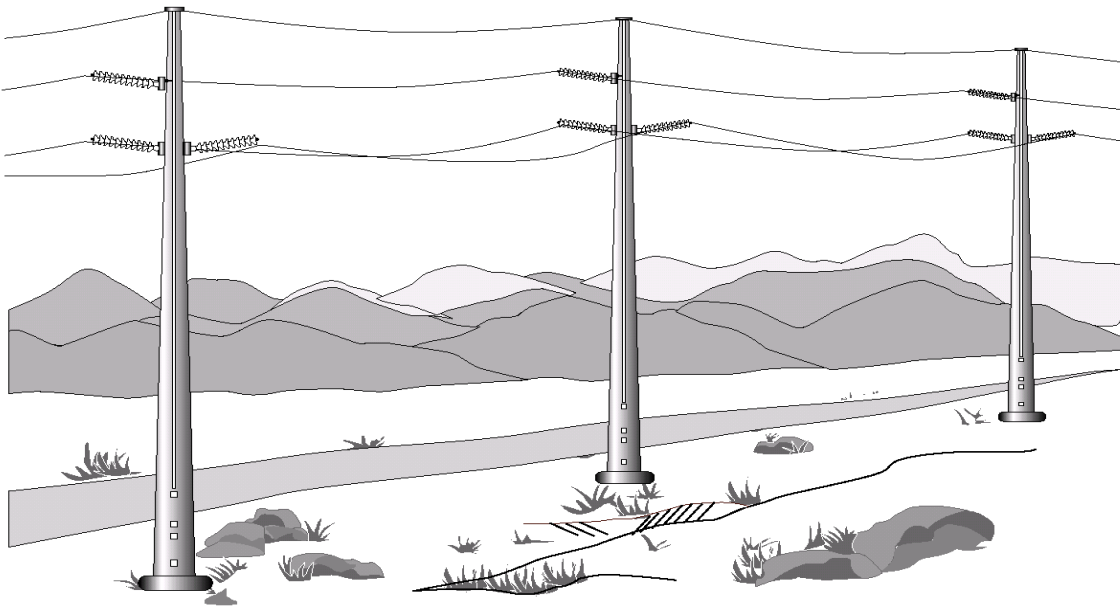
1. **STRUCTURE NUMBER SIGNS:** The structure number signs, with the structure numbers as designated on the plan and profile drawings, shall be attached to the structures on the ahead and back span faces of structure.
 - a. **Steel Pole Structures:** Signs and mounting plates shall be fabricated and attached to the structures in accordance with Drawings 41 9027-2 and 41 9027-3. Holes shall not be drilled into tubular steel structures.
 - b. **Lattice Steel Structures:** The structure number signs shall be fabricated and attached to the structures in accordance with Drawing 41 9007.
2. **AERIAL PATROL MILE MARKER SIGNS:** The first structure of each mile section of line shall be identified with two (2) aerial patrol mile marker signs, one (1) on the ahead and one (1) on the back span face of the mounting plate.
 - a. **Steel Pole Structures:** Signs and mounting plates shall be fabricated and attached in accordance with Drawing 41 9027-1.
 - b. **Lattice Steel Structures:** Signs shall be fabricated and attached in accordance with Drawing 41 9005.
3. **AERIAL PATROL WARNING SIGNS:** Aerial patrol warning signs, located as designated on the plan and profile drawings and described in WAPA Construction Standard Section 10.6.8 "Line Markers", shall be fabricated and mounted in accordance with Drawing 41 9028.
4. **DANGER SIGNS:**
 - a. **Steel Pole Structures:** Mount two (2) danger signs on each heavy-duty steel structure in accordance with Drawing 41 9027-2.
 - b. **Lattice Steel Structures:** Mount two (2) danger signs on each lattice-type steel structure in accordance with Drawing 41 9008.



Western Area
Power Administration

CONSTRUCTION STANDARDS

STANDARD 6 LIGHT DUTY TRANSMISSION LINE STEEL POLE STRUCTURES



2026

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6.1.1 CONTRACTOR-FURNISHED DATA AND DRAWINGS:

1. **GENERAL:** Use United States standard units of measurement and English words, signs and symbols. Submit data and drawings for all structures. Include design calculations for all structure components. Drawings shall be new originals. Reproductions of the specification drawings are not acceptable.

Thoroughly check data and drawings for accuracy and completeness before submittal. WAPA will not check details and intermediate dimensions.

Submit electronic versions of data and drawings as they are completed and checked for one (1) or several structures rather than delaying to include drawings for the complete specifications requirements in one (1) submittal.

WAPA will electronically return the design data sheets and drawings and indicate required changes in the reply email. Contractor shall change the designs and details which WAPA determines necessary to make the finished structures conform to these specifications.

WAPA's review time is specified in the project specifications in the "Commencement, Prosecution and Completion of Work" paragraph of Division 1, "General Requirements". WAPA approval shall not relieve the Contractor from meeting the specification requirements nor the responsibility for design and drawing correctness. Fabrication prior to design data and drawing approval will be at the Contractor's risk.

2. **DESIGN DATA:** Prior to fabrication, submit for approval, the following design data for each type and height of structure:
 - a. General dimensions, wood equivalent class and weight.
 - b. Ultimate moment capacities at ground line, splices, joints and points where plate size changes.
 - c. Guy locations, ultimate load, size and capacity.
 - d. Guy anchor type and capacity.
 - e. Guy hardware and guy anchor catalog sheets.
3. **MILL TEST REPORTS:** Submit certified copies of test reports of structural steel, bolts, nuts and the chemical analyses and coating test of the galvanizing within 20-days of material shipment.

Certified mill test reports for steel shapes and plates shall show customer's order, mill order and WAPA specifications number. Mill certification shall show the weights of steel furnished for each size and heat number represented by the tests.

4. **WELDING SUBMITTALS:**
 - a. Prior to fabrication, submit all weld procedures which are not prequalified in accordance with AWS D1.1, "Structural Welding Code – Steel".
 - b. Prior to fabrication submit Fabricator's standard weld and evaluation procedures.
 - c. Submit weld test reports within 20-working days after tests are performed.

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5. DULLING TREATMENT SUBMITTALS:

- a. Chemical composition of dulling treatment.
- b. Application procedure.
- c. Upon request, submit one (1) set of three (3) galvanized samples prior to dulling and one (1) set of three (3) samples after dulling. Dulled samples shall represent the reflectance specified in the project specifications. Each sample shall be a dulled-galvanized steel panel, 3-inches by 6-inches by 1/4-inch thick and have the respective percent of reflectance stamped into the metal.

Approved samples shall constitute comparison standards for dulled-galvanized steel inspection.

6. PAINTING SUBMITTALS:

- a. Paints: Manufacturer's technical information including color chips, paint label analysis, surface preparation, spread rates, thinning instructions, coverage of paint, recommended number of coats, and application instructions.
- b. Material Safety Data Sheets (MSDS) for each paint, oil, epoxy and other hazardous materials.

7. POLYURETHANE COATING SUBMITTALS:

- a. Manufacturer's technical information and data sheets including color, surface preparation, thickness, recommended application instructions, and safety information.

8. APPROVAL DRAWINGS: Prior to fabrication, submit for approval, drawings and/or catalog data sheets covering each type and height of structure showing the following:

- a. Dimensions.
- b. For Each Structure Component: Mark number, position, size, material and location.
- c. For Each Bolted Connection: Quantity, type (grade) and size of bolts.
- d. A complete bill of materials, including hardware and weights, listing all material for one (1) structure or the portion shown thereon. Show the number of pieces required and description of each piece, including size and length. Total weight of one (1) complete structure shall be noted. Calculate weights in accordance with AISC 303 "Code of Standard Practice for Steel Buildings and Bridges", except that weights for nonrectangular plates and shapes used to fabricate pole shafts and davit arms are to be based on actual detailed dimensions shown on the final shop drawings.
- e. Weight, center of gravity and lifting point of each major structure component (pole shaft section, arm assembly, etc) and of complete structure.
- f. Slip joint location(s) and design length. The drawings shall also provide the slip joint tolerances and required jacking forces (minimum and maximum).
- g. Embedment depth for direct-embedded structures.
- h. Location, edge preparation details and material for each field weld.

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- i. Method for permanently restraining slip-joints after installation for H-frame structures if approved by WAPA.
 - j. Guy pretension loads.
 - k. Guy locations, arrangements, and attachment details.
 - l. Guy anchors and installation details.
 - m. Structure identification plate location.
 - n. Plan and elevation views for each structure type showing exact location of attachments for removable steps.
 - o. All structure components and connections.
 - p. Ground plate locations in accordance with Drawing 41 1015.
 - q. Mounting locations for structure signs in accordance with Drawings 41 9027-1, 41 9027-2, 41 9027-3, 41 9028, and 41 9030 or as specified in the project specifications.
 - r. Details of removable steps and attachments and attaching welds.
 - s. WAPA specifications number and project title.
 - t. Specific WAPA structure type(s) shown or referenced on each drawing.
 - u. Type and grade of material (ASTM specification) and structure finish, (i.e., galvanized, dulled galvanized, metallized, weathering steel or painted-over-galvanized).
 - v. All instructions required for the field installation, including minimum jacking forces.
9. FINAL DRAWINGS: Prior to material shipment and before final payment, furnish as-built drawings and bill of materials required in paragraph 7 above.
10. SUBMITTAL REQUIREMENTS: Submit samples and electronic versions of data and drawings to the COR for approval as follows:
- a. Design Data.
 - b. Mill Test Reports.
 - c. Welding Submittals.
 - d. Dulling Treatment Submittals: Submit electronic copy of photo(s) comparing a galvanized piece to a dulled piece showing reduced reflectance. Forward the samples to the COR.
 - e. Painting Submittals: Forward one (1) set of color chips and one (1) electronic copy of manufacturer's technical information and MSDS to the COR.
 - f. Polyurethane Coating Submittals: Forward one (1) electronic copy of manufacturer's technical information and data sheets to the COR.
 - g. Approval Drawings.
 - h. Final Drawings.

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6.1.2 DESIGN REQUIREMENTS:

1. GENERAL: Transmission line steel poles shall be designed in accordance with ASCE/SEI 48-19. Arm Connections, flange plates, slip joints, and other pole components may be designed using published theories accepted by industry as good engineering practice and testing. Design so that ultimate stresses do not exceed the material yield stress. Design yield strength for structural steel plates shall not exceed 65-ksi. The wood pole class equivalent light duty steel pole shall have a moment capacity at any cross section that is equal to or greater than the equivalent class wood pole.
2. DESIGN GUIDES:
 - a. ASCE/SEI 48-19, "Design of Steel Transmission Pole Structures".
 - b. AISC "Steel Construction Manual".
 - c. AWS D1.1, "Structural Welding Code – Steel".
 - d. NESC 2023 National Electric Safety Code .
3. SPECIFIC REQUIREMENTS:
 - a. Light Duty Steel Pole Structures:
 - (1) Pole shafts shall be closed shapes and tapered consistent with strength requirements.
 - (2) Crossarms for H-frame structures shall be square or rectangular structural tubing.
 - (3) Davit arms shall be closed shapes and shall provide the electrical clearances shown on the Drawings.
 - (4) Brackets and braces may be open or closed shapes and shall provide the electrical clearances shown on the Drawings.
 - (5) Structural steel shall not be less than 3/16-inch thick, except for structure identification plates.
 - (6) Thickness of flange plates shall be designed assuming loads are transferred directly by point loads through bolts, and not by bearing between the flange plates.
 - (7) Sections joined by slip joints shall have a minimum lap of 1.5-times the largest inside diameter of the female section. Use complete penetration welds in the female splice area, accounting for any over slip. Shims shall not be used in slip joints.
 - (a) For any slip joints located between phases, the over-jacking tolerance for the designed slip joint shall be added to the pole length between the phases.
 - (8) Non-compact sections shall not be used for the inner section at slip joints for the length of the slip, including over slip. Members shall be designed such that the result of equation $w/t\sqrt{(F_y/E)}$ is less than 1.41 for 12-sided shapes, 1.53 for 8-sided shapes, and 1.26 for 16-sided shapes. Calculate "w" in accordance with Chapter 5 of ASCE 48-19.
 - (9) H-frame structures shall use flange plate connections if more than one section is used to achieve design height. If slip joint connections are approved for H-frame structures, the slip joints shall be permanently restrained from movement after installation.

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- (10) All structures shall be capped at the top and arm ends.

Pole caps for galvanized structures with pole top aerial patrol mile marker signs and/or warning signs shall be minimum 1/4-inch thick and shall be attached to pole tops by a minimum of four 5/8-inch-diameter bolts in a symmetrical pattern.

Pole caps for weathering steel structures shall be welded to pole tops.

- (11) Pole shaft base sections of weathering-steel and metallized structures shall be hermetically sealed.
- (12) Galvanized tubular members shall have vent holes at both ends to allow air circulation after installation. Direct-embedded galvanized pole shafts shall have two 1-inch-diameter vent holes 2-feet above ground line.
- (13) Direct-embedded weathering steel pole shafts shall be metallized in accordance with Section 6.1.11, "Metallizing".
- (14) Direct-embedded pole shafts shall be coated with polyurethane coating in accordance with Section 6.1.14, "Polyurethane Coating".
- (15) Structure sections and complete structures shall have approved method to prevent slippage of slings and ensure safe lifting and handling.
- (16) Structure number signs and identification plates shall not interfere with installation of removable steps.
- (17) Location and spacing of holes shall be within tolerances specified in Section 6.1.5, "Quality Control".
- (18) Contractor shall determine details not shown on the Drawings based on the intended use and fabricator's recommendations.

b. Guys and Anchors:

- (1) Guy size and arrangement shall be as specified in the project specifications.
- (2) Guy hardware and structure attachments shall be capable of supporting the minimum rated breaking strength of attached guys. Steel hardware shall be galvanized or galvanized and dulled in accordance with Sections 6.1.9, "Galvanizing" and 6.1.10, "Dulled Galvanizing".
- (3) Guys and guy attachments shall not interfere with installation of removable steps.
- (4) Determine number and type of guy anchors. Guy anchors shall develop the minimum rated breaking strength of attached guys. No more than two (2) guys shall be attached to any one (1) anchor.

c. Maintenance Provisions:

- (1) Maintenance provisions, if required in the project specifications, shall consist of removable steps, attachments for removable steps and fall protection anchorage plates.

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- (2) Dimensions and details for maintenance provisions shall be as shown on Drawings 41 2701, 43 2218, 43 2219, and 43 2220 unless otherwise specified in the project specifications.
- (3) Welds for attachments for removable steps shall be designed for a minimum 5,000 lb factored vertical loads.

4. EMBEDMENT DESIGN FOR DIRECT-EMBEDDED STRUCTURES:

a. Auger Diameter:

- (1) Direct-Embedded Structures with Native Backfill: Auger diameter shall be large enough to provide space for use of tamping tools all around the poles to the full depth of the holes.
- (2) Direct-Embedded Structures with Concrete Backfill: Auger diameter shall be pole shaft base diameter plus a minimum of 12-inches, unless otherwise specified in the project specifications.

- #### b. Embedment Depth: Structure embedment depth shall be 10 percent of the total pole length plus 2-feet, unless otherwise specified in the project specifications.

6.1.3 GROUNDING REQUIREMENTS:

1. GENERAL: All connections on all structures shall provide for electrical continuity across the connections, and an electrical path shall be provided from every part of the structure to the ground. Grounding requirements will vary with the type of material and structure finish and shall be in accordance with Drawing 41 1015 and this section.
2. GALVANIZED, DULLED GALVANIZED AND METALLIZED STRUCTURES:
 - a. Pigtail jumpers and ground plates are not required on galvanized, dulled galvanized or metallized structures.
3. WEATHERING-STEEL STRUCTURES:
 - a. Pigtail jumpers and welded ground plates are required on both sides of all slip joints and bolted connections, including flange joints, davit arm and crossarm connections and on the pole shafts or arm shafts adjacent to post insulator connections.
 - b. After installing removable steps and fall protection anchorage plates, spot weld the removable steps and fall protection anchorage plates to the attachments on the pole shafts. Welding shall be sufficient to provide electrical continuity between the removable steps and the pole shafts. Preferred welding rod series is E8018-C3. Other acceptable series are E8018-C1 and E8018-C2.
 - c. Weathering-Steel Structures with Native Backfill: 1/2-inch-thick stainless steel welded hermetically-sealed bearing plates are required for all poles.
 - d. Weathering-Steel Structures with Concrete Foundations: Pigtail jumpers and welded ground plates are required 2-feet above base plates on all pole shafts.
4. PAINTED-OVER-GALVANIZED STRUCTURES:

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Pigtail jumpers and ground plates are not required on painted-over-galvanized structures provided the following surfaces of the structures are not painted, (i.e., masked, or otherwise protected from paint), to ensure the electrical continuity of the structure:

- a. Faying surfaces shall not be painted, including:
 - (1) Areas inside slip joints: Outside surface of male (bottom) section and inside surface of female (top) section.
 - (2) Arm connections: Outside surface of arm connection vangs on pole shaft and inside surface of arm brackets on arms.
 - (3) Post insulator mounting brackets: Exterior face of mounting brackets.
- b. Overhead ground wire attachment plates shall not be painted.
- c. Portions of direct-embedded galvanized pole shafts that will be below ground line shall not be painted.
- d. If any of the above surfaces are painted, the paint shall be removed prior to structure installation.

6.1.4 MATERIAL:

1. POLE SHAFTS, DAVIT ARMS AND CROSSARMS:

- a. Galvanized, Dulled Galvanized, Metallized or Painted Steel: ASTM A572 Grade 65 or ASTM A871 Grade 65.
 - (1) Silicon, Phosphorous, Carbon, and Manganese content of pole shaft material shall be within the limits of ASTM A385.
 - (2) Galvanize, galvanize and dull, metallize or galvanize and paint material after fabrication in accordance with Sections 6.1.9, "Galvanizing", 6.1.10, "Dulled Galvanizing", 6.1.11, "Metallizing", and 6.1.13, "Painting".
 - (3) Structural steel other than ASTM A572 Grade 65 or ASTM A871 Grade 65 shall be approved by the Civil Engineer and shall meet or exceed all chemical and physical requirements for ASTM A572 Grade 65 or ASTM A871 Grade 65 and all applicable requirements of ASTM A6, including minimum and maximum tensile strength, yield point, elongation, bend test requirements and Charpy V-Notch Impact requirements.
- b. Weathering Steel: ASTM A871 Grade 65.
- c. Structural Tubing:
 - (1) Galvanized, Dulled Galvanized, Metallized or Painted Steel: ASTM A500 Grade B.
 - (2) Weathering Steel: ASTM A847 Grade 50.
- d. Actual material yield strengths shall not exceed the design yield strength by more than 15 ksi, unless an alternate Welding Procedure Specification (WPS) is submitted, approved by the COR, and followed during fabrication.
- e. Material shall have a minimum longitudinal impact strength of 15-foot-pounds at minus 20-degrees Fahrenheit as determined by the Charpy "V" Notch Impact test in accordance with ASTM A370 and A673.

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2. CONNECTION PLATES:

- a. Galvanized, Dulled Galvanized, Metallized, or Painted Steel: ASTM A572, ASTM A633 or ASTM A871.
- b. Weathering Steel: ASTM A871.
- c. Actual material yield strengths shall not exceed the design yield strength by more than 15 ksi, unless an alternate WPS is submitted, approved by the COR, and followed during fabrication.
- d. Material shall have a minimum longitudinal impact strength of 15-foot-pounds at minus 20-degrees Fahrenheit as determined by the Charpy “V” Notch Impact test in accordance with ASTM A370 and A673.

3. X-BRACES AND MISCELLANEOUS STRUCTURAL STEEL:

- a. Galvanized, Dulled Galvanized, Metallized or Painted Steel: ASTM A36, ASTM A242, ASTM A572, ASTM A588, ASTM A633 or ASTM A871.
- b. Weathering steel: ASTM A242, ASTM A588 or ASTM A871.
- c. Actual material yield strengths for any welded steel shall not exceed the design yield strength by more than 15 ksi, unless an alternate WPS is submitted, approved by the COR, and followed during fabrication.
- d. Material shall have a minimum longitudinal impact strength of 15-foot-pounds at minus 20-degrees Fahrenheit as determined by the Charpy “V” Notch Impact test in accordance with ASTM A370 and A673.

4. CONNECTION BOLTS, NUTS, LOCKNUTS AND LOCK WASHERS:

- a. Galvanized, Dulled Galvanized or Painted Steel:
 - (1) Bolts: ASTM F3125 Grade A325 Type 1, ASTM A354 Grade BC or ASTM A394 Type 1.
 - (2) Nuts: ASTM A563 Grade DH or other suitable grade specified in ASTM A563 Table X1.1.
 - (3) Locknuts:
 - (a) Palnuts (regular) or Type MF No. 1 (regular or square).
 - (b) In lieu of separate locknuts, self-locking heavy hex nuts for use with ASTM F3125 Grade A325 Type 1 structural bolts, conforming to ASTM A194 Grade 2H or ASTM A563 Grade DH may be used. Self-locking heavy hex nuts shall be Anco style self-locking nuts with stainless steel ratchet pin or equal.
 - (4) Lock washers: ASTM F436.
 - (5) Galvanize or galvanize and dull material after fabrication in accordance with Sections 6.1.9, “Galvanizing” and 6.1.10, “Dulled Galvanizing”. Material for painted structures shall be galvanized, then painted in accordance with Section 6.1.13, “Painting”, except lock washers do not require painting.

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b. Weathering Steel:

- (1) Bolts: ASTM F3125 Grade A325 Type 3, ASTM A354 Grade BC Modified or ASTM A394 Type 3.
- (2) Nuts: ASTM A563 Grade C3 or other suitable grade specified in ASTM A563 Table X1.1.
- (3) Locknuts: Locknuts shall be galvanized in accordance with Section 6.1.9 “Galvanizing”, then prime coated to match weathering steel finish.
 - (a) Palnuts (regular) or Type MF No. 1 (regular or square).
 - (b) In lieu of separate locknuts, self-locking heavy hex nuts for use with ASTM F3125 Grade A325 Type 3 structural bolts, conforming to ASTM A194 Grade 2H or ASTM A563 Grade DH3 may be used. Self-locking heavy hex nuts shall be Anco style self-locking nuts with stainless steel ratchet pin or equal.
- (4) Lock washers: ASTM F436. Lock washers shall be galvanized in accordance with Section 6.1.9, “Galvanizing”.

5. GROUND PLATES

- a. Galvanized, Dulled Galvanized, Metallized, or Painted over Galvanized Structures Backfilled with Native Soils: ASTM A36, ASTM A572, or ASTM A633 galvanized, metallized, or stainless steel conforming to an applicable ASTM standard suitable for the intended use. Stainless steel threaded inserts welded to the pole shafts may be substituted for the ground plates shown on Drawing 41 1015.
- b. Weathering-Steel and Concrete Structures: Stainless steel conforming to an applicable ASTM standard suitable for the intended use shown on Drawing 41 1015.

6. BEARING PLATES:

- a. Galvanized, Dulled Galvanized, Metallized or Painted Steel: ASTM A 36, ASTM A 572 or ASTM A 633, galvanized, metallized or stainless steel conforming to an applicable ASTM standard suitable for the intended use. Actual material yield strengths shall not exceed the design yield strength by more than 15 ksi, unless an alternate WPS is submitted, approved by the COR, and followed during fabrication.
- b. Weathering-Steel Structures: Stainless steel conforming to an applicable ASTM standard suitable for the intended use.

7. U-BOLTS AND CHAIN LINKS: ASTM A36, galvanized.

8. ARC-WELDING ELECTRODES: Arc-welding electrodes shall be in accordance with AWS D1.1.

9. PAINT SYSTEM: Paint system shall be chemical, corrosion and abrasion resistant and shall produce the color and finish specified in the project specifications. All paint system components shall be from the same manufacturer. Paint system shall be approved by the COR.

10. POLYURETHANE COATING: CorroCote II Classic as manufactured by Madison Chemical Industries, Inc., or approved equal.

11. GUYS: ASTM A475 Class B or A586 Class B, galvanized.

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12. GUY HARDWARE: Hardware shall be galvanized and of the type and manufacturer's rated strength as shown on the Contractor-furnished data and drawings. Hardware shall conform to an applicable ASTM standard suitable for the intended use.
13. STEEL GUY ANCHORS AND RODS: Anchors and rods shall be galvanized and of the type and manufacturer's rated strength as shown on the Contractor-furnished data and drawings. Rods for disk and plate-type anchors shall be coated with an approved corrosion-preventive, nonconductive material.
14. CONCRETE GUY ANCHORS: Concrete requirements shall be in accordance with Construction Standard 3 – Concrete.
15. REMOVABLE STEPS:
 - a. Galvanized, Dulled Galvanized, Metallized, or Painted Steel: ASTM F3125 Grade A325 Type 1, ASTM A354 Grade BC, or ASTM A394 Type 1. Galvanize, galvanize and dull, or metallize rungs after fabrication in accordance with Sections 5.1.9, "Galvanizing", 5.1.10, "Dulled Galvanizing" or 5.1.11, "Metallizing". Rungs for painted structures shall be galvanized or metallized but shall not be painted to protect the knurling.
 - b. Weathering Steel: ASTM F3125 Grade A325 Type 3, ASTM A354 Grade BC Modified or ASTM A394 Type 3.
 - c. Removable steps shall be corrugated, knurled, dimpled or otherwise treated to minimize slipping. Coating with skid-resistant material is not acceptable.
16. ATTACHMENTS FOR REMOVABLE STEPS:
 - a. Galvanized, Dulled Galvanized, Metallized or Painted Steel: ASTM A36.
 - b. Weathering steel: ASTM A242, ASTM A588 or ASTM A871.
17. FALL PROTECTION ANCHORAGE PLATES:
 - a. Galvanized, Dulled Galvanized, Metallized or Painted Steel: ASTM A572.
 - b. Weathering steel: ASTM A242, ASTM A588 or ASTM A871.
18. STRUCTURE IDENTIFICATION PLATES:
 - a. Galvanized, Dulled Galvanized, Metallized or Painted Steel: ASTM A36.
 - b. Weathering Steel: ASTM A242, ASTM A588 or ASTM A871.
 - c. Minimum plate thickness shall be 1/8-inch.

6.1.5 QUALITY CONTROL:

1. GENERAL: Contractor shall have defined quality control methods and functions available for review and approval. Maintain permanent records on mill test reports, weld procedures, welding operators, qualifications for welders and tack welders, inspector test results and visual and nondestructive test records.

Structure components and welds shall be inspected to determine conformance to contract requirements, drawings, codes and standards and procedures, including dimensional compliance, quality of welds, weld contour, weld size and overall workmanship.

2. WORKMANSHIP AND DEFECTIVE MATERIAL: Work shall be equal to best modern practice in the manufacture and fabrication of material. Design details, fabrication and erection not covered

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by the Drawings or these specifications shall conform to AISC “Steel Construction Manual” and ASCE/SEI 48-19, “Design of Steel Transmission Pole Structures”. Contractor shall be responsible for correct fitting of parts and shall replace defective material discovered during erection.

3. INSPECTION AND TESTS: Inspection of material will be made in accordance with Construction Standard 1 – General Requirements, Section 1.2.3, “Material Inspection”. WAPA inspection of material at the mill will be waived.
4. DIMENSIONAL TOLERANCES: Allowable variations from specified dimensions are as follows:
 - a. Overall Length of Structure: -6-inches and +12-inches.
 - b. Length of Component Pole Shaft Sections: ± 3 -inches.
 - c. Structure Cross Section:
 - (1) Diameters 36 Inches or Less: $-1/8$ -and $+1/4$ -inch.
 - (2) Diameters Greater Than 36 Inches: $-1/4$ -inch and $+1/2$ -inch.
 - (3) Circumference of All Sections: -0-inch.
 - d. Vertical Spacing Between Conductor Attachment Points and Ground Wire Attachment Points: ± 1 -inch.
 - e. Straightness of Structure: $1/8$ -inch in 10-feet of length.
 - f. Location of Drilled Holes: $\pm 1/16$ -inch.
 - g. Hole Spacing on Same Connection: $\pm 1/16$ -inch (noncumulative).
 - h. Maximum Difference Between Interior Width of Arm Brackets and Exterior Width of Arm Mounting Boxes or Vangs: $1/4$ -inch per side.
 - i. Maximum Gap Between Mating Flange Plates Before Installing Bolts: $1/2$ -inch.
 - j. Length of Davit Arm: ± 1 -inch.
 - k. Length of Crossarm: $\pm 1/4$ -inch
 - l. Length of Overlap of Slip Joint:
 - (1) Under slip: -10%, but not less than 1.5-times the largest inside diameter of the female section. The minimum slip joint length shall be capable of developing the full required capacity of the connection.
 - (2) Over slip: +6-inches
 - m. Variance in Longitudinal Location of Conductor Attachment at End of Davit Arm or Crossarm: ± 2 -inches per 10-feet of arm length or 1-degree from theoretical location.
 - n. Structure Identification Plate Location: 6-feet, ± 1 -foot above ground line.
 - o. Vertical Location of Guy Attachment Points with Respect to Conductor and Ground Wire Attachment Points: ± 1 -inch.
 - p. Clear dimensions from pole face (excluding removable ladder clips): -0-and $+1/2$ -inch.

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- q. Dimensions for Attachments for Removable Steps: $\pm 1/16$ -inch.
- r. Vertical Spacing of Attachments for Removable Steps: 12-inches $\pm 1/2$ -inch.
- s. Tolerances not listed above shall be in accordance with applicable codes and standards.

6.1.6 FABRICATION:

1. GENERAL: Plates shall be edge-planed or flame-cut with mechanically guided torches. Surface roughness of plate edges shall be in accordance with AWS D1.1.
2. STRAIGHTENING MATERIAL: Before being laid out or worked in any manner, structural material shall be straight, free from sharp kinks and bends and clean of rust and dirt. Straightening operations shall not damage the metal.
3. SHEARING AND CUTTING: Shearing and cutting shall be neatly finished on material exposed to view. Copes and re-entrant cuts shall be filleted before cutting.
4. HOLES:
 - a. General: Holes in steel less than $13/16$ -inch thick may be punched to full size unless otherwise shown on the Drawings. Holes shown on the Drawings as drilled holes and holes in steel $13/16$ -inch thick or greater shall be drilled or subpunched and reamed. Holes shall be clean-cut and without torn or ragged edges. Burrs resulting from reaming or drilling shall be removed with a tool making a $1/16$ -inch chamfer. Holes shall be cylindrical and perpendicular to the member. Place holes in plates prior to bending unless holes will be deformed during the forming process.
 - b. Punching: For hole punching to full size, the punch diameter shall be the nominal hole diameter, and the die diameter shall not be more than $1/16$ -inch larger than the punch diameter. For subpunching, the punch diameter shall be $1/4$ -inch smaller than the nominal hole diameter and the die diameter shall not be more than $3/32$ -inch larger than the punch diameter. Subpunched and reamed holes shall not have a punched surface in the hole periphery.
 - c. Reaming and Drilling: Finished hole diameters for reamed or drilled holes shall be as shown on the Drawings and $1/16$ -inch larger than the nominal diameter of the bolts that will be used at each hole location.
5. EDGE DISTANCES AND BOLT SPACING: Edge distances and bolt spacing shall be in accordance with AISC "Steel Construction Manual" unless otherwise shown on the Drawings.
6. POLE SHAFT-TO-FLANGE PLATE CONNECTIONS: Welds to attach pole shafts to flange plates shall be complete penetration with backing bars or complete joint penetration with back gouging.
7. CROSSARM- AND DAVIT ARM-TO-ARM BRACKET CONNECTIONS: Welds to attach crossarms and davit arms to arm brackets and flange plates shall be complete penetration with backing bars. Complete joint penetration with back gouging is allowable if the fit-up permits.
8. COLD FORMING: Fabricator shall have documented, detailed procedures describing cold forming methods to produce bends without cracking. Cracking or opening of surface laminations shall be investigated and repaired. Repairs shall be inspected and recorded. Plates with cracks, laminations or lamellar tears shall be rejected. Minimum inside radii of bends shall be equal to or greater than specified by ASTM A6 Appendix X4.

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9. **SLIP JOINTS:** Visual indicators on the pole sections shall be provided for when minimum, design, and maximum slip occur for identification during field installation.
10. **WELDING:**
 - a. **General:** Welding shall be performed in accordance with the latest revision of AWS D1.1. Welds shall be as shown on the shop drawings and made to minimize residual stresses. Weld procedure, welders, welding operators and tack welders shall be qualified in accordance with AWS D1.1.
 - b. **Longitudinal Seam Welds:** Complete joint penetration is required within 6-inches of base plates, flange plates, arm brackets, and for the outer section of splice joints equal to the maximum lap dimension. The remaining seam welds shall have 80-percent minimum penetration through the material thickness. The use of permanent backing material is not permitted.
 - c. Welding procedure specifications and supporting procedure qualification records, if applicable, for partial penetration seam welds shall be submitted and approved prior to fabrication.
 - d. Vangs shall be welded all around to seal the joints. Gaps shall not be permitted.

6.1.7 NONDESTRUCTIVE AND METALLOGRAPHIC WELD TESTS:

1. **GENERAL:** Inspect welds and perform tests in accordance with AWS D1.1 or in accordance with procedures approved by the COR. Repair and reexamine defective welds in accordance with AWS D1.1. Document and notify the COR of any defects and subsequent weld repairs.
2. **VISUAL INSPECTION:** All welds shall be visually inspected in accordance with AWS D1.1.
3. **ULTRASONIC AND RADIOGRAPHIC TESTS FOR COMPLETE PENETRATION WELDS:** Perform ultrasonic or radiographic tests on the entire length of each complete joint penetration Shop and field weld in accordance with AWS D1.1. Perform tests after galvanizing for complete joint penetration welds used at T-joints, as defined by AWS D1.1. Otherwise, tests can be performed before galvanizing.
4. **ULTRASONIC AND METALLOGRAPHIC TESTS FOR PARTIAL PENETRATION WELDS:** Perform either ultrasonic or metallographic tests for partial penetration welds.
 - a. **Ultrasonic Tests:** Perform ultrasonic tests in accordance with AWS D1.1 or procedures approved by WAPA. Test a minimum of 10-percent of each length of partial penetration weld at random intervals, with no test length exceeding 12-inches.
 - b. **Metallographic Tests:** Perform metallographic tests using a test lab approved by WAPA. For each tubular piece mark number, remove a weld sample from the first tubular section and from every tenth section thereafter. Remove samples by core drilling and plug the holes with complete penetration welds without permanent backing material. Test procedure shall include a sample report for documenting test results which shall include the following:
 - (1) WAPA contract number.
 - (2) Structure type and piece mark number.
 - (3) Material thickness.
 - (4) Name, location, email address and telephone number of test lab.
 - (5) A sketch showing location of removed weld samples.
 - (6) Actual weld penetration of samples.

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5. **MAGNETIC PARTICLE AND DYE PENETRANT TESTS:** Magnetic particle or dye penetrant weld tests is required where cracking is suspected. Perform magnetic particle tests in accordance with ASTM E 709. Perform dye penetrant tests in accordance with ASTM E 165. Acceptance standards for the tests shall be in accordance with AWS D1.1.

6.1.8 MARKING:

1. **STRUCTURE COMPONENTS:**
 - a. Mark structure components with the designations shown on final erection drawings. Stamp or weld markings into the steel before painting, galvanizing or metallizing. The markings shall be 1/2-inch-minimum height and clearly legible after painting, galvanizing or metallizing. Mating pole shaft sections shall be match marked to ensure correct orientation.
 - b. Stamp the total weight of individual pole shaft and arm sections at the base of each section.
2. **STRUCTURE IDENTIFICATION PLATE:** Identify each structure with an identification plate located approximately 6-feet above ground line on the backspan side of the pole.
 - a. Stamp the following information into the plates using numerals and letters not less than 1/2-inch high:
 - (1) Structure Number (i.e. 17/2).
 - (2) Length and Class of pole (or ultimate ground line moment if non-catalog item).
 - (3) Owner's Name (WAPA).
 - (4) Total pole weight in pounds.
 - (5) Manufacturer's name.
 - (6) Month and Year of fabrication.
 - b. Plates shall be welded all-around to the pole shafts before galvanizing, metallizing or painting. The numerals and letters shall be clearly legible after galvanizing, metallizing or painting.

6.1.9 GALVANIZING:

1. **CLEANING:** After shopwork completion, clean material of rust, loose scale, dirt, oil, grease and other foreign substances. Clean all slag from welded areas.
2. **PLATE AND SHAPE GALVANIZING:** After fabrication and cleaning, galvanize plates and shapes in accordance with ASTM A123. Double dipping or progressive dipping of closed-member shapes shall not be permitted. After galvanizing, pole shaft sections shall not have lateral variations greater than 1/1000 the axial length of the section. Holes shall be free of excess spelter after galvanizing.
3. **HARDWARE GALVANIZING:** Galvanize bolts, nuts, washers, locknuts and lock washers in accordance with ASTM A153. Remove excess spelter by centrifugal spinning.
4. **STRAIGHTENING AFTER GALVANIZING:** Plates and shapes which have been warped by the galvanizing process shall be straightened by rerolling or pressing. Material shall not be hammered or straightened in a manner that will damage the galvanizing. Material that has been harmfully bent or warped, in the opinion of the COR, shall be rejected.
5. **GALVANIZING REPAIR:** Material with damaged galvanizing shall be redipped unless the damage is local and can be repaired. If the galvanized coating becomes damaged after being dipped twice, the material shall be rejected. Where repair is authorized, the damaged area shall

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be repaired in accordance with ASTM A780, except the minimum coating thickness shall be 3-mils.

- a. Zinc Rich Paint: When utilizing paints containing zinc dust, surfaces shall be cooled to ambient temperature, dry, free from rust, mill scale, paint, dirt and other contaminants. Surfaces may be cleaned by wire brush or equivalent cleaning methods, grinding is not permitted. Zinc paint shall be applied with a brush, spray painting is not permitted. The minimum required dry paint thickness is 5-mils. Zinc rich paint shall have a minimum of 94-percent zinc dust by weight.

6.1.10 DULLED GALVANIZING:

1. DULLING TREATMENT: Exposed surfaces of galvanized steel structures, including connection and anchor bolts, nuts, washers, locknuts, lock washers and visible portions of embedded material shall be given an approved dulling treatment to provide a gray or blackish-gray coloration. Treatment shall dull the shine and reflectance of surfaces and provide a uniform appearance for all treated surfaces. Soft or water-soluble surface deposits resulting from the treatment shall be removed by rinsing. Treatment shall have a life of at least 1-year and not be detrimental to the service life of the protective zinc coating. Dulled surfaces shall be free of white rust, zinc oxide.
2. REFLECTANCE: Finished steel shall maintain a reflectance no greater than that specified in the project specifications, plus or minus 3-percent. Reflectance shall be measured utilizing any reflectometer calibrated against "Neutral Matte Finish" color standards obtainable from Munsell Color, a division of X-Rite Incorporated. The reflectometer shall have a margin of error no greater than plus or minus 3-percent.

6.1.11 METALLIZING:

1. GENERAL: Metallizing shall be in accordance with the manufacturer's recommendations and ASCE/SEI 48-19. Structures shall be metallized with zinc and have a minimum coating thickness of 5-mils. Zinc shall have a minimum purity of 99.9-percent.
2. SURFACE PREPARATION: After fabrication, blast clean steel in accordance with Steel Structures Painting Council Surface Preparation Specification SSPC-SP 5, "White Metal Blast Cleaning".
3. DIRECT-EMBEDDED STRUCTURES WITH CONCRETE BACKFILL: If any portion of a pole shaft above ground line is metallized, the entire structure shall be metallized so that all visible surfaces match.
4. WEATHERING-STEEL DIRECT-EMBEDDED STRUCTURES WITH NATIVE BACKFILL: Metallize pole shafts from bottom of poles to 2-feet above ground line prior to polyurethane coating.

6.1.12 WEATHERING-STEEL FINISH:

After fabrication, blast clean steel in accordance with Steel Structures Painting Council Surface Preparation Specifications as follows:

1. DIRECT-EMBEDDED STRUCTURES WITH CONCRETE BACKFILL:
 - a. Top of Structure to 3-Feet Above Bottom of Structure: SSPC-SP 7, "Brush-Off Blast Cleaning".
 - b. Bottom 3-Feet of Structure: SSPC-SP 6, "Commercial Blast Cleaning".

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2. DIRECT-EMBEDDED STRUCTURES WITH NATIVE BACKFILL:

- a. Top of structure to 2-feet above ground line: SSPC-SP 7, “Brush-Off Blast Cleaning”.
- b. 2-feet above ground line to bottom of structure: SSPC-SP 5, “White Metal Blast Cleaning”.

6.1.13 PAINTING:

1. GENERAL: Provide material and equipment, clean surfaces and apply paint to all structure components, except as noted below, in accordance with the manufacturer’s instructions and this paragraph. Prevent dust or other contamination from falling on wet, newly painted surfaces and do not move components until paint is thoroughly dry. Painted surfaces shall have uniform texture and color-matched appearance.

Repair paint on steel pole structures which is damaged or removed due to ground plate installation, welding, transport to work sites, storage at the work sites, installation or any other Contractor's operation. Reclean exposed surfaces and reapply paint as necessary to restore damaged and bare surfaces to the specified condition. Painting materials shall be handled, used, stored and disposed of according to Federal, State and local regulations.

2. SURFACE PREPARATION AND APPLICATION: Surface preparation and application shall be in accordance with manufacturer’s recommendations.
3. SURFACES NOT TO BE PAINTED: The following areas and faying surfaces of the structures shall be masked or otherwise protected from paint to ensure the electrical continuity of the structures:
 - a. Areas inside slip joints: Outside surfaces of male (bottom) sections and inside surfaces of female (top) sections.
 - b. Arm connections: Outside surfaces of arm connection areas and inside surfaces of arm connection plates.
 - c. Post insulator mounting brackets: Exterior surfaces of mounting brackets.
 - d. Overhead ground wire attachment plates.
 - e. Portions of galvanized pole shafts that will be below ground line.
 - f. Removable steps and attachments.
 - g. Ground plates.

If any of the above surfaces are painted, grounding requirements for weathering-steel structures in Section 6.1.3, “Grounding Requirements” shall apply.

6.1.14 POLYURETHANE COATING:

1. GENERAL: Minimum coating thickness and surface preparation shall be in accordance with manufacturer's recommendations. Top edge of coating shall be feathered, in lieu of masked, to prevent flaking.

Take precautions to prevent blistering of polyurethane coating. Damaged or blistered coating shall be repaired in accordance with manufacturer's recommendations prior to structure installation.

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Polyurethane coating shall not be applied to ground plates or bearing plates.

2. DIRECT-EMBEDDED STRUCTURES WITH CONCRETE BACKFILL:

- a. Coat bottom 2-feet of direct-embedded weathering-steel pole shafts with polyurethane coating.
- b. Polyurethane coating is not required for galvanized, dulled galvanized, metallized or painted-over-galvanized structures.

3. DIRECT-EMBEDDED STRUCTURES WITH NATIVE BACKFILL:

- a. Coat galvanized pole shafts from 2-feet above ground line to 6-inches above bottom of poles with polyurethane coating. Bottom 6-inches of pole shafts shall be left uncoated for electrical grounding.
- b. Coat weathering-steel pole shafts from 2-feet above ground line to bottom of poles with polyurethane coating. Do not coat bearing plates.

6.1.15 HANDLING AND TRANSPORTING:

1. GENERAL: Handle and transport steel structures and components to avoid bending or damage. Notify Fabricator and WAPA COR of any bent or damaged pieces for repair or replacement recommendations. Material with damaged galvanizing, metallizing, paint or polyurethane coating shall be replaced or repaired in accordance with Sections 6.1.9, "Galvanizing", 6.1.13, "Painting", or 6.1.14, "Polyurethane Coating".
2. MATERIAL HANDLING AND PACKAGING:
 - a. Provide 6-inch minimum height wood blocking material so that unloaded materials will not be in direct contact with the ground and will remain stable, unable to roll.
 - b. Box all loose hardware and label by count and description. Bolts of different lengths shall be packaged separately.
3. INVOICE OR PACKING LIST: Shipping invoices shall be accompanied by an invoice or packing list or checklist of all parts in each shipment. Parts shall be identifiable by structure number. Invoices and packing lists shall also be emailed to the Civil Engineer and the COR.
4. NOTIFICATION: Notification shall be given to the COR and personnel that will accept delivery 2-weeks prior to delivery and again 48-hours prior to delivery. Furnish a detailed list 20-days in advance of each delivery of all material that will be delivered with each shipment including quantities, weights, name of common carrier, bill of lading number, expected time of arrival and any other pertinent information.
5. UNLOADING: Offloading contractor shall provide sufficient manpower, a minimum of one (1) helper, to safely and efficiently unload, and not rely on help from Government representatives.

6.1.16 INSTALLATION:

1. GENERAL:
 - a. Installation shall be in accordance with the Fabricator's recommendations and AISC 303 "Code of Standard Practice for Steel Buildings and Bridges".

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- b. All slip joints shall be jacked together using hydraulic jacking devices in accordance with fabricator's recommendations.
 - (1) The installed slip joint length shall be in accordance with the specified tolerances.
- c. Lubricants other than soapy water shall not be used in slip joint assembly.
- d. Secure all slip joints by positive mechanical means before lifting or installing structures.
- e. Provided dimensional tolerances listed in Sections 6.1.5.4(8) and 6.1.5.4(9) in the "Quality Control" paragraph are not exceeded, spaces in bolted connections greater than or equal to 1/8-inch shall be filled with galvanized washers or ring fills before installing bolts.
- f. Straightness of assembled structure shall be within 1/8-inch in 10-feet of length.
- g. Lift structures by slings attached at lifting points as shown on final drawings.
- h. Raking of structures shall not be permitted unless approved by the COR.
- i. Concrete backfill shall cure a minimum of 14-days before stringing conductors and overhead ground wires, unless approved by the COR.
- j. Remove all corrosive and foreign material, including chalk and grease marks, from structures and internally threaded portions of ground plates, including material deposited on the structures prior to and during installation.
- k. Correct installation errors and omissions, including retightening of nuts and retightening or retensioning of guys.

2. DIRECT-EMBEDDED STRUCTURES:

- a. Structure embedment depth shall be 10-percent of the total pole length plus 2-feet, or as listed in the project specifications and shown on the Drawings, unless rock is encountered.

Rock is defined as a massive or stratified cemented formational material having a standard penetration test (SPT) "N" value of 100 or more throughout the entire embedment depth.

If rock is encountered, structure embedment depths may be reduced to the overburden depth plus "Keyed into Rock" depth listed in the project specifications.

- b. If a structure embedment depth is reduced due to rock, cut off the bottom of the pole shaft a length equal to the reduction in embedment depth and reweld the bearing plate to the pole shaft bottom. Repair damaged galvanizing, metallizing or polyurethane coating in accordance with Sections 6.1.9, "Galvanizing", or 6.1.14, "Polyurethane Coating".
- c. Verify structure alignment prior to backfill placement to ensure correct orientation with respect to line angle.
- d. After setting and aligning structures which are to receive native backfill, place and compact backfill to a dry density not less than the natural in-place dry density of the surrounding earth. Backfill shall be banked and tamped around the poles to a height of 12-inches above the natural ground surface. Any surplus excavated material shall be leveled neatly. If satisfactory backfill material is not available from excavation or within the immediate vicinity of the structure, the Contractor shall import any backfill material required.

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- e. After setting and aligning structures which are to receive concrete backfill, temporarily guy or hold structures to prevent displacement during concrete backfill placement and for a minimum of 3-days thereafter.
- f. Concrete backfill shall meet 28-day compressive strength and a minimum of 7-days before placing the next section and a minimum of 14-days before stringing wires.

3. GUYS AND ANCHORS:

- a. Install guys and anchors in accordance with manufacturer's recommendations. Compact backfill for guy anchor excavations in accordance with Standard 2 – Sitework, Section 2.7, "Compaction". Pretension guys as shown on the final erection drawings.
- b. Perform load tests on up to 10-percent of guy anchors to verify manufacturer's rated strength and installation methods. Anchors shall hold maximum load listed in design data for 5-minutes. Maximum allowable movement shall be 2-inches or 10-percent of helix or disk diameter, whichever is less. Number of tests and specific anchors to be tested shall be at the discretion of the COR.
- c. If it is necessary to relocate guy anchors out-of-line, or more than 5-feet from their initially approved location, prior to installation resubmit revised design data and drawings for each affected structure in accordance with Section 6.1.1, "Contractor-Furnished Data and Drawings". Minimum anchor spacing shall be 8-feet for relocated anchors.

4. MAINTENANCE PROVISIONS:

- a. Install fall protection anchorage plates to removable climbing rung sections in accordance with Drawing 41 2701.
- b. For weathering-steel structures, after installing removable steps and fall protection anchorage plates, spot weld the removable steps and fall protection anchorage plates to the attachments on the pole shafts. Welding shall be sufficient to provide electrical continuity between the removable steps and the pole shafts. Preferred welding rod series is E8018-C3. Other acceptable series are E8018-C1 and E8018-C2.
- c. Trial fit removable climbing rung sections into clips on every structure.

5. STRUCTURE ORIENTATION: Install tangent structures so that the transverse structure axes are perpendicular to the centerline of transmission line and install angle structures so that the transverse structure axes are perpendicular to the line angle bisectors, except structures listed in the "Special Structure Orientation" table in the "Light Duty Transmission Line Steel Pole Structures" Division of the project specifications.

6. FIELD WELDING: Field welding is only permitted when authorized by the COR and the backside of the weld is accessible for coating repair. Field welding, including welding procedures and welders, shall be in accordance with Section 6.1.6, "Fabrication". Perform nondestructive weld tests and inspect field welds in accordance with Section 6.1.7, "Nondestructive and Metallographic Weld Tests". Clean field welds by sandblasting or power grinding.

Repair damaged paint, galvanizing, metallizing or polyurethane coating in accordance with the Sections 6.1.9, "Galvanizing", 6.1.13, "Painting" or 6.1.14, "Polyurethane Coating".

7. DIRECT-EMBEDDED H-FRAME STRUCTURES: If ground line elevations vary by 5-feet or less at direct-embedded H-frame legs, install structures vertically plumb so that the center conductor attachment is a distance "H", height portion of structure designation, above ground line. If ground line elevations vary by more than 5-feet, notify the COR.

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Concrete backfill projections shall extend a minimum of 18-inches above ground line for both legs of H-frame structures when concrete backfill is specified.

8. **TEMPORARY GUYING REQUIREMENTS:** Upon request, if conductors or overhead ground wires are temporarily dead-ended on self-supporting structures, the structures shall be guyed to remain plumb until final conductors and ground wires are strung at some future date. Variation from plumb shall not exceed 3-inches at any elevation in any horizontal direction after initial stringing.
9. **VIBRATION CONTROL:** Before insulators, conductors or overhead ground wires are installed, davit arms shall be restrained or dampened, if necessary, to prevent fatigue crack initiation and propagation due to fluctuating loads.
10. **INSTALLATION TOLERANCES:** Allowable variations from specified dimensions and locations for installed structures are as follows:
 - a. **Centerline Location:** Within 3-inches of theoretical centerline location.
 - b. **Embedment Depth, "E":** -6-inches and +24-inches, where rock is not encountered; -3-inches and +12-inches, where rock is encountered.
 - c. **Installed Height, "H":** ± 12 -inches.
 - d. **Installed Position Prior to Stringing:**
 - (1) Variation from plumb shall not exceed 6-inches at top of structure in any horizontal direction.
 - (2) Variation in Longitudinal Location of Conductor Attachments at End of Davit Arm (Arm Alignment): ± 2 -inches per 10-feet of arm length from theoretical location.

6.1.17 STRUCTURE SIGNS:

1. **STRUCTURE NUMBER SIGNS:** The structure number signs, with the structure numbers as designated on the plan and profile drawings, shall be attached to the structures on the ahead and back span faces of structure.
 - a. **Steel Pole Structures:** Signs and mounting plates shall be fabricated and attached to the structures in accordance with Drawings 41 9027-2, 41 9027-3, or 41-9030. Holes shall not be drilled into tubular steel structures.
2. **AERIAL PATROL MILE MARKER SIGNS:** The first structure of each mile section of line shall be identified with two (2) aerial patrol mile marker signs, one (1) on the ahead and one (1) on the back span face of the mounting plate.
 - a. **Steel Pole Structures:** Signs shall be fabricated and attached in accordance with Drawing 41 9027-1.
3. **AERIAL PATROL WARNING SIGNS:** Aerial patrol warning signs, located as designated on the plan and profile drawings and described in WAPA Construction Standard Section 10.6.8 "Line Markers", shall be fabricated and mounted in accordance with Drawings 41 9028 and 41 9030.
4. **DANGER SIGNS:** Mount two (2) danger signs on each steel structure in accordance with Drawing 41 9027-2.

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Western Area
Power Administration

CONSTRUCTION STANDARDS

Standard 7 WOOD POLES



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STANDARD 7 – WOOD POLES

SECTION 7.1 – WOOD POLE STRUCTURES

7.1.1 GENERAL:

1. STRUCTURES: The Bidding Schedule items for the various types and lengths of wood pole structures include the following:
 - a. Earthwork: Performing earthwork for placing poles and anchors, including excavation, unwatering as required, placing, and compacting backfill, drilling holes in rock for grouted anchors and other earthwork as required to complete installation of poles and anchors.
 - b. Wood Pole Structures: Furnishing and constructing wood pole structures including installing the following material, complete with associated hardware, in the quantities listed for the respective structures on the drawings:
 - (1) Poles, crossarms, and braces as applicable.
 - (2) Guy assemblies, one (1) guy, either single or double guy strand, shall include the length of guy assembly; with strand and fittings for guy attachment to connect the guys to the pole bands and to the anchor rods. The Contractor will not receive extra payment for guys longer than shown on the Drawings.
 - (3) Guy anchors, including copper-clad anchor rods, and anchor accessories.
 - (4) Structure grounding including staples, ground wire, ground rods and counterpoise where required. See the "Transmission Line Electrical" Standards.
 - (5) Two (2) aerial patrol number signs on the first structure in each station mile, aerial patrol warning signs, and all structure number signs. See the "Electrical" Standards.
 - (6) Overhead ground wire support assemblies. See the "Transmission Line Electrical" Standards.
 - c. Submittals: Providing purchase orders, test reports, data sheets and certificates in accordance with submittals paragraph of Division 1 – General Requirements.

7.1.2 CONTRACTOR-FURNISHED DATA:

As soon as practical after award of contract and before any material is installed, furnish three (3) electronic copies of the following data, which shall include sufficient information to show that the material meets the intent of these specifications.

1. DATA SHEETS: Catalog data sheets, bill of material or detail purchase orders, and individual structure material drawings for each type of structure including:
 - a. Wood poles, including type, Class, and treatment.
 - b. Crossarms, including type, treatment and sketch showing crossarm drilling details.
 - c. Braces.
 - d. Pole bands.
 - e. Dead end tees.
 - f. Strain bands.
 - g. Guy wires.
 - h. Guy clamps.
 - i. Anchor rods.
 - j. Guy anchors, markers and/or protectors.
 - k. Miscellaneous hardware, fittings, and bolts.

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- l. Material Safety Data Sheets (MSDS).
 - m. Signs.
2. CERTIFICATIONS: Certified electronic copies of records or test results as follows:
- a. Guying System: Submit guy, hardware and anchor data and drawings for approval. Data shall include test results and manufacturer's certification that the guying system will develop the required capacity.
 - b. Sapwood Test: A boring shall be made after treatment at the crown of the midpoint in each pole.
 - c. Treatment Tests: Wood products shall be inspected in accordance with AWPAs M2 to assure compliance with the requirements in AWPAs U1 (latest edition). Use Category 4C, Commodity Specification D: Poles, or as specified herein. The penetration of preservative shall be tested in accordance with the requirements of AWPAs. The retention of preservative shall be tested in accordance with the requirements of AWPAs A9. Borings shall not be taken in through-bored or deep-incised areas. Penetration tests shall be performed on each pole. A single boring shall be taken from each of 20 randomly selected poles to determine the retention of preservative.

Treatment test results shall show:

- (1) Compliance with applicable AWPAs specifications.
- (2) Number and type of pieces per charge.
- (3) Species of wood.
- (4) Kind of preservative used.
- (5) Depth of sapwood.
- (6) Penetration obtained.
- (7) Retention obtained.
- (8) Moisture content after treatment.

Preservative Tests: The preservative used in the treating of wood products shall be tested in accordance with AWPAs M2

7.1.3 MATERIAL:

1. WOOD POLES: Conform to the following:
- a. Specifications and Dimensions: ANSI 05.1, unless otherwise specified.
 - b. Class: Shall be Class 1 or Class 2 with a maximum top circumference of 39- and 38-inches, respectively, unless specified otherwise in the Bidding Schedule.
 - c. Species: Only Pacific Coast Douglas Fir (Fir) or Western Red Cedar (Cedar) poles shall be permitted.
 - d. Drilling: Poles shall be bored for crossarms, braces, post insulators, pole bands and miscellaneous hardware before treatment in most cases.
 - e. Incising:
 - (1) Incising of Fir poles may be required to meet the penetration or checking requirements of the preservative treatment. The pattern and depth of incising of the pole shall be at the option of the Contractor. Incising shall be accomplished in a manner which will

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not unduly damage the surface of the pole by splintering, raising the wood fibers from the surface, gouging, or loosening the sapwood from the heartwood.

- (2) Incising of Cedar is not required.
 - f. Through-Boring:
 - (1) The ground line of the Fir poles shall be through-bored before treatment in accordance with Drawing 41 6106. Ground line shall be determined per ANSI 05.1 unless specified otherwise.
 - (2) Through-boring is not required for full-length treated Cedar.
 - g. Marking Disc Recesses: Shall be placed on the pole face and butt before treatment. Recesses on the face shall be placed approximately 12-feet from the butt on poles 55-feet and shorter, 14-feet from the butt on poles between 60- and 75-feet, and 16-feet from the butt on poles 80-feet and longer. The recesses shall have flat bottoms, a minimum 2-inch diameter, and a depth of 1/4-inch to 1/2-inch at the recess periphery.
 - h. Gaining: If adjustable phase fittings are not used, poles shall be gained to a depth of 1/4-inch for poles with a diameter equal to or less than the minimum width of the phase fitting. Gains for crossarms on poles having sweep or curvature shall be cut so that the crossarms will be mounted at right angles to the plane of the greatest curvature. Only gaining necessary for hardware connections will be allowed.
 - i. Roofing: Poles shall be roofed 15-degrees from horizontal before treatment. Unless otherwise approved, slope pole roofs toward or away from the center of the structure.
 - j. Pole Antisplitting Devices: Shall be placed in pole tops before treatment and be equal to "Star-Lock" which is manufactured by The Bayne Company, P.O. Box 14557, Spokane Valley, Washington 99214.
2. CROSSARMS: Shall be glued laminated and conform to the following:
- a. Glued Laminated:
 - (1) General: The laminating stock shall consist of Pacific Coast Douglas Fir.
 - (2) Manufacture: Material, manufacture and quality control shall be in conformance with ANSI A190.1 and ANSI 05.2.
 - (3) Laminating Combinations: Shall meet the requirements of ANSI A190.1 Product Standard for Structural Glued Laminated Timber and shall provide overall ultimate fiber strength of 6800-psi.
 - (4) Adhesives: Wet-use type complying with ANSI A190.1 and ASTM D 2559. Melamine urea adhesives shall not be used.
 - (5) Appearance: As specified in AITC 110, Industrial Appearance Grade. Edges of crossarms shall be eased to 3/16-inch radius.
 - b. Drilling: Crossarms shall be drilled before treatment in accordance with a WAPA-approved sketch showing crossarm drilling details. Holes in crossarms shall be drilled 1/8-inch larger than their respective bolt diameters.
 - c. Cross Section: Crossarms shall have a finished cross section as shown on the Drawings.

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3. WOOD BRACES:

a. Solid-Sawn:

- (1) Lumber: Seasoned Pacific Coast Douglas Fir, cut from live timber and kiln-dried or air seasoned in accordance with AWP A M1.
- (2) Manufacture: Manufactured in accordance with ANSI 05.3, free of heart center (FOHC), surfaced 4 sides (S4S) after seasoning, and incised four sides to depth of 3/16-inch. Lumber shall provide an ultimate design value of 6,600-psi in bending.

Maximum knot sizes for braces shall be as follows:

FACE WIDTH (IN)	KNOT SIZE (IN)
3 3/8 and 3 5/8	3/4
4 3/8	1
5 3/8	1 1/8
8 1/2	1 1/2

b. Glued Laminated:

- (1) General: The laminating stock shall consist of Pacific Coast Douglas Fir.
- (2) Manufacture: Material, manufacture, and quality control shall be in conformance with ANSI A190.1 A190 and ANSI 05.2.
- (3) Laminating Combinations: Shall meet the requirements of ANSI A90.1 Structural Glued Laminated Timber.
- (4) Adhesives: Wet-use type complying with ANSI A190.1 and ASTM D2559. Melamine urea adhesives shall not be used.
- (5) Appearance: As specified in AITC 110, Industrial Appearance Grade.

c. Cross Section: Wood braces shall have a finished cross section as shown on the Drawings.

4. KNEE BRACES: Shall be fiberglass and conform to the following:

- a. Fiberglass: Outside knee braces shall be made of fiberglass with a minimum ultimate strength of 25,000-pounds.

5. HARDWARE AND ASSOCIATED MATERIAL:

- a. Steel Angles: Steel shall conform to ASTM A36. Pieces shall be fabricated in accordance with the wood pole structure drawings.
- b. Bolts, Nuts, Locknuts and Lag Screws: Bolts, nuts and lag screws shall be square headed and in accordance with ANSI C135.1. Unless otherwise specified, rolled, or cut threads of the American Standard coarse-thread series shall be furnished. The 7/8-inch double-arming bolts shall be furnished with four (4) square nuts and threaded 6-inches at each end. Nuts and locknuts shall run freely (hand fit) the entire length of the threads. Locknuts shall be Type "MF". Bolts used in overhead ground wire assemblies shall be furnished with hexagonal head, hexagonal nut and cotter key and shall be made of steel commensurate with the ultimate strength specified for the hardware. All pinned hardware, including guy strain insulators, shall be supplied with a bolt, nut, and cotter

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key. For bolt lengths “as required”, tolerances shall be 2-inches beyond the locknut for a maximum length and two (2) threads beyond the locknut for a minimum.

- c. H-Frame Crossarm Fittings: Steel adjustable spacer fittings shall be made of 1/4-inch steel for 69- and 115-kV construction and 5/16-inch-thick steel for 230-kV construction. Fittings shall meet the requirements of ASTM A36 and shall be Hughes Brothers Catalog No. 3414 or 3415, Brooks Manufacturing Company Catalog No. 586 or 587, or equal. Plates shall show no defects after being bent. Each phase fitting shall support a minimum load of 4,000-pounds without evidence of permanent deformation and shall have an ultimate strength of not less than 10,000-pounds.
 - d. Twisted Shackles: Equal to Hughes Brothers Catalog No. 2866. Twisted shackles shall be furnished as part of the structure material.
 - e. End Fittings: Braces shall be furnished complete with end fittings.
 - f. Brackets: Each angle or extension bracket shall support a minimum load of 5,000-pounds without evidence of permanent deformation and shall have an ultimate strength of not less than 12,500-pounds.
 - g. Square Washers: Standard commercial quality.
 - h. Spring Lockwashers: Standard commercial quality.
 - i. Pole Bands: Pole top bands for overhead ground wire suspension assemblies on H-frame structures shall be equal to Hughes Brothers Catalog No. 2845-B. Type A 4-way strain bands for pole-to-pole ties and for all overhead ground wire attachments and guys on 3-pole structures shall be equal to Hughes Brothers Catalog No. 3103, Joslyn J25967 series, or an approved equal. Type B 4-way strain bands for conductor tension assemblies and conductor guys shall be equal to Hughes Brothers Catalog No. 3112, Joslyn J25969 series, or an approved equal. Pole top bands, strain bands, connecting links and ground clips shall be made of steel which will meet the requirements of ASTM A36.
 - j. Dead-end Tees: May be used in lieu of pole bands. Dead-end tees shall have equivalent strength.
6. WELDING: Welding shall be in accordance with the provisions of AWS D1.1, “Structural Welding Code - Steel”. Surfaces of finished beads and adjacent metal shall be thoroughly cleaned by sandblasting to such an extent that zinc coating, when applied, will adhere firmly, uniformly and permanently to the coated surfaces.
7. PLATE AND ANGLE GALVANIZING: Plates and angles shall be galvanized after fabrication. After cleaning, material shall be zinc coated (galvanized) in accordance with ASTM A123.
8. HARDWARE GALVANIZING: Bolts, nuts, washers, locknuts and lag screws shall be galvanized in accordance with ASTM A153. Metal shall be free from weld splatter and flux, burrs, sharp edges and dross and shall be smooth so that interconnecting parts will fit properly. Bolts shall be galvanized after being threaded and excess zinc shall be removed from the threads. Nuts and locknuts shall be tapped after being galvanized.
9. ALTERNATE BACKFILL: Poly-set by Utility Structural Systems, P.O. Box 14294, Arlington, Texas 76094, or equal, may be used as a backfill system. The system shall be capable of working in water and shall be used in accordance with the manufacturer's recommendations.

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7.1.4 QUALITY CONTROL:

1. WOOD POLES:

- a. General: In accordance with ANSI 05.1, except as follows:
 - (1) Spiral Grain: The maximum twist of grain that is permitted is 1/2-twist in 18-feet.
 - (2) Sweep: Shall be measured from butt of pole.
 - (3) Inner Bark: All inner bark shall be removed.
- b. Seasoning: Seasoning of Fir poles shall be by the Boulton drying method or a combination of Boulton drying with air seasoning or with kiln-drying in accordance with ANSI 05.1. Seasoning of Cedar shall be by kiln drying or a combination of air seasoning and kiln drying in accordance with ANSI 05.1.
 - (1) Boulton drying solution temperature shall be kept between 180-degrees Fahrenheit and 220-degrees Fahrenheit for not less than 24-hours to remove any incipient decay. The average moisture content using the oven-drying method of AWP in the 0.5- to 1.5-inch zone at midlength shall not exceed 18-percent after Boultonizing and prior to pressure treatment.
 - (2) Air seasoning of Fir shall not exceed 2-years.
 - (3) For kiln drying on Fir and Cedar, the maximum dry bulb temperature shall be increased gradually and shall not exceed 160-degrees Fahrenheit and 190-degrees Fahrenheit, respectively. The maximum wet bulb depression shall not exceed 50-degrees Fahrenheit, with the exception that during the first 24-hours, there is no limitation on wet bulb depression.
- c. Treatment: Poles which do not meet the preservative penetration and retention requirements of these specifications shall be rejected. Wood shall be dry to the touch at the time of installation.

2. CROSSARMS AND BRACES:

- a. Glued Laminated Timber: In accordance with ANSI A190.1 ANSI/AITC A190.1.
- b. Solid-Sawn Timber: In accordance with paragraph 169a, "Select Structural Transmission Crossarms, Planks and Timbers", of the West Coast Lumber Inspection Bureau Grading Rules No. 17. Moisture content shall not exceed 22-percent after seasoning, and the moisture content gradient shall not exceed 5-percent between the center and surface of the crossarm or brace.

3. INSPECTIONS AND TESTS:

- a. Wood Products: Pole supplier shall lay out and turn poles as required for inspection by WAPA, in accordance with AWP M2, before and after treatment. Treated poles shall be inspected in accordance with AWP M1 and M2. Poles may be inspected by WAPA on a spot check basis. Crossarms and braces may be inspected by WAPA before and after treatment. Complete tests as detailed in the "Contractor-Furnished Data" paragraph. The COR reserves the right to witness tests and to approve the manner in which the tests are conducted. Furnish all test apparatus and instruments required.
- b. Steel Products: Furnish all hardware and fittings. Inspection of steel material will be made in accordance with the "Contractor-Furnished Material" paragraph of the "General Requirements" Division. WAPA inspection and tests of material at the mill will be waived.

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As soon as practicable after contract award, submit, as designated below, certified electronic copies of reports of chemical analyses and physical tests of structural steel and bolts and of chemical analyses and coating tests of galvanizing.

Certified mill test reports for steel shapes and plates shall show customer's order, mill order and WAPA specifications number. Mill certification shall show weights of steel furnished for each size and heat number represented by tests. No material shall be shipped until certified copies of reports have been received.

7.1.5 MARKING:

1. WOOD POLES: Poles shall be marked with two (2) aluminum discs in accordance with ANSI 05.1. The discs shall be made of 24-gage aluminum and shall be approximately 2-inches in diameter. The discs shall be punched for nails, placed in the marking disc recesses on the pole face and butt, and attached with two 2-inch aluminum twist nails.
2. CROSSARMS AND BRACES: Glued laminated timber shall be marked with an AITC Quality Mark indicating conformance with ANSI A190.1 ANSI/AITC A190.1, and permanently branded as to stress, grade, species, preservative, and year of treatment. Solid sawn timber shall be marked with a WWPA grade stamp.

7.1.6 WOOD TREATMENT:

1. WOOD POLES:
 - a. Preservative:
 - (1) DCOI (4,5-Dichloro-2-n-Octyl-4-Isothiazolin-3-One) meeting the requirements of AWWA P39. The petroleum shall be hydrocarbon solvent, Type A only, meeting the requirements of AWWA Hydrocarbon Solvent Standard, Type A (HSA).
 - (2) Pentachlorophenol meeting the requirements of AWWA P35. The petroleum shall be hydrocarbon solvent, Type A only, meeting the requirements of AWWA HSA. After February of 2027, Pentachlorophenol will no longer be allowed in accordance with the Environmental Protection Agency (EPA), docket EPA-HQ-OPP-2014-0653.
 - (3) Copper Naphthenate meeting the requirements of AWWA P36. The petroleum shall be hydrocarbon solvent, Type A only, meeting the requirements of AWWA HSA.
 - b. Treatment:
 - (1) Fir poles shall be full length pressure-treated by an empty-cell process in accordance with AWWA U1 (latest edition). Use Category 4C, Commodity Specification D: Poles. After pressure treatment, an expansion bath shall be performed for a minimum of 3-hours, and/or final steaming for a minimum of 2-hours, followed by final vacuum for a minimum of 2-hours.
 - (2) Cedar poles shall be full-length pressure-treated or thermal-treated in accordance with AWWA T1 respectively.
 - (3) Poles shall be clean and dry to the touch at the time of delivery. Poles that bleed preservative at the plant or at delivery shall be rejected.
 - (4) All borings, except through-borings, shall be plugged with tight-fitting cylindrical wood plugs that have been treated with the preservative used to treat the pole.

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c. Penetration:

- (1) For Fir poles, penetration of preservative shall be 100-percent in the ground line bored area as shown on Drawing 41 6106. The minimum penetration of preservative shall be 90-percent of sapwood in all other areas where the sapwood has a minimum thickness of 7/8-inch. If the sapwood is less than 7/8-inch-thick, the pole shall be incised, and penetration of preservative shall be a minimum of 3/4-inch.
- (2) For Cedar, the minimum penetration at ground line of the pole shall be 100-percent for 1/8- to 1/2-inch sapwood thickness and 90-percent of the sapwood over 1/2-inch.

d. Retention:

- (1) For Fir poles, the retention of preservative shall not be less than 0.60-pounds per cubic foot for Pentachlorophenol, 0.20 pounds per cubic foot of DCOI, and 0.15-pounds per cubic foot for Copper Naphthenate in the assay zone of 0.25- to 1.0-inch from the surface and in accordance with AWP A U1 (latest edition). Use Category 4C, Commodity Specification D: Poles.
- (2) For Cedar poles, the retention of preservative shall not be less than 1.0-pounds per cubic foot for Pentachlorophenol, 0.33 for DCOI and 0.12-pounds per cubic foot for Copper Naphthenate in the assay zone of 0.10- 0.60-inches from the surface and in accordance with AWP A U1 (latest edition). Use Category 4C, Commodity Specification D: Poles.

e. Moisture Content:

- (1) For Fir poles, the average moisture content after treatment, oven-dry basis, or toluene extraction method, of the 0.5- to 1.5-inch zone at midlength shall not exceed 18-percent.
- (2) For Cedar poles, the average moisture content after treatment, oven-dry basis, or toluene extraction method, of the 0- 1.0-inch zone at midlength shall not exceed 18-percent.

Poles shall be tested at random, after treatment, for moisture content. Measurements shall be made with a resistance-type moisture meter equipped with insulated electrodes. These measurements will be taken at midpoint to a depth of 1-inch for Fir and 1/2-inch for Cedar. Poles having a moisture content in excess of that specified shall be rejected.

- f. After treatment, the surface dimension of any check shall not exceed a width greater than 1/2-inch for any 4-feet of continuous length with the exception of the top, which must meet ANSI 05.1. If checks are separated by less than 1/4-inch, they are considered continuous.

- g. Pole may be retreated only once.

2. CROSSARMS AND BRACES:

- (1) Glued laminated timber shall be incised on all 4-sides and treated with a preservative in accordance with AWP A T1 or as stated herein.
- (2) Solid-sawn timber shall be incised on all 4-sides and treated with a preservative in accordance with AWP A T1 or as stated herein.

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- (3) Pentachlorophenol, DCOI, and copper naphthenate shall meet the requirements of AWWA. Solvent for pentachlorophenol and copper naphthenate shall be Type A per AWWA. The minimum retention of copper naphthenate preservative shall be:

THICKNESS OF CROSSARM (IN)	ASSAY ZONE (IN FROM SURFACE)	COPPER NAPHTHENATE (POUNDS/CUBIC FT AS COPPER METAL)
under 5	0.4	0.040
over 5	0.5	0.040

Penetration to 2 1/2-inches is required longitudinally from bolt holes and ends.

- (4) Timber shall be clean and dry to the touch after treatment.

3. **FIELD TREATMENT:** Roofs, gains and field-drilled holes shall be impregnated and treated thoroughly by covering the exposed surfaces.

The preservative treatment shall be a -percent copper naphthenate in petroleum solvent. The concentration shall not be less than 19.25-percent, by volume, of copper naphthenate (2-percent copper as metal) and shall be 10-9-0 Green F.O.

The preservative shall be the premixed type, furnished in the manufacturer's standard size container and ready to use. Apply in accordance with manufacturer's instructions.

7.1.7 STORAGE, HANDLING AND TRANSPORT:

1. **POLES:** In accordance with ANSI 05.1 and AWWA M4. Tools producing a penetration of more than 1-inch shall not be used. Untreated poles shall be stacked in such a way as to allow free circulation of air around each pole.
2. **CROSSARMS AND BRACES:** Protect from elements and store off ground.
3. **HARDWARE AND ASSOCIATED MATERIAL:** Protect from elements. Store on pallets or in containers.

7.1.8 ASSEMBLY:

1. **POLES:** Assemble in accordance with the structure drawings.
2. **CROSSARMS:** Drill and assemble in accordance with crossarm drilling details and structure drawings. Where preassembled crossarms complete with phase fittings are furnished, bolt lengths may be shorter than lengths specified on the furnished drawings. They shall be of sufficient length to extend completely through nuts and locknuts.

7.1.9 INSTALLATION:

1. **POLES:**
 - a. **Site Grading:** Grade structure sites as necessary for the structure installations and to ensure that the through-bored area of pole butts will be at the ground level.
 - b. **Sloping Ground:** For 2- or 3-pole structures located on steeply sloping ground, longer poles shall be used on the lower sides; and the depth of the holes, measured on the downhill sides, shall be at least as deep as shown in Table 7-1.

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- c. Set poles so that the sweep, concave faces of all poles in the same structure face the same direction. Tangent structures shall be set “sweep-to-sweep” or “back-to-back” along the transmission centerline. Angle structures shall be positioned so that the sweep is in the same direction as the guys.
- d. Pole Holes: Holes shall be dug in the correct locations and shall be large enough to provide space for use of tamping tools all around the poles to the full depth of the holes. Poles shall be carefully placed in the holes so that the structure grounding material will not be damaged or displaced.
- e. Raking: Poles requiring raking shall be raked the full length of the pole in accordance with Table 7-1. Poles shall not be raked by use of guy wires. Poles with x-bracing shall not be raked.
- f. Setting: Except as otherwise provided or directed, poles shall be set in accordance with Table 7-1. Poles not required to be raked shall be set plumb and in alignment. Unless otherwise specified, structures at line angles shall be set so as to bisect the angles.

Pole shall be set to within 3-inches of the specified setting. The tops in 2-pole structures shall be at the same elevation. Poles in 3-pole structures at angle and dead-end points and at other points of unbalanced stress shall be set 6-inches deeper than shown in Table 7-1 and poles with extra-large diameters shall be used at these points whenever possible.

TABLE 7-1

LENGTH OF POLE (FT)	DEPTH OF SETTING IN EARTH OR ROCK (FT)	RAKE OF POLE FOR TYPE 3A-1, 3AB-1 AND 3TA-1 STRUCTURES (INS)
45	6.5	8
50	7.0	9
55	7.5	10
60	8.0	10
65	8.5	11
70	9.0	12
75	9.5	13
80	10.0	14
85	10.5	15
90	11.0	16
95	11.0	17
100	11.0	18
105	12.0	19
110	12.0	20

- g. Backfill:
 - (1) General: After the poles have been set and aligned properly, the holes shall be backfilled. Unless otherwise specified, holes dug for poles shall be backfilled with earth. Backfill in each hole shall be compacted to a dry density not less than the natural in-place dry density of the surrounding earth. Backfill shall be banked and tamped around the poles to a height of 12-inches above the natural ground surface. Any surplus excavated material shall be leveled neatly. If satisfactory backfill material is not available from excavation or within the immediate vicinity of the structure, the Contractor shall import any backfill material required.

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- (2) Alternate Backfill:
 - (a) General: If alternate backfill is used, place in accordance with manufacturer's recommendations.
 - (b) Material: Rigid polyurethane foam equal to Poly-set by Utility Structural Systems, P.O. Box 14294, Arlington, Texas 76094, may be used as a backfill system. The system shall be capable of working in water.
- (3) Gravel Backfill:
 - (a) General: Use if required in the Bidding Schedule.
 - (b) Material: Gravel shall be free-draining material with a maximum size of 2 1/2-inches.
 - (c) Measurement: The quantity for gravel backfill in the Bidding Schedule is an estimated amount, and payment will be made only for the actual volume of material used as measured in the transporting vehicles.
- 2. CROSSARMS: Install as shown on the structure drawings.
- 3. X-BRACES: Install as shown on the structure drawings. Install bolts for attaching x-braces with heads to outside of structure.
- 4. KNEE BRACES AND VEE BRACES: Install as shown on the structure drawings.
- 5. POLE BANDS: Install pole top bands and 4-way strain bands where shown on the structure and guying drawings. Any ground clips, shackles for pole top bands, one (1) or two (2) connecting links for strain bands, as required, and all other hardware shown on the band drawings shall be furnished and installed as a part of the bands.
- 6. BOLTS: Install bolts snug tight plus 1/3-turn for bolt lengths up to and including 4-diameters, snug tight plus 1/2-turn for bolt lengths over 4-diameters not exceeding 8-diameters, and snug tight plus 2/3-turn for bolt lengths 8-diameters but not exceeding 12-diameters.
- 7. MISCELLANEOUS STRUCTURE MATERIAL: Strand for pole-to-pole ties, hardware, brackets, fittings and other miscellaneous material shall be installed as required to complete the structure installations as shown on the structure drawings.

7.1.10 STRUCTURE SIGNS:

- 1. STRUCTURE NUMBER SIGNS: The structure number signs, with the structure numbers as designated on the plan and profile drawings, shall be attached to the structures on the ahead and back span face of structure.
 - a. Wood Pole Structures: Wood pole structure number signs shall consist of two (2) levels of numbers, one (1) directly above the other. The upper number shall indicate the station mile, and the lower number shall indicate the number of the structure within that station mile. The numbers shall be 6-inch-high aluminum, aluminum alloy or stainless steel attached with galvanized nails.
- 2. AERIAL PATROL MILE MARKER SIGNS: The first structure of each mile section of line shall be identified with two (2) aerial patrol mile marker signs, one (1) on the ahead and one (1) on the back span face of the wood pole structure

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- a. Signs shall be fabricated and attached in accordance with Drawing 41 9004. If an aerial patrol mile marker sign falls on a structure that does not have a crossarm, 6-inch-high aluminum, aluminum alloy, or stainless steel, numbers shall be attached similar to numbers on wood pole structure number signs in lieu of using a rectangular steel sign.
- b. AERIAL PATROL WARNING SIGNS: Aerial patrol warning signs, located as designated on the plan and profile drawings and described in the “Line Markers” paragraph of the “Conductor, Overhead Ground Wire and Accessories” Section, shall be fabricated and mounted in accordance with Drawing 41 9026.

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SECTION 7.2 – GUYS AND ANCHORS

7.2.1 MATERIAL:

1. GUY WIRE: ASTM A475, Class B, high-strength grade, 7-wire, 7/16-inch-diameter, galvanized.
2. ATTACHMENT HARDWARE:
 - a. Automatic Dead Ends: When used in place of clamps, shall be spring-loaded vise type as shown on Drawing 41 6047. They shall consist of aluminum alloy tubes and yoke, plated cold-forged steel chuck and stainless steel bails. They shall develop the full strength of the guy strand.
 - b. Twisted Loop Grip Dead Ends: Galvanized steel, equal to “Guy-Grip” Dead-Ends manufactured by Preformed Line Products Company, 660 Beta Drive, Cleveland, Ohio 44143. They shall develop the full strength of the guy strand.
3. SHEAVE WHEELS: Made of steel which meets the requirements of ASTM A36. The sheave wheel shall have an outside diameter of 2-1/2-inches, with a 13/16-inch hole through the wheel.
4. GUY STRAIN ISOLATORS: Guy strain isolators used on guyed structures shall be 10-foot fiberglass with a minimum ultimate strength of 30,000-pounds and shall be furnished complete with bolt, nut and cotter keys in accordance with the Drawings.
5. GUY WIRE PROTECTORS: Made of metal of not less than 18-gage and approximately 8-feet long. The protectors and all attachment parts shall be hot-dipped galvanized if made of steel. The protectors shall clamp to the cable at two (2) or more places with U-bolts or other approved methods. The edges and corners of the protectors shall be smooth with no rough points and the protectors shall be at least three-quarters round.
6. GUY WIRE MARKERS: Markers shall be orange and made of UV-stabilized, high-impact, high-density polyethylene. The markers shall be 96-inches long and full-round, suitable for 7/16-inch guy wire, and equal to Preformed Line Products, PG series
7. GUY ANCHORS:
 - a. General: Use for anchoring in earth. Use grouted anchors for anchoring in rock.
 - b. Concrete Anchors: In accordance with Drawing 41 6049. The copper-covered anchor rod shall be 1-inch-diameter by 8-feet-long, capable of withstanding a tension of 29,000-pounds, and meet requirements in the copper-covered anchor rod subparagraph.
 - c. Steel Anchors: Anchors shall be a noncorrosive material and galvanized or coated with an approved noncorrosive material.
 - (1) Steel Screw Anchors: Equal to those manufactured by Hubbell Power Systems, 210 N. Allen, Centralia, Missouri 65240. Installed anchor and anchor assembly shall withstand a tension of 29,000-pounds applied along the axis of the anchor rod.
 - (2) Steel Disk Anchors: Equal to those manufactured by CHANCE®, part of Hubbell Power Systems, 210 N. Allen, Centralia, Missouri 65240. by Tubeco Steel and Manufacturing, Inc., 301 East 1st Street, Crane, Texas 79731. Installed anchor and anchor assembly shall withstand a tension of 29,000-pounds applied along the axis of the anchor rod.
 - (3) Grouted Anchors: In accordance with Drawing 41 6050.

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- (4) Grout: Five Star® Grout, Five Star Products, Inc., 2 Enterprise Drive, Suite 303, Shelton, Connecticut 06484, or equal.
- (5) Copper-Covered Anchor Rods: Continuous molten copper welded to a steel core. Threaded at both ends and complete with a nonferrous thimble or twin-eye head for 7/16-inch-diameter, galvanized-steel strand and a combination of one (1) nonferrous washer and one (1) bronze closed-end nut or one (1) bronze square nut and one (1) bronze cap nut. Rods shall be 1-inch-diameter by 8-feet-long. Rods, nuts and washers shall be highly corrosion resistant when assembled and placed in the ground. The completed anchor rod assembly with anchor held immobile shall withstand a tension of 29,000-pounds applied to the thimble or twin-eye along the axis of the anchor rod.

7.2.2 INSTALLATION:

1. STRUCTURE GUYS:

- a. General: Construct where required by the Drawings. Guys shall be tightened to take out the slack in the guy strand, but the tension shall not be sufficient to cause noticeable deflection of poles.
- b. Guy Protectors: Install guy protectors as directed by the COR in locations exposed to pedestrian traffic in towns or cities and adjacent to unfenced highways.
- c. Guy Wire Clips: May be used for serving the ends of the guy strand provided they are installed by means of a tool designed for that purpose. In lieu of guy wire clips, the use of noncrimping-type or sleeve-type of servicing device will be acceptable.
- d. Guy Wire Markers: Install guy wire markers at groundline at all guy locations.

2. GUY ANCHORS:

- a. Concrete Anchors: Placing a concrete anchor shall consist of excavating as required, installing anchor and anchor rod in position, backfilling and compacting backfill. After the anchor and anchor rod have been set and aligned properly, the excavation made for anchor installations shall be backfilled with suitable material and thoroughly tamped in layers not more than 6-inches-thick. Backfill shall be compacted to a dry density of not less than the natural in-place dry density of the surrounding earth. Surplus excavated material shall be leveled neatly. Install in accordance with Drawing 41 6047.
- b. Steel Screw Anchors: Screw anchors shall be power installed according to manufacturer's recommended procedure.
- c. Steel Disk Anchors: Steel disk anchors shall be installed according to manufacturer's recommended procedure.
- d. Grouted Anchors: Install as shown on Drawing 41 6050. Placing the anchor shall consist of drilling the required hole, installing the anchor rod in position, and grouting in accordance with manufacturer's instructions.
- e. Guy Anchor Tests: If steel disk or screw anchors are used, load tests shall be performed to verify manufacturer's rated strength and installation methods. Anchors shall hold required load for 2-minutes without significant movement. Load tests shall be performed by the Contractor on a minimum of 10-percent and up to 100-percent of the anchors installed, as directed by the COR.

STANDARD 7 – WOOD POLES

SECTION 7.3 – BOG SHOES AND ANCHORS

7.3.1 GENERAL:

Bog shoes and anchors may be required where wet soils do not provide a suitable base to support poles. Use if required in the Bidding Schedule.

7.3.2 MATERIAL:

1. BOG SHOES: Pressure-treated Douglas Fir or Lodge-Pole Pine and constructed in accordance with Drawing 41 9019. Timbers may be round or rectangular in section with a minimum diameter or width of 8-inches.
2. BOG ANCHORS: Reinforced concrete and constructed in accordance with Drawing 41 9019.

7.3.3 INSTALLATION:

1. BOG SHOES: Installed as shown on Drawing 41 9019 and where directed by the COR.
2. BOG ANCHORS: Installed as shown on Drawing 41 9019 and where directed by the COR.



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STANDARD 8 – GLUED LAMINATED STRUCTURES

SECTION 8.1 – GLUED LAMINATED STRUCTURES

8.1.1 GENERAL:

The Bidding Schedule items for the various types and lengths of glued laminated structures include the following:

1. **EARTHWORK:** Performing earthwork for placing poles and anchors, including excavation, unwatering as required, placing and compacting backfill, drilling holes in rock for grouted anchors and other earthwork as required to complete installation of poles and anchors.
2. **STRUCTURES:** Designing, detailing and furnishing glued laminated wood pole structures complete with foundation designs and embedment depths and the following:
 - a. Poles, crossarms and braces as applicable.
 - b. Attachment hardware, connection bolts, nuts and locknuts.
 - c. Guying requirements including guy assemblies when guying is permitted. One (1) guy, either single or double guy strand, shall include the length of guy assembly; with strand and fittings for guy attachment to connect the guys to the pole bands and to the anchor rods. The Contractor will not receive extra payment for guys longer than shown on the Drawings.
 - d. Guy anchors, including copper-clad anchor rods and anchor accessories.
 - e. Structure grounding including staples, hardware grounding clips, ground wire, ground rods and counterpoise where required. See the "Transmission Line Electrical" Standard and standard Drawing 41 1012.
 - f. Two (2) aerial patrol number signs on the first structure in each station mile, aerial patrol warning signs, and all structure number signs. See the "Transmission Line Electrical" Standard.
 - g. Overhead ground wire support assemblies. See the "Transmission Line Electrical" Standard.

8.1.2 CONTRACTOR-FURNISHED DATA AND DRAWINGS:

1. **GENERAL:** Use United States standard units of measurement and English words, signs and symbols. Submit data and drawing of structures. Include design calculations for all structural components. Drawings shall be new originals. Reproducibles of specification drawings are not acceptable.

Data and drawings shall be thoroughly checked for accuracy and completeness before submittal. WAPA will not check details and intermediate dimensions.

WAPA will return one (1) set of the design data sheets which require changes and drawings marked to indicate approved or not approved and any required changes. The Contractor shall change the designs and details which WAPA determines necessary to make the finished structures conform to these specifications.

WAPA approval shall not relieve the Contractor from meeting the specifications requirements nor the responsibility for design and drawing correctness. Fabrication prior to design data and drawing approval shall be at the Contractor's risk.

STANDARD 8 – GLUED LAMINATED STRUCTURES

2. DESIGN DATA SHALL INCLUDE:
 - a. General dimensions and weight.
 - b. Total ultimate loads and moments including the ultimate moment capacity at ground line and splices.
 - c. Maximum deflection at top of structure.
 - d. Camber requirements. Raking of the poles will be permitted.
 - e. Species of Timber.
 - f. Type of Preservative.
 - g. Quantity of Structures
 - h. Certification that the Contractor has:
 - (1) Successfully designed and supplied manufactured items of comparable magnitude and purpose for a 3-year period.
 - (2) Manufacturing facilities used to supply glued laminated structures are adequate for the type and size of structures required.
3. APPROVAL DRAWINGS: Prior to fabrication, submit for approval, the Drawings for the structures. Design calculations/drawings should not be included as part of the package. They will be requested if needed. The submittal shall include:
 - a. Erection drawings showing the following:
 - (1) Project Name, Voltage and Dimensions.
 - (2) A complete bill of material, including hardware and weights, listing all material for one (1) structure or the portion shown thereon. Total weight of one (1) complete structure shall be noted.
 - (3) Weight, center of gravity, lifting location or lifting method for entire structure.
 - (4) Camber orientation as it relates to direction of transmission line.
 - (5) Foundation auger diameter, embedment depth and rake of pole if required.
4. FINAL ORIGINAL DRAWINGS: Prior to pole shipment, furnish final electronic copies of drawings in PDF and AutoCAD version 2020.
5. SUBMITTALS: Provide in accordance with submittals paragraph of Division 1 – General Requirements.

STANDARD 8 – GLUED LAMINATED STRUCTURES

8.1.3 DESIGN REQUIREMENTS:

1. GENERAL: Design using published theories accepted by the industry as good engineering practice. Construction shall be Grade B. Overload factors shall be in accordance with NESC C2-2023 2017. Structure and attachments shall be designed for the simultaneous application of dead loads, wind on structure and wire loads as shown on Drawings. If other load cases are provided, a 1.1 overload factor shall be used. X-braces may be used if the overall structure cost is less with them.
2. SPECIFIC REQUIREMENTS: Design consistent with the following:
 - a. Include proper theory to accommodate stresses from structure deflection (secondary bending). Structure deflection shall not exceed 1.5-percent of the adjusted groundline (AGL) under everyday loading conditions, defined as 60-degrees Fahrenheit, no ice and no wind.
 - b. Camber structures so that the structure axis is vertical after the conductors are strung. In multi-pole angle structures, all poles shall be aligned and oriented on the bisector of the angle being turned.
 - c. The Pole Supplier shall be fully responsible for the structure designs and the satisfactory performance under acceptance tests. Approval by WAPA does not relieve the Pole Supplier of responsibility for the adequacy of the designs and drawings.
3. EMBEDMENT DESIGN:
 - a. Auger Diameter: Auger diameter shall be the maximum pole base dimension plus a minimum of 12-inches.
 - b. Embedment Depth: The bearing capacity of the soil shall be assumed to be 5,500-psf (Class 6). The Contractor shall determine the embedment depth with a minimum embedment depth of 10-percent of the overall length plus 4-feet.
 - c. Pole Supplier shall determine if a foundation reinforcement system is required. If required, the foundation system shall be an integral part of the structure and shall be included in the structure unit price.
 - d. WAPA's position is that each laminated pole (and foundation reinforcement, if required) will be placed in an augered hole as described above and backfilled with thoroughly compacted, well graded, washed, or unwashed, 2-inch minus rock. The pole supplier should also provide their recommended backfill material, if different than above. If the pole supplier's installation instructions contain additional foundation requirements (i.e. caissons, culverts, etc.), the Contractor shall determine the costs in acquiring and installing those additional requirements and those costs will be added onto the bid price for the structure.

8.1.4 MATERIAL:

1. GENERAL: Furnish all material in accordance with the Drawings and the requirements of this specification. In addition to the laminated poles and foundation reinforcement (if required), the pole supplier shall provide all hardware and fasteners necessary to attach all conductors, overhead ground wires and optical ground wires to the structure as outlined in the referenced structure drawing. Dead end tees shall be furnished in lieu of pole bands as shown on Drawing 41 6138. Holes necessary for installing the hardware shall be drilled at the appropriate locations prior to preservative treatment. Crossarms, bracing, hardware, guys, anchors, and associated material shall conform to the requirements in Standard 7 – Wood Poles.

STANDARD 8 – GLUED LAMINATED STRUCTURES

2. HARDWARE AND ASSOCIATED MATERIAL:

- a. Bolts, Nuts and Locknuts: Bolts and nuts shall be square headed and in accordance with ANSI C135.1. Unless otherwise specified, rolled or cut threads of the American Standard coarse thread series shall be furnished. The double arming bolts shall be furnished with four (4) square nuts and threaded 6-inches at each end. Locknuts shall be Type MF.

3. WEST COAST REGION DOUGLAS FIR OR SOUTHERN PINE GLUED LAMINATED WOOD POLES: Conforming to the following:

- a. General: Poles shall be in accordance with ANSI 05.2, Structural Glued Laminated Timber for Utility Structures and all applicable AWWA specifications, including U1, Use Category System: User Specification for Treated Wood, Commodity Specification D (Poles), especially Section 6.0, (Glued Laminated Poles), and T1, Use Category System: Processing and Treatment Standard, Section D (Poles), especially Section 10.0 (Glue Laminated Poles), for the preparation and treatment except as modified in this specification.

All referenced specifications and Standards shall be of the latest revision.

Structural Glue Laminated Timber is an engineered, product comprised of assemblies of specifically selected and prepared wood laminates bonded with adhesives.

Lumber shall be West Coast Region Douglas Fir or Southern Pine as defined in Section 4.1 ANSI 05.2.

All Laminating lumber shall be graded in accordance with applicable grading rules of the West Coast Lumber Inspection Bureau (WCLIB) for Douglas fir as supplemented by the requirements of ANSI A190.1 and AITC 117.

All glued laminated poles shall have been glued with a wet use adhesive as specified in ANSI Standard A190.1.

- (1) Flaws: All lumber for laminating poles shall be free of timber breaks.
 - (2) Soundness: Decay in any form is not permitted, including decay in knots in any form.
 - (3) Moisture Content: Shall be per Section 4.3 of ANSI 05.2. The mean equilibrium moisture content shall be 12-percent.
- b. Incising and Through Boring: Laminated poles constructed of Douglas Fir shall be incised prior to treatment. This incising shall be for the full pole length and on all four (4) sides with a minimum depth of 5/8-inch. The pattern shall minimize any damage to the surface of the pole by splintering and shall be a sufficiently dense pattern to assure uniform treatment. All laminated poles shall have a full length inner raceway in addition to the unglued edge joints to allow for full penetration of preservative and to allow for moisture drainage. In the absence of an internal raceway, all unglued edge joints shall be permanently sealed on the top of the pole and along the full length of the cut side.
 - c. All laminated poles constructed of Douglas Fir shall be incised and through bored prior to treatment. This drilling is in the zone extending 2-foot above and 3-foot below the standard groundline (as defined in ANSI 05.1), or as otherwise designated. For drilling, the boring shall be 3/16-inch diameter by 3-inches long and shall be spaced in a diamond pattern so that holes within a given diamond are approximately 6-inches apart. Drilled holes on the edge faces shall be omitted for the first two (2) laminations on each side. Care shall be taken on the edge faces to ensure that drill holes do not penetrate along glue lines. All

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laminated poles constructed with Southern Pine shall be drilled with this pattern on the two (2) constant pole faces only.

For best results, all cuts and drilling should be done prior to treatment. This shall include a mechanism (i.e. internal grooves) for allowing wood preservative to flow longitudinally through the entire length of each internal joint of the pole. Care should be taken to avoid mechanical damage in both handling and in service. When mechanical damage occurs, field treatment should be in accordance with AWPAs Standard M4. All poles shall be inspected after treatment in accordance with the applicable sections of AWPAs Standard M2.

4. Treatment of Douglas Fir Poles:

- a. General: All poles shall be treated in accordance with AWPAs specifications, U1. Use Category System: User Specification for Treated, Wood, Commodity Specification D (Poles), Section 4.4, Table 4.4A, Use Category 4C and Processing and Treatment Standard T1, Section 8.4 (Poles), especially Section 8.4.8 (Glue Laminated Poles) except as modified or changed in this paragraph.

- b. Preservatives:

The preservative used in the treatment of the poles shall be one of the following:

- (1) Copper Naphthenate meeting the requirement of AWPAs specification P36-22, Standard for Copper Naphthenate (CuN). The petroleum shall be hydrocarbon solvent, Type A only, meeting the requirements of AWPAs specification HSA-23, Standard for Hydrocarbon Solvent, Type A.

The Copper Naphthenate petroleum solution, as determined in accordance with AWPAs specifications, shall contain not less than one percent (1 percent), by weight, of Copper Naphthenate and not less than two percent (2 percent) copper as metal.

- (2) Pentachlorophenol petroleum solution consisting of pentachlorophenol meeting the requirements of AWPAs specifications P35-16, Standard for Pentachlorophenol (PCP) dissolved in suitable petroleum oil meeting the requirements for Type A solvent of AWPAs specification HSA-23, Standard for Hydrocarbon Solvent, Type A.

The concentration of pentachlorophenol, as determined in accordance with AWPAs specifications, shall be not less than 5 percent by weight.

- (3) DCOI (4,5-Dichloro-2-n-Octyl-4-Isotiazolin-3-One) meeting the requirements of AWPAs P39-18 (reaffirmed 2020) dissolved in suitable petroleum oil meeting the requirements for Type A solvent of AWPAs specification HSA-23, Standard for Hydrocarbon Solvent, Type A.

The concentration of DCOI, as determined in accordance with AWPAs analysis method standard A30-24, Standard Method for the Determination of DCOI in Wood and Solutions by High Performance Liquid Chromatography (HPLC), shall be such that the resulting retention values match the requirements set forth in AWPAs U1-24, Commodity Specification D: Poles, Table 6.5, Use Category 4C

Items treated with DCOI shall be stamped with “DA

- c. Penetration: Penetration shall be as defined in AWPAs T1, Section D, Table D10 (Assay and penetration zones for glued laminated poles) and determined from increment borer cores taken 1- to 2-feet below the brand from each piece of the charge. These cores shall be used to check penetration of the preservative. Additional cores in through-bored

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members shall be taken from a zone approximately 1-foot above the intended ground line and 1-foot below the top of the drilled zone. These cores shall be assayed for retention. If 90-percent of the boring meets the penetration requirements, the charge shall be accepted, but the non-conforming poles in the charge will be retreated.

Penetration of preservative shall be 100-percent in the ground line bored area.

- d. Retention: The pole shall be treated so as to maintain the minimums noted in AWP A U1, Commodity Specification D (Poles), Table 6.5 4.4A, Use Category 4C. Retention shall be determined with borer cores taken at the same points as for penetration determination.
 - (1) Color: Upon completion of the treating process, all poles shall be as light colored as reasonably possible to obtain a light to medium brown; color chart range three (3) to seven (7) poles darker than chart seven may be rejected. Poles shall be clean and dry, without excess surface oil.

8.1.5 QUALITY CONTROL:

- 1. GENERAL: The supplier shall have defined quality control methods and functions available for review and approval. Maintain permanent records on material specifications. The supplier shall eliminate all material that would be considered defective according to these specifications.
- 2. FRAMING: Drilling, if any, shall be as specified according to the Drawings included with the order. Drilling on specified poles and square cut roofing on all poles shall be completed BEFORE the treatment process.
- 3. HUMIDITY: The relative humidity of the manufacturing area shall be maintained at such a level that the moisture content will not change substantially during the manufacturing process. All bonding shall be performed as soon as practical after checking moisture content.
- 4. ADHESIVES: Adhesives for structural laminating shall conform to all applicable requirements of ANSI A190.1 to comply with wet conditions of use and be compatible with the selected preservative solution to be used. Adhesives containing urea shall not be used.

8.1.6 MANUFACTURE:

The selection, preparation, assembly and bonding of the laminations shall be in accordance with ANSI A190.1 and as specified herein.

- 1. EDGE JOINTS: Unglued edge joints shall be permitted for multiple width lamination lay-up as permitted by ANSI A190.1. The non-cut edge joint gaps shall be limited to 1/4-inch and occasionally to a maximum of 3/8-inch. The cut edge joint gap shall be limited to 3/8-inch for a nominal width of 10-inches and less, 1/2-inch for a nominal width of 10-inches to 12-inches, 3/4-inches for a nominal width of 12-inches to 14-inches, 7/8-inch for a nominal width of 14-inches to 16-inches, and 1-inch for nominal widths over 16-inches.
- 2. END JOINTS: End joints of laminations shall be pre-glued and cured before assembly of face joint into structural members. Spacing of the end joints shall be as specified in ANSI A190.1.
- 3. REPAIRS: Structural repairs as defined in ANSI A190.1 are allowed. End blocks as defined in ANSI A190.1 are prohibited.
- 4. SECOND STAGE GLUING: When two (2) or more laminated members that are over 2-inches in net thickness are glued together, a gap-filling adhesive shall be used in accordance with ANSI A190.1.

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5. **PROOF-LOADING:** Proof loading shall be in accordance with ANSI A190.1. All laminated stock in high stress area shall be E-rated lumber.
6. **END JOINT SPACING:** When proof loading is performed in accordance with ANSI A190.1, end joint spacing is not required.
7. **DIMENSIONS AND TOLERANCES:** Allowable variations from specified dimensions are as follows:
 - a. Sizes and tolerances for poles shall be in accordance with the following:
 - (1) Depth: $\pm 1/2$ -inch.
 - (2) Width: $\pm 1/4$ -inch.
 - (3) Squareness: $\pm 3/8$ -inch per foot of depth.
 - (4) Length of poles under 50-feet: +6-inches, -3-inches.
 - (5) Length of poles over 50-feet: +12-inches, -6-inches.
 - b. Unless specified otherwise on the plans, drawings or purchase order, holes shall be a minimum of $1/16$ -inch and a maximum of $1/8$ -inch larger than the bolt diameter.
 - c. Hole locations: $\pm 1/8$ -inch.
 - d. The camber or straightness tolerance for poles is $\pm 1/2$ -inch for members up to 20-feet. For members over 20-feet, the tolerance is increased by $\pm 1/2$ -inch per each additional 20-feet, or fraction thereof, but should not exceed ± 2 -inches. These tolerances are at the time of manufacture without allowance for dead load deflection and should be used for straight or slightly cambered members and not more sharply curved members.
8. **APPEARANCE:** Glued laminated structural members shall be manufactured in accordance with the industrial appearance grade as defined in AITC 110 and as required in 1 through 6 as follows.
 - a. Poles shall be eased to a minimum of $3/4$ -inch and a maximum of 1-inch.
 - b. After gluing, all members shall be surfaced, at least on the two (2) sides where glue lines are exposed.
 - c. Splintering around the holes caused by drilling, shall be kept to a minimum. Holes shall be drilled perpendicular to the starting and finishing faces of members with a uniform cross section unless otherwise specified or as specified on the plans and drawings of members with a variable cross section.
 - d. Occasional laminations may contain wane, may be scant of the specified width or both. These conditions in a lamination shall not be more than $3/16$ -inch in width.
 - e. Medium splits in the outside laminations of vertical mounted members and short splits in the top laminations of horizontal and diagonally mounted members, developing at the laminating plant after gluing, are permitted.
 - f. All voids in the roof of poles shall be filled (after treating) with a void-filling compound unless otherwise specified. The compound shall be sanded or scraped smooth after patching. Wood dowels may be used to repair improperly drilled holes, as long as the defect does not affect the structural integrity of the member.

8.1.7 POLE MARKING AND CODE LETTERS:

1. **GENERAL:** The following information shall be included on a metal tag affixed thereto.

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- a. The supplier's code or trademark.
- b. The plant location and the year of treatment.
- c. Code letters denoting the pole's species and preservative used. The size designation and/or equivalent class and the length of the pole.
- d. Poles shall be marked with two (2) aluminum discs in accordance with ANSI 05.1. The discs shall be made of 24-gauge aluminum and approximately 2-inches in diameter. The discs shall be punched for nails, placed in the marking disc recesses, and attached with two (2) twisted 2-inch aluminum twist nails. Marking on the face shall be approximately 6-feet above the ground line.
- e. The approximate treated weight of the pole shall be marked at the balance point of the pole.

8.1.8 TESTING AND INSPECTION:

1. **REQUIREMENTS:** Testing and inspection shall be in accordance with ANSI A190.1
2. **MATERIAL:** Testing and inspection shall be performed on the material and from the production that is supplied on the purchase order and produced in accordance with this standard. Samples for physical testing shall be taken at random.
3. **VOID-FILLING COMPOUNDS:** Physical tests of void-filling compounds shall be made on samples of daily production in accordance with AITC test 110
4. **RECORDS:** The results of all strength and wood failure tests of face, edge and end joints and test of void-filling compounds conducted on material produced in accordance with AITC 200 shall be sent to the purchaser within 5-working-days, if requested by the purchaser. Legible copies of handwritten records shall suffice.
5. **QUALITY CONTROL SYSTEM:** The quality control system shall be as specified in ANSI A190.1. Daily records of the material produced under this standard shall be submitted to the purchaser within 5-working-days. Daily records shall include, at least, the requirements established in the Manufacturer's Procedures Manual and Quality Control Manual and any others required in this standard.
 - a. **Inspection:** Treated laminated poles shall be inspected after treatment in accordance with the applicable sections of AWWA Standard M2.
 - b. **Penetration:** Penetration determination shall be made on 100-percent of the poles regardless of the specie. Penetration determination of the Douglas Fir shall be from one (1) boring per pole at the same location as noted in specification paragraph 1.4.2 and between the marking disc and the ground line. Part of these borings may be used for retention analysis.

8.1.9 STORAGE, HANDLING AND TRANSPORTING:

Shipments are to be made by truck, and all applicable Federal and State rules and regulations shall be followed. No pole shall be permitted to protrude above the top of the side stakes. Unloading of poles is the responsibility of the Contractor unless otherwise stated.

1. **ACCEPTANCE:** Final inspection and acceptance of each pole will be made by WAPA at the destination. In case such inspection shows that material does not meet the specifications or have been damaged in transit, then before accepting them from the transportation company and before

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unloading, WAPA will report to the Contractor by telephone or fax, who will provide instruction on how to proceed. The Contractor shall pay transportation costs both ways on all rejected poles.

Neither inspection, waiving of inspection nor WAPA's acceptance shall relieve the processor from obligations to furnish poles to meet the requirements of this specification.

8.1.10 INSTALLATION:

Install structures in accordance with manufacturer's instructions.

8.1.11 STRUCTURE SIGNS

1. STRUCTURE SIGNS:

- a. The structure number signs, with the structure numbers as designated on the plan and profile drawings, shall be attached to the structures on the ahead and back span face of structure.

- (1) Glued laminated wood pole structure number signs shall consist of two (2) levels of numbers, one (1) directly above the other. The upper number shall indicate the station mile, and the lower number shall indicate the number of the structure within that station mile. The numbers shall be 6-inch-high aluminum, aluminum alloy or stainless steel attached with galvanized nails.

2. AERIAL PATROL MILE MARKER SIGNS: The first structure of each mile section of line shall be identified with two (2) aerial patrol mile marker signs, one (1) on the ahead and one (1) on the back span face of the glued laminated wood pole structure

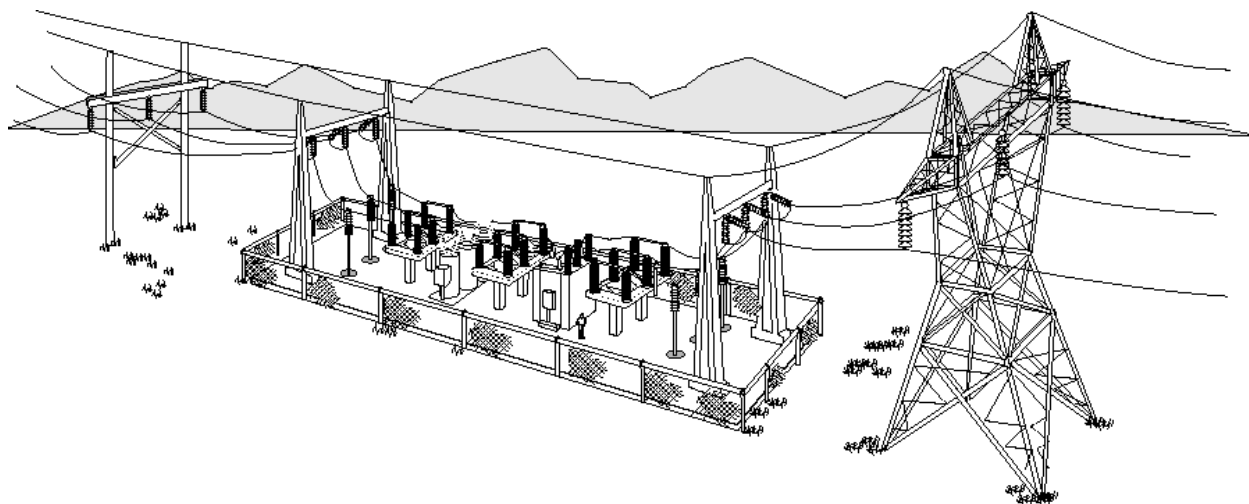
- a. Signs shall be fabricated and attached in accordance with Drawing 41 9004. If an aerial patrol mile marker sign falls on a structure that does not have a crossarm, 6-inch-high aluminum, aluminum alloy, or stainless steel, numbers shall be attached similar to numbers on glued laminated wood pole structure number signs in lieu of using a rectangular steel sign.
- b. **AERIAL PATROL WARNING SIGNS:** Aerial patrol warning signs, located as designated on the plan and profile drawings and described in the "Line Markers" paragraph of the "Conductor, Overhead Ground Wire and Accessories" Section, shall be fabricated and mounted in accordance with Drawing 41 9026.



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SECTION 9.1 – ELECTRICAL GENERAL

9.1.1 ELECTRICAL INSTALLATION:

1. GENERAL:

- a. Requirement for substation electrical features shall be in accordance with this Standard, except that electrical features (such as heating, ventilating and air-conditioning and service building wiring systems) covered by other Standards shall meet the requirements of the applicable Standards.
- b. Contractor Design: The Contractor shall perform any additional electrical design as required; furnish electrical material and equipment not furnished by WAPA; install and remove, modify and reinstall electrical material and equipment as required; and make the electrical installation complete and ready for service. The Contractor shall make revisions of final drawings to show “as-built” conditions. Charges incurred in providing design personnel shall be paid by the Contractor and included in applicable Bidding Schedule items.
- c. Grout: Grout shall be placed under electrical equipment as required. Grouting shall be in accordance with the Standard 3 – Concrete, Section 3.1.10 “Grouting Mortar”.
- d. WAPA Approval and Inspection: WAPA inspection will be made during the construction period to ensure that the requirements are fulfilled as to material, workmanship, design, installation and operation. WAPA reserves the right to inspect any or all equipment and material that will be provided at the supplier's manufacturing plant during fabrication and testing at no additional cost to WAPA (WAPA's inspector's travel, food and lodging expense are not the responsibility of the Contractor). Actual ice tests performed on load interrupter and disconnecting switches shall be witnessed by a WAPA inspector, if prior design ice tests were not made.

2. EQUIPMENT AND MATERIAL:

- a. General: Electrical equipment and material shall be as specified in this standard, the project specifications and as shown on the project drawings and in accordance with the NEMA, ANSI, IEEE, ICEA and ASTM Standards; the NEC; the Federal Specifications; the NESC; and the Standards of the Underwriters' Laboratories, Inc., as applicable. Electrical equipment and material that is identified in the project specifications requiring a seismic qualification level shall be qualified to meet the seismic qualification level in accordance with the latest IEEE Std 693. If electrical equipment was qualified with its support structure, the provided structure shall match the structure identified within the Contractor provided seismic qualification documents. Only new electrical equipment from the current manufacture shall be furnished.
- b. Units of Measurement: Units of measurement shall be in accordance with American Standards, and data, drawings and nameplates shall be in English.
- c. Mounting Bolts, Nuts and Washers: Mounting bolts, nuts and washers for electrical equipment and material used outdoors and unprotected from the weather shall be galvanized in accordance with ASTM A 153 or of noncorrosive metal. Cadmium-plated mounting hardware will be permitted only where protected in weatherproof enclosures or on equipment located indoors.
- d. Energizing Heaters for Electrical Equipment: The Contractor shall provide power for and shall make arrangements to energize the heaters for electrical equipment, as recommended by the manufacturer or WAPA, from the time the equipment is received at the site until final connections are made to the station-service power supply.

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- e. Delivery of Insulating Oil: The Contractor shall contact the COR to arrange delivery of insulating oil required for Government-furnished equipment.
 - f. Changes Required by Contractor-Furnished Equipment: If the Contractor-furnished electrical equipment and material are of such size, type, ratings or other physical properties that changes are required in the designs shown in the specifications, the Contractor shall effect all changes necessary as required and approved by the COR without additional compensation, unless the Contractor can show that the changes are necessary regardless of the manufacturer.
 - g. Switch-Operating and Equipment Platforms: The Contractor shall furnish and install switch-operating and equipment cabinet platforms in accordance with the Standard 4 – Substation Metalwork and Transmission Line Lattice Structures. A switch operating platform is required at each operating mechanism of each circuit switcher and each disconnecting, interrupter and grounding switch. An equipment platform is required at each main electrical control cabinet, each main pneumatic control cabinet and each compressor housing of electrical equipment. Equipment platforms will not be required for minor connection boxes such as instrument transformer, terminal boxes and the individual-pole control cabinets of circuit breakers. The location of platforms shall be subject to WAPA approval.
 - h. Painting: Painting of equipment shall meet the requirements of the Standard 12 – Painting.
3. INSTALLATION: All electrical installations, assembly operations and adjustments shall be in accordance with the following:
- a. Conflicting Requirements: In the event of conflicting requirements, precedence is established by the order of the following:
 - (1) The Schedule (excluding the specifications)
 - (2) Representations and other instructions
 - (3) Contract Clauses
 - (4) Other documents, exhibits, and attachments
 - (5) The project specifications.
 - (6) The Drawings included in the project specifications.
 - (7) These standards.
 - (8) The latest edition of “National Electrical Code”, “National Electrical Safety Code” and the adopted electrical code of the State in which the construction is located. The Contractor shall cooperate with any agency designated by that State to inspect the electrical installation for conformance with the applicable State code. If there is a conflict between the requirements in the project specifications and drawings and applicable national or state codes, the more stringent requirements shall prevail.
 - b. Manufacturer's Instructions: Installation of the electrical equipment shall be in accordance with the directions furnished by the manufacturer's instruction books and, if required, erecting engineers.
 - c. Damage or Failure of Material and Equipment: The Contractor shall correct by repair or replacement, at his expense, damage to or failure of any part of the items of material and

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equipment which in the opinion of the COR was caused by faulty installation, faulty mechanical assembly or mishandling.

Repair of damaged painted and galvanized surfaces shall be in accordance with the Standard 12 – Painting. The repair of damage to existing installations shall be in accordance with the Standard 1 – General Requirements, Section 1.3.4 “Protection of Existing Installations”.

The Contractor shall replace, at his expense, any insulating oil that is contaminated by faulty handling.

- d. **Material Not Specified:** Design, installation details and material not specifically covered in the specifications, drawings, these standards or in reference standards shall be subject to the approval of the COR.
- e. **Manufacturer's Erecting Engineer:** Disassembly, movement, reassembly, assembly, checking, adjustment, installation, tests and preparation for service of equipment shall be accomplished under the direction of a manufacturer's erecting engineer when specified. The Contractor shall follow the instructions of erecting engineers and shall correct any work performed contrary to or in the absence of the erecting engineer.

Unless otherwise specified, the equipment manufacturer will furnish the services of the erecting engineer for Government-furnished equipment. The Contractor shall make arrangements with the COR to obtain the services of the erecting engineer for Government-furnished equipment.

Unless otherwise specified, the Contractor shall make arrangements with the equipment manufacturer to obtain the services of erecting engineers for Contractor-furnished equipment and for Government-furnished outdoor equipment, which is removed and reinstalled, modified or transferred from another location.

- f. **Contractor's Assembly and Connections:** The Contractor shall assemble components of equipment including Government-furnished equipment, such as supporting structures, which is furnished disassembled. The Contractor shall make all electrical wire, cable, conduit and grounding connections and furnish all miscellaneous material required for making these connections.
- g. **Manufacturer's Drawings:** Applicable prints of manufacturer's drawings of Government-furnished electrical equipment received by WAPA, will be furnished to the Contractor upon request within 10-days of request.
- h. **Electrical Control and Protective Equipment:** Electrical control and protective equipment, including any existing control equipment to be removed and reinstalled, shall have a uniform height. The equipment shall be similar in appearance and general construction so that the installation will have a uniform appearance when the equipment is installed.
- i. **Door Latching Mechanisms:** Door latching mechanisms on the electrical equipment enclosures shall include provisions for padlock.
- j. **Government-Furnished Equipment:** Except as otherwise specified in Project Specifications, the Government-furnished equipment will be delivered to the Contractor at the substation site, and the Contractor shall unload the equipment from the trucks. The Contractor shall inspect the equipment for possible damage during shipment or transportation, assemble and fill equipment with oil or SF6 gas, if needed, and install equipment complete and ready for operation at the locations shown. WAPA will furnish the oil and SF6 gas for Government-furnished equipment, and special tools, wrenches, and devices, as furnished by the manufacturer, for assembling the Government-furnished equipment.

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The Contractor shall follow the manufacturer's instructions for storing Government-furnished equipment prior to installation, assembling or erecting equipment, and testing and energizing equipment.

- (1) **Transformers:** Transformers may be shipped with such accessories as bushings, surge arresters, radiators and pumps removed. Oil for transformers will be delivered to the Contractor in tank trucks at the substation site, or the transformer manufacturer may ship transformers filled with oil. If the transformer oil is shipped to the substation site separately, the Contractor shall have 36-hours from the hour of arrival at the substation site to remove the oil from each tank truck and fill the transformer. Any time required in excess of 36-hours will be paid for by the Contractor at the usual and reasonable rate charged therefore. Transformers will be furnished with multi-ratio, bushing-type current transformers in the high- and low-voltage bushings. The Contractor shall exercise all possible precautions to prevent moisture or foreign material from entering any portion of transformers. Openings left in the transformer by the removal of covers and accessories shall be sealed as soon as possible with a durable weatherproof material.
- (2) **Capacitor banks:** Capacitor banks will be partially assembled into individual racks. Installation will involve erecting steel, insulators, racks, voltage transformers and making electrical interconnections.
- (3) **Power circuit breakers:** Power circuit breakers may be shipped with the bushings and external operating mechanism removed. SF6 gas will be delivered to the Contractor in gas bottles at the substation site. Power circuit breakers shall be assembled and installed at the location shown on the Drawings and per the manufacturer's instruction manuals, and then filled with SF6 gas as required. Empty and unused SF6 gas in bottles are the property of WAPA and shall be returned to the COR.

Circuit breakers shall be checked for proper operating speed in accordance with, IEEE Std C37.09 , after they have been installed. The Contractor shall mark the time-travel charts for timing tests on the circuit breakers after they have been installed. The Contractor shall furnish a report on the results of the timing tests conducted in the field. He shall also make other checks, adjustments and tests required by the manufacturer's instruction books and erecting engineers before the breakers are placed in service.

4. **MARKING:** The Contractor shall mark electrical equipment to be designated, other than power circuit breakers, circuit switchers, load interrupter switches, disconnecting switches, combination fuse disconnecting/disconnecting switches with interrupters and fuse disconnecting switches with the assigned designations, either by painting or by nameplate, with letters approximately 1 1/2-inches high. Power circuit breaker, circuit switcher, load interrupter switch, disconnecting switch, combination fuse disconnecting/disconnecting switches with interrupter and fuse switch identification signs are provided for in section 9.6 "Substation Signs".
5. **TOOLS:** Special tools and appliances furnished by the manufacturer for maintenance and adjustment of its electrical equipment supplied as a part of the project shall become the property of WAPA. The Contractor shall furnish all additional tools and equipment as necessary to properly install, adjust and check the operation of the electrical equipment. Special tools furnished with Government-furnished equipment shall be cared for and stored by the Contractor and delivered to WAPA at the substation site at the time of completion of the contract.
6. **SPARE PARTS:** Spare parts furnished by the Contractor, and with Government-furnished equipment, shall be cared for and stored by the Contractor and delivered to WAPA at the substation site at the time of completion of the contract.

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7. DRAWINGS FOR GOVERNMENT-FURNISHED EQUIPMENT: WAPA will furnish applicable instruction books and prints of manufacturers' drawings to the Contractor.
8. DOBLE TESTS: Prior to energization of outdoor electrical equipment installed by the Contractor, WAPA will perform Doble tests on that equipment. The time for conducting these tests will be coordinated with the COR.

The Contractor shall participate in the Doble testing to the extent that he shall remove all electrical connections to each item of equipment to be tested, if connections have been made prior to the testing, and shall restore the connections after the testing has been satisfactorily completed. In addition, the Contractor shall make and remove required connections between the test apparatus and the equipment to be tested.

The Doble testing apparatus will be furnished and operated by WAPA.

9. RELATED ITEMS OF WORK: Payment for the various items of electrical equipment and material will be made at the applicable unit or lump-sum prices bid therefore in the Bidding Schedule, which prices shall include the costs of the following:
 - a. Performing required design.
 - b. Preparing for storage of existing equipment removed and not reinstalled.
 - c. Furnishing drawings and data.
 - d. Furnishing apparatus necessary to perform required tests.
 - e. Testing and providing assistance for WAPA testing as required.
 - f. Providing erecting engineers as required.
 - g. Transporting and storing equipment and material.
 - h. Modifying equipment.
 - i. Assembling, adjusting, leveling and grouting and installing equipment.
 - j. Painting equipment and material in accordance with Standard 12.
 - k. Furnishing and installing brackets, fastenings, bolts, nuts, lockwashers and other accessories and drilling holes in steel structures, other than tubular structures, as required for mounting or installing electrical equipment and material.
 - l. Furnishing material for marking assigned designations on electrical equipment to be designated.
 - m. Transporting and handling insulating oil for all electrical equipment requiring insulating oil.
 - n. Furnishing filtering equipment and storage tanks and filtering insulating oil as required.
 - o. Handling spare parts to electrical equipment that requires spare parts.
 - p. Furnishing to WAPA special tools and appliances supplied by each manufacturer for maintenance and adjustment of the equipment.
 - q. Providing power for and energizing heaters in circuit breaker cabinets until connections are made to station-service supply.

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- r. Making all control, metering, relaying and station-service power connections and furnishing miscellaneous material which are required for making these connections to electrical equipment. The Contractor shall estimate the number of connections to be made to the equipment based on prior knowledge or experience with similar equipment. No additional compensation will be allowed the Contractor in the event that actual connections exceed the number estimated by him at the time of bidding.

9.1.2 ACCEPTANCE TESTS:

There are two (2) methods of acceptance tests (Method A and Method B). Method A shall be provided unless the more extensive testing of Method B is required for specific contractor provided equipment listed under Method B below or by the Project Specifications. Following are the requirements of the two (2) methods.

1. **METHOD A:** During a period of time agreed to by the Contractor and the COR, representatives of the Contractor and WAPA shall make arrangements for a complete check of the wiring of the entire installation. During this period, the Contractor shall process the checkout to completion, shall retain full responsibility for the removal and replacement of any wiring connections as required in processing of the checkout and shall make any wiring changes which are necessary for proper and adequate functioning of the installation.

Replace wiring, instruments and equipment, which are damaged in the checkout process, unless this damage results from negligence by WAPA as determined by the COR. Wiring checkout shall include the insulation and continuity test of cables and conductors installed by the Contractor. The insulation and continuity tests shall be made after identification tags and sleeves have been installed. The Contractor shall have competent personnel at the site processing the checkout.

Unless otherwise specified, after any phase of the work has been completed, including the above wiring checkout, the installation will be tested and operated, by and at the expense of WAPA. The Contractor or his representative may witness the tests.

Final payment under the contract will not be made until these tests are completed and the COR has determined that the requirements of the specifications and these standards have been fulfilled; provided, that if WAPA, through no fault of the Contractor or of the material furnished by the Contractor, and except for acts of God or forces beyond WAPA's control, is delayed in making the acceptance tests beyond a period of 30-days from the date of final completion of the installation of all equipment, payment of the balance due under the contract will be made at the end of the 30-day period.

2. **METHOD B:**

- a. **General:** Prior to beginning onsite testing, a meeting will be conducted at a time and place designated by the COR, with the Contractor, the Contractor's Test Personnel (CTP) and WAPA to review the Contractor's testing procedures and plans.

None of the following testing requirements or procedures are intended to replicate tests or procedures performed at the equipment manufacturer's factory or place of assembly. The testing prescribed here is intended only to verify that no equipment damage has occurred in transit, assembly or erection. The WAPA site representative shall be notified 72-hours in advance of all testing.

- b. **Personnel:** The Contractor shall supply on-site test personnel, hereafter referred to as the CTP (Contractor Test Personnel), who shall perform and document the substation tests as listed in this paragraph.

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The Contractor shall designate one (1) of the test personnel as principal. Submit the resume of the principal onsite test person to the COR. The principal onsite test person shall meet the following qualifications:

- (1) Minimum of 5-years' testing experience on similar projects.
- (2) Experience shall include projects of similar scope and voltage class.
- (3) Employee of a testing firm that has been established for a minimum of 3-years.

The COR shall have the right to refuse the services of any test personnel that do not meet the stated qualifications.

- c. Test Reports and Documents: All test report forms will be provided by WAPA unless the COR approves the use of Contractor-supplied test report forms.

Test reports shall be completed as follows:

- (1) With no blank or uncompleted sections.
 - (2) In permanent form (ink or type).
 - (3) Submitted to the WAPA onsite inspector within 48-hours and to the COR within 7-days after any testing is complete. The COR or his designated onsite representative shall have a period of 48-hours to review all test reports and request any such tests be performed again if any results are questionable. Such testing shall be completed without additional expense to WAPA.
 - (4) Signed and dated as witnessed by the WAPA onsite inspector.
- d. Instrument Calibration: Test equipment used for any measurements shall be calibrated within 1-year of onsite usage with certification traceable to the National Institute of Standards and Technology relative to their intended use.
- e. Transformer Testing: The testing requirements of this paragraph shall apply to all Government-furnished or Contractor-furnished power transformers including station service transformers. All testing shall be done only after the transformer is ready for service.
- (1) Ratio Test: The CTP shall determine turns ratios between windings for each winding in every tap changer position. The equipment used shall be a transformer turns ratio tester manufactured by James G. Biddle Company, Multi-Amp Corporation or equivalent.
 - (2) Coil Resistance: On transformers larger than 1 MVA the CTP shall determine resistance of every winding using a dc micro-ohm meter ("ducor") or a dc low-resistance ohmmeter utilizing a four (4) point measurement method.
 - (3) Fans and Pumps: The CTP shall check fans and pumps for correct operation in both manual and automatic modes including proper voltage, current and rotation.
 - (4) Alarms and Protective Devices: The CTP shall check calibration of liquid level gauges, liquid and winding temperature gauges and operation of sudden pressure relay(s), gas accumulation relays and all other associated devices. Tests shall be performed with fans, pumps, annunciators and relays in operational mode and after all wiring is complete. The equipment used shall include hot oil bath, 1-percent accuracy thermometer, sudden pressure relay testing device of a design approved by the COR and other devices needed for proper testing as listed in the appropriate manufacturer's instruction book.

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- (5) Core Ground: On transformers with 1 MVA or more of capacity, if accessible from the exterior of the transformer, the CTP shall determine the resistance of the transformer core to tank with the core ground removed. Core ground shall be reattached immediately following the test. The equipment used shall be a dc megohm resistance tester using a minimum of 500 V dc. If core ground connection is inside the tank, this test shall be performed immediately prior to final closing of the tank.
 - (6) The CTP shall test all aspects of power transformer winding temperature indicating or alarm circuits. Primary current shall be injected into such circuits and operation and calibration of any dials, indicators or relays shall be verified. If installed on the power transformer, the calibration of any associated Resistive Temperature Devices (RTDs) shall be verified.
 - (7) The CTP shall test bushing current transformers prior to and after installation of transformer bushings on Government-furnished transformers.
- f. Power Circuit Breakers: The Government will provide a circuit breaker manufacturer's erecting engineer to perform timing tests on the circuit breakers after they have been installed. The CTP shall perform micro-ohm resistance measurements, commonly called "ductor" tests, on all phases of the power circuit breakers as specified in IEEE Std C37.09. CTP shall also make all other checks, adjustments and tests required by the manufacturer's instruction books and erecting engineer before the breakers are placed in service. If the equipment supplier's erecting engineer makes any adjustments to make this equipment meet specifications, the CTP shall perform additional tests at no additional cost to WAPA.

The Contractor shall provide a gas analyzer and other special equipment, if required by the manufacturer, to analyze the SF6 gas.

All tests shall be performed in the presence of the manufacturer's erecting engineer.

- g. Control or Power Cable: Testing shall not begin on control or power cable until the Contractor has submitted manufacturer's data on all cable supplied. After installation, the CTP shall perform megohmmeter and continuity tests on all control and power cable. The insulation and continuity tests shall be made after identification tags and sleeves have been installed. Continuity tests shall also be performed on the shield. The insulation of each individual cable conductor shall be tested with respect to all other conductors, the shielding and to an earth reference. The overall covering (or jacket) insulation shall be tested to the shielding and to an earth reference. For cables with 600 V insulation, the megohm test voltage shall be 1,000 V dc. Each test shall last until the megohmmeter reading is stable. Megohm values less than the manufacturer's supplied test values shall be considered a failure. The Contractor shall seal and make waterproof both ends of all cables after the cable has passed testing. The COR may allow members of the Contractor's staff, other than the CTP, to perform continuity and megohmmeter tests after submission of a record of experience.
- h. High-Voltage Cable Testing: All high-voltage cable, whether supplied by the Contractor or by WAPA, shall be tested by the CTP as per IEEE Std 400 (IEEE Guide for Field Testing and Evaluation of the Insulation of Shielding Power Cable Systems Rated 5-kV and Above) and IEEE Std 48 (IEEE Standard Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5-kV Through 765-kV or Extruded Insulation Rated 2.5-kV Through 500-kV), both as amended. For cable supplied by WAPA, the CTP shall perform all tests as described in this section before any such cable is installed. For WAPA or Contractor-supplied cable, the CTP shall perform post-installation tests as described in this section only after all cable is in its final resting place, any specified planking or other equipment has been placed, all splices have been made and all cable terminations have been installed. The CTP shall guard all exposed cable ends during high-voltage testing.

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When equipment, such as transformers, motors, etc., is connected to the cable circuit undergoing test, voltages lower than the recommended values may be used to comply with the limitations imposed by the connected equipment.

- (1) The testing shall be performed in the following order:
- (2) A megohmmeter test of the cable insulation.
- (3) Apply the total test voltage in at least five (5) equal steps. After 5-minutes, the leakage current at each step is recorded and plotted on a voltage vs. current graph. If this curve becomes non-linear, breakdown of the insulating system is possible and the COR shall be consulted.
- (4) When the full test voltage is achieved, this voltage shall be retained for 15-minutes and the leakage current shall be recorded every minute. This information shall be plotted on a current vs. time graph.

At the completion of any phase of testing, the CTP shall not short the energized cable to ground. The cable shall be discharged through the test set or through an insulated hot-stick-operated resistor. After discharge, the cable shall be solidly grounded for a period of at least twice the length of the test period.

i. Instrument Transformers:

- (1) General: Upon receipt of all potential transformers, capacitor voltage transformers, coupling capacitor voltage transformers and current transformers, the CTP shall perform tests as specified in the following paragraphs. All tests and requirements shall be conducted in accordance with the most current revision of IEEE Std C57.13 standards. The Contractor shall test all bushing current transformers as specified in the following paragraphs. On power circuit breakers or power transformers supplied by WAPA, bushing current transformers shall be tested after the equipment is assembled but before the equipment is filled with its final dielectric.
- (2) Current Transformers:
 - (a) Polarity and Phase Angle: The CTP shall determine correct CT polarity and primary to secondary phase angle by the dc voltage impulse method (so-called “kicking”) and/or the primary to secondary current phase angle relationship method. The CT shall be demagnetized prior to energization.
 - (b) Ratio: The CTP shall determine CT ratios (including all tap ratios on the primary or secondary) by the current injection method or the voltage application method.
 - (c) Excitation/Saturation: The CTP shall verify the accuracy class of CT's by the voltage application method. At least five (5) points on the manufacturer's saturation curve shall be checked. The highest applied voltage shall be sufficient to completely saturate the CT core on full ratio. Following saturation, the voltage shall be lowered gradually and evenly to demagnetize the core.
 - (d) Megohmmeter Tests: The CTP shall perform megohmmeter tests and verify single-point grounding on all CT secondary circuits as specified under control, Metering and Relaying (CMR) Equipment Tests.
 - (e) Voltage Transformers and Coupling Capacitor Voltage Transformers:

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- (3) Polarity and Phase Angle: The CTP shall determine correct VT polarity and phase angle by the dc voltage impulse method or the primary to secondary voltage phase angle relationship method.
 - (a) Ratio: The CTP shall determine VT ratios by the voltage application method or a turns ratio test. The ratio of CCVT's shall be verified by application of a voltage of between 5,000 and 10,000 V ac to the primary. The secondary of the CCVT shall be compared with a Contractor-supplied 1.0- or 0.3-percent accuracy wound PT.
 - (b) Control, Metering and Relaying (CMR) Equipment Tests:
- j. General: The CTP shall perform work to verify that WAPA-supplied CMR equipment is wired as shown on the Government-furnished wiring diagrams.
 - (1) The CTP shall use a dc ohmmeter and Government-furnished schematic and wiring diagrams to verify the proper wiring of all CMR equipment. These checks shall be performed before any power is applied.

WAPA will supply one (1) complete set of schematic drawings and equipment wiring diagrams which will be designated as the "Master Set". The CTP shall draw translucent yellow lines through indicated electrical connections on the schematic and wiring diagrams indicating that each electrical connection has been verified. The yellow lines shall be drawn with a marking device that is translucent to copying by photostatic copying. This master set shall not be removed from the substation.

Single-Point Grounding: All current and potential circuits shall be grounded at a single point. Testing for single-point grounding shall be accomplished by lifting the ground and megohmmeter testing at 500 V dc to ensure no other ground connection is present. The CTP shall ensure that no solid state equipment is damaged.
 - (2) DC Control Circuits: Prior to energization from the substation dc system, each device on dc circuits shall be tested for proper connection according to schematic diagrams. These tests shall include checks to ensure that connections to ground do not exist and tests for proper voltage magnitude and polarity.
 - (3) Current Circuits: A secondary current of approximately 1-amp shall be injected at each CT secondary connection point. Each device in the current circuit shall be tested for proper current magnitude and direction (polarity) referenced to the injection current. In addition to the above test, the impedance of each complete secondary circuit shall be measured with 5-amps of injected current. The equipment used may include a variable current source, ac ammeter and phase angle meter. Also, all shorting devices (i.e., test switches, relay cases, etc.) shall be checked for proper operation.
 - (4) Voltage Circuits: A secondary voltage of 69 or 120 V ac, as applicable, shall be applied at the VT secondary connection point. The VT shall not be back fed. Each device on the voltage circuit shall be tested for proper voltage magnitude and direction referenced to the applied voltage. The equipment used may include a variable voltage source, voltmeter and phase angle meter.
- k. Station Service Equipment: Station service equipment includes switchgear assemblies, switchboards, panelboards, transfer switches and safety switches. Station service equipment shall be tested per these specifications covering voltage circuits, current circuits, dc circuits and operational tests. The main bus shall be tested for insulation dielectric strength with at least 2,500 V dc for a minimum of 15-minutes on each phase and neutral. Proper connections between neutral and ground shall be verified.

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- l. Testing of Protective Relays: WAPA will test all protective relays, transducers, panel instruments and revenue meter equipment. The COR will coordinate such testing with the Contractor's approved construction schedule.
- m. Operational Tests: After satisfactory completion of all other tests the CTP and the WAPA representative shall operationally check the control and protection systems of the installation. After each operational check, the CTP shall date and initial the appropriate electrical connections shown on the appropriate "Master Set" schematic drawing. Tests shall include:
 - (1) Walk-around inspection of installation, including inspection of all major equipment.
 - (2) Tripping and closing power circuit breakers using each protective device and each control device.
 - (3) Causing annunciation or remote SCADA indication for every alarm condition.
 - (4) Opening and closing motor-operated disconnect switches and motor-operated interrupter switches using each protective device and each control device.
 - (5) Functional check of every dc circuit. During this period, the Contractor shall process the checkout, and make any wiring changes which are necessary for proper and adequate functioning of the installation. Any wiring or design errors in Government-furnished equipment discovered by the CTP during the wiring check shall be reported to the COR. The Contractor shall replace all wiring, instruments and equipment which are damaged in the checkout process, unless this damage results from negligence by WAPA as determined by the COR.
- n. Energization Tests: After satisfactory completion of the operational tests listed above, WAPA will energize and load the installation. WAPA will check for proper current and voltage magnitude and phase angles at every protective and metering device associated with the energized portion of the installation.
- o. Infrared Inspection: After any new or modified section of the high-voltage buswork or equipment is energized and loaded to normal operating levels for at least a period of 48-hours, the CTP shall perform an infrared inspection. The infrared equipment used shall be capable of detecting a temperature difference of 2-degrees-Fahrenheit and shall produce a video recording. This recording shall be forwarded to the COR for review within 48-hours. If the COR determines that the records show an existing or potential problem, the Contractor shall repair this problem unless the problem exists on Government-furnished equipment and the COR determines that the problem shown was not the fault of the Contractor.

9.1.3 ELECTRICAL DRAWINGS AND DATA:

- 1. GENERAL: Drawings and technical data required to be furnished by the Contractor shall be in English, with dimensions in feet and inches, weight in pounds and volume in cubic feet or cubic inches.

Submittals shall be provided in accordance with SUBMITTALS paragraph of DIVISION 1 – General Requirements.

The Drawings and data shall be complete, accurate in their content and legible. Drawings shall be prepared using CAD, shall be drawn to scale and shall have neat lettering. Drawing and data formats shall be in accordance with SUBMITTALS paragraph of DIVISION 1 – General Requirements. WAPA will require 30-calendar-days to answer correspondence pertaining to each submittal of data or drawings.

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Schematic and wiring diagrams shall have graphical symbols and device function numbers conforming to the latest applicable standards of IEC 60617 and IEEE Std C37.2.

WAPA shall have the right to require the Contractor to make any changes in the Drawings and data that may be necessary to show the equipment furnished conforms to the requirements of the specifications and these standards. The design and coordination of this electrical equipment shall be the responsibility of the Contractor. WAPA's review of the Contractor's drawings shall not relieve the Contractor of meeting all requirements of these specifications or for the correctness of his drawings. Revised drawings shall show revision dates with changes and revisions circled on the Drawings.

Table 9-1 summarizes the Drawing and data required for electrical equipment being furnished.

TABLE 9-1 – ELECTRICAL DRAWINGS AND DATA SCHEDULE

TYPE OF DRAWINGS AND DATA	9.1.3 PARA.	DELIVERY TIME	TYPE OF MATERIAL
Equipment installation including seismic qualification report	2.	60-days after notice to proceed	Blackline Prints in PDF
Equipment informational drawings and data	3.	60-days after notice to proceed	PDF or CAD Drawings
Equipment final drawings	4.(1)	21-days before start of construction or installation of subject equipment	CAD Drawings and PDF
Equipment parts identification lists and bills of materials	4.(2)	21-days before start of construction or installation of subject equipment	Lists in Excel, Word or PDF
*Manufacturer's operation and maintenance instructions	4.(3)	21-days before start of construction or installation of subject equipment	Books, Word or PDF
Equipment and oil test reports	5.	Prior to shipment of equipment	Certified Data in PDF
Equipment insulating Liquid PCB certification	6.	Prior to delivery of oil or equipment	Certified Data in PDF
Insulator test reports	7.	Prior to shipment	Certified Data in PDF
Insulated conductor data	8.	Within 60-days after notice to proceed	Certified Data in PDF
Revised wiring diagrams	9.	60-days after receipt of drawings	Marked Print in PDF
Contractor's "As-Built" drawings	10.(1)	Within 60-days after final checkout of electrical installation	Bond Drawing Prints or PDF
As-Built WAPA drawings	10.(2)	Within 60-days after final checkout of electrical installation	Marked Print or PDF

* Furnish one (1) print of each final drawing and a copy of instruction manual with equipment.

2. **EQUIPMENT INSTALLATION DRAWINGS AND DATA:** Installation drawings and data are required for preparing installation drawings for foundations and for equipment support structures if Government-furnished. The required quantity, delivery time and destination are listed in Table 9-1. Drawings and data required include those in the following list that are applicable:
 - a. Equipment or equipment and associated support outlines, dimensions, and weights.

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- b. Base type, dimensions and mounting details.
 - c. Location, types, sizes and projections of required embedded anchor bolts.
 - d. Location and size of required openings in the floors for conduits.
 - e. Impact loading for oil filled equipment.
 - f. Orientation of all equipment and a complete anchor bolt setting plan.
 - g. Size and location of jacking pads for transformer.
 - h. Pole spacing for circuit breaker.
 - i. Overall equipment cabinet dimensions, including height above equipment base.
 - j. Seismic qualification report, for equipment specifications requiring a seismic qualification report.
3. **EQUIPMENT INFORMATIONAL DRAWINGS AND DATA:** The Contractor shall furnish informational drawings and data for electrical equipment supplied by the Contractor. The required quantities, delivery time and destinations are listed in Table 9-1.

The Drawings and data shall include equipment outlines, details, schematic diagrams, wiring diagrams and instructions. The Drawings and data shall specifically verify conformance with equipment requirements and shall be sufficiently complete to allow preparation of final installation drawings including wiring diagrams.

Whenever drawings and data reference multiple electrical equipment items, the Contractor shall highlight, encircle and use arrows to indicate which items the Contractor is furnishing.

4. **EQUIPMENT FINAL DRAWINGS AND DATA:** At least 21-days before the date the Contractor begins to install or make any external connections to any Contractor-furnished equipment, he shall furnish to the destinations listed in Table 9-1, the final drawings and data required in the following subparagraphs.
- a. **Final Drawings for Equipment:** The final drawings shall be CAD drawings and PDF format and shall show changes and revision dates therefor, made up to the time the Drawings and data are furnished. Final drawings shall include all of the following that are applicable for equipment furnished by the Contractor.
 - (1) Outlines and details of electrical equipment and equipment components such as supports, surge arresters and bushings.
 - (2) Wiring and schematic diagrams.
 - (3) Control cabinet physical layout drawings, (showing the layout of components in the cabinets).
 - (4) Nameplate drawings or data sheets.
 - b. **Sets of Parts Identification Lists or Bills of Materials:** Each part shall be assigned an identifying number which can be used for ordering replacements and a reference number that locates the part on the appropriate outline drawing. Separate lists are not required if data is shown on outline drawings.

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- c. Sets of manufacturer's instructions covering installation, operation and maintenance repair for electrical equipment and for each device appurtenant to the equipment.
- 5. EQUIPMENT TEST REPORTS: After completion of required tests on the electrical equipment and prior to shipment of equipment, the Contractor shall furnish certified electronic copies of test reports, performance curves and data. Copies of oscillograms shall be furnished as clear positive film transparencies. Any equipment that does not successfully pass the testing requirements will be rejected.
- 6. EQUIPMENT INSULATING LIQUID PCB CERTIFICATION: Certification shall be furnished showing that insulating liquids used in equipment do not contain polychlorinated biphenyls.
- 7. INSULATORS: Test reports shall specify the name and location of the factory where the insulators were made.
 - a. Porcelain Suspension Insulator Units: Each class of suspension-type insulator units shall be tested in accordance with NEMA C29.1 and NEMA C29.2B for the mechanical and electrical strength ratings required under the specifications and as follows:
 - (1) Design Tests:
 - (a) Low-Frequency Dry Flashover: NEMA C29.2B.
 - (b) Low-Frequency Wet Flashover: NEMA C29.2B.
 - (c) Critical Impulse Flashover – Positive and Negative: NEMA C29.2B.
 - (d) Radio-Influence Voltage: NEMA C29.2B.
 - (e) Thermal-Mechanical Performance Test: Ten (10) insulators per lot shall be tested in accordance with IEC Publication 60575. Each value measured shall not be lower than the mechanical and electrical strength required by these specifications.
 - (f) Thermal Shock: NEMA C29.2B.
 - (g) Residual-Strength: NEMA C29.2B.
 - (h) Impact: NEMA C29.2B.
 - (i) Cotter Key Test: NEMA C29.2B.
 - (j) Cement Expansion: NEMA C29.2B.
 - (2) Quality Conformance Test:
 - (a) Visual and Dimensional Tests: NEMA C29.2B.
 - (b) Porosity Tests: NEMA C29.2B. Test three (3) samples per lot.
 - (c) Galvanizing Tests: NEMA C29.2B.
 - (d) Combined Mechanical and Electrical Strength Tests: NEMA C29.2B.
 - (e) Puncture Tests: NEMA C29.2B.

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- (3) Routine Tests: A Certificate of Compliance stating the following routine tests have been performed is required.
 - (a) Tension-Proof Tests: NEMA C29.2B.
 - (b) Flashover Tests: NEMA C29.2B.
- b. Porcelain Station Post Insulators: Test station post type insulators in accordance with NEMA C29.9B.
 - (1) Design Tests:
 - (a) Low-Frequency Wet Withstand Test: NEMA C29.9.
 - (b) Critical-Impulse Flashover, Positive Test: NEMA C29.9.
 - (c) Impulse Withstand Test: NEMA C29.9.
 - (d) Radio-Influence Voltage (RIV) Test: NEMA C29.9.
 - (e) Thermal Shock Test: NEMA C29.9.
 - (f) Compression Strength Test: NEMA C29.9.
 - (g) Torsional Strength Test: NEMA C29.9.
 - (2) Quality Conformance Tests
 - (a) Visual and Dimensional Tests: NEMA C29.9.
 - (b) Porosity Test: NEMA C29.9. Test three (3) samples per lot.
 - (c) Galvanizing Test: NEMA C29.9.
 - (d) Cantilever Strength Test: NEMA C29.9.
 - (e) Tensile Strength Test: NEMA C29.9.
 - (3) Routine Tests
 - (a) Flashover Test: NEMA C29.9.
 - (b) Mechanical Proof Test: NEMA C29.9.

8. INSULATED CONDUCTOR DATA: The Contractor shall furnish quantity, manufacturer's data that completely identify all insulated wire and cable to be furnished. The required delivery time and destination are listed in Table 9-1.

The Contractor shall also submit, for approval, electronic copies of cable manufacturer's certified data for all control cable with sufficient detail to allow WAPA to verify the following specifications for the cable.

- a. Type/class and gauge of copper used for conductors.
- b. Type of material, thickness, voltage rating, temperature rating and NEC Type of individual conductor insulation.
- c. Individual conductor color coating.
- d. Type of material, thickness and temperature rating of binder tape or jacket covering.
- e. Type of material, thickness, overlap (if applicable) and minimum coverage percentage (if applicable) of the protective metal shield.
- f. Type of material and thickness of overall cable covering (jacket).

Data submitted for shielded cable, other than Type RG-8A/U (Coaxial), shall include manufacturer's certification that cable conforms to requirements of these specifications and give the number of groups, number of wires per group and size of wires used to meet the 14,472-

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circular mil area requirement for braid-type shielding or the dimensions and details of other type permitted. Data submitted for Type RG-8A/U shall include manufacturer's certification that the Type RG-84/U cable conforms to the requirements of Military Specification MIL-C-17.

9. **RIGHT TO USE THE CONTRACTOR'S DRAWINGS:** WAPA reserves the right to use, reproduce in whole or in part, to distribute and to reuse any and all such drawings, whether copyrighted or not, in connection with the following:
 - a. Installation, maintenance, replacement and repair of the articles to be furnished under the specifications and these standards.
 - b. Making any and all such drawings and reproductions thereof available to subsequent bidders and the Contractors, where necessary for fabricating and furnishing articles connected with or dependent upon, information shown on the Drawings and duplicating the Drawings to be furnished hereunder.

The depositing of all such drawings with WAPA shall constitute a license to WAPA to use said drawings in the manner hereinabove stated.

10. **REVISED WIRING DIAGRAMS:** The Contractor shall furnish three (3) marked prints, for approval, of wiring diagrams or cable routing list showing the Contractor proposed changes. These changes shall be furnished 60-days after receipt of Government-furnished drawings in accordance with the Standard 1 – General Requirements, Section 1.2.1 "Government-Furnished Material".
11. **"AS-BUILT" DRAWINGS:** Within 60-days after final checkout of electrical installation, the Contractor shall furnish the following "as-built" electrical drawings in accordance with Table 9-1:
 - a. Contractor's "As-Built" Equipment Drawings: The Contractor shall revise all equipment drawings and data which do not agree with "as-built" equipment or are otherwise deficient.
 - b. As-Built WAPA Drawings: One (1) full-size print of specifications drawings furnished to the Contractor for "as-built" construction purposes shall be marked to show any changes and additions made during construction and to show outlines of the equipment actually furnished. The marked prints shall be returned to the COR so that the revisions can be transferred to the original drawings.

9.1.4 INSULATING OIL:

1. **GENERAL:** Electrical equipment shall be designed to operate with oil which conforms to the requirements of ASTM D 3487, "Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus", except that the maximum pour point temperature shall be reduced when specified and that for oil-filled instrument transformers, distribution transformers and bushings the manufacturer's standard insulating oil is acceptable.

Electrical equipment with insulating liquids containing polychlorinated biphenyls (PCB) is not acceptable. Equipment requiring insulating oil shall be permanently marked and certification furnished to the COR to certify that there are no PCBs present when the equipment is manufactured. If the oil is shipped separately, the Contractor shall also furnish certification that the oil does not contain PCBs when delivered to WAPA. The oil truck driver shall have in his possession and furnish this certification to WAPA upon arrival at the delivery site.

2. **SAMPLING AND TESTING:** Certified results of tests which demonstrate compliance with ASTM D 3487 and these standards shall be furnished. Results of tests shall be of the actual oil being furnished or results of tests of a sample representative of oil being furnished are acceptable.

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Unless otherwise specified, the Contractor shall test a sample of the oil from the equipment or, directly from the shipping container, at WAPA's receiving facility to demonstrate that the following requirement is met:

TYPE OF TEST	ASTM METHOD	TEST LIMIT
Dielectric Strength	D 1816 (1-mm)	30-kV minimum

Insulating oil, after it is placed in the equipment, or if it is shipped in the equipment, will be tested by WAPA and if it does not exceed a dielectric strength of 30,000 V in accordance with ASTM D 1816 (0.040-inch gap), the Contractor shall filter the oil until its dielectric strength does exceed 30,000 V.

3. **INSTALLATION:** The Contractor shall process the insulating oil as required for the oil-filled electrical equipment to be installed under these specifications. Unless otherwise specified, the Contractor shall provide the filtering equipment. Separately shipped insulating oil shall be filtered at least once before it is placed in the equipment.

For power transformers, regulators and reactors rated 230-kV and above, unless otherwise specified, the Contractor shall provide for the following as part of processing the oil:

- a. Purification unit having a capacity of at least 1,000-gallons per hour and a capability of obtaining an absolute pressure of 5-millimeters or less of mercury.
- b. Oil storage equipment.
- c. The electrical power for operating the purification unit.
- d. A gas analyzer and any other special equipment if required by the manufacturer of the oil-filled equipment.

The Contractor shall furnish all necessary material and labor to complete the electrical and oil supply connections to the purification equipment and shall furnish operators for the unit while it is in use.

The filling of the equipment shall be conducted in accordance with the manufacturer's instruction books and the purification unit instruction book and under the supervision of the manufacturer's erection engineer.

The Contractor shall make every reasonable effort to operate the processing equipment in such a manner so that after one (1) pass of the oil through the processing equipment the dielectric strength of the oil is not less than 30-kV when tested in accordance with ASTM D 1816 (0.040-inch gap). If after passing through the processing equipment the dielectric strength of the oil is less than 30-kV, the Contractor shall reprocess the oil until it reaches a dielectric strength of not less than 30-kV.

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SECTION 9.2 – GROUNDING, CONDUIT AND LOW-VOLTAGE CABLE SYSTEMS

9.2.1 GROUNDING SYSTEM:

1. MATERIAL:

- a. Ground Cables: Copper ground cables, No. 2/0 AWG and larger, shall be annealed bare-copper cable, concentric stranded and in accordance with ASTM B8, Class B. No. 6 AWG copper ground cable used for trench cover and fence post grounding shall be annealed, concentric stranded, bare or insulated cable in accordance with ASTM B8, Class C. No additional payment will be made for furnishing and installing insulated cable.

All ground cables above grade shall be copper-clad steel (CCS). CCS cable shall be dead-soft annealed (DSA) with a minimum conductivity of 40% and shall comply with ASTM B228, where applicable. The CCS cable shall have a short-circuit withstand rating equal to or greater than that of the ground grid conductor to which it is connected. Unless otherwise specified, the ground grid conductor is typically 4/0 AWG copper, with a short-circuit rating of 40 kA for 30 cycles. The table below provides CCS conductor sizes equivalent to common bare copper grounding conductors and shall be used to determine the appropriate CCS cable size:

Bare Copper Wire AWG Size	Copperweld CCS 40% DSA Equivalent Size	Copperweld CCS Short Circuit Current Rating for 0.5s (kA)	AFL CCS 40% DSA Equivalent Size	AFL CCS Short Circuit Current Rating for 0.5s (kA)
No. 6 1 Str	7 x 068	5	3 No. 9	5
2/0 7 Str	7 No. 6	31	7 No. 4	28
4/0 7 Str	19 No. 9	41	19 No. 8	42
500 37 Str	19 No. 5	104	19 No. 4	107

- b. Cable Fittings, Lugs and Connectors: Cable fittings shall be compression, swage or bolted-solderless-type and shall have current-carrying capacity equal to that of the cable with which they are connected to. Cable fittings, lugs and connectors, together with the bolts, nuts and washers used therewith for copper ground cables, shall be of copper alloy, containing not more than 4-percent zinc. Aluminum connectors shall be used to connect aluminum-to-aluminum and tinned-bronzed connectors shall be used to make aluminum-to-copper connections.
- c. Ground Rods: Each ground rod shall have a copper jacketed steel core with 3/4-inch nominal diameter and be in conformance with UL Bulletin 467. 20-foot-long ground rods shall consist of two 10-foot sectional rods joined and bonded by threaded couplings of high strength copper alloy.
- d. Grounding Connectors for Underground and Embedded in Concrete: Connectors shall be compression or swage type. Connections shall be DMC Power Swage System, AFL Swage System, Burndy HyGround or equal. If swaged type connectors are used, the connectors and installation tooling shall be furnished by the same manufacturer. Connectors shall be a heavy-duty type, made of new material from fresh stock.

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2. INSTALLATION:

- a. Ground Mat: The ground mat shall be installed at a minimum depth of 18 inches below finished subgrade elevation, unless otherwise directed by the COR.
- b. Excavation and Placing and Compacting Backfill: Excavation and placing and compacting backfill shall be in accordance with Standard 2 – Sitework.
- c. Driven Ground Rods: Ground rods shall be driven vertically the full length of the rod until the top is at least 14-inches below established elevation of the subgrade. When solid rock is encountered, ground rods shall be grouted into vertical holes of such depth that the top of the rod will be 14-inches below established elevation of subgrade. The diameter of holes shall be at least 1 1/2 times the diameter of the ground rod.
- d. Connections: Electrical equipment, steel structures, pull box covers, corrugated metal pipe (CMP) and exposed metal surfaces shall be connected to the grounding system with the proper size copper conductor as shown on the Drawings. Grounding connections to trench covers, manhole covers and pull box covers shall be made with bolted connectors and shall be in accordance with Drawing 31 1061. Grounding of metal structures shall be in accordance with Drawing 31 1060. Connections above ground to tubular metal structures shall be made by connecting the ground wire to the ground tabs or baseplates of the metal structures and shall be in accordance with Drawing 31 1060. Each gate shall be bonded to its supporting fence post that is connected to the ground grid in accordance with Drawing 31 1501.

Grounding of electrical equipment mounted on pedestal-type concrete foundations shall be accomplished by connecting the ground wire directly to the ground mat and the equipment. Ground wire shall be connected to electrical equipment by cable with a flat plate connector similar to DMC Power Type GC910 or GC920, Burndy Type QA-B or as approved by the COR.

Paint, scale or other foreign material shall be removed from the point of contact on metal surfaces before any ground connections are made. After connections are made, any paint or galvanizing on the metal finishes that has been damaged or removed as a result of connections being made shall be repaired in accordance with the "Painting" Standard.

- e. Ground wire risers to equipment mounted on supports shall be fastened above the baseplate at intervals not to exceed 5-feet and in accordance with Drawing 31 1077.
 - (1) Cable risers shall be secured to tubular metal supports by one(1) of the following methods:
 - (a) Ground connectors, similar to Burndy Type GBM, shall be bolted securely to the structure face by a 1/2-inch bolt, drilled and tapped to the structure. For galvanized structures, a cold-galvanizing compound shall be applied to the threads after tapping.
 - (b) Ground connectors, similar to Burndy Type GBM, shall be bolted securely to a threaded 1/2-inch stud fastener attached to structure by powder-actuated tools as manufactured by Ramset Fastening Systems, Remington Arms Company, Inc. or by Hilti, Inc.
 - (c) Approved grounding-type clamps shall be secured to studbolts that shall be welded on the supports. Studbolts shall be standard commercial quality, shall be flux-filled for end-welding with automatic end-welding guns and shall be field

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installed. Sizes and edge-distance locations of the studbolts shall be subject to the approval of the COR.

- (2) Cable riser shall be secured to concrete supports by a method similar to that described in b. above or by approved grounding-type clamps secured to threaded 1/2-inch stud fasteners attached to the concrete structure with a wedge or expanding type anchor.
- f. Insulated cable grounding: refer to Section 9.2.3.4 below for grounding installation and requirements.
- g. Cable Trench Grounding: Cable trench grounding shall be installed in accordance with Drawing 31 1061. Two 2/0 AWG copper grounding conductors, or equivalent copper-clad steel conductors, shall be installed for the entire length of each cable trench. Where the trench crosses a copper main ground mat conductor, connections shall be made between the trench grounding conductors and the substation ground mat.copper
 - (1) Metallic Covers: Grounding of trench covers shall be in accordance with Drawing 31 1061 and the following instructions. Each trench cover shall be connected to one (1) of the No. 2/0 AWG copper ground cables with a No. 6 AWG copper jumper cable. The connector shall ensure that each No. 6 AWG copper jumper cable, connecting the trench covers to the seven (7) No. 4, or nineteen (19) No. 8, copper-covered steel ground cables, will be of sufficient length to permit removal of the trench covers without disconnecting the jumper cable. Copper-to-aluminum cable connection shall be made with tinned-bronze connectors. Oxide-inhibiting paste shall be applied, the aluminum surfaces wire brushed through the paste, and additional paste applied, if necessary, to cover contact area. Paste remaining after the connectors are tightened shall be retained as a seal against moisture. If No. 6 AWG insulated copper cable is furnished and installed in accordance with 1.(1), the insulation shall be stripped back at least 12-inches prior to making connection.
 - (2) Non-metallic Covers: Connecting non-metallic covers to the grounding system is not required. When non-metallic covers are used, support the two (2) ground cables, one (1) on each of the inside trench walls just underneath the covers, by brackets or clips in accordance with Drawing 31 1061.
- h. Service-Building Grounding: The building ground mat or metal frame shall be connected to the substation ground system as shown on the Drawings. All metallic equipment in the building and all metal roof joists, metal fascia, metallic door and window frames, exposed metal surfaces, metallic conduits and shielded cables shall be connected to the building ground mat or metal frame using No. 4 AWG bare stranded conductor or by effective grounding through mechanical connection to the grounded metal frame of the building.
- i. Pull Box Grounding: A copper ground cable shall be installed from the station ground mat into each pullbox. The copper conductor shall be sized as shown on the Drawings or as directed. Metal parts within and on the pullbox shall be connected to the pull box grounding with 4/0 AWG copper cable. The metallic cover of the pullbox shall be grounded with No. 6 AWG copper cable. Provide sufficient cable to permit removal of cover without disconnecting the cable.
- j. Equipment Grounding: The Contractor shall make all ground connections between all grounding pads and the grounding system whether or not such grounding connections are shown on the grounding drawings. The number of grounding terminals for each piece of equipment may be one (1), two (2) or more in some cases.

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- k. Operating Mechanism Bonding (Group-Operated Switches and Equipment Cabinet Platforms): The Contractor shall bond operating mechanisms of group-operated switches to switch operating platforms and Equipment Cabinet Platforms as shown on Drawing 31 1075. Where double platforms are used, they shall be electrically bonded together.
 - l. Damaged Ground Cable: Existing ground cables shown on the Drawings are shown in approximate locations, and caution shall be used in excavating near the existing ground cables. The Contractor shall repair ground cables damaged during construction to the satisfaction of the COR at no additional cost to WAPA.
3. TESTS: When specified, the Contractor shall perform continuity or resistance testing for the grounding system. The type of test required is dependent upon the work being performed and shall be as follows:
- a. For greenfield substations: Prior to energization, the Contractor shall measure the grounding system resistance using an AEMC ground resistance tester or approved equivalent. Ground resistance testing shall be performed using the fall-of-potential method in accordance with IEEE Std 81. The current probe shall be placed at a minimum distance equal to three (3) times the diagonal length of the grounding system (ground electrode). The potential probe shall be installed at 62% of the distance between the grounding system and the current probe. Unless otherwise specified, the grounding system resistance shall not exceed one (1) ohm. If the measured resistance exceeds this value, the Contractor shall notify the COR and perform corrective measures as directed. Where site constraints prevent installation of probes at the required spacing, the Contractor shall submit an alternate testing method for approval by the COR.
 - b. For brownfield substations: Grounding system expansions and newly installed grounding conductors shall be tested for continuity using a DV Power GGT or approved equivalent continuity tester. Testing shall be conducted in accordance with the high-current test method described in IEEE Std 81. If test results indicate a broken, high-resistance, or inadequate ground connection, the Contractor shall notify the COR as soon as possible. Corrective actions shall be performed as directed by the COR.

9.2.2 ELECTRICAL CONDUIT SYSTEM:

1. GENERAL: The electrical conduit system includes the embedded and exposed conduit systems.
- Conduit accessories include conduit fittings, bushed elbows, nipples, chase nipples, connectors, reducers, outlet bodies, outlet body extensions, steel boxes, caps, pipe plugs, locknuts, bondnuts, bushings, pull boxes, junction boxes, junction box extensions, sealing varnish, threaded joint compound, expansion couplings, liquid-tight conduit fittings, material for sealing ends of conduits terminating at outdoor equipment and other incidentals required to complete the conduit systems and to fasten, clamp, attach and support conduit in place.
2. MATERIAL: Material for the electrical conduit installations shall conform to the following:
- a. Rigid Steel Conduit, Zinc Coated: UL 514 and NEMA C80.1.
 - b. Electrical Rigid Aluminum Conduit (ERAC): NEMA C80.5.
 - c. Electrical Plastic Conduit and Fittings: Schedule No. 40 or 80 as specified, PVC, in accordance with NEMA Publications TC 2 and TC 3.
 - d. Flexible Metal Conduit: Federal Specification DLA A-A-55810 for indoor use only. For outdoor use, liquid-tight type flexible metal conduit shall be used.

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- e. Metal Conduit Fittings: Federal Specifications DLA A-A-50552 and DLA A-A-50553.
- f. Plastic-Coated Conduit: Plastic-coated conduit shall be rigid steel conduit, zinc coated, with a factory-applied bonded plastic compound protective coat at least 0.04-inch-thick, placed uniformly around the conduit and equal to Occidental Coating Co.; Plastic Applicators; Republic Steel GALVANITE; or Robroy Industries PLASTI-BOND. Fittings shall have an equal bonded coating and shall be sleeved to provide a watertight joint.
- g. Tape Covered Conduit: Tape covered conduit can be used in lieu of plastic coated conduit. Tape covered conduit shall be rigid steel conduit, zinc coated, wrapped with an all-weather corrosion protection system. Prior to wrapping, the conduit shall be dry, clean, free of oils, grease or other contaminants, de-burred, with no sharp edges. The all-weather corrosion protection system shall be applied, and stored until installed, in a dry, sheltered, area. The all-weather corrosion protection system's pipe primer shall be uniformly applied to the conduit with a minimum of 1-mil thickness and allowed to dry as directed by the Manufacturer. Irregular surfaces shall be filled with all-weather corrosion protection system's electrical insulation putty as directed by the Manufacturer. 20-mil corrosion protection tape shall be applied uniformly, wrapping spirally, with a 75-percent overlap continuously over the entire length of conduit to be protected and with a 100-percent overlap on each end. If conduit fittings, couplings, etc., are to be used, they shall be installed on at least one (1) conduit end and shall be prepped, primed, irregular surfaces filled, and wrapped along with the conduit prior to installation to create a watertight joint. Additional care, application and installation requirements shall be in accordance with Manufacturer's instructions. The all-weather corrosion protection system shall be 3M Scotchrap All Weather Corrosion Protection System or equal.
- h. Protective Varnish: Protective varnish shall be General Electric Company, "Glyptal" No. 1201-B; Minnesota Mining and Manufacturing Co., "Scotchkote"; or Westinghouse Electric Corp., No. B-6-614; or equal.
- i. Outlet Bodies: Federal Specification DLA A-A-50563 and equal to Crouse-Hinds Company, or Appleton Electric Company, outlet bodies.
- j. Junction Box, Junction Box Extension, and Junction Box Cover (Steel, Cadmium or Zinc Coated): Federal Specification DLA A-A-59214.
- k. Octagon Concrete Rings and Plates: Octagon concrete rings and plates shall be Appleton Electric Company, Types OCR and CCP; or equal.
- l. Expansion Couplings: Expansion couplings, where required for installation in conduit systems at expansion and contraction joints, shall be zinc coated and a watertight type. For 2-inch and smaller metal conduit, couplings shall be equal to Dresser Manufacturing Company's Type 38. Expansion couplings for plastic conduit shall be equal to Carlon Electrical Products "PV-Duit" fittings.
- m. Embedded Sheet Steel Pull Boxes: Embedded sheet steel pull and junction boxes, where indicated on drawings to be furnished, shall be not less than 10-gage, shall be thoroughly cleaned and shall have a primer coat of red vinyl-resin paint and a final coat of gray vinyl-resin paint.
- n. Pull Boxes Embedded in Masonry Walls: Pull boxes embedded in masonry walls shall be equal to Russell and Stoll Catalog No. AB100A. Each box shall be furnished with a temporary cover to exclude the entry of foreign material.

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- o. Fabricated Sheet Steel Boxes and Cabinets: Large junction and conduit boxes, excluding outlet boxes to contain wiring devices or to accommodate lighting fixtures, shall be fabricated galvanized finish. Covers shall be attached to boxes with bronze, brass or stainless steel screws or bolts. Any installed boxes exposed to the weather shall be of weather-resistant, watertight construction and covers for such boxes shall be provided with gaskets.
 - p. Sealing Material: Sealing material for sealing the ends of conduits terminating at boxes or panelboards shall be equal to “Duxseal” as manufactured by Johns-Manville or “Isofoam PE-2” as manufactured by Isocyanate Products, Inc.
 - q. Concrete Cable Splice Boxes: Cable splice boxes shall be equal to Brooks Products, Inc., No. 67T body with a bolt-down steel cover.
 - r. Adhesive: Adhesive for joining plastic conduit shall be in accordance with the conduit manufacturer's recommendations.
3. INSTALLATION: Install conduit and make conduit connections to equipment. Perform excavation work and backfill in accordance with Standard 2 – Sitework. Conduit shall be installed complete with necessary fittings and supports and bends shall be gradual and smooth to permit the pulling of insulated electrical wires and cables without undue stress or damage to the insulated electrical wires and cable sheath or to the conduit. Buried conduit shall be in accordance with Drawing 31 1006. Conduit runs and bends shall be entirely free from kinks, indentations or flattened surfaces. Unless otherwise indicated, metal conduit bends made in the field shall be bent cold to prevent damage to the protective coating and have not less than the minimum radii specified in the “National Electrical Code”.
- a. Burrs and sharp corners at the ends of each piece of metal conduit shall be removed. All 90-degree conduit bends shall be rigid metal. An exception is permitted for conduit entering a cable trench, where a 90-degree bend may be Schedule 40 PVC.
 - b. Male threads of rigid metal conduit joints shall be cleaned and coated with a suitable graphite or zinc sealing material before making joints and shall be tightened securely to prevent the entrance of moisture or any other foreign material.
 - c. For steel conduit, the completed joints, terminations, wrench marks and all other places where the zinc covering is damaged shall be completely covered with a protective varnish to provide protection from corrosion. Joints in embedded nonmetallic conduit shall be tightened securely and permanently sealed to prevent the entrance of any foreign material.
 - d. Bushings and chase nipples or bell ends shall be installed on the ends of conduit to protect the insulation or sheath of the wires or cables from abrasion. Locknuts and bondnuts shall be installed on metal conduit to provide tight ground connections between conduit and boxes, panelboards and cabinets.
 - e. Unless otherwise specified or directed, conduits are to be terminated with a coupling or adapter flush with finished concrete surface.
 - f. Open ends of conduit shall be closed with plugs or capped bushings during construction.
 - g. Ends of conduits, including spare conduits, terminating at outdoor boxes, panelboards, cabinets or open air shall be sealed with airtight and watertight mechanical duct plugs and accessories equal to those manufactured by Tyco Electronics Corporation Telecom Networks Ltd.(formally Jackmoon USA Inc.) or an approved sealing material. Sealing

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material shall be used only when the number or size of cables does not permit the use of duct plugs.

- h. Unless otherwise directed, exposed conduit runs shall be straight and shall be parallel with each other and with the centerlines of structures where they are located. Unless otherwise specified or directed, exposed conduits shall be rigidly supported at intervals of not more than 5-feet. Installation of exposed conduit shall include, where required, the drilling of holes in bottom and top of enclosures or plates and inside of enclosures of control, station-service and other electrical equipment. Exposed conduits shall be tightened securely and shall be supported rigidly in place and connections to outdoor boxes shall be watertight.
- i. Metal conduit extending into the earth shall be in accordance with Drawing 31 1006.
- j. At electrical equipment enclosures not equipped with threaded hubs, conduits shall be terminated in accordance with Drawing 31 1700, unless otherwise noted.
- k. Rigid steel conduit buried directly in earth shall be plastic-coated or tape covered type. Joints shall be made with watertight fittings that shall be coated or covered in accordance with the manufacturer's instructions and damaged portions of protective coat shall be repaired or covered in accordance with manufacturer's instructions.
- l. Conduits rising to electrical equipment mounted on tubular metal structures shall be tightened securely and shall be supported rigidly in place by the use of approved conduit clamps, hex head nuts, and a threaded 3/8-inch stud attached to the structure in accordance with 31 1700 by one (1) of the following methods:
 - (1) Threaded 3/8-inch stud fastener attached to the structure by powder-actuated tools as manufactured by Ramset Fastening Systems; by Remington Arms Company, Inc.; or by Hilti, Inc.
 - (2) Studbolts welded on supports shall be standard commercial quality, shall be flux-filled for end-welding with automatic end-welding guns and shall be field installed. Sizes and edge-distance locations of the studbolts shall be subject to the approval of the COR.
- m. Install red or yellow detectable warning tape directly above each conduit run, located 12 inches below finished grade.
- n. Bending of plastic-coated conduit shall be made in accordance with manufacturer's recommendations. Where manufacturer warns of possible damage to conduit or plastic coating when bending larger sizes of plastic-coated conduit, factory bends shall be used.
- o. Bending of tape covered conduit is not permitted. All bends must be made prior to tape cover installation and wrapped as described above.
- p. In addition to above requirements, nonmetallic conduit shall be installed in accordance with the applicable requirements of NEMA Publication TC 2 including Appendix A.
- q. Buried electrical conduit shall have 1-inch of sand or fine earth around each conduit. The remaining portions of the trenches shall be backfilled and compacted as provided in the Standard 2 – Sitework.
- r. Provide synthetic pull ropes in all conduits.

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9.2.3 INSULATED CONDUCTORS AND CABLES:

1. GENERAL: For the purposes of these standards the following definitions shall apply:
 - a. Cable: Cable, cables, wire, wires or conductor.
 - b. Power Cable: Cable used for power loads, including receptacle outlets, motors, heating, ventilation and lighting and cable used for controlling heating, ventilation and lighting equipment.
 - c. Control Cable: Cable used for control, alarm, metering, relaying, supervisory, annunciator and WAPA identified low-current control circuits and circuits not identified as power circuits.
 - d. Telemetry Cable: Cable used for supervisory, computer control, voice communication and logic level signals.
 - e. RTU Cable: Cable used for supervisory and data acquisition.
 - f. Yard: Substation areas, except building interiors.
 - g. Yard Cable: Cable with portion of its length located in yard.
 - h. Indoor Cable: Cable with its entire length indoor.
 - i. NEC: National Electrical Code NFPA 70.
 - j. NESC: National Electrical Safety Code, IEEE C2.
 - k. WC Plus a Specified Number: Wire and cable NEMA Publication having specified WC number.
 - l. ICEA: Insulated Cable Engineers Association.
2. MATERIAL:
 - a. General: All cable shall:
 - (1) Be in accordance with National Electrical Code (NEC), NFPA, IEEE/ANSI/NEMA WC and ICEA Publications as specified.
 - (2) Be furnished with a certification of date of manufacture. Cable that was manufactured more than 2-years prior to bid opening date is not acceptable.
 - (3) Be round, except for 2-conductor cable with parallel conductors.
 - (4) Have Class B or Class C bare copper conductor. Tinned copper is not acceptable.
 - (5) Have American Wire Gage designation.
 - (6) Have coverings or insulation suitable for installation in vertical position without injury to the covering or deformation of insulation when supported in accordance with NEC Article 300.21.

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- b. Indoor power cable for circuits rated at 600 V or less shall be NEC Type XHHW or XHHW-2 shall be UL approved, and shall bear UL label “XHHW” (or XHHW-2, as applicable) on outer surface per NEC.
- c. For stations rated 138-kV and below with or without capacitor banks; also for stations rated 230-kV and below and having no capacitor banks, power cable for circuits rated at 600 V or less and installed in yard shall be:
 - (1) Single conductor or multiconductor non-shielded type, with ground.
 - (2) NEC 90-degrees Celsius Type XHHW-2.
 - (3) UL approved and bear UL type label on outer surface per NEC.
 - (4) Overall covering (Jacket) shall be sunlight resistant.
- d. For 161-kV and 230-kV stations with capacitor banks and all stations rated above 230-kV, power cable for circuits rated at 600 V or less and installed in yard shall be suitable for all uses and shall be as follows:
 - (1) Single conductor or multiconductor shielded typ.
 - (2) NEC 90-degrees Celsius Type XHHW-2. Cross-linked polyethylene Type per NEMA WC 70-2009 /ICEA S-95-658, Section 3 and meeting thickness and test requirements per NEMA WC 70, Table 3-4, Column B.
 - (3) Shielding: Conforming to NEMA WC 70, Section 5, except that type shall be limited to the following:

Bare copper tape with a thickness of at least 5-mils and a minimum overlap of 10-percent or copper braid consisting of 24 groups of six (6) or (7) No. 30 AWG wires per group or the equivalent in total circular mil area and shall provide a minimum coverage of 85-percent. (Example, each No. 30 AWG wire has an area of 100.5-circular-mils and six (6) strands of wire in 24 groups to give a total area of 14,472-circular-mils.)
 - (4) Overall covering (Jacket): Thermoplastic polyvinyl chloride (PVC) or easy pulling PVC, and sunlight resistant type per NEMA WC 70, Section 4 and thickness per NEMA WC 70, Table 4-5.
- e. Multiconductor Control Cable: Unless otherwise indicated, cables for control, alarm and relaying circuits, except control circuits for heating, ventilating and lighting, shall be as follows:
 - (1) 600 V insulated.
 - (2) Multiconductor type suitable for installation in trays, direct burial and general use.
 - (3) Individual conductors insulated with NEC Type XHHW or XHHW-2 (NEMA WC57-2014 XLPE) insulation and color-coded in accordance with Drawing 31 6005 (WC57-2014/ICEA S-73-532 Table E-1).
 - (a) No. 10 AWG at least 30-mils (0.76-millimeter) thick.
 - (b) No. 16 AWG at least 25-mils (0.63-millimeter) thick.
 - (4) Binder tape or jacket covering.
 - (5) A protective metal shield with drain wire:

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- (a) Corrugated longitudinal copper tape with a thickness of at least 5-mils and a minimum overlap of 10-percent; or
 - (b) Copper braid consisting of 24 groups of six (6) or seven (7) No. 30 AWG wires per group or the equivalent in total circular mil area and shall provide a minimum coverage of 85-percent. (Example, each No. 30 AWG wire has an area of 100.5-circular mils and six (6) strands of the wire in 24 groups to give a total area of 14,472-circular-mils.)
- (6) An overall covering (jacket) of thermoplastic or neoprene:
 - (a) Cable with No. 10 AWG individual conductors at least 60-mils (1.52-millimeters) thick, except 12-conductor cable shall be at least 80-mils (2.03-millimeters) thick.
 - (b) Cable with No. 16 AWG individual conductors at least 45-mils (1.14-millimeters) thick, except 12-conductor cable shall be at least 60-mils (1.52-millimeters) thick.
- f. RTU Cable: RTU cable used for supervisory control and data acquisition (SCADA) shall be suitable for all uses and shall be as follows:
 - (1) 600 V insulated.
 - (2) Multiconductor or twisted pair suitable for installation in trays, ducts and general use.
 - (3) Conductor sizes shall be No. 14 and 18 AWG.
 - (4) The core shall be completely covered with a layer of non-hygroscopic dielectric material. The covering shall be applied with an overlap.
 - (5) Shielding: Cable shall be shielded and have a drain wire.
 - (6) An overall covering (jacket) of thermoplastic or neoprene.
 - (7) Twisted pair cable shall meet all requirements listed above. The core shall consist of twisted pairs, individually insulated and with varying lengths to minimize crosstalk.
 - (8) Color coding shall be as specification Drawing 31 6005.
- g. Multiconductor Telemetry Cable: Multiconductor telemetry cable shall be suitable for all uses and shall be as follows:
 - (1) The core shall consist of twisted pairs, individually insulated and with varying lengths of lay to minimize crosstalk.
 - (a) Insulation shall be extruded high-density polyethylene or crystalline propylene/ethylene copolymer insulating compound.
 - (b) Insulation shall be color coded in accordance with RUS Bulletin 1753-205 (PE39).
 - (2) The core shall be completely covered with a layer of non-hygroscopic dielectric material. The covering shall be applied with an overlap.

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- (3) Shielding:
 - (a) Standard Cable: 0.005-inch (0.127-mm) thick copper or 0.008-inch (0.203-mm) aluminum shield.
 - (b) Direct Burial Cable: 0.006-inch (0.152-mm) copper-clad steel or 0.010-inch (0.245-mm) stainless steel aluminum laminated or copper shield. The shield shall be separated from the core by an inner jacket of hi-molecular weight polyethylene. The shield shall be placed between the inner-jacket and the outer cable jacket. The cable shall be rodent-proof.
- (4) Cable Jacket: The outer cable jacket shall be black high molecular weight polyethylene and be resistant to abrasion, moisture, weather and environmental cracking.
- h. Power Cable Above 2,000 V: Power cable 2,001 V rating and above shall be filled or unfilled cross-linked-thermosetting-polyethylene insulated type non-shielded ethylene-propylene rubber insulated type per NEMA WC 71, or shielded ethylene-propylene-rubber insulated type per NEMA Publication No. WC 74-2012 and be as follows:
 - (1) Single-conductor type with Class B or Class C stranded copper conductors.
 - (2) Suitable for all uses including direct burial.
 - (3) Insulation: Cross-linked-thermosetting-polyethylene type per WC 71, Section 4 and with thickness and tests per WC 71, Table 4-2 and Section 4.4, for 133-percent insulation level for 2,001 to 5,000 V; per WC 74, Section 4 and with thickness and tests per WC 74, Table 4-4 for 133-percent insulation level for 5,000 V to 25,000 V and 100-percent insulation level for 25,001 to 35,000 V; or

Ethylene-propylene rubber type per WC 71, Section 4 and with thickness and tests per WC 71, table 4-2 and Section 4.4, for 133-percent insulation level for 2001 to 5,000 V; per WC 74, Section 4 and with thickness and tests per WC 74, Table 4-4, for 133-percent insulation level for 5,000 to 25,000 V and 100-percent insulation level for 25,001 to 35,000 V.

In either case, per NEMA WC 71 Section 4.3.2 and NEMA WC 74 Section 4.2.1.2 delta to delta systems shall have 173-percent insulation level (the next higher voltage class at a 100-percent insulation level is acceptable in lieu of 173-percent).
 - (4) Shielding:
 - (a) For conductor 5,000 V to 46,000 V per NEMA WC-74 (ICEA S-93-639) Sections 5 and 6.
 - (5) Covering (Jacket):
 - (a) Jacket shall be black sunlight resistant and either low smoke halogen free polyolefin, polyvinyl chloride (PVC), easy pulling PVC, rubber or thermoplastic Type per WC 71, Section 5 and WC 74, Section 7.
- i. Coaxial Cable: Coaxial cable shall be Type RG-213/U and in accordance with Military Specification MIL-C-17.

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3. DETERMINATION OF CONDUCTOR SIZES: The Contractor shall determine conductor sizes, except where shown on the Drawings or specified. Sizes shall be determined in accordance with NEC and the following requirements, provided that in the event of differences between NEC and the following requirements, the more stringent requirements shall apply:
 - a. Minimum Conductor Sizes for 600-V Insulated Cables: All conductors shall be No. 10 AWG or larger except for the following:
 - (1) Heating, ventilation and lighting:
 - (a) Power: No. 12 AWG or larger.
 - (b) Control: No. 14 AWG or larger.
 - (2) Annunciator and WAPA identified low-current control circuits:
 - (a) No. 16 AWG or larger.
 - b. Minimum Size of Buried Single Conductor: No. 8 AWG or larger.
 - c. Conductor Sizes for Power and Lighting Circuits: The Contractor shall determine all conductor sizes in accordance with the NEC except where shown on the Drawings or specified.
4. INSTALLATION:
 - a. The Contractor shall not procure nor begin installation of any control cable until the manufacturer's certified data required by section 9.1.3 "Electrical Drawings and Data" is approved in writing by the Electrical Engineer.
 - b. The Contractor shall install cables in accordance with the Drawings and requirements of these Standards, NESC and NEC requirements where applicable. The Contractor shall complete the installation, including connecting to and extending existing circuits where required. No combination of ac and dc circuits or current transformer and potential transformer circuits shall be carried in the same multiconductor cable. Sufficient length shall be left at the ends of cable to make connections conveniently to equipment, fixtures and devices. Spare single conductors at each end of a multiconductor cable shall be retained in a length equal to that of the longest single conductor of the multiconductor cable. All conductors in current transformer cable shall be retained in sufficient length to reach the farthest terminal used to select current transformer ratios. At termination of each multiconductor cable, the conductors shall be formed into neat packs and laced or tied. Circuits not installed in conduit and consisting of two (2) or more single conductors shall be tied together at 10-foot intervals by self-locking cable ties.
 - c. The self-locking cable ties shall be equal to Thomas and Betts molded Zytel No. 101 nylon "TYRAP".
 - d. Within fenced substation areas, buried cables shall be installed in accordance with Drawing 31 1006. For other applications, buried cable shall be installed in accordance with NEC Article 300-5, for cables rated 600 V or less, and Article 710-3 for cables rated above 600 V.
 - e. Excavation and placing and compacting backfill for buried cable shall be in accordance with the applicable paragraphs of Standard 2 – Sitework.

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- f. Cable shall not be pulled into conduits until the conduit runs have been cleaned and are free from obstructions and sharp corners. A clean, dry, tight-fitting rag shall be drawn through the conduit immediately before installing insulated conductors. Cable shall be installed so that there will not be cuts or abrasions in the insulation or protective covering or kinks in cable.
- g. Gradual and uniform pulling stresses only will be permitted on cable. Where a lubricant is needed as an aid to the pulling of cable, only soapstone or other approved material not injurious to cable sheath shall be used. Any cable damaged during installation shall be removed and replaced with equivalent cable at the Contractor's expense.
- h. Splices:

- (1) Cable Rated at 600 V: No splices shall be made in cable unless authorized by the COR. Where splices are authorized, they shall be permitted only at boxes, outlets, panelboards, cabinets, cable trenches or cable trays. All splices shall be covered with insulation equal to that on the insulated conductors.

Splices for copper conductors larger than No 8 AWG shall be made using pre-insulated mechanical connectors UL Listed for Direct Burial (UL 486D). Connectors shall be constructed of high-strength aluminum alloy, dual-rated for copper and aluminum conductors, and insulated with high-dielectric strength EPDM rubber or plastisol. Connectors must be pre-filled with an oxide inhibitor and require no taping, heat shrink, or additional compounds. The connectors must feature a secure, resealable, and waterproof closure (e.g., Polaris Edge or ISW Series). Installation shall follow manufacturer's instructions for torque and wire stripping

Connectors for splicing conductors in multiconductor cable shall be of the 2-way type equal to T&B compression or T&B STA-KON connectors. No. 8 AWG and smaller size wires and cables shall be spliced or joined so as to be mechanically and electrically secure before being soldered. Where shielded cables are spliced, care shall be taken to ensure that the shielding tape is continuously connected across the splice. Crimps shall be installed with tooling equipment with a T&B "SHURE-STAKE" mechanism, ratcheting style crimper or equal.

All crimps made for electrical connections shall be performed with 'go/no-go style crimpers and tugging on the conductor to ensure crimp is secure. All crimps shall be verified by WAPA inspection personnel prior to commissioning.

- (2) Cables Rated Above 3,000 V: Install with the required number of manufacturers recommended splice kits. All splices shall be suitable for grounding the shields. The splices shall be completely moisture proof and be insulated for at least the same level as that of the cable.

Solderless-type lugs and connectors shall be used for joining or connecting cables to terminal blocks or devices. Terminations of wire No. 8 AWG and smaller shall be made with preinsulated pressure-crimp-type terminal connectors with ring tongues equal to T&B "STA-KON" terminals manufactured by ABB. Crimps shall be installed with tooling equipment with a T&B "SHURE-STAKE" mechanism ratcheting style crimper, or equal.

- i. Connectors shall be suitable for use on the particular conductor on which the connector is used.

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- j. Wires, cables and individual conductors of multiconductor power cables shall be neatly tagged at each end with fiber tags attached by cords. Fiber tags shall be 1 1/2-inch-diameter, shall be not less than 1/16-inch-thick, and shall have a 3/32-inch-diameter hole drilled or punched with the center approximately 3/16-inch from the edge. Tags shall be marked with the cable designation or conductor designation as applicable. Designations shall be as indicated on wiring diagrams, shall be lettered with black, waterproof ink and shall be covered with a coat of clear varnish or shellac.

Individual conductors of multiconductor control and telemetering cable shall be marked at each end with heat shrinkable marking sleeves. The heat shrinkable marking sleeves shall be suitable for being slipped onto each conductor and heat shrunk to fit the conductor using a heat gun. After shrinking, the marker sleeve shall be tight enough to stay in place regardless of conductor position and loose enough to permit the marker to be slid and twisted so it can be read after the conductor is terminated. The lettering shall be machine printed or neatly hand printed with indelible ink, black on white background and shall be in accordance with the designations shown on wiring diagrams. The heat shrink tubing shall be suitable for being printed in a typewriter or printer with multiple strike inked textile ribbon. The heat-shrink marking shall be equal to Critchley, E-Z Mark Type I HS, with a nominal shrink ratio of 2:1, as manufactured by Critchley Inc.

- k. Cable installed in a vertical plane or in an inclined plane shall be supported by means of approved cable grips, including hooks, and installed with slack spans between supports. Cable entering equipment shall be securely clamped by means of approved commercial cable clamps. When cables are installed in sleeves under equipment, the openings shall be blocked with foam rubber material approved by the COR. Where cables pass through sleeves or blockouts, urethane foam equal to Isofoam PE-2 may be used in lieu of clamps or woven grips for supporting cables or in lieu of foam rubber for blocking openings.
- l. Panelboard and switchboard wiring shall be permanently supported and clamped to prevent loosening or shifting.
- m. Runs, connections, soldering, taping and tagging of insulated conductors provided shall be subject to approval of the COR. After all insulated conductors are installed and all equipment, devices and fixtures have been connected, acceptance tests shall be conducted in accordance with Section 9.1.2 – “Acceptance Tests”.
- n. Shielded cables shall be grounded as specified:
 - (1) Cable insulation shall be stripped as required to expose the cable shield. The shield shall be grounded at the control or AC panel and at the associated equipment cabinet or terminal box ground bar. A constant force spring shall be used to bond the cable shield to a grounding pigtail, which shall be terminated on the ground bar.
 - (2) Except as required by Section 16 below, shielded control cables routed from the yard into the service building and terminated at control, metering, or relaying panels shall include a minimum of one (1) non-active conductor in each cable. This conductor shall be grounded at both ends. Cable shielding and spare conductors of shielded control cables shall also be grounded at both ends using the method shown on Drawing 31 6000 or by other methods approved by the COR.
- o. All non-shielded AC cables installed in conduit shall include a dedicated bare copper grounding conductor bonded at both ends. Where conduit routes to a cable trench, the grounding conductor shall be bonded to the trench ground at the point of conduit exit and to the ground bar at the associated equipment cabinet or terminal box. Grounding conductors shall be sized and installed in accordance with applicable NEC requirements.

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- p. Of the total number of conductors in control cables for dc circuits from the switchboard to a power circuit breaker, or motor-operated disconnect switch there shall be at least six (6) spare conductors. Of the total number of conductors in control cable for dc circuits from the switchboard to a power transformer or reactor, there shall be at least four (4) spare conductors. These spare conductors shall be in addition to a nonactive conductor in each cable. The nonactive conductor shall be grounded at both ends. Spare conductors in each individual cable shall be counted in pairs. If there are four (4) unused conductors in a cable, one (1) conductor shall be used as the ground nonactive conductor leaving three (3) conductors for spares, but only two (2) of the remaining three (3) conductors can be counted as spares.
- q. DC circuits connecting to a device at a power circuit breaker, transformer or reactor shall be run radially and the positive and negative leads in a circuit shall be run in the same cable.
- r. A 5-conductor cable shall be provided for each 3-phase current or potential transformer secondary winding circuit.
- s. The Contractor shall install cable without exceeding the maximum allowable pulling tensions and sidewall pressures as recommended by the cable manufacturer. The Contractor's conduit and pull box system shall be designed to meet these requirements.

9.2.4 TERMINAL BOXES:

- 1. GENERAL: Fuses with the fuse cutout bases shall be provided in the terminal boxes for the wound-type voltage transformers and coupling capacitor voltage transformers.
- 2. MATERIAL:
 - a. Terminal Boxes: Instrument transformer and coupling capacitor voltage transformer terminal boxes shall be in accordance with Drawing 31 1085. Type G and H terminal boxes shall be in accordance with Drawing 31 1086.

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SECTION 9.3 – BUS SYSTEMS

9.3.1 OUTDOOR STRAIN AND JUMPER BUSES, RIGID BUS AND OVERHEAD GROUND WIRE:

1. MATERIAL:

a. Cable:

- (1) All-aluminum cable shall be hard-drawn and in accordance with ASTM B231, Class AA.
- (2) Copper strain and jumper buses shall be copper cable in accordance with ASTM B8, Class A.
- (3) ACSR cable shall be in accordance with ASTM B232. The galvanized steel strand core wire shall be seven (7) strand and shall be in accordance with ASTM B498.
- (4) Overhead ground wire shall be seven (7) wire, 3/8-inch, conforming to "High-Strength Grade", "Class A" steel strand in accordance with ASTM A363.

b. Aluminum Pipe: Unless otherwise specified, rigid buses shall be Schedule 40 seamless aluminum pipe equal to 6063-T6 alloy in accordance with ASTM B241/B241M.

c. Insulators:

- (1) Suspension: Unless otherwise specified, suspension-type insulators shall be gray in color, be the ball-and-socket type and radio noise-free. Insulator shells shall be made of wet process porcelain. The insulator units shall meet the requirements of Nema C29.1 and 2, except as otherwise specified in these paragraphs.

20,000-pound-strength insulators shall be Class 52-3 (ANSI Type B), with a combined mechanical and electrical strength rating of 20,000-pounds.

Metal caps and pins of insulators shall be manufactured from metal exhibiting a yield-strength to breaking-strength ratio of not less than two-thirds. Cotter pins shall be made of stainless steel, of the self-locking type and have a spread of approximately 1-inch at the end of the legs.

Each insulator shall be permanently marked in accordance with Nema C 29.2.

- (2) Station Post: Unless otherwise specified, post-type insulators shall be gray in color and shall be made of wet-process porcelain. Base caps that are identified as having ten (10) 3/8-inch or 12-inch bolt circles shall be in accordance with Drawing 31 1081, otherwise they shall use industry standard 5-inch or 7-inch base cap bolt circles. The insulator units shall meet the requirements of Nema C29.9 and C29.1 that provides additional testing details.

Each insulator shall be permanently marked in accordance with Nema C29.9.

d. Hardware Fittings: Each item of hardware shall be galvanized steel or galvanized malleable iron. Each overhead ground wire dead end assembly shall develop no less than 95-percent of the ultimate strength of the overhead ground wire. Items for use in insulator assemblies shall have a rated breaking strength of not less than that of the rated mechanical strength of the insulators with which they are used. Clevis connections shall be made with threaded hex-head bolts, nuts and stainless steel self-locking cotter pins. Threaded assemblies in

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tension shall have a rated strength of not less than two (2) times the rated strength of the surrounding hardware.

- e. Clamps and Connectors: Clamps and connectors for use at 345-kV and above shall be streamlined type for extra-high-voltage application and shall have a radio-influence-voltage (RIV) level of 250-microvolts or less when attached to a single conductor energized under the following conditions:

PHASE-TO-PHASE BUS VOLTAGE (kV)		MAXIMUM PHASE-TO-GROUND VOLTAGE PLUS 20-PERCENT (kV)	*MAXIMUM DISTANCE BETWEEN FITTING AND GROUND PLANE (FT)
NOMINAL	MAXIMUM		
345	362	250	9
500	550	380	13

*Equal to approximately 0.4-inch per line-to-ground kilovolts.

- (1) Rigid bus support fittings and terminal connections for aluminum pipe shall be in accordance with ASTM B26/B26M Designation No. 356 T6. Fitting and connector material shall meet the mechanical strength requirements of Table 2, ASTM B26/B26M for Alloy No. 356 T6.
- (2) Expansion bus supports and expansion terminal connectors shall provide space for expansion of aluminum rigid bus runs (from expansion to fixed fitting) for a temperature range from (-20-degrees-Celcius or -30-degrees-Celcius) to +93-degrees-Celcius. The minimum requirements for expansion fittings shall be in accordance with the following tables:

MINIMUM REQUIREMENTS FOR EXPANSION BUS SUPPORTS					
				† BUS LENGTH LIMIT	
BOLT CIRCLE (INS)	MINIMUM AMBIENT TEMPERATURE		MINIMUM EXPANSION SPACE EACH SIDE (INS)	ONE SIDE (FT)	BOTH SIDES (FT)
	°C	°F			
3	-20	-4	1.125	35	70
3	-30	-22	1.125	30	60
*5	-20	-4	2.125	65	130
*5	-30	-22	2.125	60	120
7	-20	-4	3.000	95	190
7	-30	-22	3.000	85	170

* 5-inch bolt circle is specified for all insulator stacks on Drawing 31 1081.

† These limits would increase if greater expansion space is provided.

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MINIMUM REQUIREMENTS FOR EXPANSION TERMINALS			
EXPANSION TERMINAL (TYPE)	MINIMUM AMBIENT TEMPERATURE (C°)	MINIMUM EXPANSION SPACE (INS)	‡ BUS LENGTH LIMIT (FT)
Pad-To-Tube	-20	3.75	120
Pad-To-Tube	-30	3.75	110
Stud-To-Tube	-20	2.00	60
Stud-To-Tube	-30	2.00	55

‡ These limits would increase if greater expansion space is provided.

Except as otherwise specified, expansion terminals shall be the type with alignment guides and not the semi-flexible type or the type without alignment guide.

- (3) Clamps or Compression Type Fittings (DMC Power's Cable Connectors, DMC Power's Full Tension Connectors and Swaging System, AFL Swage System or equal) for ACSR or Aluminum Conductors: Suspension and bus support clamps, terminals, dead end fittings and strain clamps shall be aluminum alloy and of the type shown on the Drawings and in the project specifications. All clevis connections shall be made with threaded hex-head bolts, nuts and stainless steel self-locking cotter pins. Compression-type dead end fittings shall develop at least 95-percent of the ultimate strength of the conductor and shall have a conductivity of not less than that of the conductor with which they are used. If swaged type fittings are used, the fittings and installation tooling shall be furnished by the same manufacturer.
- (4) Bus Connectors, Corona Bells, Couplers, Height Adapters and Equipment Terminal Connectors: Connectors and height adapters, including equipment terminal connectors and corona bells, shall be of the sizes required and of the types indicated on the Drawings and in the project specifications.
 - (a) Welded couplers for splices shall be made of aluminum 6063-T6 alloy tubing in accordance with ASTM B241/B241M with center stop to provide correct gap between the ends of the tubing during welding.
 - (b) Bends shall be factory elbows connectors (angle couplers). Material for welded elbow connectors shall be in accordance with ASTM B26/B26M Designation No. 356 T6.
 - (c) Compression-type splices, couplers, elbows and fittings (DMC Power's Substation Bus Connectors and Swaging System, AFL Swage System or equal) in lieu of welded-type may be used on the rigid bus as approved by the COR. Material for compression splices and elbows shall be made of 6061-T6 aluminum alloy per ASTM B241. Splices or couplers shall be the long type (DMC Power's PLK1001 or equal). Splices or couplers shall not interfere with fixed, expansion and slip bus supports. If swaged type fittings are used, the fittings and installation tooling shall be furnished by the same manufacturer.
 - (d) Aluminum-to-aluminum and aluminum-to-copper connections shall be made with aluminum connectors. Aluminum connectors shall be made of aluminum alloy SG70A in accordance with ASTM B 26 (Aluminum Association Alloy Designation No. 356) and shall be designed and proportioned for contact with copper surfaces without the use of any plating or bushings. Where-ever

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possible, aluminum conductors and fittings shall be installed above copper conductor and fittings to prevent washing of copper salts over the aluminum.

- (e) Copper-to-copper connections shall be made with bronze connectors.
- (f) Where bronze connectors are specified for aluminum connections, the connector shall be tin plated to a thickness of not less than 0.0005-inch over the entire area that is in contact with aluminum.
- (g) Terminal connector pads shall be in accordance with latest NEMA CC-1.
 - 1) Terminal connector hardware shall consist of stainless-steel bolts, washers, and lock washers with silicone bronze nuts for all connections. Galvanized steel is not allowed. Bolts shall be 304 (18-8) or 316 stainless steel with a minimum tensile strength of 70,000 psi in accordance with NEMA CC-1, Section 4.5. Bolts shall be torqued in accordance with the manufacturer's recommendations.
- (5) Paste: Paste shall be of the oxide-inhibiting, corrosion-resistant type equal to No-Ox-Id or Penetrox-A.
- (6) Corona Rings: Corona rings shall be provided to shield hardware as shown on the Drawings and as required by equipment and material manufacturers and suppliers.
- (7) Corona Hardware Shields: Corona hardware shields shall be provided to shield NEMA mounting hardware (bolts, nuts, washers, etc.) as required by the equipment and material manufacturers and suppliers and this Section 9.3.1.(5).

2. INSTALLATION:

- a. Rigid Bus: Rigid buses shall be formed and installed such that stresses between connecting terminals and between bus supports are reduced to a minimum. Bends shall be made with welded elbows connectors (angle couplers) unless shown otherwise on the Drawings or in the project specifications. Where field bends are required, the bends shall have a radius equal to eight (8) times the nominal pipe size. The bus shall be free of kinks, indentations and flattened surfaces. The number of splices shall be kept to a minimum. Splices and couplers shall not be located in the middle third of the span between bus supports and shall be located a maximum of 10-feet from bus supports. Unless otherwise approved by the COR, noted on the Drawings, or noted in the project specifications, splices in aluminum pipe bus shall be welded or DMC Power's Long Splice type PLK1001 or equal. The welded-type splices and elbows shall be installed and welded in accordance with detailed instructions furnished by the manufacturer of the couplers. Compression type splices, elbows and fittings shall be installed in accordance with detailed instructions and using compression equipment provided by the manufacturer of the couplers in accordance with its lease and loan policy. Provide a 1/4-inch diameter weep hole (for drainage) at the low point of each rigid tubular bus conductor span

Expansion fittings should be installed in accordance with manufacturer's instructions. A simple method of determining the setting for a specific fitting and a specific conductor temperature is illustrated by the following example:

EXAMPLE: Expansion fitting parameters and conductor temperature

$$\begin{aligned} \text{TR} = \text{Temperature range} &= (-22^{\circ}\text{F to } +200^{\circ}\text{F}) \text{ or } (-30^{\circ}\text{C to } +93^{\circ}\text{C}) \\ &= 222^{\circ}\text{F or } 123^{\circ}\text{C} \end{aligned}$$

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S = Expansion space for 120-foot maximum bus length = 3.75-inches

TC = Conductor installation temperature = 68°F

L = Bus length = 120-feet or less

Using the +200°F limit as a reference, the setting must provide expansion for (200°F - 68°F) = 132°F. Since the expansion function is linear, the proportion needed of the total space

provided is simply $\left(\frac{132^{\circ}F}{T_R} \right) S = \left(\frac{132^{\circ}F}{222^{\circ}F} \right) 3.75 = 2.23$ inches from the 200°F reference limit.

Clean all mating surfaces prior to installing bolted connectors. Oxide-inhibiting paste shall be used in making all-aluminum and aluminum-to-copper connections. The paste shall be applied, the aluminum surfaces shall be wire brushed through the paste and additional paste shall be applied, if necessary, to cover the contact area. Paste remaining after the connectors are tightened shall be retained as a seal against moisture. All bolted-type connectors shall be clamped and locked securely using torque wrenches and the moments recommended by the manufacturers.

Welding of aluminum pipe bus shall be done in accordance with AWS D1.2. The finished welds shall be smooth and free of weld spatter, adhesions, scratches, etc. Weld around the entire perimeter of electrical fittings to the rigid bus.

Welding shall be performed only by welders who are currently certified in accordance with AWS D1.2. Provide written certification to the COR.

ACSR damping cable shall have multi-strand core and shall be installed in rigid pipe buses in accordance with the following table except as otherwise allowed:

NOMINAL PIPE SIZE (INS)	SINGLE ACSR CABLE (KCMIL)
1 1/2 to 3	266.8
3 1/2	397.5
4	795
5	1431
6	1590

Vibration-damping ACSR cable shall be inserted into aluminum pipe buses, shall be continuous unspliced length throughout bus runs and shall be left unrestrained in order to dampen vibrations. Corona bells shall be installed on all open ends of pipe bus including those at equipment terminals and at expansion connectors without alignment guides. AAC cable can be substituted if no ACSR is used during construction.

- b. Strain and Jumper Buses and Overhead Ground Wire: Equipment and methods used for installing strain and jumper buses and overhead ground wire shall be subject to the approval of the COR. Joints, splices and repair sleeves will not be allowed and particular care shall be taken to insure that the cables do not become abraded. Sections of the cables damaged by the application of gripping attachments will be considered as damaged material.

Clean mating surfaces prior to installing bolted connectors. Oxide-inhibiting paste shall be used in making aluminum-to-aluminum and aluminum-to-copper connections. The paste

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shall be applied, the aluminum surfaces shall be wire brushed through the paste and additional paste shall be applied, if necessary, to cover the contact area. Paste remaining after the connectors are tightened shall be retained as a seal against moisture. Bolted-type connectors shall be clamped and locked securely using torque wrenches and the moments recommended by the manufacturers.

Specific instructions, including sag data and drawings not included in the specifications, necessary to complete the strain and jumper bus and overhead ground wire installation will be furnished by the COR.

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SECTION 9.4 – EXISTING OUTDOOR ELECTRICAL EQUIPMENT AND MATERIAL

9.4.1 EXISTING OUTDOOR ELECTRICAL EQUIPMENT AND MATERIAL:

1. **STORAGE OF REMOVED EQUIPMENT AND MATERIAL:** Disconnect, dismantle and load equipment and material from the existing installation and haul them to the locations where they are to be stored. Provide storage and care for removed equipment and material until they are transported. Equipment with PCBs shall be removed in accordance with Division 13.
2. **LOST OR DAMAGED EQUIPMENT AND MATERIAL:** Equipment and material to be reused shall be stored properly until ready for installation. Replace material lost or damaged after they are removed. Equipment destroyed or damaged in handling or storage to such an extent that it is no longer usable, as determined by the COR, will be considered as damaged material. The Contractor may repair damaged equipment that can be satisfactorily repaired, as determined by the COR. Otherwise, the Contractor shall replace such equipment. Extreme care shall be used to avoid damaging bushings or other parts of the equipment that would prevent immediate reuse of the equipment.
3. **DISCONNECTED GROUNDING CABLE RISERS:** Grounding cable risers disconnected from removed equipment shall be buried at least 18-inches under the finished grade. Excavations shall be filled with compacted backfill to the required subgrade elevation and the gravel surfacing shall be restored as provided in the Standard 2 – Sitework.
4. **DISCONNECTED UNDERGROUND CONDUITS:** Underground conduits that are to be abandoned shall have all cables removed from the inside, shall be cut off at finished grade and shall be capped.
5. **DISCONNECTED CONTROL AND STATION-SERVICE POWER CABLES:** Control and station-service power cables which are disconnected from equipment and are not reused shall be disconnected at both ends and the portion that is buried underground shall be abandoned. The portion in conduit, trench and/or trays shall be removed and disposed of by the Contractor.

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SECTION 9.5 – SUBSTATION LIGHTING

9.5.1 LIGHTING UNITS:

1. GENERAL: Grounding, electrical conduit and insulated wire and cable systems other than lighting fixture wire shall be in accordance with section 9.2 “Grounding, Conduit and Low-Voltage Cable Systems”. Provide temporary lighting equipment, if necessary, to accommodate and facilitate construction operations.
2. INSTALLATION: Install substation lighting units at the locations shown on the Drawings, and make conduit, wiring, cable and grounding connections. Angle floodlights or add diffusers so they do not shine past the fences.

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SECTION 9.6 – SUBSTATION SIGNS

9.6.1 SECURITY, IDENTIFICATION, DANGER WARNING AND SAFETY SIGNS:

1. **GENERAL:** Security signs, phase-identification signs and equipment identification signs shall be in accordance with Drawing 31 1000 except that text or format may vary for miscellaneous items. Danger signs shall be in accordance with Drawing 31 1089. Danger sign for shunt capacitor banks shall be in accordance with Drawing 31 1079. Warning and safety signs will be prepared as needed on a case by case basis. The mounting bolts, nuts and washers shall be galvanized or of nonferrous, noncorrosive metal.
2. **INSTALLATION:** Signs shall be mounted in a manner to avoid chipping the surfaces. The mounting location of signs shall be as specified in project specifications and as directed by the COR.

The Contractor shall perform required drilling and tapping for mounting the signs on steel members.

Signs mounted on concrete structures shall be secured either by the powder-actuated tool method or by inset expansion screw anchors.

Signs mounted on electrical equipment or enclosures with a NEMA 3R or higher rating shall be bolted to the enclosure door or panel. Bolts shall be installed with rubber gaskets on both sides and clear silicone sealant to maintain the weather rating of the enclosure.

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SECTION 9.7 – CONTROL, METERING AND RELAYING EQUIPMENT

9.7.1 SWITCHBOARD SECTIONS:

1. GENERAL: The Contractor shall furnish switchboard wire, insulating tape, solder, flux, connectors, terminals, brackets, bolts and other material required for installing switchboard sections and switchboard devices and material required for filling holes and cutouts in existing switchboards.

The Contractor shall receive, install, connect and make ready for service Government-furnished switchboard sections and unmounted switchboard devices. The switchboard sections shall be installed in the service building where shown on the Drawings. Any apparent damage shall be noted on the shipper's paperwork and immediately brought to the attention of the COR.

2. MATERIAL:

- a. Switchboard Wiring: Switchboard-type No. 14 AWG, Class K stranded, copper conductor, rated for 600 V service, with insulation equal to General Electric Company Vulkene (SIS).
- b. Wire Terminations: Wire terminations shall be made with preinsulated, pressure-crimp-type terminal connectors with ring tongues equal to T&B "STA-KON" terminals manufactured by ABB.
- c. Crimps shall be installed with tooling equipment with a T&B "SHURE-STAKE" mechanism, ratcheting style crimper or equal.
- d. All crimps made for electrical connections shall be performed with 'go/no-go style crimpers' and tugging on the lug to ensure crimp is secure. All crimps shall be verified by Western inspection personnel prior to commissioning.

3. INSTALLATION: Government-furnished switchboard sections and unmounted switchboard devices shall be installed complete and ready for normal operation. Installation shall include the following:

- a. Receiving, handling, storing and providing proper care for the switchboard sections and unmounted devices prior to and during installation. After installation, the Contractor shall repair damaged finished surfaces of the switchboard sections in accordance with the "Painting" Standards.
- b. Drilling holes required for mounting.
- c. Mounting and leveling each switchboard section in position. Channel bases shall be grouted with grouting mortar in accordance with the Standard 3 – Concrete, Section 3.1.10 "Grouting Mortar".
- d. Installing unmounted switchboard devices.
- e. Removing and replacing end trims.
- f. Making electrical connections from outdoor and service building electrical equipment to switchboard sections, between switch-board sections and between switchboard panels as required. Wiring connections between switchboards shall be made by multiconductor control cable. Single conductor or switchboard wiring may only be used for connections between adjacent switchboard sections and panels. The Contractor-installed wires and cables shall be tagged as directed by the COR.

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- g. Making wiring connections between adjacent existing switchboard panels and connections between devices within a switchboard panel. These wiring connections shall meet the following requirements:
- (1) Exposed wiring shall be kept to a minimum, but where used, wiring shall be formed into compact groups bound together and firmly supported and shall be run straight, horizontally or vertically with short-radius, right-angle bends. Hinge wiring shall be twisted around the longitudinal axis of the wire, wherever possible, instead of being bent laterally. Each wire shall be protected from abrasion where it leaves a channel or duct. Splices will not be permitted in wiring. Connections shall be made at device studs or terminal blocks. Wiring between various devices shall be performed by the most direct method rather than looping back and forth across switchboards. Wires at terminal blocks shall be arranged or grouped for connections to a minimum number of external cables.
 - (2) Filling holes and cutouts resulting from removal of existing equipment. Switchboard filling shall be approved by the COR. Cutouts shall be filled with steel plates. Joints and filled holes shall be finished smooth and flush with the surrounding panel.
 - (3) Repairing and replacing damaged material. Repairs and replacements shall be approved by the COR.
 - (4) Correcting errors made by the Contractor in installation at no expense to WAPA.

9.7.2 UNMOUNTED DEVICES ON EXISTING SWITCHBOARDS:

1. GENERAL: Furnish switchboard wire, steel plates and associated material for filling holes and cutouts; insulating tape; solder; flux, mimic bus with symbols; and connections for installing the switchboard devices.

The Contractor shall receive, install and connect unmounted switchboard devices; remove existing devices; and remove and reinstall existing devices as specified. Government-furnished devices will be delivered to the Contractor as provided for in the project specifications.

2. MATERIAL:

- a. Switchboard Wiring: Switchboard-type No. 14 AWG, Class K stranded, copper conductor, rated for 600-V service, with insulation equal to General Electric Company Vulkene (SIS).
- b. Wire Terminations: Preinsulated, pressure-crimp-type terminal connectors with ring tongues equal to T&B "STA-KON" terminals manufactured by ABB.

3. INSTALLATION: Make internal and external connections, make internal switchboard wiring changes and additions and extend or replace existing internal wires and cables where additional length is required to enable the switchboards and equipment to be made ready for service. Connections shall be made properly and adjustments shall be made where required to put switchboards and equipment into normal operation.

Cut and drill holes where required for mounting. The Contractor is responsible for proper installation of the devices on switchboard panels as specified.

Special care shall be taken when disconnecting, moving, removing and reconnecting electrical devices, and end trims, to avoid equipment misoperation and damage to the equipment. Wires and cables to be disconnected and reused shall be tagged prior to removal. Unused existing wire and cable shall be coiled and turned over to the COR. Electrical devices to be reused shall be reinstalled as shown on the Drawings. Electrical devices not reused shall be turned over to the COR. Existing circuits from which devices have been removed shall be reconnected and tested to verify operation and retention of existing circuits. Repair areas from which devices have

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been removed as directed by the COR. Holes and panel cutouts shall be filled so that the panel space may be reused. Cutouts shall be filled with steel plates and joints and filled holes shall be finished smooth and flush with the surrounding panel. Unfinished and damaged portions of repaired panels shall be finished inside and outside to match the finish and color of the adjacent, undamaged finished surface.

Equipment destroyed or damaged in handling and storage, as determined by the COR, shall be repaired in a manner approved by the COR or shall be replaced by and at the expense of the Contractor.

The Contractor shall make the necessary arrangements with the COR before removing equipment and material.

9.7.3 DIRECT- AND ALTERNATING-CURRENT DISTRIBUTION BOARDS:

1. GENERAL: Distribution boards required to complete the low-voltage ac and dc systems shall be in accordance with this standard, WAPA's equipment standard WAPA ES 2.4, project specifications and the Drawings.
2. INSTALLATION: Distribution boards shall be installed complete as described in this paragraph, including wire and connections required to put the distribution boards into readiness for normal operations. The installation and location of the distribution boards shall be as shown on the Drawings. All cables shall enter the boards from beneath by means of the building cable trenches or raised floor construction under the boards as specified. Furnish anchoring, supporting and mounting material as required to install the distribution boards.

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SECTION 9.8 – STATION BATTERY AND BATTERY CHARGERS

9.8.1 STATION BATTERY:

1. GENERAL: The Contractor shall receive, install, connect and make ready for service the Government-furnished station battery. If the battery is a flooded lead acid design, the “battery” includes one (1) or more separate rack(s) which is (are) to be received, assembled and installed by the Contractor. If the battery is a valve regulated lead acid (VRLA) design, then the “battery” includes/is equipped with a modular framing system, which is to be received, assembled and installed by the Contractor. The battery shall be installed in the service building battery room/location as shown on the Drawings. The battery will be delivered to the Contractor at the substation site as provided in the Standard 1 – General Requirements, Section 1.2.1 “Government-Furnished Material”. Any apparent damage noticed at the time of delivery shall be noted on the shipper’s paperwork and immediately brought to the attention of the COR.
2. INSTALLATION: The Government-furnished, 125 V station battery shall be installed complete and ready for use. Installation shall include the following:
 - a. Receive, unload, handle, store and provide proper care for the battery prior to and during installation. “Receive” includes making an immediate inventory (using the packing list supplied by the manufacturer with the battery) of all items, parts, manufacturer’s data/drawings and accessories shipped and notifying the COR of any shortages. “Store” includes indoor storage in a cool, clean, dry location in accordance with the manufacturer’s installation instructions. “Proper care” includes satisfying the manufacturer’s conditions for preserving warranty coverage.
 - b. Provide the initial charge and maintain a proper charge on the battery until the installation is accepted by WAPA. If the permanent battery location is not available, battery cells/modules may be stored on the shipping pallets/crates for an interval not to exceed 6-months from the date of shipment to the date of initial charge. The battery is to be given its initial charge (see manufacturer’s installation instructions) before the end of the 6-month storage interval. The Contractor is to provide the manufacturer’s required re-charging and maintenance charging for extended storage. The Contractor shall furnish temporary battery charging equipment and loading devices needed to make the initial charge, discharge tests and subsequent re-chargings.
 - c. Provide and install the necessary expansion type anchors, flat washers, beveled washers and miscellaneous hardware as required to install the anchors in accordance with the manufacturer’s recommendations. Determine the floor anchor bolt locations based upon the battery’s permanent location. Prior to the drilling of any holes for anchor bolts, the Contractor shall locate and mark the reinforcement steel embedded in the concrete slab. All required anchor bolt holes shall be drilled so as to miss the embedded reinforcing steel and allow proper cover to be maintained on the reinforcing steel in accordance with WAPA’s Concrete Standards Drawing 01 2004. The proposed location of the anchor bolts and battery framework shall be approved by the COR prior to drilling anchor bolt holes. The battery/rack shall be anchored to the concrete floor. GNB “Absolyte” VRLA modules shall be anchored as follows:
 - (1) The Contractor shall locate and drill holes in the concrete floor for the 1/2-inch diameter, carbon steel, stud type expansion anchors. The anchor bolt layout pattern shall be in accordance with “GNB Industrial Battery Company” Drawing 400948, Revision B, dated 93/06/10 or subsequent revision, as provided with the battery. The anchor bolt holes for the battery frame shall use either of the base anchor holes provided in the bottom flange of the S4 x 7.7 horizontal support “I” beam. Due to the bevel on the flange of the S4 x 7.7, steel S shape member, beveled washers may be required for proper installation. Only one (1) anchor bolt for each end of the support beam is necessary, and only one (1) anchor bolt on either side of the beam web is required. If the floor reinforcing is in a position that interferes with alternating the

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anchor bolts on either side of the web, then both anchor bolts may be installed on the same side of the web, provided that the anchor bolts for an adjacent horizontal support are both located on the opposite side of the web in relation to the horizontal support affected by the floor reinforcing. A typical installation of a battery with the 4 (across) by 5 (high) module arrangement should require a total of ten (10) anchor bolts with five (5) being left of the horizontal support webs and five (5) being right and five (5) of the ten (10) using the front anchor bolt holes and five (5) using the back anchor bolt holes.

- (2) The anchor bolts shall have a minimum 1-inch and a maximum of 1 1/2-inches projection above the concrete floor finish grade. The anchor bolt shall have a minimum of 2 1/4-inch embedment into the concrete, with the maximum embedment as per the manufacturer's recommendation, but shall not completely penetrate the concrete slab. The anchor bolt embedment should be designed based on a slab thickness of 5-inches and concrete strength of 4,000-psi(f'c). The anchor bolt shall resist an ultimate tensile load of 5,000-pounds and an ultimate shear load of 2,500-pounds each, at its design embedment depth. The anchor bolts shall be as follows or equal:
 - (a) Hilti Kwik Bolt II. Manufactured by: Hilti Fastener Corporation; P.O. Box 21148; Tulsa, Oklahoma 74121.
 - (b) Rawl-Bolt or Rawl-Stud. Manufactured by: The Rawlplug Company, Inc.; New Rochelle, New York 10802.
- d. Assemble the battery according to the manufacturer's instructions, placing the battery in its permanent location. The battery shall be level.
- e. Furnish miscellaneous material, including terminals, mounting brackets, bolts, leveling spacers and shims and other items required for assembling and installing the battery and making connections.
- f. Making internal and external connections. External connections shall be made to the dc distribution board and to the battery temperature sensor(s) for the battery chargers. Refer to the manufacturer's recommendations on use of the NO-OX-ID "A" grease when making connections. The cable size for the cabling to the dc distribution board shall be as shown on the Drawings.
- g. Each battery temperature sensor supplied with and used by the battery chargers shall be connected to a negative terminal of a cell in the center of a group of cells. The temperature sensor shall be fastened to the post using the terminal connection bolt and located between the intercell connector strap and the washer. (From the cell negative terminal post: intercell connector strap, temperature sensor, washer and bolt head).
- h. Repair or replace damaged material.

9.8.2 BATTERY CHARGERS:

1. GENERAL: The Contractor shall receive, connect and make ready for service the Government-furnished battery chargers. Battery chargers shall be installed in the service building control room as shown on the Drawings. The battery chargers will be delivered to the Contractor as provided in the Standard 1 – General Requirements, Section 1.2.1 "Government-Furnished Material". Any apparent damage noticed at the time of delivery shall be noted on the shipper's paperwork and immediately brought to the attention of the COR.

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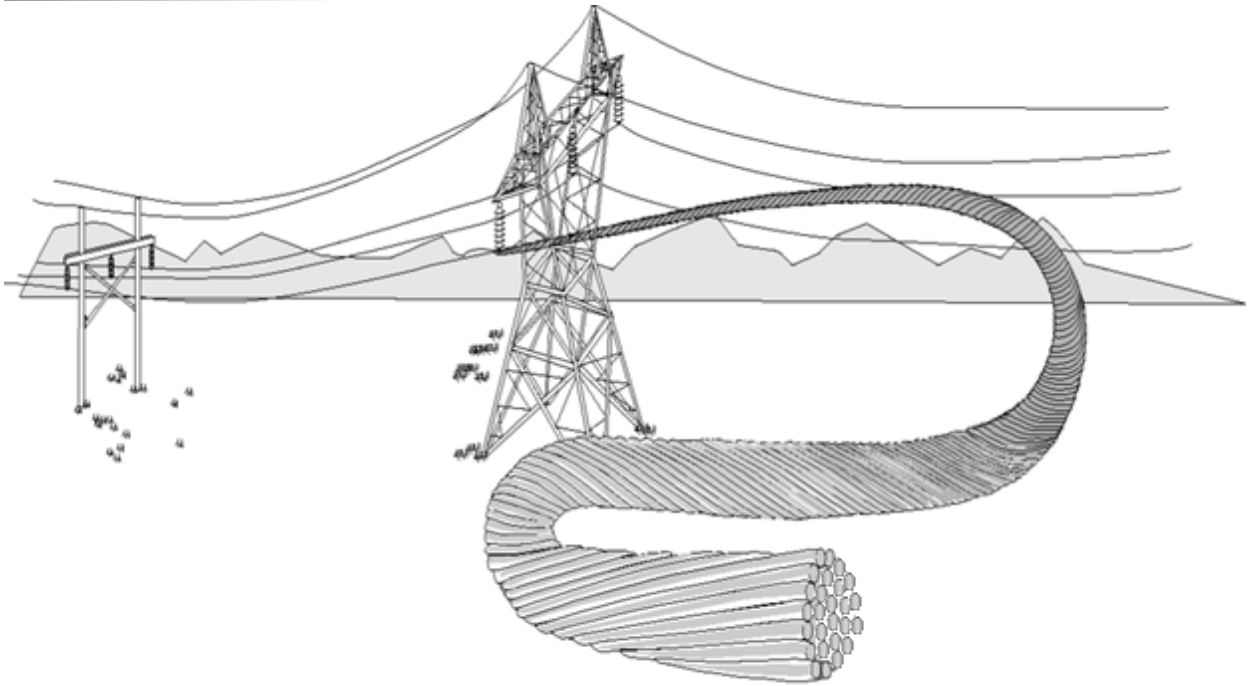
2. INSTALLATION: The Government-furnished battery chargers shall be installed complete and ready for normal operation. Installation shall include the following:
 - a. Receiving, handling, storing and providing proper care for the battery chargers prior to and during installation.
 - b. Drilling holes required for mounting.
 - c. Furnishing miscellaneous material including anchors, terminals, brackets, bolts and related items required for installation.
 - d. Mounting and leveling each battery charger.
 - e. Furnishing material and making wiring connections to ac and dc distribution boards, including installing and terminating:
 - (1) Battery temperature compensation remote sensors (one (1) for each charger), as described above under the installation requirements for the battery.
 - (2) Cabling for charger alarm output contacts.
 - (3) Charger to charger interconnections, such as for load sharing.
 - f. Repairing or replacing damaged material as determined by the COR.
 - g. Repairing damaged finished surfaces in accordance with the Standard 12 – Painting.
 - h. Equipment and wiring checkout in accordance with section 9.1.2 – “Acceptance Tests”.



Western Area
Power Administration

CONSTRUCTION STANDARDS

STANDARD 10 TRANSMISSION LINE – ELECTRICAL



2026

SAFETY
A HABIT TO LIVE BY

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SECTION 10.1 – GENERAL

10.1.1 GENERAL:

Comply with requirements specified under the “Safety and Health Requirements” paragraph of the “General Requirements” Standards.

Some drawings are typical, and the Contractor shall not be entitled to any allowance above the prices bid in the Bidding Schedule by reason of modifications of a minor nature.

10.1.2 ITEMS REQUIRING SPECIAL ATTENTION:

Items requiring special attention include the bolts in line hardware and accessories and the installation of sleeves in compression fittings. Obtain installation instructions from the manufacturers of such items and furnish at least two (2) copies of such instructions to the COR at least 40-days prior to installation. The following installation procedures shall be adhered to:

1. **BOLT TIGHTENING:** Bolts used with suspension clamps, vibration dampers and jumper conductor connectors shall be torqued to the manufacturer's recommended values using torque wrenches or other manufacturer-recommended methods. Both nuts of “U” bolts shall be torqued to the indicated value. WAPA will make spot checks of bolt torques and, if deficiencies are found, the Contractor shall re-torque bolts to the extent deemed necessary by the COR.
2. **COMPRESSION FITTINGS:** Ensure that compression joints are centered, that the correct length of steel strand is inserted into the fitting and that the steel sleeves of joints and dead ends are properly compressed onto the steel strands before proceeding. Where aluminum sleeves are used for conductor compression fittings, care shall be exercised to ensure that compression deformations do not become sources of corona discharge. The COR reserves the right to witness and approve the installation of all compression fittings and to reject any compression fitting which is installed without the COR being present to witness the installation.
3. **BEND RADIUS:** Ensure that the minimum bend radius of the optical overhead ground wire (OPGW) and composite core conductor is not exceeded at any time during installation. Strictly adhere to the manufacturer's recommendations.

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SECTION 10.2 – DRAWINGS, DATA AND TEST REPORTS

10.2.1 GENERAL:

Material shall not be installed prior to meeting the requirements of this standard for drawings, data and test reports.

10.2.2 DRAWINGS AND DATA:

As soon as practicable after award of contract, but at least 40-days prior to installation of material, furnish WAPA, for review, an electronic set each of catalog data sheets of accessories and hardware used in conductor and overhead ground wire installation; drawings showing the complete insulator and overhead ground wire assemblies and details of all hardware and fittings used in the assemblies; and a complete material list showing the name of the manufacturer and the manufacturer's catalog number or type, for each item of material listed below. Strike through all unused rows of the table and add one row for each contract line (CLIN) specified material that is not listed in the table below.

For vibration dampers or spacer dampers the data furnished shall include the necessary vibration protection recommended by the damper manufacturer, based on protectable span lengths. This data shall include the total quantities of dampers or spacer dampers required for the project.

For composite insulators, the drawings and data furnished shall include description of the type resin used in the insulator core, the type base material used in the housing and weathersheds and the method used to seal the junction of the metal end fittings and housing or sheath; drawings showing ratings and dimensions, including corona ring dimensions and mounting position on the insulator; and handling and installation instructions for the insulators being furnished.

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For OPGW, the drawings and data furnished shall include catalog data sheets of OPGW, accessories and hardware used in OPGW installation; drawings showing the OPGW attachment assemblies and details of all hardware and fittings used in the assemblies.

ITEM	MANUFACTURER AND PART NUM.	ITEM	MANUFACTURER AND PART NUM.
1. conductor		16. conductor armor rod	
2. conductor splice		17. OGW armor rod	
3. bundled conductor spacer		18. OPGW protector rod	
4. overhead ground wire (OGW)		19. conductor vibration damper	
5. OGW splice		20. OGW vibration damper	
6. optical overhead ground wire (OPGW)		21. OPGW vibration damper	
7. other wire, if required		22. conductor deadend	
8. insulator (porcelain disc or toughened glass disc)		23. OGW deadend	
9. insulator (composite, suspension)		24. OPGW deadend	
10. insulator (composite, horizontal line post)		25. avian diversion or marking device	
11. insulator (composite, station post)		26. marker ball	
12. other insulator, if required (examples: porcelain station post, two- part insulator assembly, static wire insulator)		other fitting or hardware (examples: grading ring, turnbuckle, yoke plate, clamped conductor weight, suspended conductor assembly weight, spacer damper, avian line marker)	
13. conductor suspension			
14. OPGW suspension			
15. OGW suspension			

10.2.3 TEST REPORTS:

As soon as practicable after completion of individual tests, furnish to the engineer, for review and approval, electronic certified copies of records or results of tests as follows:

1. CONDUCTOR INSULATOR ASSEMBLIES: In accordance with Section 10.3.3.
2. CONDUCTOR: In accordance with Section 10.6.1.2.
3. OVERHEAD GROUND WIRE: In accordance with Section 10.6.2.2.
4. OVERHEAD GROUND WIRE ASSEMBLIES: In accordance with Section 10.4.3.
5. VIBRATION DAMPERS: In accordance with Section 10.6.5.3.
6. OPTICAL OVERHEAD GROUND WIRE: In accordance with Section 10.6.3.2.

Certified Reports: Certified reports of results of previous design tests made on insulators, suspension clamps, assembly coupling hardware, compression or implosive dead ends, joints, conductors, overhead ground wires, vibration dampers and conductor spacer dampers, identical to those required will be accepted as meeting the design test requirements of these standards.

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SECTION 10.3 – CONDUCTOR INSULATOR ASSEMBLIES

10.3.1 GENERAL:

Standard conductor insulator assemblies are shown on Drawings 41 1020-1, 41 1020-2, 41 1021, 41 1022, 41 1023-1, 41 1023-2, 41 1023-3, 41 1023-4, 41 1024 and 41 1025. Lines designed for operation above 230 kV shall have assembly drawings prepared for that line.

10.3.2 MATERIAL:

1. GENERAL: Material to be used on the line end of insulator assemblies shall be protected during shipment and handling to prevent any damage that would become a source of corona discharge. Turnbuckles may be used, at the Contractor's option and at no additional cost to WAPA, as a part of tension insulator assemblies.

The string length of a suspension assembly shall measure from the structure attachment point to the bottom of the clamp.

The string length of a tension assembly shall measure from the structure attachment point to the compression dead end assembly attachment point.

Material lists or purchase orders for suspension discs shall expressly indicate the insulator color or state: "colorless."

The quality assurance system of design, manufacture and inspection of insulators shall conform to ISO 9001 and quality assurance certification according to ISO 9001 issued by an authorized inspection agency shall be submitted prior to installation.

2. PORCELAIN AND TOUGHENED GLASS INSULATORS: Insulator units for conductor insulator assemblies shall be ball-and-socket type and shall meet the requirements of ANSI/NEMA C29.1 and ANSI/NEMA C29.2B except as otherwise specified in these paragraphs.

The following classes, listed by Mechanical and Electrical strength, shall be specified:

- a. 20,000-pound-strength insulators shall be ANSI class 52-3-H (Type B).
- b. 30,000-pound-strength insulators shall be ANSI class 52-5-H (Type J).
- c. 40,000-pound-strength insulators shall be ANSI class 52-8-H (Type K).
- d. 50,000-pound-strength insulators shall be ANSI class 52-11 (Type K).

Insulator shells shall be made of wet-process porcelain or toughened glass. Toughened glass insulators shall be colorless or "clear" in color. Insulators shall be fabricated using hot cured alumina cement only. A plastic or other ring shall not be used to fill the space between the edge of the cap and the porcelain or glass shell.

Porcelain heads shall be oriented perpendicular to the shell to distribute uniform stresses on the head portion.

Insulators shall be designed and manufactured to provide mechanical ruggedness and long service life without sacrificing electrical and operating characteristics specified here. All insulator surfaces and grooves shall be shaped for natural cleaning by rain.

To facilitate live-line transmission maintenance activities, specifically the use of a hotstick to move the cotter key on the insulator bell to the "unlocked" position, the porcelain insulator skirts shall be manufactured in such a manner that all insulator skirts become progressively shorter in length toward the shank of the insulator. Reference ANSI/NEMA C29.2B Figure 1.

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Metal cap sockets and ball pins of insulators shall be manufactured from metal exhibiting a yield-strength to breaking-strength ratio of not less than 50-percent. Split cotter pins shall be made of austenitic stainless steel, of the humped back self-locking type, and have a spread of approximately 1-inch at the end of the legs. The cotter key shall prevent an insulator from being unintentionally uncoupled from an adjacent insulator during normal handling and use.

Metal cap sockets and ball pins shall be checked after galvanizing by the applicable socket and ball gauges specified in ANSI/NEMA C29.2B. Ball pins shall be checked with the applicable “GO” gauges in at least two (2) directions at approximately 90-degrees to each other and “NO-GO” gauges shall not pass in any direction.

The class “-H” suffix, recently added to the standard, reflects the reality of higher M&E strength ratings for several classes. Each insulator shall be permanently marked in accordance with ANSI/NEMA C29.2B, identifying the manufacturer, the year of manufacture and ratings of the following two quality conformance and routine tests, listed below by class, identified “M&E” and “TEST”:

- a. Class 52-3-H: 20,000-pound M&E and 10,000-pound TEST
- b. Class 52-5-H: 30,000-pound M&E and 15,000-pound TEST
- c. Class 52-8-H: 40,000-pound M&E and 20,000-pound TEST
- d. Class 52-11: 50,000-pound M&E and 25,000-pound TEST

3. COMPOSITE SUSPENSION AND LINE POST INSULATORS: This section applies to insulators referred to as composite, polymer, polymer-fiberglass or non-ceramic.

Composite suspension insulators shall meet the requirements of ANSI/NEMA C29.11, C29.12 and C29.17, except as otherwise specified in these paragraphs.

All fibers of the insulator core shall be continuous from end-to-end of the rod, oriented parallel to the rod and fully and completely coated with a vinylester or epoxy resin matrix. During fabrication of the insulator core, the glass fibers shall not be allowed to touch one another without resin matrix surrounding each individual fiber.

The insulator core shall be “electrical grade epoxy rod” to achieve maximum tensile strength. The insulator core shall be mechanically and electrically sound and free from voids, foreign substances and similar manufacturing flaws.

The housing of the composite insulator shall be equipped with weathersheds. The base material for the housing (sheath) and weathersheds shall be a silicone or EPDM rubber or a silicone compound blended with an EP rubber during the batching process such that an alloy of the two (2) is formed during the final vulcanization process. The sheath shall have a minimum thickness of 3.0-mm. The housing and weathersheds shall be continuous or bonded and be smooth and free from imperfections.

The rod, sheath and sheds shall be joined into one (1) integral unit without voids by a compression molding process, high-temperature injection molding process or a high temperature vulcanization process. Adhesives or other bonding material shall not be used for joining the rod, sheath and sheds.

Each insulator design is required to have a minimum leakage specification of 0.87-inches per kV.

The end fittings shall be designed to transmit the mechanical load to the core and to develop the uniform and consistent mechanical strength of the insulator. The insulators' end fittings shall be connected to the rod core by means of compression or cemented wedge method at attachment. Fracturing of the rod is not acceptable. The junction of the metal end fittings and the housing/sheath shall be permanently sealed to prohibit the entrance of moisture and foreign

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material. The end fittings of composite insulators after complete assembly with the core and housing shall be coaxial with one another resulting in no eccentric loading. Any member of the end fitting that is machined, bent or worked in any manner after galvanizing shall be re-galvanized. The zinc coating shall adhere tightly to the surface of the base metal. The zinc-coated parts shall be free from uncoated spots. The coating shall be free from blisters, flux, blackspots, dross, tear drop edges, flaking zinc, rough appearance and in general shall be smooth, clean and unscarred when received.

Insulators shall be designed and manufactured to provide mechanical ruggedness and long service life without sacrificing electrical and operating characteristics herein specified. All insulator surfaces and grooves shall be shaped for easy cleaning.

Each insulator shall be permanently marked in accordance with ANSI/NEMA C29.12 or C29.17.

4. **PORCELAIN LINE POST INSULATORS:** Insulator bodies shall be made of wet-process porcelain. The insulator units shall meet the requirements of ANSI/NEMA C29.7, except as otherwise specified in these paragraphs.

Each insulator shall be permanently marked in accordance with ANSI/NEMA C29.7.

5. **GRADING RINGS:** Grading rings, also called corona rings or stress distribution discs, are required at the energized end for composite insulator assemblies used at 230-kV, or greater. Grading rings are required at both ends of composite insulator assemblies used at 345-kV or greater. Grading rings shall have a cast-aluminum alloy, all surfaces smooth and free from burrs, and all edges and fillets rounded to minimize field concentrations and radio interference. Grading rings shall be capable of installation and removal with hot line tools without disassembling any other part of the insulator assembly.

Grading rings shall be sized and located as determined by the insulator manufacturer.

The design of the insulator end fitting and the grading ring shall be such that the ring is capable of being mounted only in the position and orientation determined by the insulator manufacturer. In lieu of this, the insulator end fitting or grading ring shall be clearly marked showing the correct location and orientation of the grading ring.

6. **SUSPENSION CLAMPS:** Suspension clamps for use with conductors shall be suitable for use directly on the conductors without armor rods unless otherwise specified. Clamp-top-type suspension clamps for use on line post insulators are not acceptable except as part of a line post jumper assembly unless otherwise specified.

Design of clamps shall be such that unit pressures on the conductor are maintained at levels which prevent damage to conductor strands under maximum loading conditions encountered. Conductor supporting seat shall have sufficiently large longitudinal radii to prevent concentration of vibration bending and tension stresses at the conductor take off points. Centers of radii of the conductor seat shall be located on vertical lines extended below the clamp and no closer to the center of the clamp than the outside edges of the U-bolts. Clamps for conductors smaller than 795,000-circular-mil shall have a clamp bore diameter equal to the nominal diameter of the conductor with a tolerance of plus 0.1-inches. Clamps for 795,000-circular-mil conductor and larger shall have a clamp core diameter equal to the nominal diameter of the conductor with a tolerance of plus 0.05-inches and limit bending, bearing and compression stresses of the conductor. Clamp shall be designed for a maximum-total vertical-conductor angle of 30-degrees (15-degrees on each side).

Suspension clamps shall have aluminum alloy bodies, no bolt ends projecting below the bottom of the clamp if used at 230-kV and above, all surfaces smooth and free from burrs and all edges and fillets rounded to minimize field concentration and radio interference. Each clamp shall

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be complete with a keeper piece, at least two (2) U-bolts, and a 5/8-inch-diameter bolt having a hexagonal head and provided with hexagonal nut and with stainless steel self-locking cotter key. Each suspension clamp shall be capable of holding the conductor without slipping under an unbalanced tension of 4,000-pounds, except that clamps used for NESC heavy loading areas or 1,272,000-circular-mil and larger conductor shall be capable of holding the conductor without slipping under an unbalanced tension of 5,000-pounds. The clamps shall be the nonmagnetic type. Each suspension clamp shall be designed to limit losses to a maximum of 10-W, with a 600-amp, root mean square, 60-Hz current flowing through the conductor.

Magnetic losses shall be determined by averaging the losses as determined from a simultaneous measurement on at least four (4) clamps. If dissimilar metals are used in making up the clamp, precautions shall be taken to minimize corrosion due to electrolytic action.

Armor grip suspension (AGS) assemblies may be used in place of clamps, when correctly sized and connecting hardware substitutions are made to the applicable standard assemblies drawing(s). The Contractor shall submit complete attachment assembly outlines with connecting hardware for approval. Complete assembly outlines shall be dimensioned with the total insulator length.

7. **ARMOR RODS:** Armor rods shall have parrot-bill ends at voltages above 230-kV and shall be color coded to identify the applicable conductor size.
8. **ASSEMBLY COUPLING HARDWARE:** Material and methods used in the fabrication of assembly coupling hardware shall be selected to provide good toughness and ductility. Each component part of the coupling hardware used in the assemblies shall also be designed such that permanent deformation or yield does not occur at less than two-thirds of its ultimate rated breaking strength. The assembly coupling hardware shall be of corona-free quality for voltages of 230-kV and above; shall be galvanized; and all pins shall be complete with nuts, bolts and self-locking stainless steel cotter keys.

Castings shall be uniform, without sharp edges or corners, free of cracks and shall not contain any defects to the extent that the strength or suitability of the item is affected.

Forgings shall be uniform in quality and condition, without sharp edges or corners, free of cracks and shall be free of any defects to the extent that the strength or suitability of the item is affected.

Socket fittings shall be made of forged steel, cast steel, malleable iron or ductile iron.

Ball fittings shall be made of steel forged in one (1) piece. They shall be heat treated to obtain the ultimate strength specified on applicable drawings.

Bolts, nuts and locknuts shall be galvanized steel. Bolts shall conform to SAE J429, Grade 8, and be made of a grade of steel commensurate with the ultimate strength specified for the hardware.

Unless otherwise specified, ferrous metal shall be galvanized to meet or exceed the requirements of ASTM A153. Metal shall be free from burrs, sharp edges, lumps and dross, and smooth so that interconnecting parts will fit properly and so that the parts may be assembled and disassembled readily. Threaded parts shall be galvanized after being threaded and excessive zinc removed from the threads. Nuts and locknuts shall be re-tapped after being galvanized and shall be capable of being threaded the entire length of the threads without the use of a wrench.

9. **COMPRESSION DEAD ENDS:** Each dead end assembly shall include a hot-dipped, galvanized-steel oval eye end, aluminum sleeve, dead end pad and jumper connector pad of the compression type with a bolted connection between the jumper connector pad and the dead end pad. Each dead end, when attached to the conductor, shall develop not less than 95-percent

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of the ultimate strength of the conductor and have a conductivity of not less than that of the conductor.

The angle between the dead end bodies and the jumper connectors shall be approximately 60-degrees unless specified with a different angle, expressed in the project specifications or project drawings.

Dead ends and jumper connectors shall be protected during shipment to minimize damage that might serve as a point source for corona discharge. If such damage does occur, it shall be corrected by the Contractor before installation.

10. IMPLOSIVE DEAD ENDS: Implosive dead ends may be used in place of or in combination with compression dead ends as approved by the COR. If implosive dead ends are used, install in accordance with the manufacturer's recommendations.

Each dead end assembly shall include a swivel hot-dipped, galvanized-steel eye end, aluminum sleeves, dead end pad and jumper connector of the implosive type with bolted connection between the jumper connector pad and the dead end pad. The required implosive charge shall be mounted on the dead end and jumper connector and the placement location for the detonator shall be clearly indicated. To develop the rated strength and electrical conductivity of connector, inspect the installed implosive fittings to ensure that there is only one (1) shallow lower profile in the middle of the aluminum sleeve and no other indentations or "throats" on the sleeve. Each dead end, when attached to the conductor, shall develop not less than 100-percent of the ultimate strength of the conductor and have a conductivity of not less than that of the conductor.

11. STRAIN CLAMPS: Strain clamps shall not be used unless specified. Strain clamps shall be complete with a socket-eye fitting and U-bolt arrangement for binding the conductor. Strain clamps shall be capable of holding the conductor without slipping or damaging the conductor when the conductor is under a tension of 85-percent of its ultimate strength. Strain clamps for ACSR conductor shall have aluminum alloy bodies.

10.3.3 TESTS:

1. GENERAL: Insulators, material and assemblies shall be subjected to the applicable tests required by this paragraph. Furnish insulators, hardware, fittings, test apparatus and instruments required to complete the test. The COR reserves the right to witness tests and to approve the manner in which the tests are conducted.
2. INSULATORS: Test reports shall specify the name and location of the factory where the insulators were made.

If there is a change in manufacturing location or insulator design, new Design tests shall be supplied.

Quality Conformance and Routine test reports shall specify the name and location of the factory where the insulators were made and the applicable order number.

- a. Porcelain and Toughened Glass Insulators: Each class of disc insulator units shall be tested in accordance with ANSI/NEMA C29.2B and CSA C411.1 for the mechanical and electrical strength ratings required under the specifications and as follows:

- (1) Design Tests: A Certificate of Compliance stating the following Design tests have been performed is required.

- (a) Low-Frequency Dry Flashover Test: ANSI/NEMA C29.2B, paragraph 8.2.1.

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- (b) Low-Frequency Wet Flashover Test: ANSI/NEMA C29.2B, paragraph 8.2.2.
- (c) Critical Impulse Flashover – Positive and Negative Tests: ANSI/NEMA C29.2B, paragraph 8.2.3.
- (d) Radio-Influence Voltage Test: ANSI/NEMA C29.2B, paragraph 8.2.4.
- (e) Thermal-Mechanical Load Cycle Test: ANSI/NEMA C29.2B, paragraph 8.2.5.
- (f) Thermal Shock Test: ANSI/NEMA C29.2B, paragraph 8.2.6.
- (g) Residual-Strength Test: ANSI/NEMA C29.2B, paragraph 8.2.7.
- (h) Impact Test: ANSI/NEMA C29.2B, paragraph 8.2.8.
- (i) Cotter Key Test: ANSI/NEMA C29.2B, paragraph 8.2.9.
- (j) Cement Expansion: ANSI/NEMA C29.2B, paragraph 8.2.10.
- (k) Steep-Front Impulse Voltage Test: CSA C411.1:16, paragraph 6.6.
- (2) Quality Conformance Tests:
 - (a) Visual and Dimensional Tests: ANSI/NEMA C29.2B, paragraph 8.3.1.
 - (b) Porosity Test: ANSI/NEMA C29.2B, paragraph 8.3.2. Test three (3) samples per lot.
 - (c) Galvanizing Test: ANSI/NEMA C29.2B, paragraph 8.3.3.
 - (d) Combined Mechanical and Electrical-Strength Test: ANSI/NEMA C29.2B, paragraph 8.3.4. The entire lot shall be rejected if any insulator fails below the rated M&E strength. The failure mode shall be identified for each insulator in the test report.
 - (e) Puncture Test: ANSI /NEMA C29.2B, paragraph 8.3.5.
 - (f) Verification of Coupling Lock System: ANSI/NEMA C29.2B, paragraph 8.3.6.
- (3) Routine Tests: A Certificate of Compliance stating the following routine tests have been performed is required.
 - (a) Cold-to-Hot Thermal Shock Test: ANSI/NEMA C29.2B, paragraph 8.4.1. (Toughened glass suspension insulators only.)
 - (b) Hot-to-Cold Thermal Shock Test: ANSI/NEMA C29.2B, paragraph 8.4.2. (Toughened glass suspension insulators only.)
 - (c) Tension-Proof Tests: ANSI/NEMA C29.2B, paragraph 8.4.3.
 - (d) Flashover Tests: ANSI/NEMA C29.2B, paragraph 8.4.4.
- b. Composite Suspension Insulators: Insulators shall be tested in accordance with ANSI/NEMA C29.12 as follows:
 - (1) Prototype Tests:

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- (a) Tests on Interfaces and Connection of End Fittings: ANSI/NEMA C29.12, paragraph 8.1.
 - (b) Core Time-Load Test: ANSI/NEMA C29.12, paragraph 8.2.
 - (c) Housing Tracking and Erosion Tests: ANSI/NEMA C29.12, paragraph 8.3.
 - (d) Core Material Tests: ANSI/NEMA C29.12, paragraph 8.4.
 - 1) Dye Penetration Evaluation, paragraph 8.4.1.
 - 2) Water Diffusion Test Evaluation, paragraph 8.4.2.
 - (e) Flammability Test: ANSI/NEMA C29.12, paragraph 8.5.
- (2) Design Tests:
- (a) Low-Frequency Dry Flashover Test: ANSI/NEMA C29.12, paragraph 9.1.
 - (b) Low-Frequency Wet Flashover Test: ANSI/NEMA C29.12, paragraph 9.2.
 - (c) Critical Impulse Flashover Tests – Positive and Negative: ANSI/NEMA C29.12, paragraph 9.3.
 - (d) Radio-Influence Voltage Test: ANSI/NEMA C29.12, paragraph 9.4.
- (3) Quality Conformance Tests:
- (a) Dimensional Tests: ANSI/NEMA C29.12, paragraph 10.1.
 - (b) Galvanizing Test: ANSI/NEMA C29.12, paragraph 10.2
 - (c) Specified Mechanical Load Test: ANSI/NEMA C29.12, paragraph 10.3.
- (4) Routine Tests:
- (a) Tension-Proof Test: ANSI/NEMA C29.12, paragraph 11.1.
 - (b) Visual Examination: ANSI/NEMA C29.12, paragraph 11.2.
- c. Composite Line Post Insulators: Insulators shall be tested in accordance with ANSI/NEMA C29.17 as follows:
- (1) Prototype Tests:
- (a) Tests on Interfaces and Connection of End Fittings: ANSI/NEMA C29.17, paragraph 7.1.
 - (b) Assembled Core Load Tests: ANSI/NEMA C29.17, paragraph 7.2.
 - 1) Core Time-Load Test: ANSI/NEMA C29.17, paragraph 7.2.1.
 - 2) Tensile Load Test: ANSI/NEMA C29.17, paragraph 7.2.2.
 - (c) Housing Tracking and Erosion Tests: ANSI/NEMA C29.17, paragraph 7.3.
 - (d) Aging or Weathering Test: ANSI/NEMA C29.17, paragraph 7.4.
 - (e) Core Material Tests: ANSI/NEMA C29.17, paragraph 7.5.

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- 1) Dye Penetration Test: ANSI/NEMA C29.17, paragraph 7.5.1.
 - 2) Water Diffusion Test: ANSI/NEMA C29.17, paragraph 7.5.2.
- (2) Design Tests:
- (a) Low Frequency Dry Flashover Test: ANSI/NEMA I C29.17, paragraph 8.1.
 - (b) Low Frequency Wet Flashover Test: ANSI/NEMA C29.17, paragraph 8.2.
 - (c) Critical Lightning Critical-Impulse Tests – Positive and Negative: ANSI/NEMA C29.17, paragraph 8.3.
 - (d) Radio-Influence Voltage Test: ANSI/NEMA C29.17, paragraph 8.4.
- (3) Sample Tests:
- (a) Verification of Dimensions: ANSI/NEMA C29.17, paragraph 9.2.
 - (b) Galvanizing Test: ANSI/NEMA C29.17, paragraph 9.3.
 - (c) Cantilever-Strength Tests: ANSI/NEMA C29.17, paragraph 9.4.
 - 1) Cantilever Load-Deflection Test: ANSI/NEMA C29.17, paragraph 9.4.2.
 - 2) Cantilever Breaking Load (CBL) Test: ANSI/NEMA C29.17, paragraph 9.4.3.
 - (d) Specified Tensile Load Test: ANSI/NEMA I C29.17, paragraph 9.5.
- (4) Routine Tests:
- (a) Tensile Load Tests: ANSI/NEMA C29.17, paragraph 10.1.
 - (b) Visual Examination: ANSI/NEMA C29.17, paragraph 10.2.
- d. Porcelain Line Post Insulators: Test post-type insulators in accordance with ANSI/NEMA C29.7.
- (1) Design Tests:
- (a) Low-Frequency Dry Flashover Test: ANSI/NEMA I C29.7, paragraph 8.2.1.
 - (b) Low-Frequency Wet Flashover Test: ANSI/NEMA C29.7, paragraph 8.2.2.
 - (c) Critical Impulse Flashover Test – Positive: ANSI/NEMA C29.7, paragraph 8.2.3.
 - (d) Radio-Influence Voltage Test: ANSI/NEMA C29.7, paragraph 8.2.4.
 - (e) Thermal Shock Test: ANSI/NEMA C29.7, paragraph 8.2.5.
- (2) Quality Conformance Tests:
- (a) Visual and Dimensional Tests: ANSI/NEMA C29.7, paragraph 8.3.1.
 - (b) Porosity Test: ANSI/NEMA C29.7, paragraph 8.3.2. Test three (3) samples per lot.
 - (c) Galvanizing Test: ANSI/NEMA C29.7, paragraph 8.3.3.
 - (d) Cantilever-Strength Test: ANSI/NEMA C29.7, paragraph 8.3.4.
- (3) Routine Tests:
- (a) Flashover Test: ANSI/NEMA C29.7, paragraph 8.4.1.

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(b) Cantilever Test: ANSI/NEMA C29.7, paragraph 8.4.2.

3. ASSEMBLIES AND HARDWARE:

- a. Suspension Clamps: Tests shall be performed which show that suspension clamps meet the requirements of IEEE C135.61 (Testing of Overhead Transmission Line Hardware).
- b. Assembly Coupling Hardware: Tests shall be performed which show that assembly coupling hardware meet the requirements of IEEE C135.61.
- c. Compression Dead Ends: Tests shall be performed which show that compression dead ends develop not less than 95-percent of the ultimate strength of the conductor.
- d. Implosive Dead Ends: Design tests shall be performed which show that implosive dead ends develop no less than 100-percent of the ultimate strength of the conductor with which they are to be used.
- e. Strain Clamps: Tests shall be performed which show that strain clamps develop not less than 85-percent of the ultimate strength of the conductor.
- f. Grading Ring Design Test: Grading rings shall be tested using a mechanical shaker with at least a 1-inch stroke at the grading ring and a frequency of 3-cycles per second for a duration of 2,000,000-cycles. Movement shall be along the long axis of the insulator. The test shall reflect the manufacturer's recommended method for attaching the grading ring to the insulator. The grading ring shall be attached to the insulator and the insulator attached to the shaker in a vertical position. The test shall be considered successful if no movement is detected in the ring in relationship to the insulator and there is no physical damage to the grading ring and the attachment assembly. The manufacturer will demonstrate that the design of the insulator results in a surface stress level of no more than 0.43-kV per inch, for the first inch (1-inch) distance from the end fitting interface, as measured along the sheath area.
- g. Insulator Assembly Corona Test: One (1) complete insulator assembly of each type for use at 345-kV line-to-line and above shall be tested in accordance with the following criteria:

Each conductor or subconductor may be simulated by conductor or bar no larger than the conductor or subconductor diameter plus 0.10-inches. The test shall duplicate the conductor arrangement and insulator assembly in dimensions and hardware material used.

The test shall be conducted with the assemblies installed not more than the specified distance from a grounded plane, and subjected to an AC voltage to determine that the corona extinction voltage level is not less than the specified voltage. No correction shall be made for climatic conditions. The line-to-ground test voltage may be reduced by 3-percent for each 1,000-feet that the elevation of the test site exceeds mean sea level.

The corona detection device shall be a light amplifier with a gain of 30,000 or more. The test specimen image when viewed shall be no smaller than 20-percent of the light amplifier screen. The device shall be able to detect light generated by corona in the visual spectrum.

In a dark laboratory, the test specimen shall be energized with a high enough voltage to create a detectable, glow corona on the specimen with the light amplifier. This is to prove the detection system is working.

In a dark laboratory, with an applied voltage high enough to create corona and the ground plane in place, the voltage shall be lowered to the specified voltage. The test specimen shall be viewed from at least two (2) directions approximately 180° apart on the plane of the building floor that

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has the best view of the flat plane or planes of the test specimen. There shall be no visible corona on the test specimen when viewed with the light amplifier.

10.3.4 INSTALLATION:

At least 2-weeks prior to installation, electronically furnish manufacturer's assembly and installation instructions to the COR and assemble each type of conductor insulator assembly to assure that all pieces fit together as required. Assembly shall be complete with suspension clamp or compression dead end. Verify that the hardware will allow free conductor motion and will not bind up. All hardware pins shall be bolt, nut and stainless steel cotter key. The Contractor shall verify that the assemblies will connect to the structure attachment points with the correct horizontal or vertical orientation.

All insulators shall be wiped clean with a nonabrasive cloth, as approved by the COR at the time of installation. The porcelain or glass portions shall be bright and the metal portions free from dirt. Cracked or chipped insulators and insulators with bent cotter keys or with loose cement shall not be installed.

Insulators that are cracked, chipped or damaged in any way shall be replaced with sound units.

Special precautions shall be used during handling, transporting and installation of composite insulators. Do not lay them on the ground unprotected or drag them along the ground during structure installation. During installation of insulators or structures, care must be taken that no impact, cantilever or torsion loads are applied to the insulators as a result of binding in any part of the assembly. Any composite insulator with damage to the sheds, sheath or which is observed to have had an impact, cantilever or torsion load applied shall be replaced by and at the expense of the Contractor.

The following imperfections shall be acceptable on the composite insulator surface: Superficial defects of an area less than 25-square-mm (total defective area not to exceed 2-percent of the total insulator surface) and less than 1-mm in depth.

Where practical, the nuts and cotter keys used in assemblies shall be faced in toward the structure to facilitate removal during hot line maintenance. This does not apply to cotter keys in the individual insulator units.

Each completed suspension insulator string shall be installed on the conductor and adjusted to hang in a vertical plane through the axis of the structures after the conductors are sagged and clipped in. The clipping in of conductors shall then be completed and all nuts tightened according to manufacturer's recommendations.

Compression dead ends and jumper connectors and strain clamps in tension assemblies shall be installed on the conductor in accordance with the manufacturer's recommendations. Furnish necessary tools and joint-inhibitor compound.

Implosive dead ends and jumper connectors shall be applied to the conductor and inspected in accordance with the manufacturer's specific installation procedure. Implosive dead ends do not require the cleaning of the conductor nor joint inhibitor compound. Implosive dead ends may be installed on the ground supported by a tripod or in the air. The Contractor must be aware of the peak noise level generated at the time of implosion and take necessary precautions to ensure that personnel are adequately protected and all pertinent regulations adhered to. Follow all local blasting regulations and all safety requirements as described in the "Safety and Health" paragraph of the "General Requirements" Standards. Coordinate all detonations with the COR. After detonation, wipe off any carbon residue with a cloth. Do not use a metal file or mechanical sander.

Jumper connector pads shall be attached to the line side of dead end pads, and the jumper connector bolt shall be inserted from the line end toward the structure end of the assembly where such installation will minimize corona onset and radio-influence voltages. Bolts shall be tightened to the torque value as recommended by the manufacturer.

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SECTION 10.4 – OVERHEAD GROUND WIRE ASSEMBLIES

10.4.1 GENERAL:

Standard steel strand overhead ground wire assemblies for the structures are shown on Drawings 41 1017, 41 1018 and 41 1019. Standard optical overhead ground wire assemblies are shown on Drawing 41 1031.

10.4.2 MATERIAL:

1. GENERAL: Turnbuckles may be used at the Contractor's option and at no additional cost to WAPA, as part of tension assemblies.
2. SUSPENSION CLAMPS – STEEL STRAND OVERHEAD GROUND WIRE: Suspension clamps shall be of malleable iron or high-strength forged steel and galvanized. The clamps shall be sized for use with the specified steel-strand overhead ground wires without armor rods installed, unless otherwise specified, and shall be suitable for use on vertical line angles from 3-degrees to a maximum of 35-degrees. Suspension clamps shall have an ultimate strength of 15,000-pounds. Overhead ground wire supporting seat shall have sufficiently large longitudinal radii to prevent concentration of vibration bending and tension stresses at the overhead ground wire take off points. Centers of radii of the overhead ground wire seat shall be located on vertical lines extended below the clamp and no closer to the center of clamp than the outside edges of the U-bolts. Clamp bore diameter for use with the overhead ground wire shall be the diameter of the overhead ground wire with a tolerance of plus 0.34-inch. Each clamp shall be complete with at least two (2) U-bolts, keeper piece, and a 5/8-inch-diameter bolt having a hexagonal head and provided with a hexagonal nut and with stainless steel self-locking-type cotter key. Unthreaded length of the bolt shall be adequate to ensure free rotation of the bolt with the nut run onto the bolt to the limit permitted by the threaded portion of the bolt. Cable seat and keeper piece shall be smooth and free from burrs. Each suspension clamp assembly shall be capable of holding the overhead ground wire without slipping under an unbalanced tension of 4,000-pounds.
3. SUSPENSION CLAMPS – OPTICAL OVERHEAD GROUND WIRE: Suspension clamps shall be specifically designated for OPGW. Suspension clamps shall be of malleable iron or high-strength forged steel and galvanized. The clamps shall be sized for use with the specified OPGW and shall be suitable for use on vertical line angles to a maximum of 30-degrees. Suspension clamps shall have an ultimate strength of 15,000-pounds. The OPGW wire supporting seat shall have sufficiently large longitudinal radii to prevent concentration of vibration bending and tension stresses at the OPGW take off points. Centers of radii of the OPGW seat shall be located on vertical lines extended below the clamp and no closer to the center of clamp than the outside edges of the U-bolts. Each clamp shall be complete with at least two (2) U-bolts, keeper piece and a 5/8-inch-diameter bolt having a hexagonal head and provided with a hexagonal nut and with stainless steel self-locking-type cotter key. Unthreaded length of the bolt shall be adequate to ensure free rotation of the bolt with the nut run onto the bolt to the limit permitted by the threaded portion of the bolt. Cable seat and keeper piece shall be smooth and free from burrs. Each suspension clamp assembly shall be capable of holding the overhead ground wire without slipping under an unbalanced tension of 3,000-pounds.
4. ARMOR GRIP SUSPENSIONS: Armor grip suspension (AGS) assemblies may be used in place of clamps, when correctly sized and connecting hardware substitutions are made to the applicable standard assemblies drawing(s). The Contractor shall submit complete attachment assembly outlines with connecting hardware and integral armor rods, if present, for approval.
5. TENSION ASSEMBLIES – OPTICAL OVERHEAD GROUND WIRE: Tension and dead end clamps shall be specifically designated for OPGW. Each dead end assembly shall develop no less than 95-percent of the ultimate strength of the optical overhead ground wire.

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6. **ASSEMBLY COUPLING HARDWARE:** Material and methods used in the fabrication of assembly coupling, also referred to as connecting hardware shall be selected to provide good toughness and ductility. Each component part of the coupling hardware used in the assemblies shall also be designed such that permanent deformation or yield does not occur at less than two-thirds of its ultimate rated breaking strength. Assembly coupling hardware shall have a rated ultimate breaking strength equal to or greater than the assembly ultimate strength. The assembly coupling hardware shall be galvanized and shall be complete with nuts, bolts and self-locking stainless steel cotter keys.

Bolts, nuts and locknuts shall be galvanized steel. Bolts shall conform to SAE J429, Grade 5 or 8 and be made of a grade of steel commensurate with the ultimate strength specified for the hardware.

Metal shall be free from burrs, sharp edges, lumps and dross and smooth so that interconnecting parts will fit properly and so that the parts may be assembled and disassembled readily. Threaded parts shall be galvanized after being threaded and excessive zinc removed from the threads. Nuts and locknuts shall be retapped after being galvanized and shall be capable of being threaded the entire length of the threads without the use of a wrench.

7. **COMPRESSION DEAD ENDS:** Compression dead end for steel strand overhead ground wires shall consist of a galvanized-steel eye and an aluminum sleeve or consist of a stainless-steel sleeve connected to a galvanized-steel clevis, with the clevis connected to a galvanized-steel eye. Each dead end assembly shall develop no less than 95-percent of the ultimate strength of the overhead ground wire.
8. **IMPLOSIVE DEAD ENDS:** Implosive dead ends may be used in place of or in combination with compression dead ends as approved by the COR. If implosive dead ends are used, install in accordance with manufacturer's recommendations and requirements in section 10.3.4.

Implosive dead end for overhead ground wires shall consist of 1-piece, galvanized-steel eye and sleeve. The required implosive charge shall be mounted on the dead end and the placement location of the detonator shall be clearly indicated. Each dead end assembly shall develop no less than 95-percent of the ultimate strength of the overhead ground wire with which it is used.

9. **INSULATORS:** Insulators for use with OGW or OPGW suspension and tension assemblies shall be wet-process porcelain or composite as specified, clevis type, with a combined mechanical and electrical strength as specified.

10.4.3 TESTS:

1. **SUSPENSION CLAMPS:** Tests shall be performed which show that suspension clamps meet the requirements of IEEE C135.61.
2. **ASSEMBLY COUPLING HARDWARE:** Tests shall be performed which show that assembly coupling hardware meet the requirements of IEEE C135.61.
3. **COMPRESSION AND IMPLOSIVE DEAD ENDS:** Compression and implosive dead ends shall undergo tests which show that the dead ends develop not less than 95-percent of the ultimate strength of the overhead ground wire.
4. **INSULATORS:** Test insulator units in accordance with all the requirements of ANSI/NEMA C29.2B, Perform tests required in accordance with Section 10.3.3.3, above.

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10.4.4 INSTALLATION:

1. GENERAL: Assemblies used for steel strand and OPGW shall be suspension or tension types as specified on Material Quantity drawings or noted on the Plan and Profile drawings.

At least 2-weeks prior to installation, furnish electronic copies of manufacturer's assembly and installation instructions to the COR. Assemble each type of overhead ground wire assembly to verify fit. Assembly shall be complete with suspension clamp or AGS, tension dead end or compression dead end. Verify that the hardware will allow free overhead ground wire motion and will not bind during service. All hardware pins shall be bolt, nut and stainless steel cotter key. The Contractor shall verify that the assemblies will connect to the structure attachment points with the correct horizontal or vertical orientation.

Each completed suspension assembly shall be installed on the overhead ground wire and adjusted to hang in a vertical plane through the axis of the structures after the overhead ground wires are clipped in. The clipping in of overhead ground wires shall then be completed and all nuts tightened according to manufacturer's recommendations.

2. COMPRESSION DEAD ENDS: Compression dead ends in tension assemblies shall be applied to the steel strand overhead ground wires in accordance with the manufacturer's recommendations. Furnish all necessary tools and joint-inhibitor compound.
3. IMPLOSIVE DEAD ENDS: Implosive dead ends shall be applied to the steel strand overhead ground wire and inspected in accordance with the manufacturer's specific installation procedure. Implosive dead ends do not require joint inhibitor compound. Implosive dead ends may be installed on the ground supported by a tripod or in the air. The Contractor must be aware of the peak noise level generated at the time of implosion and take necessary precautions to ensure that personnel are adequately protected and all pertinent regulations adhered to. Follow all local blasting regulations and all safety requirements as described in the "Safety and Health" paragraph of the "General Requirements" Standards. Coordinate all detonations with the COR.
4. TURNBUCKLES: Turnbuckles shall be initially installed such that not more than one-half of the allowable adjustment in either direction is used.

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SECTION 10.5 – ACCESSORIES FOR STRUCTURES

10.5.1 GENERAL:

Coordinate between the structure and insulator manufacturers to ensure that the mounting plates and insulator base mounts connect satisfactorily.

10.5.2 STRUCTURE GROUNDING:

Structure grounding shall be provided with each structure, as follows:

1. WOOD STRUCTURES:

Material and Installation: Material and installation of grounding for wood and laminated wood pole structure grounding, including ground wire, shall be installed as shown on Drawing 41 1012 and as directed by the COR. Bury structure ground wire for pole-to-pole ties a minimum of 18-inches in uncultivated land and 24-inches in cultivated land. Ground wire shall not be spliced.

2. STEEL OR CONCRETE POLE STRUCTURES:

Material and Installation: Material and installation of grounding for steel or concrete pole structures shall be in accordance with Drawing 41 1015.

3. LATTICED STEEL STRUCTURES:

Material and Installation: Material and installation of grounding for latticed steel structures shall be in accordance with Drawing 41 1013.

10.5.3 GROUND RESISTANCE MEASUREMENTS:

When specified, ground resistance measurements shall be made at each structure before the static wires are installed, according to IEEE 81, "Guide for measuring earth resistivity". These readings shall be made using a "Ground Megger" or other instrument approved by the COR. A list of readings and where each was taken shall be furnished to the engineer and the COR.

The final ground resistance at each structure shall be 25-Ohms or less. If the ground resistance measurements do not meet this criteria, additional ground rod assemblies or a counterpoise shall be installed in accordance with Drawing 41 2034 and as directed by the COR.

Ground resistance measurements submitted to WAPA shall include:

1. Structure number and stationing.
2. Initial ground resistance.
3. Corrective action (additional ground rod(s) or counterpoise).
4. Final ground resistance.

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SECTION 10.6 – CONDUCTOR, OVERHEAD GROUND WIRE AND ACCESSORIES

10.6.1 CONDUCTORS:

1. MATERIAL:

a. Conductor: ACSR in accordance with requirements of ASTM B 232.

- (1) General Characteristics: Each individual wire entering construction of the completed conductor shall conform to ASTM B 230. Core wire shall be Class A, galvanized-steel wire conforming to ASTM B 498 and ASTM B 500.

If the conductor is specified as nonspecular type, it shall have the outer surface treated to produce a dull finish in accordance with ASTM B 979.

- (2) Raised Strand Limitation: Conductors shall be designed and fabricated to ensure that all strands in the outer layer will remain the same distance (within a plus tolerance of 25-mils) from the center of the conductor before and after the conductors are strung.
- (3) Packaging and Shipping: Completed conductor shall be furnished on reels sufficiently sturdy in construction to withstand any normal service incident to shipping, hauling and field erection. No random length shall be wound on the same reel with a specified standard length, and reels on which random lengths are furnished shall be of the same overall width and have bushings of the same inside sleeve diameters as the reels for the specified standard conductor lengths.

b. Conductor: ACSS in accordance with requirements of ASTM B 856 or ASTM B 857.

- (1) General Characteristics: The ACSS conductor shall meet the requirements of ASTM B 856 for round wire constructions and ASTM B 857 for trapezoidal conductors. Core wires shall be ACSS/MA2, regular strength Class A, Zinc-5-percent aluminum-mischmetal alloy-coated steel strand (Zn-5Al-MM) in accordance with ASTM B 802 and suitable for a continuous operating temperature of 250-degrees Celsius (482-degrees Fahrenheit). Galvanized steel core wires, type ACSS/GA, are not acceptable. If high strength, extra-high strength, or ultra-high strength core is instead required, this requirement will be explicitly stated in the project or material specifications.

- (2) If the conductor is specified as nonspecular type, it shall have the outer surface treated to produce a dull finish in accordance with ASTM B979.

- (3) Raised Strand Limitation: Conductors shall be designed and fabricated to ensure that all strands in the outer layer will remain the same distance (within a plus tolerance of 25-mils) from the center of the conductor before and after the conductors are strung.

- (4) Packaging and Shipping: Completed conductor shall be furnished on reels sufficiently sturdy in construction to withstand any normal service incident to shipping, hauling and field erection. No random length shall be wound on the same reel with a specified standard length, and reels on which random lengths are furnished shall be of the same overall width and have bushings of the same inside sleeve diameters as the reels for the specified standard conductor lengths.

c. Dead Ends, Compression Joints, Repair Sleeves and Terminal Connectors: Class A in accordance with requirements of ANSI/NEMA C119.4.

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Joints for splicing conductor shall be compression type, include an overall aluminum alloy sleeve, and develop not less than 95-percent of the ultimate strength of the conductor. Conductivity of the completed splices shall not be less than that of the conductor.

Compression repair sleeves may be used in lieu of compression joints to repair minor damage to conductor, provided that not more than two (2) of the aluminum strands in the outer layer are broken and there has been no damage to strands in other layers.

- d. Implosive Conductor Joints and Repair Sleeves: Implosive joints may be used in place of or in combination with compression joints as approved by the COR. Install joints and sleeves in accordance with manufacturer's recommendations.

Implosive joints for splicing conductor shall include an overall aluminum sleeve and develop no less than 100-percent of the ultimate strength of the conductor with which they are to be used. To develop the rated strength and electrical conductivity of connector, inspect the installed implosive fittings to ensure that there is only one (1) shallow lower profile in the middle of the aluminum sleeve and no other indentations or "throats" on the sleeve. Conductivity of the completed splices shall not be less than that of the conductor. The required implosive charge shall be mounted on the joint and sleeve and the placement location of the detonator shall be clearly indicated.

Implosive repair sleeves can be used in lieu of implosive joints to repair damage to the conductor provided that the steel core is not damaged and that the aluminum strands are damaged over a length of no more than 4-inches. Sleeves shall develop no less than 100-percent of the ultimate strength of the aluminum strands of the conductor.

- e. Hardware: Clevis and eye fittings, Y-clevis fittings, socket fittings, ball fittings, chain links, shackles, triangular and rectangular yoke plates, suspension clamps and strain clamps in accordance with requirements of IEEE C135.61.

2. TESTS:

- a. Conductor: During fabrication, physical tests shall be made in accordance with the requirements of ASTM B232, ASTM B498, ASTM B500, ASTM B609 and ASTM B802, as applicable. If the conductor is fabricated by two (2) or more manufacturers, tests shall be performed by each manufacturer. Submit certification that the conductor meets all requirements of ASTM B232, ASTM B230, ASTM B498, ASTM B500, ASTM B609 and ASTM B802 in accordance with the "Drawings, Data and Test Reports" Section.
- b. Dead Ends, Compression Joints, Repair Sleeves and Terminal Connectors: During fabrication, physical tests shall be made in accordance with requirements of ANSI/NEMA C119.4 Class A (Heavy duty).

Conductor joints shall undergo tests which show that the joints develop not less than 95-percent of the ultimate strength of the conductor.

- c. Implosive Conductor Joints: Conductor joints shall undergo tests which show that the joints develop not less than 100-percent of the ultimate strength of the conductor.
- d. Hardware: During fabrication, physical tests shall be made in accordance with the requirements of IEEE C135.61.

3. INSTALLATION:

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- a. General: Equipment and methods used for stringing conductors shall be subject to approval of the COR. Requirements of IEEE 524 and manufacturer's recommendations shall be strictly adhered to. Ensure that conductors will not be scratched, grooved, kinked, twisted, abraded or otherwise deformed; and such that support structures will not be damaged. If the conductors are damaged, repair or replace the damaged sections in a manner approved by the COR and at no additional cost to WAPA. All sections of conductors damaged by the application of gripping attachments shall be repaired or replaced before the conductors are sagged in place.

Conduct stringing operations so that at no time will any suspension attachment be subjected to longitudinal loads and any tension tower be subjected to torsion resulting from longitudinal loads on opposing faces at opposite ends of crossarms. Vertical angles of pulling lines shall be such as to minimize, within practical limits, the vertical loading in structures and shall be subject to approval of the COR.

- b. Safety Precautions: Procedures used for stringing and sagging conductors, including special safety precautions when stringing adjacent to energized facilities and at powerline crossings, shall meet the minimum requirements set forth in the "Safety and Health" Section of the "General Requirements" Standards.
- c. Existing Energized Lines: Portions of the transmission line may closely parallel existing energized transmission lines. During stringing operations, a buildup of voltage due to energized parallel facilities can result in safety hazards. The Contractor shall be responsible for familiarizing himself with the area and shall implement adequate safety measures when stringing conductors adjacent to energized facilities, particularly those located within 2-miles of the transmission line.
- d. Stringing Method: Conductors shall be strung by the controlled-tension method, except in certain isolated spans upon approval from the COR, using neoprene-lined, double-bull-wheel-type tension stringing equipment.
- e. Stringing Equipment: Pulling lines shall be of sufficient length to avoid applying undue strain to the insulators and structures and shall be connected to the conductors with swivel connectors and stocking-type grips as directed by the COR. The end of the grips (sock) shall be taped to the conductor so that the grips will run freely in the sheaves. Conductor splices shall not be passed through a sheave except as specifically permitted by the COR. Reel stands shall be heavily constructed, and provisions shall be made for braking the reels. Conductor shall not be dragged over ground, rock or fence wires, nor over any objects which may injure the conductor. Guards shall consist of material over which the conductor may slide without damage and shall be subject to the approval of the COR.

Implosive joints may be pulled through stringing sheaves as recommended from manufacturer's stringing charts and as approved by the COR. Length of pull shall be determined by the stringing sheave characteristics, stringing tension, weight span and deflection angle.

- f. Stringing Sheaves: Design, size, material and points of attachment of the stringing sheaves, and vertical angles of running lines, shall be subject to the approval of WAPA. Minimum diameter of the sheaves at the bottom of the groove shall be at least 12 times the diameter of the conductor with which it is used, and the size and shape of the groove shall conform to the conductor manufacturer's recommendations. Manufacturer's recommendations may require 20 times the diameter sheaves for the first one (1) of the set up. Sheaves shall be equipped with high-quality ball or roller bearings and shall have neoprene-lined grooves.

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If implosive joints are to be passed through the stringing sheaves, obtain the implosive joint manufacturer's recommendation for sheave size. The sheaves must be compatible with the joints and allow the joint to pass through without binding. The diameter of the sheaves at the bottom of the groove will be from 12 to 20 times the diameter of the conductor. Sheaves must be designed to withstand the possible wedging load imposed by the implosive joint. There must be enough space between the sheave and the supporting frame to allow free passage of the connector.

- g. Time Allowed for Stringing and Clipping: Once stringing has started for any wire setup, all the subconductors for all the conductor phases in that setup shall be completely pulled into the snubs during the same calendar day and they shall all be kept at the same reduced sag until they are pulled to final tension. Conductors shall not be allowed to hang in the stringing blocks more than 24-hours before being pulled to the specified sag. After being sagged, conductors shall be allowed to hang in the stringing blocks for not less than 2-hours before being clipped in, to permit the conductor tension to equalize. Total time which the conductors are allowed to remain in the stringing blocks before being clipped in shall not be more than 72-hours (3 days) unless approved by the COR. Less time shall be allowed for fiber optic overhead ground wires in accordance with the manufacturer's recommendations. Notwithstanding the 72-hour limitation, pulling of any third conductor setup will not be allowed until the corresponding first conductor setup is clipped in.
- h. Tensioning Equipment: In order to minimize the danger of failure, the design of the tension equipment shall be such that when the desired tension is obtained, the same constant tension will be held so long as the brakes are left at this setting, whether the brakes are actuated manually, pneumatically, hydraulically or electrically. Equipment shall be so designed that there can be no conduction of heat generated by the braking action of the bull wheels. There shall be slight mechanical braking on the reels to prevent loose conductor between the reels and the bull wheels. Bull wheels shall have a neoprene lining not less than 1/4-inch thick and shall have a minimum outside diameter of 42-inches.

A minimum of four (4) and one-half (1/2) turns of conductor shall be placed around the bull wheels. The equipment shall be capable of maintaining a continuous tension equal to the initial load tension of the conductor at 30-degrees Fahrenheit for NESC Light loading, 15-degrees Fahrenheit for NESC Medium loading and 0-degrees Fahrenheit for NESC Heavy loading. When stringing conductors by the controlled-tension method, the sag in each conductor shall be maintained at least 20-percent greater than the sags specified in the stringing sag tables, prior to final adjustment of the sag before clipping in the conductors.

- i. Sagging Conductors: Conductors shall not be prestretched and shall be sagged in accordance with sag tables which will be furnished to the Contractor after Notice to Proceed has been issued. Length of conductor sagged in one operation shall be limited to the length that can be sagged satisfactorily but shall not exceed 16,000-feet unless approved by the COR. In sagging 1-reel lengths, the sag of two (2) spans shall be checked. The length of the spans used for checking shall be approximately equal to the ruling span. Sag of spans on both sides of all horizontal angles of more than 10-degrees shall be checked. After the conductors have been pulled to the required sag, intermediate spans shall be inspected to determine whether the sags are uniform and correct.

Sagging operations shall not be carried on when, in the opinion of the COR, wind, extremely low temperature or other adverse weather conditions prevent satisfactory sagging. A tolerance of plus or minus 1/2-inch sag per 100-feet of span length, but not to exceed 6-inches in any one (1) span, will be permitted when stringing is being done at temperatures of 0-degrees Fahrenheit and above, and a tolerance of plus or minus 1/4-inch sag per 100-feet of span length, but not to exceed 3-inches in any one (1) span, will be permitted when stringing is being done at temperatures below 0-degrees Fahrenheit; provided, that all conductors in the span assume the same sag and the necessary ground clearance is

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obtained; provided further, that the conductor tension between successive sagging operations is equalized so that the suspension insulator assemblies will assume the proper position when conductor is clipped in. After clipping in is completed, all suspension insulator strings shall hang vertically. Each phase of conductor shall be tied off, both ahead and back, at the last clipped structure of each sag setup, which tie-offs shall be left in place until the tie-offs of the subsequent setup are in place. Check the sag at all points to be checked. Furnish the necessary personnel for signaling and climbing purposes. The Contractor shall target all spans for sagging, and the COR may verify the sag at any point with the Contractor's equipment. At all suspension or tension structures, attach conductors to the insulator assemblies by suspension clamps or dead end fittings, in accordance with the "Conductor Insulator Assemblies" Subdivision. Conductor arrangements throughout the line shall be as shown on the plan and profile sheets or as specified by the COR.

- j. **Cleaning Conductor:** During stringing operations, remove dirt or grease that can be readily observed on the conductors by cleaning with a clean cloth or method approved by the manufacturer. Proper precautions shall be taken by personnel cleaning the conductor to protect themselves against the toxic and drying actions of the chemical being used. The cleaning apparatus itself shall be kept clean such that particles collected during the conductor cleaning process do not scratch or mar subsequent conductor.
- k. **Compression Dead Ends, Joints and Repair Sleeves:** Compression joints and repair sleeves shall be located at least 25-feet away from the structures. No joints or repair sleeves shall be used in spans crossing over interstate highways, railroads, communication lines, utility lines of voltages greater than 15-kV or in the two (2) spans adjoining the crossing span, without approval of the COR. To develop rated mechanical strength and electrical conductivity, the installation of compression joints shall be carefully supervised to ensure that the joints are centered properly. Distance between two (2) joints, between two (2) repair sleeves, or between a joint and a repair sleeve on any one (1) conductor shall not be less than 4,000-feet. Not more than one (1) joint or repair sleeve will be permitted in any one (1) conductor in any one (1) span. No joints will be permitted in the approach span.

Apply conductor dead ends, joints and repair sleeves to conductors in accordance with the manufacturer's recommendations. Furnish filler paste and all necessary tools, including compressors required for applying compression splices.

Jumper connections shall be made with compression-type jumper connectors which shall be bolted to the compression-type dead ends. After the joints, dead ends and jumper connectors are compressed onto the conductor, remove, by suitable means, any sharp edges or protrusions formed during the compression operations.

- l. **Implosive Fittings:** Location of implosive joints and repair sleeves shall be as described for compression joints and repair sleeves unless the implosive joint is initially installed and pulled through sheaves, subject to approval by the COR.

Follow the manufacturer's recommendations and as described in sections 10.3.4 and 10.4.4 for installation and inspection of a properly installed fitting. To develop the rated strength and electrical conductivity of connector, inspect the installed implosive fittings to ensure that there is only one (1) shallow lower profile in the middle of the aluminum sleeve and no other indentations or "throats" on the sleeve. After detonation, wipe off any carbon residue with a cloth. Do not use a metal file or mechanical sander.

Implosive fittings do not require joint-inhibitor compound. Implosive fittings may be installed on the ground supported by a tripod or in the air. The Contractor must be aware of the peak noise level generated at the time of implosion and take necessary precautions to ensure that personnel are adequately protected and all pertinent regulations adhered to. Follow all

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local blasting regulations and all safety requirements as described in the “Safety and Health” Section of the “General Requirements” Standard. Coordinate all detonations with the COR.

- m. Offset Data: If necessary, use insulator offset data to ensure that suspension insulator strings hang in a vertical plane through the axis of the structure after the conductors are clipped in. The Contractor shall submit, for review, insulator offset data to the COR and engineer at least 2-weeks prior to stringing of each section of line for which offset data is required.
- n. Concrete Footings and Foundations: Stringing shall not begin until 7-days after placement of concrete in footings and foundations.
- o. Damping of Unused Conductor Arms: Conductor arms on steel pole structures which will not be strung shall be dampened with weights, salvaged suspension insulator strings, or other approved means in accordance with the manufacturer's instructions.

10.6.2 STEEL STRAND OVERHEAD GROUND WIRE:

- 1. GENERAL: Special safety precautions during stringing near energized lines and the equipment methods and limitations used in stringing overhead ground wires shall be the same as those used in stringing conductors as described in the “Conductors” paragraph.
 - a. Material:
 - (1) Overhead Ground Wires: 7-wire galvanized-steel strand or Zinc-5-percent aluminum-mischmetal alloy-coated (Zn-5Al-MM) steel strand conforming to high-strength or extra-high-strength grade, diameter as specified, Class B, steel strand.
 - (2) The 7-wire galvanized-steel strand shall be in accordance with ASTM A363.
 - (3) The 7-wire Zinc-5-percent aluminum-mischmetal alloy-coated steel strand shall be in accordance with ASTM A925.
 - (4) The completed strand shall be furnished on reels sufficiently sturdy to withstand normal service incident to shipping, hauling and field erection.
 - b. Overhead Ground Wire Compression Joints: Joints used for splicing or repairing damaged overhead ground wire shall be compression-type, full-tension joints. Use of repair sleeves is not permitted.
 - c. Overhead Ground Wire Implosive Joints: Implosive joints may be used in place of or in combination with compression joints as approved by the COR. If implosive joints are used, install in accordance with manufacturer's recommendations.
- 2. TESTS:
 - a. Overhead Ground Wire: Perform tests enumerated in ASTM A363 or ASTM A925 on samples taken at random from 10-percent of the reels of the completed galvanized-steel wire or Zinc-5-percent aluminum mischmetal alloy-coated wire, respectively. Submit certification that the overhead ground wire meets all requirements of ASTM A363 or ASTM A925 in accordance with the “Drawings, Data and Test Reports” Section.
 - b. Overhead Ground Wire Compression Joints: Overhead ground wire joints shall undergo tests which show that the joints develop not less than 95-percent of the ultimate strength of the overhead ground wire.

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- c. Overhead Ground Wire Implosive Joints: Overhead ground wire joints shall undergo tests which show that the joints develop not less than 95-percent of the ultimate strength of the overhead ground wire.
- 3. INSTALLATION: String overhead ground wires in accordance with conductor installation requirements of the "Conductors" paragraph, except that neoprene-lined or unlined sheaves may be used. Sheaves shall be at least 7-inch diameter at the bottom of the groove.

10.6.3 OPTICAL OVERHEAD GROUND WIRE:

- 1. MATERIAL:
 - a. General Characteristics: OPGW shall be in accordance with requirements of IEEE 1138. Stranding shall be in accordance with ASTM A363.
 - b. Packaging and Shipping: Completed OPGW shall be furnished on reels sufficiently sturdy in construction to withstand any normal service incident to shipping, hauling and field erection. No random length shall be wound on the same reel with a specified standard length.
- 2. TESTS: OPGW shall be in accordance with all requirements of IEEE 1138.
- 3. INSTALLATION: String overhead ground wires in accordance with manufacturer recommendations and conductor installation requirements of the "Conductors" paragraph, except that neoprene-lined shall be used.
 - a. General: Equipment and methods used for stringing OPGW shall be subject to approval of the COR. Requirements of IEEE 524 and manufacturer's recommendations shall be strictly adhered to. Ensure that OPGW will not be scratched, grooved, kinked, twisted, abraded or otherwise deformed; and such that support structures will not be damaged.

Conduct stringing operations so that at no time will any suspension attachment be subjected to longitudinal loads and any tension tower be subjected to torsion resulting from longitudinal loads on opposing faces at opposite ends of crossarms. Ensure that suspension structures maintain balanced loads at all times, especially when connecting to floating deadend assemblies. Vertical angles of pulling lines shall be such as to minimize, within practical limits, the vertical loading in structures and shall be subject to approval of the COR.

10.6.4 ALL-DIELECTRIC SELF-SUPPORTING FIBER OPTIC CABLE:

- 1. GENERAL: All-dielectric self-supporting (ADSS) is jacketed fiber optic cable installed in the transmission line span, without any metallic 'messenger' cable support. New ADSS is installed infrequently, in specific cases where an alternative to installing OPGW or a buried fiber is required. Generally, ADSS designs are developed for application in distribution-length spans to about 500 Feet, although an installed span of 875 Feet is in service on a WAPA circuit near Lake Natoma, CA.

ADSS installations shall comply with requirements of IEEE 1222, IEEE 1222 corr.1 and IEEE 1591.2. Design coordination shall include factors for selection, such as sag-tension characteristics, and applicable NESC loading. Since ADSS is frequently located in the working space, in the proximity of the circuit phases, electric field strength impacts on cable jacket materials may be a factor.

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10.6.5 VIBRATION DAMPERS:

1. GENERAL: A minimum of one (1) vibration damper is required per wire per span. Using the information provided on specification drawing "Vibration Dampers", the vibration damper manufacturer shall determine at what span lengths two (2) or more dampers are required. Based on these requirements, the Contractor shall determine the total number of dampers needed for the project. Exceptions to the minimum vibration damper requirement may be granted if the manufacturer does not recommend vibration dampers for approach spans or other slack spans

Provide stockbridge-type vibration dampers for conductors and stockbridge-type or spiral vibration dampers for the overhead ground wires.

2. MATERIAL:

- a. General: Dampers shall be suitable for installation directly on the conductors or the overhead ground wires or directly to armor rods or AGS armor rods, as applicable.
- b. Stockbridge-Type Vibration Dampers: Stockbridge-type vibration dampers shall have an aluminum clamp compressed or cast onto the messenger wire between the weights. Ferrous metal shall be galvanized in accordance with ASTM A153. All metal shall be free from burrs, sharp edges, lumps or dross and shall be smooth so that interconnecting parts will fit properly and so that the parts may be assembled and disassembled readily. Threaded steel parts shall be galvanized after being threaded, and excessive zinc shall be removed from the threads. Damper clamps shall be designed to permit installation and removal using hot line tools.
- c. Spiral Vibration Dampers: Spiral vibration dampers shall have two (2) sections: a damping section and a gripping section. Solid, helical-formed rods shall be made from noncorrosive material, such as polyvinyl chloride. Rods shall have a surface hardness which does not abrade overhead ground wires.

3. TESTS:

- a. Aeolian Vibration Tests: Tests which demonstrate the effectiveness of vibration dampers in limiting the peak-to-peak bending amplitude, caused by aeolian vibration and as defined in the IEEE Task Force on Conductor Vibration (IEEE Paper No. 31 CP 65-156), to 10-mils for ACSR conductors and to 15-mils for steel-strand overhead ground wire shall be performed. OPGW vibration damper tests shall be performed in accordance with IEEE 1138.

Perform tests in suspension spans of the ranges shown on the specification drawing "Vibration Dampers", with cable tensions not less than 20-percent of the cable nominal ultimate strengths and with vibration dampers installed at the manufacturer's recommended spacing, for ACSR conductors with diameters within plus or minus 0.25-inch of the diameter of the ACSR cable sizes for which vibration dampers are being furnished and steel strand with diameters within 0.06-inch of the steel-strand overhead ground wire for which vibration dampers are being furnished. These tests shall be conducted with splice/armor rods installed, when rods are specified.

The test for each cable size shall be continued for a minimum of 3-weeks or until a full range of winds between 0- and 20-miles-per-hour and at right angles to the line have been recorded.

Laboratory tests which are equivalent to the above tests may be performed at the option of the Contractor in accordance with IEEE 664, "IEEE Guide for Laboratory Measurement of the Power Dissipation Characteristics of Aeolian Vibration Dampers for Single Conductors".

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Certified reports of previous tests results which show that vibration dampers meet the requirements of these specifications may be substituted for the test results required above.

The Contractor shall provide the “Vibration Damper” drawing to the manufacturer to obtain the vibration damper spacing and number of dampers that has been determined, from tests, to be the most effective in limiting the bending amplitudes as specified above and for all applications listed on the Drawing. The Contractor shall determine the necessary vibration damper protection including the total quantity of and catalog number for all vibration dampers needed for the project, the manufacturer's spacing recommendations and the manufacturer's protectable span length recommendations. The Contractor shall submit the necessary vibration protection, a copy of the “Vibration Damper” drawing marked to reflect the manufacturer's recommendations for all applications shown on the Drawing and results of the required test reports in accordance with the “Drawings, Data and Test Reports” Section.

4. **INSTALLATION:** Install additional vibration dampers in accordance with the manufacturer's recommendations. Spans with midspan accessories like compression splices, implosive joints, repair sleeves, aerial marker balls and flying taps shall have vibration dampers installed at both ends.

Vibration damper installation shall be completed within 72-hours after conductors or overhead ground wires have been clipped in unless otherwise approved by the COR. Fasten vibration dampers securely to the conductors and overhead ground wires in accordance with the manufacturer's spacing recommendations. Components shall be properly aligned and the installation completed with torque wrenches to ensure that bolts are tightened to the values recommended by the manufacturer. WAPA will make spot checks of vibration damper installations and, if deficiencies are found, the Contractor shall correct the damper installations to the extent deemed necessary by the COR.

Hang the stockbridge-type vibration dampers in a vertical plane and verify that any drain holes provided in the damper weights are open after installation. Install vibration dampers for conductors so that the head of the clamp bolt faces toward the structure to facilitate removal during hot line maintenance.

The Contractor shall submit to WAPA the final vibration damper quantities and spacings, per the vibration damper manufacturer's requirements.

10.6.6 HOLD-DOWN WEIGHTS:

1. **MATERIAL:** Weights shall be provided when indicated alongside individual structure information on plan and profile drawings, as either clamped conductor weight(s), or suspended conductor assembly weight(s). Weight shall be provided in 100- or 50-pound increments. When attached directly to the conductor, specify whether weights are applied with or without the presence of armor rods.
2. **INSTALLATION:** Hold-down weights required on conductors or assemblies used as part of jumper assemblies shall be installed at the same time jumper connections and assemblies are installed. Hold-down weight installation for all other applications shall be completed within 72-hours after conductors or overhead ground wires have been clipped in unless otherwise approved by the COR. Hold-down weights shall be assembled and installed in accordance with the manufacturer's recommendations, the plan and profile drawings and the COR.

Weights attached directly to the wire shall be installed with an equal number of weights located on each side of the suspension clamp. Install any odd-numbered weights on the uphill side of the suspension clamp.

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10.6.7 CONDUCTOR SPACER DAMPERS:

1. MATERIAL: Conductor spacer dampers shall be neoprene-lined or elastomeric and suitable for the specified bundle conductor. Spacer dampers shall be suitable for installation directly on the conductors.

Spacer dampers shall be designed to permit installation and removal using hot line tools.

The assembly weight shall not exceed 25-pounds. The head of the breakaway bolt or cap screw shall be oriented for ground level viewing.

The spacer assembly shall be free of visual corona at the specified voltage.

The energy absorbing assembly shall have the ability to:

- a. Withstand any heat generated.
- b. Avoid any displacement in the housings.
- c. Resist bond failure.
- d. Avoid any damage which would appreciably decrease the damping efficiency.

Where elastomers or other nonmetallic material is used, it shall be capable of withstanding conductor temperatures of minus 60-degrees Fahrenheit to 180-degrees Fahrenheit without permanent loss of essential properties. The energy absorbing assembly shall be designed to provide effective damping throughout a temperature range of minus 20-degrees Fahrenheit to 120-degrees Fahrenheit.

The elastomer or other energy absorbing assembly shall have adequate resistance to the effects of ozone, ultra-violet radiation and other atmospheric contaminants over the entire temperature range.

The energy absorbing assembly shall be electrically conductive. The conductivity of the individual components shall be in accordance with the manufacturer's design.

Nut cracker, hinged, open-end or boltless type clamps are acceptable provided adequate grip can be maintained on the conductor. Designs requiring a clamping bolt, cap screw or lock pin shall utilize a single captive fastener. If a special tool is required to fasten the damper, five (5) such tools shall be provided to WAPA upon completion of damper installation.

Clamping bolts or cap screws shall have a breakaway type head. The breakaway bolt or cap screw shall be furnished with a wrench stop to prevent the socket from engaging the lower head during installation.

All ferrous parts, except Belleville spring washers and parts of stainless steel, shall be galvanized in accordance with ASTM A 153. Hinge pins may also be galvanized in accordance with ASTM A 164, Type LS. Material shall be galvanized after fabrication.

The spacer damper assembly shall have all outside surfaces smooth and all edges and corners well rounded to reduce the formation of corona. All fillings, loose material, threading lubricants and all chemical residue or other substances which can cause corrosion shall be cleaned from the spacer damper assemblies.

Each spacer damper assembly shall be marked with letters and numerals designating the manufacturer, the manufacturer's catalog number, the last two (2) numbers of the year in which it was manufactured and the conductor diameter. The identifying letters and numerals shall be

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at least 1/4-inch high. They shall be cast or die stamped on one (1) or both sides of the main member of the assembly. The characters shall be distinct, durable and conspicuous.

The Contractor shall submit the "Spacer Damper" drawing to the manufacturer to obtain the spacer damper spacing and number of dampers that has been determined, from tests, to be the most effective in limiting the bending amplitudes as specified above and for all applications listed on the Drawing. The Contractor shall determine the necessary vibration protection including the total quantity of and catalog number for all spacer dampers required for this project and the manufacturer's spacing recommendations using asymmetrical spacing. The Contractor shall submit the necessary vibration protection, a copy of the "Spacer Damper" drawing marked to reflect the manufacturer's recommendations for all applications shown on the Drawing and results of the required test reports in accordance with the "Drawings, Data and Test Reports" Section.

2. TESTS:

- a. Aeolian Vibration Tests: Tests which demonstrate the effectiveness of spacer dampers in limiting the peak-to-peak bending amplitude for ACSR conductors to 0.01 times the conductor diameter.

Perform tests in suspension spans of the ranges shown on the specification drawing "Spacer Dampers", with cable tensions not less than 20-percent of the cable nominal ultimate strengths and with vibration dampers installed at the manufacturer's recommended spacing, for ACSR conductors with diameters within plus or minus 0.25-inch of the diameter of the ACSR cable sizes for which spacer dampers are being furnished.

The test for each cable size shall be continued for a minimum of 3-weeks or until a full range of winds between 0- and 20-miles-per-hour and at right angles to the line have been recorded.

Laboratory tests which are equivalent to the above tests may be performed at the option of the Contractor.

- b. Corona Test: One (1) of each complete spacer damper assembly shall be tested in accordance with the criteria specified in 10.3.3, Insulator Assembly Corona Test.

Certified reports of previous test results which show that spacer dampers meet the requirements of these requirements may be substituted for the test results required above.

3. INSTALLATION: Spacing requirements from the manufacturer shall be reviewed by WAPA prior to installation. Fasten spacer dampers securely to the conductors in accordance with the manufacturer's spacing recommendations and instructions. Components shall be properly aligned and the installation completed with torque wrenches to ensure that bolts are tightened to the values recommended by the manufacturer. Spacer damper installation shall be completed within 72-hours after conductors have been clipped in, unless otherwise approved by the COR. WAPA will make spot checks of spacer damper installations and, if deficiencies are found, the Contractor shall correct the damper installations to the extent deemed necessary by the COR.

10.6.8 LINE MARKERS:

Aerial marker balls, attached to wires, with or without accompanying aerial patrol warning signs, attached to structures, are indicated on plan and profile drawings for line angles, some river-crossing spans, and over- and under-crossings with other transmission lines operating at 69 kV and above.

Avian line marking devices may be required for static wires, to alert animals in flight. If required, they will be indicated on plan and profile drawings, for specific styles and spacing in each span.

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1. MATERIAL:

- a. Aerial Marker Balls: Aerial marker balls shall be 24-inch diameter spheres, as specified on Drawing 41 9025, suitable for attachment to the specified overhead ground wire. The aerial marker balls shall be manufactured of nonconducting material with long color retention characteristics, and attachment to the overhead ground wire shall be by means of preformed rods. When marking a river crossing, marker balls shall alternate colors orange with yellow. Material and method of attachment shall be equal to SpanGUARD as manufactured by P&R Industries, Portland, OR.
- b. Aerial Patrol Warning Signs: Aerial patrol warning signs are attached to structures and shall be in accordance with the "Structure Signs" paragraphs in the appropriate structure construction standard (4, 5, 6, 7, and 8) paragraph.

2. INSTALLATION: Aerial marker ball installation shall be completed within 72-hours after overhead ground wires have been clipped in unless otherwise approved by the COR. The aerial marker balls shall be assembled and installed in accordance with manufacturer's recommendations. Aerial patrol marker balls and aerial patrol warning signs shall be assembled and installed in accordance with Drawings 41 9005, 41 9026, 41 9028 and 41 9029. The aerial marker balls and aerial patrol warning signs shall be installed on the specified spans and in accordance with the plan and profile drawings and as directed by the COR.

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SECTION 10.7 – APPROACH SPANS

10.7.1 GENERAL:

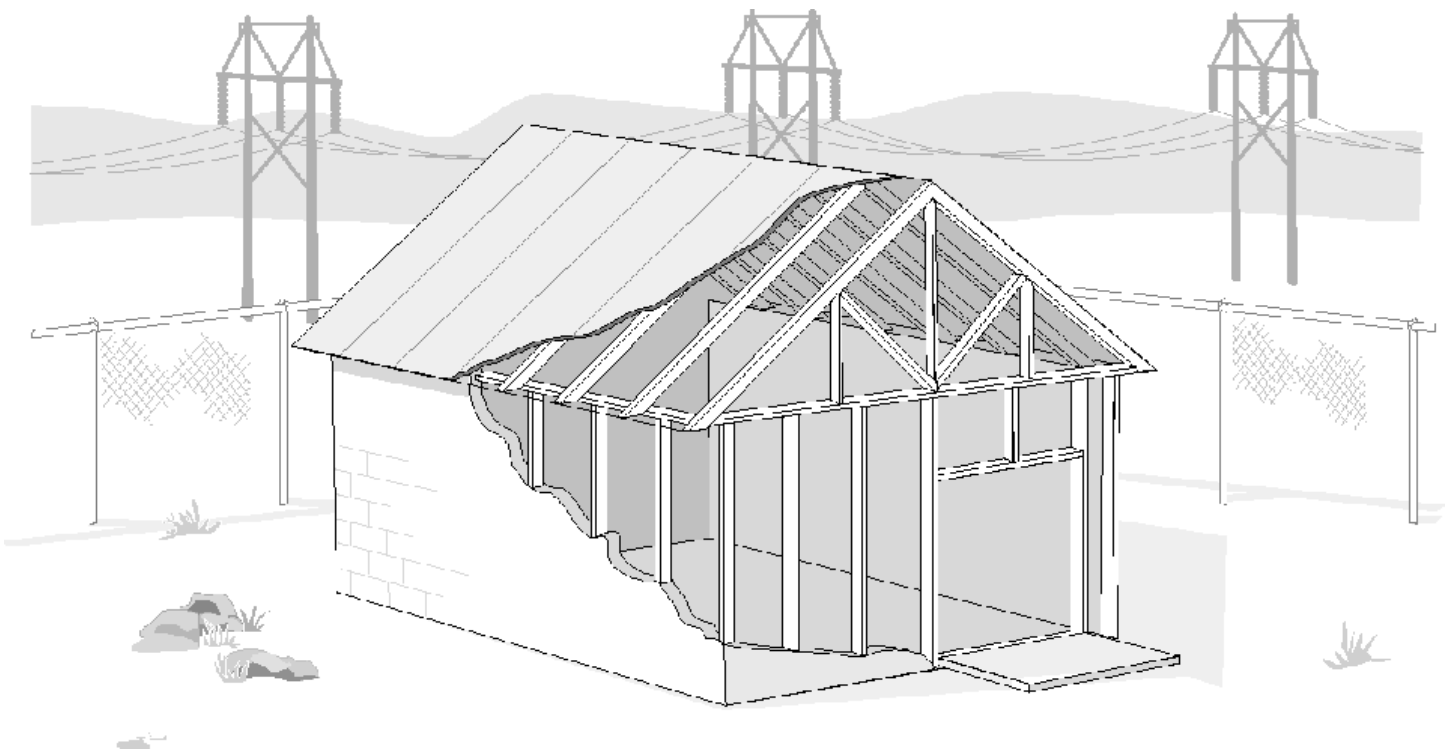
If the take-off structure is not available for termination, the material required for the approach span shall be suitably packaged and delivered to WAPA as directed by the COR.



Western Area
Power Administration

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SECTION 01 00 00 – GENERAL REQUIREMENTS

01 10 00 SUMMARY:

The Bidding Schedule item “Buildings” includes providing work required under this “Buildings” Standard.

Work includes construction of a site-built service building as detailed on the Drawings. Building construction includes a reinforced concrete foundation and slabs; cable entry box with cable sealing assemblies and metal covers; wood framed walls and pre-fabricated wood truss roof structure; masonry veneer; metal roofing panels; roof and wall insulation; painted gypsum board walls and ceiling; hollow metal doors and frames; accessible floor system; power distribution and lighting; and heating, ventilating and air-conditioning system.

For use of products containing recovered material, refer to specifications sections in this standard and in Standard 13 – Environmental Quality Protection.

01 33 00 SUBMITTAL PROCEDURES:

1. **GENERAL:** Provide and submit shop drawings, product data, installation data, samples, maintenance material, test reports, calculations, project record documents and maintenance data. For specific submittals which are required for the service building, refer to Table 1 – Submittals in Division 11 of the project specifications.
2. **CONTRACTOR REVIEW:**
 - a. **General:** Review submittals prior to transmittal. Verify that submittals are complete. Determine and verify field measurements, field construction criteria, manufacturer's catalog numbers and conformance of submittals with these specifications. When manufacturer's data is applicable to more than one (1) model number, highlight appropriate information. WAPA will return submittals without review if it is not clear what specific model or type is being proposed for the project.
 - b. **Coordination:** Check material and equipment compatibility with equipment and work of other specifications sections, electrical characteristics and control requirements. Coordinate motor voltages, control characteristics, wiring, switches and interlocks. Review the effect of any changes on work of other specifications sections.
 - c. **Certification:** Apply Contractor's stamp, signed or initialed, certifying review, verification of products, field dimensions and coordination of information with requirements.
3. **PROCEDURES:**
 - a. **Transmittal:** Submittals shall be transmitted electronically as described in Division 1 – General Requirements.
 - b. **Complete Submittals:** Incomplete, unchecked or uncoordinated submittals will be returned to the Contractor without review.
 - c. **Modifications by WAPA:** WAPA has the right to require modifications in shop drawings and data, which will make the installation conform to requirements and intent of these specifications, without additional cost to WAPA.
 - d. **Contractor's Responsibility:** Acceptance by WAPA of submittals does not relieve the Contractor of responsibility for correctness of details or dimensions, nor does it waive any requirements of these specifications.

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- e. Return of Submittals: WAPA will return submittals to the Contractor either acceptable, not acceptable, or acceptable with comments.
 - f. Resubmittals: Revise and resubmit submittals which are not acceptable. Identify changes made since previous submittal and show revision date. Submit submittals approved subject to compliance with comments if directed by WAPA.
 - g. Distribution: Distribute electronic copies of reviewed submittals to concerned persons. Instruct recipients to promptly report any inability to comply with provisions.
4. SHOP DRAWINGS:
- a. Content: Title each drawing and include WAPA's specifications number and title. Identify each element of the Drawings by reference to sheet number and detail. Identify field dimensions and show relation to adjacent construction, critical features and other material or equipment.
5. PRODUCT DATA:
- a. Content: Submit data which is pertinent. Clearly mark each copy of manufacturer's standard printed data to identify applicable products, models, options and other data. Show reference standards, performance characteristics and capacities; wiring and piping diagrams; controls; component parts; finishes; dimensions; and required clearances. Supplement standard printed data to provide information unique to the work. Delete information not applicable. If the submittal data does not clearly identify the specific product which is being proposed by the contractor, the submittal will not be reviewed.
6. INSTALLATION DATA:
- a. Content: Submit manufacturer's instructions for storage, preparation, assembly, installation, startup, adjusting, balancing and finishing.
7. SAMPLES:
- a. Required Submittals: Submit two (2) samples as specified in reference sections. Submit samples for all material within enclosed spaces or exterior surfaces at the same time for color coordination.
 - b. Content: Submit full range of manufacturer's standard finishes indicating colors, textures and patterns for review and selection by WAPA. Original color charts are acceptable unless otherwise specified. Label each sample with identification of manufacturer, finish information and these specifications number and title. Photocopies of color charts are not acceptable.
8. MAINTENANCE MATERIAL:
- a. Requirement: Provide quantities of products, spare parts, maintenance tools and maintenance material specified in referenced sections.
 - b. Storage and Delivery: Maintain spare parts in same space and condition as material to be installed and in original containers with labels intact and legible.
- Coordinate delivery with the COR. Deliver spare parts to the COR. Unload spare parts at the site and obtain receipt prior to the date of final acceptance.
9. TEST REPORTS:

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- a. Requirement: Conduct tests as required by the project specifications. Notify the COR at least 10-days prior to testing. The COR will witness each test. Submit two (2) electronic copies of full report within 10-days of test to the COR. Final payment will not be made until all tests are completed and reports submitted.
- b. Content for Test:
 - (1) WAPA's specifications number, title and specification section number.
 - (2) Material or equipment name and model and Contractor name.
 - (3) Testing agency and name of inspector.
 - (4) Name of manufacturer's representative present.
 - (5) Date, time and duration of tests.
 - (6) Type of test, description and results.
 - (7) Retesting required.

10. PROJECT RECORD DOCUMENTS:

- a. Requirement: Maintain at jobsite for WAPA one (1) copy of as-built drawings, specifications, modifications, change orders, field change orders and test records. Do not use as documents for construction. Deliver project record documents as a submittal for acceptance to the COR prior to date of final acceptance.
- b. Recording: Record and date information on a set of drawings and in a copy of these specifications provided by WAPA. Record information concurrently with construction progress. Do not conceal work until required information is recorded. Mark actual construction, including:
 - (1) Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 - (2) Field changes of dimension and detail.
 - (3) Changes made by modifications.
 - (4) Details not on original drawings.

11. MAINTENANCE DATA: Submit in accordance with the "Operation and Maintenance Data" section and the project specifications.

01 78 23 OPERATION AND MAINTENANCE DATA:

- 1. REQUIREMENT: Provide and submit operation and maintenance (O&M) data for material provided. Instruct WAPA personnel from O&M data.
- 2. SUBMITTALS:
 - a. Draft Manual: Submit a draft of the manual to the COR for review and acceptance. Submit two (2) electronic copies of draft or proposed formats and outlines of contents before starting manual. One (1) copy will be returned with comments.
 - b. Completed Manual: Submit to the COR two (2) electronic copies of the completed manual at least 30-days prior to date of final acceptance of the contract.
- 3. MANUAL FORMAT: Prepare data in form of instructional manual for use by WAPA personnel. Organize data to correspond with project specifications.

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- a. Size: 8 1/2-inches by 11-inches.
 - b. Binders: Commercial quality 3-ring binders with durable and cleanable covers.
 - c. Cover: Identify each binder with typed or printed title "OPERATING AND MAINTENANCE INSTRUCTIONS". List WAPA specifications title and building name.
 - d. Text: Provide manufacturer's printed data or neatly typewritten pages. Provide typed description of material and major component parts of material or equipment.
 - e. Drawings: Bind in with text. Fold larger drawings to size of text.
 - f. Provide electronically on CD's, two (2) sent to the COR by mail.
4. MANUAL CONTENT:
- a. Table of Contents: Specifications title; names, addresses and telephone numbers of the Contractor with names of responsible parties; and schedule of material and systems indexed to content of binder.
 - b. Content: For each material, finish, equipment or system:
 - (1) Names and Addresses: Provide names, addresses and telephone numbers of subcontractors and suppliers; area of responsibility; and local source of supply for parts and replacement.
 - (2) Identification: Mark each material safety data sheet to identify specific material component parts and data applicable to installation. Delete inapplicable information.
 - (3) Supplemental Data: Provide typed text as required to supplement material data. Provide logical sequence of instructions for each procedure.
 - (4) Warranty, Bond and Service Contract: Bind in copy of each.
 - (5) Drawings: Supplement material data with the Drawings to illustrate relationships of component parts; control diagrams; flow diagrams; replacement parts; and single-line diagrams. Do not use project record documents as maintenance drawings.
 - c. Equipment and Systems: Provide the following:
 - (1) General: Description of unit and component parts, including function, normal operating characteristics, limiting conditions, performance curves, engineering data, tests, complete nomenclature, commercial number of replaceable parts and as-installed color coded wiring diagrams.
 - (2) Operating Procedures: Startup, break-in, routine operating instructions, sequence of operation description by control manufacturer and as-installed control diagrams. Also provide regulation, control, stopping, shutdown, emergency instructions, summer and winter operating instructions and special operating instructions.
 - (3) Maintenance Procedures: Including routine operations, guide to trouble-shooting, disassembly, repair, reassembly, alignment, balancing, adjusting and checking instructions.
 - (4) Lubrications: Servicing and lubrication schedule and schedule of lubricants.

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- (5) Parts List: Original manufacturer's parts list, illustrations, assembly drawings and diagrams.
 - (6) Reports: Copy of test and balancing reports.
5. INSTRUCTION OF WAPA PERSONNEL: Prior to date of final inspection or acceptance of work, instruct WAPA-designated operating and maintenance personnel in the operation, adjustment, and maintenance of material, equipment and systems. Use operating and maintenance manual as basis of instruction. Review manual contents with personnel in detail to explain aspects of operation and maintenance.

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SECTION 31 00 00 – EARTHWORK

31 23 00 EXCAVATION AND FILL:

1. GENERAL: Provide excavation for:
 - a. Building foundations and footings, including floor slabs, entrance slabs, equipment slabs and subfloors.
 - b. Gravel fill.
 - c. Cable entry box.
 - d. Buried conduit, grounding system and utilities.

All excavation and fill activities shall be in accordance with Standard 2, "Sitework".

31 23 23 COMPACTION, BACKFILL AND GRAVEL FILLS:

1. GENERAL: Place and compact backfill around building and in utility trenches; provide gravel fill as shown on the building drawings, all in accordance with Standard 2, "Sitework". Surface of compacted backfill shall slope away from the building a minimum of 5-percent.

31 31 16 TERMITE CONTROL:

1. GENERAL: Provide soil treatment for subterranean insects at interior and exterior foundation perimeter and below slabs-on-grade.
2. QUALITY ASSURANCE:
 - a. General: Conform to EPA's Federal Insecticide, Fungicide and Rodenticide Act. Conform to State and local requirements for application, licensing and authority to use termiticides. Follow State and local regulations to meet minimum treatment standards for preventive preconstruction and during construction treatments (horizontal and vertical chemical barriers).
 - b. Applicator: At least 5-years documented experience in soil treatment for termite control. The service technician must be familiar with current termite control practices such as: trenching, rodding, sub-slab injection, coarse fan spraying of soil surfaces, crack and crevice (void) injection, excavated soil treatment and brush or spray application of infested or susceptible wood. Required to be licensed in the State in which termiticides will be applied.
3. SUBMITTALS: Submittals shall be provided in accordance with SUBMITTALS paragraph of DIVISION 1 – General Requirements and the submittal table in DIVISION 11 project specifications.
4. OPERATION AND MAINTENANCE DATA: Provide a 5-year warranty for material and installation. Cover against invasion or propagation of subterranean termites, damage to building or building contents caused by termites and cover repairs to building or building contents so caused.
5. MATERIAL: Water-based emulsion of uniform composition with synthetic dye to permit visual identification of treated soil. The Contractor shall select the appropriate termiticide based on those allowed by the jurisdiction having authority. The Contractor shall also select the termiticide based upon the Contractor's experience with the application location (climatic and ambient

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temperature conditions), extent and location of infestation and to minimize potential exposure (human health and safety).

6. INSTALLATION:

- a. Soil Condition: Verify soil surfaces are unfrozen, sufficiently dry to absorb toxicant and ready to receive treatment.
- b. Mix Dilution: Apply toxicant in accordance with manufacturer's instructions, and not more than 12-hours prior to installation of vapor barrier under floor slab or finish grading outside foundation perimeter. Apply extra treatment to structure penetrations, pipe, ducts and other soil penetrations.
- c. Coordination: Coordinate soil treatment at foundation perimeter with finish grading to avoid disturbance of treated soil.
- d. Unused Material: Do not store termiticides onsite. Dispose of all unused solutions or material in accordance with Federal, State and local hazardous waste regulations.

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SECTION 03 00 00 – CONCRETE

1. General: Requirements within sections below are minimums unless noted otherwise in General Structural Notes on drawings, project specifications, or building drawings.

03 30 00 CAST-IN-PLACE CONCRETE:

1. GENERAL: Provide material and work for the following:
 - a. Building foundation(s), including related building foundation concrete.
 - b. Slabs, including building entrance slabs and equipment slabs.
 - c. Stairs, landings, sidewalks and driveways.
 - d. Cable entry and cast-in-place pull boxes.
 - e. Precast reinforced concrete splash blocks: 4-inches-thick, 12-inches-wide and 36-inches-long, at locations shown on the Drawings.
 - f. Asphalt damp proofing for exterior of foundation wall.
 - g. Application of a concrete floor hardener and sealer in accordance with Standard 3 – Concrete, section 3.1.4.5(1) Building Concrete.
 - h. Other building concrete work as shown on the Drawings.
2. CONCRETE REQUIREMENTS: Concrete material, composition, batching, mixing, forms, placing, tolerances, finishing, protection, curing, repairing and reinforcement are specified in Standard 3 – Concrete. Refer to Standard Drawings 01 2006-1, -2 and -3 – Building Slabs-On-Ground – Specifications, Notes, Plans and Details (Sheets 1, 2 and 3 of 3). Building concrete shall have a minimum strength of 4,500-psi unless noted otherwise.

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SECTION 04 00 00 – MASONRY

1. General: Requirements within sections below are minimums unless noted otherwise in General Structural Notes on drawings, project specifications or building drawings.

04 05 13 MASONRY MORTARING:

1. GENERAL: Provide mortar for masonry veneer.
2. MATERIAL:
 - a. Portland Cement: ASTM C 150, Type 1 (normal type) and gray color.
 - b. Hydrated Lime: ASTM C 207, Type S.
 - c. Sand: ASTM C 33
 - d. Admixtures: Do not use plasticizers, water repellent, accelerators, retardants, air entraining admixtures, antifreeze compounds or calcium chloride. Do not add mortar color unless required in the project specifications.
 - e. Water: Shall be clean and free from detrimental quantities of silt, organic matter, salts, and other impurities.
3. MIXES: ASTM C 270, Type S. Thoroughly mix mortar ingredients in quantities needed for immediate use. If water is lost by evaporation, retemper within 2-hours of mixing. Do not retemper mortar after 2-hours of mixing.
4. INSTALLATION: Place mortar in accordance with Section 04 22 00 Unit Masonry; the section also includes cold weather requirements.

04 22 00 UNIT MASONRY:

1. GENERAL: Provide exterior masonry veneer with anchorage to structural backup, joint reinforcement in moderate and high seismic qualification levels, flashing, drip plates, steel lintels and accessories. Provide clear water repellent coating for the concrete masonry veneer.
2. SUBMITTALS: Submittals shall be provided in accordance with SUBMITTALS paragraph of DIVISION 1 – General Requirements and the submittal table in DIVISION 11 project specifications.
3. PROTECTION: Protect top of masonry walls from moisture infiltration when work is not in progress. Clean loose mortar and foreign material from top of walls when work resumes. Do not lay masonry on surfaces of frost, snow or ice.
4. ENVIRONMENTAL REQUIREMENTS: Cold weather construction shall be in accordance with the International Building Code. Maintain material and surrounding air temperatures to a minimum of 50-degrees Fahrenheit prior to, during, and 48-hours after completion of masonry work. Use wind breaks when wind is in excess of 15-mph.
5. MATERIAL:
 - a. General: Provide masonry units, including joint reinforcement, stretchers, headers, jambs, sash and special units as required for construction. Masonry veneer of like construction shall have a uniform appearance.

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- b. Facing Brick: ASTM C216, Type FBS, grade SW, standard modular size of 4-inches by 2 3/8 inches by 8-inches, color and texture as selected by WAPA's Architect.
- c. Concrete Masonry Units:
 - (1) Hollow or Solid Load-Bearing Units: ASTM C 90, Type 1, moisture controlled; normal weight; split, ground face or slump, size and color as required in the project specifications.
- d. Anchor and Ties for Masonry Veneer to Studs: Seismic Design Categories A and B.
 - (1) CWT corrugated wall tie, 16-gauge, galvanized steel by Hohmann and Barnard, www.h-b.com, or approved equal.
- e. Anchors, Ties and Joint Reinforcement for Masonry Veneer to Studs: Seismic Design Categories C through F.
 - (1) No. 345 BT with Seismiclip Anchor by Hohmann and Barnard, www.h-b.com, or approved equal.

Joint reinforcement – Hohmann and Barnard 220 Ladder Mesh or equal, with 9 gauge hot-dipped galvanized steel wire, cross-welded at 16-inches on center.
- f. Mortar: As specified in Section 04 05 13 Masonry Mortaring.
- g. Screws: Self-drilling screws, galvanized and equal to 1 1/4-inch, Type S, Oval Head by USG or approved equal.
- h. Flashing: H and B C Fab flashing, copper sheet bonded to asphalt, saturated glass fabric, 7 ounces per square foot, 24-inches-wide by Hohmann and Barnard, www.h-b.com, or approved equal. Provide adhesive recommended by manufacturer.
- i. Drip Plate: 26-gauge stainless steel drip plate with hemmed edge, preformed 20-ounce copper corners, 3-inch width, optional flashing adhesive strip with release paper, equal to H and B, FTSA drip plate.
- j. Mortar Barrier: Equal to Mortar Net by Hohmann and Barnard, www.h-b.com, or approved equal.
- k. Control Joints: As located and detailed on the Drawings.
- l. Joint Filler and Sealant: Closed cell polyethylene backup material and sealant as specified in Section 07 91 00 Joint Sealants.
- m. Weep Vents: Mortar Trap, standard or custom size as required to fill open head joint in masonry veneer, made from 100-percent recycled polyester plastic non-woven mesh, grey color or as noted in the project specifications, by Hohmann and Barnard, www.h-b.com, or approved equal.
- n. Water Repellent Penetrating Sealer for Concrete Masonry Units: Sealer shall be VOC compliant and not stain the masonry, equal to Enviroseal PBT, clear, breathable, high resistance to efflorescence, silane/siloxane water-based sealer, water repellency of 95 percent in accordance with ASTM C 140. Apply two (2) coats in accordance with manufacturer's recommendations.

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6. PREPARATION: Install flashing and drip plate at base of wall. Establish lines, levels and coursing. Protect from disturbance.
7. INSTALLATION:
 - a. Masonry Veneer: Maintain the cavity behind masonry clear of mortar droppings. Place masonry veneer to lines and levels indicated.
 - b. Uniformity: Maintain courses to uniform width. Make vertical and horizontal joints equal and of uniform thickness.
 - c. Bond: Lay masonry veneer in running bond. Form concave mortar joints.
 - d. Placing: Lay masonry in full bed of mortar, properly jointed with other work. Buttering corners of joints and deep or excessive furrowing of mortar joints are not permitted.
 - e. Intersections and External Corners: Fully bond intersections and external corners.
 - f. Adjustments: Do not shift or tap masonry units after mortar has taken initial set. Where adjustment must be made, remove mortar and replace. Remove excess mortar.
 - g. Cutting: Perform cutting with tools to provide straight, unchipped edges. Prevent breaking masonry veneer unit corners or edges.
 - h. Cavity Space: Maintain clear space between masonry veneer units and sheathing. Clean mortar out of cavity space and weep holes.
 - i. Weep Holes: Provide open-head joints at 24-inches on center or as shown on the Drawings.
 - j. Maximum Tolerances:
 - (1) Variation from Unit to Adjacent Unit: 1/32-inch maximum.
 - (2) Variation from Plane of Wall: 1/4-inch in 10-feet and 1/2-inch in 20-feet or more.
 - (3) Variation from Plumb: 1/4-inch.
 - (4) Variation from level Coursing: 1/8-inch in 3-feet; 1/4-inch in 10-feet; and 1/2-inch maximum.
 - (5) Variation of Joint Thickness: 1/8-inch in 3-feet.
 - k. Anchorages: Attach anchors and ties with screws to stud framing and through sheathing with screws at maximum 24-inches on center vertically and maximum 16-inches on center horizontally. Place at maximum 8-inches on center each way around perimeter of openings and control joints, within 2-inches of openings.
 - l. Flashing: Overlap flashing over the top of the stainless-steel drip plate. Lap end joints minimum 6-inches and seal watertight. Set flashing on manufacturer's recommended adhesive at the foundation wall and nail to the wood framing. Form end dams at lintels.
 - m. Lintels: Install loose steel lintels. Extend lintels a minimum of 8-inches beyond each edge of opening. Fasten to wall framing and embed lintels firmly in mortar at all bearings.
 - n. Control Joints: As detailed on the Drawings, install backup rod and sealant in mortar-free joint.

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- o. Mortar Barrier: Install at base of wall and at lintels in accordance with manufacturer's instructions.
- p. Horizontal Joint Reinforcement for moderate and high seismic qualification levels:
 - (1) Walls: Install at 16-inches on center not continuous through control joints.
 - (2) Openings: Place in first horizontal joints above and below openings. Extend minimum 16 inches each side of opening.
 - (3) Splices: Lap joint reinforcement ends a minimum of 6-inches, but not less than 16 inches each side of opening.
 - (4) Joint Corners: Reinforce joint corners.
 - (5) Embedment: Fully embed reinforcement in mortar.
- q. Water Repellent Coating: Concrete masonry units shall be sealed with two (2) coats of water repellent coating. Apply in accordance with manufacturer's recommendations.
- r. Grinding Block: When split face block is used, grind high spots of block at gable ends, as required for fascia to fit tightly against block.
- s. Cutting and Fitting: Cut and fit for pipes, conduits, sleeves and grounds. Coordinate to provide correct size, shape and location.
- t. Cleaning: Remove excess mortar and smears. Replace defective work. Match adjacent work. Clean soiled surfaces with solution which will not harm masonry veneer or adjacent material. Consult masonry manufacturer for acceptable cleaners. Use nonmetallic tools in cleaning operations.

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SECTION 05 00 00 – METALS

1. General: Requirements within sections below are minimums unless noted otherwise in General Structural Notes on drawings, project specifications or building drawings.

05 21 00 STEEL JOIST FRAMING:

1. GENERAL: Provide open web steel joists and joist girders with bridging and extended ends, as indicated on the Drawings, as specified herein, and as required for a complete and proper installation. Unless noted otherwise, latest editions of referenced specifications and standards apply.

The Drawings identify specific requirements for this project. Some paragraphs in this specification section will not apply to this job.

2. SYSTEM DESCRIPTION: Shall meet structural requirements listed below:

(1) Design Loads: As shown on the Drawings.

3. QUALITY ASSURANCE: Conform to requirements and recommendation of applicable portions of the following standards:

- a. SJI "Standard Specifications Load Tables and Weight Tables for Steel Joists and Joist Girders".
- b. SJI "Recommended Code of Standard Practice for Steel Joists and Joist Girders".
- c. AWS Code D1.1, "Structural Welding".
- d. ANSI / AISC 360 "Specification for Structural Steel Buildings".
- e. AISC "Code of Standard Practice for Steel Buildings and Bridges".
- f. OSHA Steel Erection Standards: Sections applicable to steel joists and joist girders.
- g. Steel Structures Painting Council Specification, SSPC No. 15.

4. SUBMITTALS: In accordance with the "Submittals" section.

- a. Shop Drawings: Indicate standard designations, configuration, sizes, spacing and locations of joists and joist girders, bridging, connections, attachments, cambers and details of erection. Indicate welded connections using standard AWS symbols. Indicate net weld length.

5. MATERIALS:

- a. Open Web Steel Joists: As specified on drawings.
- b. Longspan (LH) and Deep Longspan Steel Joists (DLH): As specified on drawings, if applicable.
- c. Joist Girders: As specified on drawings, if applicable.
- d. Bridging and Bridging Anchors: As specified on drawings.
- e. Top and Bottom Chord Extensions: As specified on drawings.

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- f. Sloped End Bearings: Where steel joists are sloped, provide horizontal bearing seats at each bearing.
 - g. Arc-Welding Electrodes: In accordance with AWS “Specifications for Arc-Welding Electrodes”, and suitable for base material, positions and other conditions of intended use.
6. FABRICATION: Prepare and shop prime with manufacturer’s standard thickness, but not less than dry film thickness of 2.0-mil.
7. TRANSPORTATION, STORAGE AND HANDLING: All materials shall be transported, handled and stored in a manner to avoid damage. Materials shall be stored out of contact with the ground and protected from the elements.
8. FIELD REPAIRS: Damage that requires mitigation includes, but is not limited to, bent materials and damaged protective coatings such as primer and paint.
- a. Bent Material: Bent materials shall not be used.
 - b. Primer and Paint: All damaged primer and paint shall be repaired in accordance with the coating manufacturer’s recommendations, quality assurance standards listed above and using materials consistent with originally specified shop primer and paint, including ensuring minimum required coating thickness.
9. ERECTION:
- a. Joists and Joist Girders: Erect steel joists and bear joists on supports in accordance with all of the quality assurance standards listed above.
 - b. Temporary Bracing: During erection, provide temporary bracing for induced loads and stresses in accordance with all of the quality assurance standards listed above. Submit to the COR an erection and bracing plan 30-days prior to planned work.
 - c. Field Cutting: Obtain approval of the COR prior to any field cutting or altering joists.
 - d. Tolerances: In accordance with all of the quality assurance standards listed above.
10. FIELD PRIMER AND PAINTING: After erection, clean field welds, abrasions and surfaces not primed or which are damaged. Apply primer coating in accordance with the coating manufacturer’s recommendations, quality assurance standards listed above and using materials consistent with originally specified shop primer, including ensuring minimum required coating thickness. Field finish paint (two (2) coats) exposed joists, joist girders, bearing plates and any other exposed accessories in accordance with Standard 12 – Painting.

05 31 00 STEEL DECK:

1. GENERAL: Provide steel deck, opening reinforcement, bearing plates and angles, edge supports, attachments and accessories as indicated on the Drawings, as specified herein, and as required for a complete and proper installation. Unless noted otherwise, latest editions of referenced specifications and standards apply.

The Drawings identify specific requirements for this project. Some paragraphs in this specification section will not apply to this job.

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2. SYSTEM DESCRIPTION: Conform to requirements listed below:
 - a. Deck Properties: As shown on the Drawings.
 - b. Deck Span: As shown on the Drawings.
 - c. Design Gravity Loads: As shown on the Drawings.
 - d. Design Diaphragm Loads: As shown on the Drawings.
 - e. Design Uplift Loads (Roof Deck): As shown on the Drawings.
3. QUALITY ASSURANCE: Comply with applicable provisions of latest editions of the following Codes and Standards.
 - a. AISI Manual “Cold-Formed Steel Design”.
 - b. SDI “Design Manual for Composite Decks, Form Decks and Roof Decks – No. 30”.
 - c. ANSI / AWS D1.3, “Structural Welding Code – Sheet Steel”. Welders shall be AWS qualified for welding processes involved.
 - d. ASTM A 653: Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - e. ASTM A 780: Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings.
 - f. ASTM A 792: Steel Sheet, 55-percent Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
 - g. ASTM A 1008: Steel Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
4. SUBMITTALS: In accordance with the “Submittals” section. Submit product data including section and material properties for each type of deck and fastener specified.
5. MATERIAL:
 - a. Prime-Painted Steel Deck: ASTM A 1008,, Structural Steel (SS), Grade 33 minimum, shop primed with manufacturer’s standard baked-on, rust-inhibitive primer. Color: Manufacturer’s standard gray.
 - b. Steel Deck Accessories, Flashings Closure Strips, Cover Plates, Opening Reinforcement, Cant Strips, Wet Concrete Stops and other Related Accessories: Same quality and type of material as steel deck unless noted otherwise. Minimum 20-gauge before coating.
 - c. Steel Bearing Plates, Angles, Edge Supports, Anchorages and Miscellaneous Shapes: ASTM A 36 unless noted otherwise. Refer to Section 05 12 00 “Structural Steel”.
 - d. Welding Material: Conform to AWS D1.3, weld material compatible with required application.
 - e. Fasteners: Corrosion resistant, low-velocity, powder-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
6. FABRICATION:
 - a. General: Fabricate deck material in lengths to span three (3) or more support spacing’s unless noted otherwise.

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- b. Steel Deck: Profile, depth, uncoated steel thickness (gage), fabrication width and coating requirements are as specified on drawings.
 - c. Side Laps: Overlapped or Interlocking Seam at Contractor's option.
 - d. Metal Closure Strips: Fabricate or form to the configuration required to provide tight-fitting closures at open deck ends and sides.
 - e. Ridge and Valley Cover Plates: Fabricate minimum 6-inches-wide, bent to provide tight fitting closure with deck units and 10-foot minimum lengths.
7. TRANSPORTATION, STORAGE AND HANDLING: All materials shall be transported, handled and stored in a manner to avoid damage. Materials shall be stored out of contact with the ground and protected from the elements.
8. FIELD REPAIRS: Damage that requires mitigation includes, but is not limited to, bent materials and damaged protective coatings such as primer and paint.
- a. Bent Material: Bent materials shall not be used.
 - b. Primer and Paint: All damaged primer and paint shall be repaired in accordance with the coating manufacturer's recommendations, quality assurance standards listed above and using materials consistent with originally specified shop primer and paint, including ensuring minimum required coating thicknesses.
9. EXECUTION:
- a. General: Install deck units and accessories in accordance with manufacturer's instructions, approved shop drawings, SDI Manual and as specified.
 - b. Anchor Bolts and Other Anchors: Coordinate placement of anchors in concrete construction for securing bearing plates and angles.
 - c. Placing: Do not start before supporting members are installed. Accurately align end to end before fastening. Place deck units flat and square. Secure deck without warp or excessive deflection. Do not locate deck bundles to overload structural members.
 - d. Bearing: On steel support members provide 4-inch minimum bearing. On masonry support surfaces provide 7-inch minimum bearing.
 - e. Lapping Deck Ends: Lap deck ends 3-inches minimum and locate over supports.
 - f. Nesting: Nest the deck side laps between adjacent deck units.
 - g. Welding: Comply with AWS requirements and procedures for manual shielded metal-arc welding, appearance and quality of welds and methods used in correcting welding work.
 - h. Deck Attachment: Permanently attach deck to structure using one (1) of the following options:
 - (1) Option A – Welded: Type 18, 24/4 welds, 3/4-inch-diameter puddle welds at 8 inch spacing (24/4 pattern, four (4) per 24-inches-wide sheet) at each main structural support member and five (5) welded side lap fasteners per span (between supports) deck to deck and deck to supports.

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- (2) Option B – HILTI Powder-Actuated Fasteners: HILTI ENP2K fasteners, or approved equal, in 36/7 pattern (seven (7) per 36-inch-wide sheet) at each main structural support member and six (6) number 10 drill-screw stitch fasteners per span (between supports).
 - i. Cutting and Fitting: Cut and fit deck units and accessories around other work projecting through or adjacent to the deck. Provide square and trimmed cuts.
 - j. Reinforcement at Openings: Provide additional reinforcement and closure pieces for strength, continuity of deck and support of other work. Coordinate opening locations with appropriate trades.
 - (1) Openings Less Than 15-inches in Any Direction: Use flat sheet steel placed over opening and fusion weld to top deck surface. Provide sheet at least 12-inches wider and longer than the opening. Weld at each corner and a maximum of 12 inches on center along each side.
 - (2) Openings From 15-inches to 30-inches in Any Direction and Not Supported by Structural Members: Weld a 1-inch by 1-inch by 1/4-inch steel angle to deck underside at right angle to deck ribs. Extend angle at least three (3) ribs beyond each side of the opening and weld to bottom surface of each rib. Reinforce the opening side parallel to the deck ribs with 12-inch-wide sheet steel. Place on deck top surface, and weld at each corner and at a maximum of 12-inches on center along each side.
 - (3) Openings Framed by Structural Members: Reinforce metal deck overhanging structural members with sheet steel placed on deck top. Weld at each corner and at a maximum of 12-inches on center along each side.
 - (4) Openings with Prefabricated Curbs and Mechanical Openings: Provide vertical sheet steel sleeve to protect deck and insulation, and to provide connection for mechanical ductwork. Weld at each corner and a maximum of 12-inches on center along each side.
 - k. Closure Strips and Angle Fasteners: Install sheet steel closures and angle flashings to close uncovered ends and edges of the deck between deck and walls, columns and openings. Weld into position to provide a complete deck installation.
 - l. Ridge and Valley Cover Plates: Install 6-inch-wide sheet steel where deck changes direction. Weld to top deck surface 12-inches on center maximum. Lap end joints a minimum of 3-inches, with laps made in direction of water flow.
 - m. Hanging Loads: Do not hang mechanical equipment or other loads from deck unless shown on the Drawings or approved by the Engineer-Of-Record.
 - n. Painting: Immediately after welding deck in place, wire brush, clean and repair damaged paint areas, burned areas, welds and rust spots on the top and bottom surfaces of deck units and supporting steel members. Use primer consistent with shop primer or galvanizing as required.
10. TOUCH-UP PAINT: Touch-up paint for shop-painted units shall be the same type used for the shop painting, and touch-up paint for zinc-coated units shall be “Galva Bright Premium – 7008” or an approved equal. Welds shall be touched-up with paint conforming to SSPC 20 in accordance with ASTM A 780. Finish of deck units and accessories shall be maintained by using touch-up paint whenever necessary to prevent the formation of rust.

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11. PAINTING: The underside of the metal deck shall receive two (2) coats of finish paint in accordance with Standard 12 – Painting.

05 40 00 COLD-FORMED METAL FRAMING:

1. GENERAL: Provide steel studs, joists, tracks, anchors, bridging, bracing and other accessories as indicated on the Drawings, as specified herein, and as required for a complete and proper installation. Unless noted otherwise, latest editions of referenced specifications and standards apply.

The Drawings identify specific requirements for this project. Some paragraphs in this specification section will not apply to this job.

2. QUALITY ASSURANCE: Conform to requirements and recommendations of applicable portions of the following standards:
 - a. ICC Evaluation Service, ES Legacy Report ER-4943P, latest edition.
 - b. Steel Stud Manufacturer's Association documents "Product Technical Information" and Supplemental Product Technical Information", latest editions.
 - c. AISI Manual "Cold-Formed Steel Design", latest edition.
 - d. ASTM Standard C 1002, latest edition, for hot-dip galvanized steel screws.
 - e. ASTM Standard A 123, latest edition, for hot-dip galvanizing of steel materials.
 - f. ASTM Standard A 153,, latest edition, for galvanizing of steel hardware.
 - g. AWS Code D1.1, "Structural Welding", latest edition.
3. SUBMITTALS: In accordance with Division 1 – General Requirements.
 - a. Product Data: Include manufacturer's product information for all items provided under this section, including but not limited to, structural components, accessories and fasteners showing specifications conformance.
4. MATERIAL:
 - a. All products are to be manufactured by a current member of the Steel Stud Manufacturers Association. Emboss or stamp on the web of each item provided under this section, at a maximum spacing of 48-inches, identification including, but not limited to, the manufacturer's name, yield strength and the minimum base metal thickness (mils).
 - b. Provide Structural Components (Steel Studs, Joists, Headers, Tracks, Bridging and Straps): Formed from galvanized sheet steel with sizes and minimum thicknesses as shown on the Drawings.
 - c. Accessories (including but not limited to Clips, Web Stiffeners, Anchors, Fastening Devices, Bracing, Furring, End Closures and Accessory Materials): Same quality material as track (unless noted otherwise); galvanized; and channel, strip or bar shaped as required for complete installation.
 - d. Fasteners (Self-Drilling, Self-Tapping Steel Screws): Minimum No. 6, Type S, 1.125 inches-long, unless noted otherwise.

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- e. Fasteners (Welding): Where applicable and as shown on the Drawings. All welds of galvanized steel shall be touched up with zinc-rich paint. All welds of carbon sheet steel shall be touched up with paint.
 - f. Anchor Devices: As shown on drawings and as specified in the “Miscellaneous Metals” section.
5. FABRICATION:
- a. General: Fabricate assemblies of sizes and profiles required, with joints fitted, secured, reinforced and braced for loads. Cuts are to be square for attachment to perpendicular members or as required for angular fit against abutting members.
 - b. Prefabrication Option: Components may be shop fabricated into panels prior to erection. Prefabricated panels shall be square, with components attached and braced in a manner to prevent racking and to minimize distortion while lifting and transporting.
 - c. Attachment: Unless noted otherwise on drawings, attach similar materials by welding in accordance with AWS; attach dissimilar materials with screws, bolts or suitably designed clips. Wire tying of components is not permitted.
 - d. Temporary Bracing: Provide temporary bracing where required until erection is complete.
 - e. Insulation: Provide insulation equal to that specified elsewhere and install in all multiple studs and headers which will be inaccessible at the worksite.
 - f. Repair: Touch-up welds and scratched or damaged galvanizing.
6. ERECTION: Erect in accordance with drawings, manufacturer’s instructions and these specifications.
- a. Runner Tracks: Provide uniform and level bearing surface for tracks at each stud with full shims or grout. Secure track to supporting structure with anchorage devices at maximum 24 inches on center. Anchor intersecting or abutting runner track joint to a common structural element or splice together. Do not splice runner track over headers or bracing.
 - b. Bearing and Non-Bearing Studs: Place studs at 24-inches on center, not more than 2 inches from abutting walls, and at each side of openings. Plumb, align and squarely seat studs in top and bottom runner tracks and fasten studs to tracks as shown on the Drawings or in accordance with manufacturer’s instructions. Erect studs in one (1) piece; splices and wire tying are not permitted.
 - c. Joists: Erect ceiling joists in rooms with gypsum board ceiling. Joists are to be parallel and have uniform and level end bearing. Provide end blocking for joists when joist ends are not otherwise restrained from rotation.
 - d. Corners: Unless noted otherwise on the Drawings, construct corners using a minimum of three (3) studs.
 - e. Bridging: Provide bridging per manufacturer’s recommendations.
 - f. Blocking: Attach cross studs or furring channels to studs for attachment of finish material, plumbing fixtures, toilet accessories, grab bars, specialty material, trim, electrical panels and other material anchored to walls. Install framing between studs for attachment of electrical boxes, other mechanical and electrical material.

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- g. Insulation: Install insulation in all multiple studs, headers and corners before attaching members.
- h. Painting: After erection, clean all field welds of galvanized steel and touch up with zinc rich paint.

05 50 00 METAL FABRICATIONS:

- 1. GENERAL: Provide material and work for the following:
 - a. Embedded and non-embedded metal material, including but not limited to aluminum or steel covers for the cable entry box, galvanized ledge angles, cable entry metalwork and sealing assemblies, loose steel lintels, door stop posts, bumper posts and not including metalwork which is specified in other specifications sections.
 - b. Frames, hangers and supports required for equipment, except those which are specified in other paragraphs.
 - c. Manufactured material, including soffit vents, cable sealing assemblies and ceiling access panel.
- 2. SUBMITTALS: Submittals shall be provided in accordance with SUBMITTALS paragraph of DIVISION 1 – General Requirements and the submittal table in DIVISION 11 project specifications.
- 3. MATERIAL:
 - a. Aluminum or Steel Covers: As specified in Standard 4 – Substation Metalwork and Transmission Line Lattice Structures, Section 4.2 Miscellaneous Metalwork.
 - b. Cable Sealing Assemblies: Equal to Roxtec Cable and Pipe Seals (www.roxtec.com) or approved equal, with the following features:
 - (1) Seals: Rodent resistant and watertight, with positive dust and moisture seal.
 - (2) Mounting Frame: Multiple units of manufacturer's standard galvanized steel frames with bolting flange. Refer to the Drawings for dimensions of openings. Provide rubber gasket to seal flange to concrete.
 - (3) Sealing Modules: Multi-diameter modules with adaptable cores of elastomeric material sized to fit snugly around cables as listed on the Drawings or fill spare spaces, and removable for future expansion. Spare sealing modules shall be provided in the same sizes and proportions as required for the construction contract.
 - (4) Grounding: Provide for grounding assembly.
 - (5) Accessories: Lubricant, sealant, anchors, hardware, bolts, clamps, end packing, compression plates and accessories required for complete installation.
 - c. Ceiling Access Door: Equal to Babcock-Davis BIW series insulated access panel, 22 inches by 22-inches, 1-hour fire rated with smoke gasketing, prime painted from manufacturer.
 - d. Soffit Vents for Prefinished Plywood Soffit:
 - (1) Material: 0.014-inch aluminum with painted white finish.
 - (2) Width: 2 3/4-inches.

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- (3) Length: 96-inches.
- (4) Accessories: Insect screen.
- (5) Manufacturer or equal: Air Vent Inc. model SV201 or SV202.

4. FABRICATION:

- a. General: For fabrication of metalwork which will be exposed to view, use only material which is smooth and free of surface blemishes including pitting, seam marks, weld splatter, roller marks, rolled trade names and roughness.
- b. Dimensions: Verify dimensions onsite prior to shop fabrication.
- c. Joints: Fabricate material with joints flush and tightly fitted and secured. Miter corners.
- d. Assembly: Fit and assemble in largest practical sections for delivery to worksite.
- e. Grinding: Grind exposed welds flush and smooth with adjacent finished surface. Ease exposed edges to small uniform radius.
- f. Anchorage: Provide components required for anchorage of metalwork. Fabricate anchors and related components of same material and finish as metalwork, except where specifically noted otherwise.
- g. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; and consistent with design of structure, except where specifically noted otherwise.
- h. Door Stop Posts: As detailed on the project drawings.
- i. Bumper Posts: As detailed on the project drawings.
- j. Shop Finish:
 - (1) Clean surfaces of rust, scale, grease and other foreign matter prior to finishing or placing in concrete.
 - (2) Prime paint unfinished metalwork with two (2) coats rust-inhibitive primer.
 - (3) Galvanize assembled steel material in accordance with ASTM A 123.

5. PREPARATION: Clean and strip primed steel or galvanized material to bare metal where welding is required.

6. INSTALLATION:

- a. General: Install material plumb and level, accurately fitted, and free from distortion or defects. Perform cutting, drilling, tapping and fitting required for installation of metalwork. Fit exposed connections accurately to form tight hairline joints.
- b. Cable Sealing Assemblies: Properly seal frame flange to concrete foundation. Carefully review manufacturer's installation instructions prior to pulling control cable through cable sealing assemblies. Sealing modules shall be tight around all cables and result in a watertight installation.
- c. Welding: Perform field welding in accordance with AWS D1.1. Grind exposed joints smooth and flush.

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- d. Fastening to In-Place Construction: Set anchor devices and fasteners where necessary to secure metalwork to in-place construction. Use threaded fasteners, masonry anchors, toggle bolts, through bolts, lag bolts, wood screws and other connectors as required.
 - e. Manufactured Material: Install in accordance with manufacturer's instructions.
 - f. Tolerances for Cable Entry Box Covers:
 - (1) Maximum Space between Adjoining or Abutting Sections: 1/8-inch.
 - (2) Maximum Variation from Top Surface Plane of Abutting Sections: 1/16-inch.
 - (3) Bearing: Material shall not rock on concrete supports.
 - g. Adjustments: Cut or make adjustments as approved by the COR for metalwork which does not fit. Grind concrete surfaces to eliminate high spots or racking of cover.
 - h. Painting: In accordance with Standard 12 – Painting.
7. SHOP FINISH SCHEDULE: Shop finish material as scheduled or as shown on the Drawings:
- a. Door Stop Posts: Galvanized.
 - b. Ledge and Shelf Angles Below Grade: Galvanized.
 - c. Cable Sealing Assembly Frames: Galvanized.
 - d. Lintels: Prime paint finish. Finish paint at exposed lintels.
 - e. Fabricated Access Door and Frame: Prime paint.
 - f. Below Ceiling Supports for Equipment: Galvanized finish or painted finish to match equipment.
 - g. Manufactured Material: Manufacturer's finish.
 - h. Bumper Posts: Galvanized.

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SECTION 06 00 00 – WOOD, PLASTICS AND COMPOSITES

1. General: Requirements within sections below are minimums unless noted otherwise in General Structural Notes on drawings, project specifications or building drawings.

06 10 00 ROUGH CARPENTRY:

1. GENERAL: Provide material and work for the following:
 - a. Wood framing and sheathing for walls and roof structure.
 - b. Fascia, nailers and miscellaneous wood blocking for installation of equipment, lights and overhead cable tray as detailed on the Drawings or as required for backup material.
 - c. Fire blocking.
 - d. Preservative treatment.
 - e. Connectors, fasteners, accessories and anchors. Refer to structural drawings.
2. QUALITY ASSURANCE:
 - a. Lumber: Identify with grade stamp of an agency certified by NFOPA. Lumber Grading Rules shall be in accordance with WAPA.
 - b. Plywood or Oriented Strand Board: Identify with grade stamp of APA.
3. MATERIAL:
 - a. General: Refer to the General Structural Notes on the project drawings for material properties of dimensional lumber, machine stress-rated (MSR) lumber, laminated veneer lumber, plywood and oriented strand board. Dimensions and thickness shall be as shown on the Drawings. Any other type of engineered lumber is considered 'a variance' and must be submitted as so, for review and acceptance.
 - b. Sills: Shall be Redwood or Preservative treated wood, including engineered lumber, in accordance with Chapter 23 of the IBC.
 - c. Nails, Spikes and Staples: Galvanized for exterior locations and high humidity locations and treated wood; plain finish for other interior locations; size and type to suit application.
 - d. Connectors: Refer to structural drawings.
4. SITE TREATMENT OF WOOD MATERIAL: Site treat sawn end and machined areas of treated wood with preservative compatible with shop treatment.
5. INSTALLATION:
 - a. General: Install framing, blocking and required nailers. Install members true, plumb and level. Secure in place.
 - b. Spacing: Space framing as shown on the Drawings.
 - c. Material: Construct members of continuous pieces of longest possible lengths. Provide tight fitting butt joints.

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- d. Attachment: Wall framing shall accommodate anchor bolts and miscellaneous anchors as shown on the building structural drawings.
- e. Wall Openings: Double wall-framing members at openings over 100-square-inches. Space short members above and below openings in same manner as for walls.
- f. Plywood Decking:
 - (1) Placing: Place panels perpendicular to framing with end joints staggered. Secure panels with edges centered on framing. Maintain panel joints of 1/8-inch at end and edge joints for expansion and contraction.
 - (2) Nailing: As specified in the General Structural Notes of the project drawings or the Fastening Schedule in Chapter 23 of the IBC.
- g. Wall Sheathing: As specified in the General Structural Notes of the project drawings or the Fastening Schedule in Chapter 23 Wood of the IBC. Maintain panel joints of 1/8-inch at end and edge joints.
- h. Bolts: Drill holes 1/16-inch larger than bolt diameter. Drill straight and true from one (1) side only. Use washers under nuts and bolt heads in contact with wood. Counter bore, where required, but not more than one-third of material thickness.
- i. Lag Screws: Pre-bore holes the same diameter as root of thread. Enlarge holes to shank diameter for length of shank.
- j. Nails: For conditions not specified or noted on the Drawings, provide penetration into receiving piece of minimum one-half nail length. Use 16d nails to connect two (2) pieces of 2x lumber. Replace members split by nailing.
- k. Tolerances: Surface flatness of roof deck and wall sheathing: 1/4-inch in 10-feet maximum.

06 17 53 SHOP FABRICATED WOOD TRUSSES:

- 1. GENERAL: Provide wood trusses including connectors for attachment to load bearing walls, connectors for interconnection of trusses, lateral bracing, lateral bracing connectors and miscellaneous blocking.
- 2. QUALITY ASSURANCE:
 - a. Design, fabrication and erection shall conform to Truss Plate Institute (TPI) "Design Specification for Metal Plate Connected Wood Trusses".
 - b. Design: Trusses shall be designed by a Professional Engineer registered in the state where the structure shall be built. Trusses shall meet the requirements of the latest edition of the IBC.
 - c. Qualifications of Fabricator: Fabricator shall meet the requirements for in-plant quality control practices and fabrication procedures as provided by the Truss Plate Institute Inspection Bureau or the requirements of another approved independent inspection agency.
- 3. SUBMITTALS: Submittals shall be provided in accordance with SUBMITTALS paragraph of DIVISION 1 – General Requirements and the submittal table in DIVISION 11 project specifications.

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- a. Shop Drawings: Indicate truss framing plan; species and grades of lumber used; pitch, span and spacing of trusses; gauge thickness, nominal sizes and locations of connectors at joints; bearing and anchorage details; all connectors for interconnection of trusses and bracing; framed openings, if required; and permanent bracing and bridging. Drawings shall be stamped by a Professional Engineer registered in the state where the structure shall be built.
4. DELIVERY, STORAGE AND HANDLING: In accordance with TPI.
5. MATERIAL:
 - a. Wood Chords and Webs: Lumber shall be in accordance the General Structural Notes of the project drawings, conform to TPI requirements, shall be S4S, and have a maximum moisture content of 19-percent at time of fabrication.
 - b. Plates: Conform to TPI and be galvanized.
 - c. Lateral Support: As recommended by truss manufacturer and truss engineer.
 - d. Truss Connectors: The truss manufacturer, through the engineer-of-record, is responsible for final connector selection for inter-connection of all elements of the roof truss system based upon final loads; toe-nailed connections are not acceptable. Refer to General Structural Notes, framing plan and structural details in the project drawings for additional information.
6. FABRICATION: In accordance with TPI. Ensure members are accurately cut to length, angle and true to line for tight joints.
7. INSTALLATION: Erect and brace trusses in accordance with the manufacturer's recommendations. Temporary and permanent bracings shall provide sufficient support at right angles to the plane of the truss to hold each truss in correct location and alignment. Install permanent bracing, bridging and all connectors, prior to application of loads.

06 64 00 FIBERGLASS-REINFORCED PLASTIC PANELS:

1. GENERAL: Provide fiberglass reinforced plastic (FRP) panels with matching trim pieces for wall application.
2. SUBMITTALS: Submittals shall be provided in accordance with SUBMITTALS paragraph of DIVISION 1 – General Requirements and the submittal table in DIVISION 11 project specifications.
3. MATERIAL:
 - a. FRP Panel: Fiberglass reinforced thermosetting polyester resin panel complying with ASTM D 5319, Class A rated per ASTM E 84, minimum thickness of 0.09-inches, pebbled front surface, white in color, equal to Marlite Standard FRP panel.
 - b. Trim: Semi-rigid extruded PVC for edges and corners, color white to match panels.
 - c. Adhesive: As recommended by panel manufacturer for application to gypsum wall board or fire-retardant treated plywood.
4. INSTALLATION:

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- a. Cut and drill panels in accordance with the manufacturer's installation instructions. Apply panels to substrate in a vertical orientation with seams plumb. Trim pieces shall be installed to allow for panel expansion.
- b. Refer to manufacturer's specific cleaning recommendations. Do not use abrasive cleaners.

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SECTION 07 00 00 – THERMAL AND MOISTURE PROTECTION

07 21 13 BOARD INSULATION:

1. GENERAL: Provide rigid board insulation at inside perimeter of foundation and under floor slab in accordance with the project drawings.
2. SUBMITTALS: Submittals shall be provided in accordance with SUBMITTALS paragraph of DIVISION 1 – General Requirements and the submittal table in DIVISION 11 project specifications.
3. MATERIAL:
 - a. Board Insulation: Extruded polystyrene Type IV foam board insulation per ASTM C 578, 25 psi compressive strength per ASTM D 1621, maximum water absorption of 0.3-percent by volume per ASTM C 272, minimum R-value of 5.0-per-inch, equal to Styrofoam Brand Square Edge Insulation by DOW Building Solutions.
 - b. Adhesive: As recommended by insulation manufacturer for application to concrete wall.
4. INSTALLATION:
 - a. Apply board insulation to inside face of foundation wall as recommended by the manufacturer and as shown on the project drawings. Protect from damage before and during backfilling.

07 21 16 BLANKET INSULATION:

1. GENERAL: Provide insulation above the ceiling, in exterior walls and at locations shown on the Drawings. The minimum resistance value (R) is noted on the Drawings. Insulation shall have a minimum recycled content of 25-percent.
2. SUBMITTALS: Submittals shall be provided in accordance with SUBMITTALS paragraph of DIVISION 1 – General Requirements and the submittal table in DIVISION 11 project specifications.
3. MATERIAL:
 - a. Faced Insulation: Equal to Formaldehyde-free FSK-25 (foil-scrim-kraft) Faced Batts by Johns Manville Corporation and having the following minimum characteristics:
 - (1) Compliance with ASTM C 665, Type III, Class A, Category 1.
 - (2) Surface Burning Characteristics, ASTM E 84: Flame-spread 25 or less, smoke development 50 or less.
 - (3) Water Vapor Permeance, ASTM E 96: 0.05-perms or less.
 - (4) Fungi Resistance, ASTM C 1338: Pass.
 - b. Unfaced Batt Insulation: Equal to Formaldehyde-free Unfaced Batts by Johns Manville Corporation and having the following minimum characteristics:
 - (a) Compliance with ASTM C 665, Type 1.

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- (2) Surface Burning Characteristics, ASTM E 84: Flame-spread 25 or less, smoke development 50 or less.
 - (3) Fungi Resistance, ASTM C 1338: Pass.
 - c. Safing Insulation: Equal to Thermafiber by Owens Corning.
 - (1) Unfaced, minimum 75-percent recycled content, 4.0-pcf density, thickness of 6-inches.
 - (2) Noncombustible and compliance with ASTM E 84, flame/fuel/smoke rating of 15/0/0.
 - d. Staples: As recommended by insulation manufacturer.
4. EXECUTION:
- a. Preparation: Verify adjacent material is dry and ready to receive insulation. Verify mechanical and electrical services within walls have been installed and tested.
 - b. General: Install insulation in accordance with manufacturer's instructions. Trim insulation neatly to fit spaces. Fit insulation tight in spaces and tight to exterior side of mechanical and electrical services within the plane of insulation. Leave no gaps or voids.
 - c. Faced Batt Insulation: Install insulation with vapor retarder facing warm side of building spaces. Friction staple insulation between wood studs. Tape and seal tears and cuts in vapor retarder. Maintain continuity of vapor retarder membrane.
 - d. Ceiling Insulation: Install after installations above ceiling are complete.
 - e. Safing Insulation: Apply in battery room wall cavity at ceiling height.

07 21 26 BLOWN INSULATION

- 1. GENERAL: Provide blown-in fiberglass wall and attic insulation.
- 2. SUBMITTALS: Submittals shall be provided in accordance with SUBMITTALS paragraph of DIVISION 1 – General Requirements and the submittal table in DIVISION 11 project specifications.
- 3. MATERIAL:
 - a. Fiberglass Insulation: Complying with ASTM C 764 Standard Specification for Fiberglass Fiber Loose-Fill Thermal Insulation; Noncombustibility: meets requirements, ASTM E136.
- 4. INSTALLATION:
 - a. Apply in accordance with manufacturer's coverage charts for R-values as indicated on the Drawings. Remove dust, dirt or foreign matter that may impair adhesion to the application surface. Protect adjacent surfaces that are not intended to receive thermal insulation, such as receptacles, windows and doors. Installation procedures and techniques must be as recommended by CertainTeed Corporation, using blowing machines approved for fiber glass insulation. Please refer to InsulSafe SP Installation Instruction Manual 30-24-302.
 - b. Provide a vapor retarder in accordance with section 07 26 00 Vapor Retarder.

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07 22 00 ROOF AND DECK INSULATION:

1. GENERAL: Provide rigid board insulation over metal deck, as shown on the Drawings.
2. SUBMITTALS: In accordance with Division 1 – General Requirements.
 - a. Product Data: Submit manufacturer's product information showing conformance with these specifications.
3. MATERIALS:
 - a. Roof Insulation: Polyisocyanurate foam laminated to fiber reinforced facer on both sides, ASTM D 1289, Type II, Class 1, Grade 3 (25-psi), dimensional stability 2-percent maximum change per ASTM D 2126, water absorption less than 1-percent volume per ASTM C 209, Flame Spread (foam core) less than 50 per ASTM E 84, R value of six (6) per inch, thickness as required on the Drawings, equal to H Shield Flat Polyiso by Hunter Panels. The top 2-inch layer of insulation shall be nail-base with 5/8-inch plywood laminated to the rigid board insulation.
 - b. Fasteners and Plates: Of length and diameter as recommended and supplied by the board insulation manufacturer for attachment to metal deck. Space fasteners as required to meet UL wind uplift class 90 rating.
4. PREPARATION: Steel deck surfaces shall be clean and dry.
5. EXECUTION:
 - a. General: Install materials in accordance with manufacturer's recommendations and these specifications. Install insulation with staggered joints. Cut and fit with saw, knife or other tool to leave clean, square edges. Fit insulation tightly against adjoining pieces and closely around penetrations. Use mechanical fasteners as recommended by board insulation manufacturer.

07 25 00 WEATHER BARRIERS:

1. GENERAL: Provide air/moisture barrier on the exterior of wall sheathing.
2. SUBMITTALS: Submittals shall be provided in accordance with SUBMITTALS paragraph of DIVISION 1 – General Requirements and the submittal table in DIVISION 11 project specifications.
3. MATERIAL:
 - a. Weather Barrier: Spunbonded polyolefin, non-woven, non-perforated, air penetration resistance less than 0.004-cfm-per-square-foot at 1.5-psf air pressure per ASTM E 2178, water vapor transmission of 56-perms per ASTM E 96 method A, Class A surface burning characteristics per ASTM E 84, equal to DuPont Tyvek.
 - b. Seam Tape: 3-inch-wide DuPont Tyvek Tape or equal.
 - c. Fasteners: No. 4 nails with 1-inch-diameter plastic cap.
4. INSTALLATION:

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- a. General: Attach to sheathing, overlap, shingle and tape horizontal and vertical seams in accordance with the manufacturer's installation instructions. Wrap around wall openings and overlap with flashing at base of the wall.

07 26 00 VAPOR RETARDERS:

1. GENERAL: As applicable for building construction type, provide a vapor retarders at the inside surface of walls, ceiling or top side of steel roof deck.
2. SUBMITTALS: Submittals shall be provided in accordance with SUBMITTALS paragraph of DIVISION 1 – General Requirements and the submittal table in DIVISION 11 project specifications.
3. MATERIAL:
 - a. Polyethylene Sheet: 10-mil polyethylene sheet or alternate Class 1 vapor retarder to underside of roof structure and interior face of wall framing when cellulose insulation is used. Tape all seams and seal miscellaneous openings in vapor retarder.
 - b. Self-Adhesive Vapor Retarder: Reinforced composite aluminum foil with self-adhesive SBS backing and removable poly release film, water vapor transmission of 0.03 perms per ASTM E 96, tear strength 135-lbf per ASTM D 1970, thickness of 0.015-inch, low temperature flexibility minus 20-degrees Fahrenheit, FM approval Class 1, equal to VapAir Seal MD as manufactured by Carlisle Syntec Systems.

07 41 13 METAL ROOF PANELS:

1. GENERAL: Provide metal roofing with vented ridge cap, prefinished metal fascia to match roofing, flashing and concealed anchors. Provide roofing underlayment. Roofing panels shall be grounded. Provide gutters and downspouts as shown on the Drawings.
2. SUBMITTALS: Submittals shall be provided in accordance with SUBMITTALS paragraph of DIVISION 1 – General Requirements and the submittal table in DIVISION 11 project specifications.
3. PERFORMANCE:
 - a. Leakage: Roofing installation shall be free from water leakage under all weather conditions for roof slope of 4:12.
 - b. Roof Finish: No chalk in excess of seven (7) units as measured in accordance with ASTM D4214 No fade or color change in excess of 6 NBS units when measured in accordance with ASTM D 2244.
 - c. Thermal Movement: Provide roof and accessories to accommodate thermal expansion and contraction for plus or minus 200-degrees Fahrenheit.
 - d. Wind Uplift: Class 90 per UL Standard 580.
4. MATERIAL:
 - a. Metal Roofing Panel, 3/12 or greater pitch: Equal to Span-Lok hp by AEP-Span (www.aep-span.com) and shall have the following features:
 - (1) Base Material: 24-gauge galvanized sheet steel.

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- (2) Dimensions: 2-inch standing seam height, panel width of 16-inches to 24-inches on center; standing seam height 2-inches and mechanically seamed. Crimping standing seams with hand tools is not allowed. Follow manufacturer's installation specifications and use mechanical crimpers specified by manufacturer.
 - (3) Finish: Factory-applied paint equal to Kynar 500 or Hylar 5000 consisting of baked on corrosion resistant primer and baked on finish coat. Panel color shall be selected from manufacturer's full range of standard colors.
 - (4) Panel Length: Continuous from ridge to eave.
- b. Metal Roofing Panel, less than 3/12 pitch: 24-gauge galvanized steel base material, 24 inch-width, 2 3/8-inch standing seam height, with factory applied fluoropolymer paint. Roof panels shall be McElroy Metals, 238T symmetrical panel with plank and pencil profile, or equal. Provide seam caps with two (2) continuous beads of sealant, factory formed metal closure and factory formed foam closure.
 - c. Anchor Clips, Cleats and Starter Strips: Two (2) piece, self-centering, allowance for expansion and contraction, concealed, minimum 24-gauge galvanized or aluminized sheet steel; provided by roofing manufacturer.
 - d. Vented Ridge Cap, Fascia, Trim Material, Flashings, Gutters and Downspouts: Factory formed from same material, gauge and finish as roofing material. Provide insect screen for vented ridge cap. Allow for roof panel expansion and contraction, per manufacture's recommendations.
 - e. Snow Guards: Equal to Snoblox SnowBar with stainless steel clamps, steel bar with endcap, icestopper and other accessories as required for a complete installation. Provide snow guards as shown on the project drawings.
 - f. Roof Panel Fasteners: Concealed screw attachment suitable for fastening sheet metal to plywood, as recommended by roofing manufacturer, and corrosion resistant.
 - g. Roofing Underlayment: Equal to Grace Ultra, self-adhered roofing underlayment for high temperature applications, 30-mil thickness. Prime wood sheathing with Perm-A-Barrier WB Primer at a rate of 250-350-square-feet per gallon. Add synthetic, high temperature underlayment for installation above the peel and stick membrane.
 - h. Sealant: As recommended by roof panel manufacturer or in accordance with specifications Section 07 91 00 Joint Sealants.
5. INSTALLATION:
- a. General: Execute work in accordance with roof panel manufacturer's instructions.
 - b. Underlayment: Apply underlayment to meet requirements of roofing manufacturer for weather tight installation.
 - c. Joints: Lap, lock, cleat, seam and seal all joints for weather tight installation.
 - d. Clips and Cleats: Shall be concealed, with spacing as recommended by roofing manufacturer for UL 90 rating.
 - e. Detail Standards: For gutters and downspouts fabrication, conform to the SMACNA "Architectural Sheet Metal Manual" recommendations.

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- f. Grounding: In accordance with the 4000 series drawing and approved shop drawings, provide grounding of the metal roofing system. Run a grounding wire under the ridge cap the full length of the building.
- g. Repairs: Repair or replace material which is loose, improperly fitted or damaged.
- h. Painting: Paint cut edges of roofing, flashing, and accessories with matching paint provided by roofing manufacturer. Touch up minor scratches.

07 42 13 METAL SOFFIT AND SIDING PANELS:

- 1. GENERAL: Provide preformed, prefinished metal panels with matching flashing and trim for soffit and siding at the roof overhangs.
- 2. SUBMITTALS: Submittals shall be provided in accordance with SUBMITTALS paragraph of DIVISION 1 – General Requirements and the submittal table in DIVISION 11 project specifications.
- 3. MATERIAL:
 - a. Metal Soffit Panel: Equal to McElroy Metal, vented profile and with the following minimum features:
 - (1) Width: 12-inches with two (2) 1 1/2-inch-wide vented bands.
 - (2) Depth: 1-inch interlocking ribs.
 - (3) Length: Minimum 10-feet.
 - (4) Gauge: 24-gauge.
 - (5) Finish: Factory-applied Kynar 500 paint.
 - (6) Color: As selected by WAPA from manufacturer's standard colors.
- 4. INSTALLATION: Install soffit and siding panels in accordance with approved shop drawings and manufacturer's instructions.
- 5. REPAIRS: Repair or replace material which is loose, improperly fitted or damaged.
- 6. PAINTING: Paint cut edges of soffit panels, flashing, trim and accessories with matching paint provided by the panel manufacturer. Touch up minor scratches. Do not use maintenance material.

07 42 93 PLYWOOD SOFFIT PANELS:

- 1. GENERAL: Provide prefinished plywood soffit complete with standard trim components and accessories. Refer to section 05 50 00 Metal Fabrications for soffit vent.
- 2. SUBMITTALS: Submittals shall be provided in accordance with SUBMITTALS paragraph of DIVISION 1 – General Requirements and the submittal table in DIVISION 11 project specifications.
- 3. MATERIAL:
 - a. Prefinished Plywood: Equal to panel 15 by Citadel Architectural Products (www.citadelap.com) and with the following features:
 - (1) Core: Structural C plugged exterior grade plywood, 5/16-inch thick, 4-feet-wide and 10 feet long.

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- (2) Face Sheet: 0.010-inch textured aluminum, with pebble texture and prefinished baked on polyester coating, bonded to core with waterproof adhesive.
- (3) Back Sheet: 0.004-inch fiberglass-reinforced aluminum foil backer bonded to core with waterproof adhesive.
- (4) Protective Sheets: Protect finished surfaces from damage during shipping.
- b. Trim: Provide end panel closures, corner trims, drips and other moldings as required for a complete and weathertight installation. Trim shall be extruded or roll-formed aluminum with baked on finish and color to match panels. Trim shall be by the panel manufacturer.
- c. Nails: Aluminum, colored to match panels, and of size and type recommended by manufacturer.
- d. Screws: Color to match panels and as recommended by manufacturer.
- 4. INSTALLATION: Install panels, trim and accessories as shown on the Drawings, and in accordance with manufacturer's instructions. Provide adequate separation of aluminum panel edges and backs from dissimilar metals, as recommended by manufacturer, to prevent electrolysis. Panels damaged during installation shall be repaired or replaced as directed by the COR.

07 57 13 SPRAYED POLYURETHANE FOAM:

- 1. GENERAL: Provide sprayed-in-place polyurethane foam insulation in wall cavities and other locations as indicated on the Drawings.
- 2. SUBMITTALS: Submittals shall be provided in accordance with SUBMITTALS paragraph of DIVISION 1 – General Requirements and the submittal table in DIVISION 11 project specifications.
- 3. MATERIAL: Equal to CertainTeed, Certa Spray closed cell foam or equal, and with the following characteristics:
 - a. Density (sprayed in place): Minimum 2.0-pound per cubic foot per ASTM D 1622.
 - b. Thermal Resistance (aged): R-value of 6.40-per-inch; ASTM C 518.
 - c. Compressive Strength: Minimum of 25-pounds-per-square-inch; ASTM D 1621.
 - d. Dimensional Stability: Less than 9-percent net, ASTM D 1621.
 - e. Permeance: 1.51-inch; ASTM E 96.
 - f. Water Absorption: Less than 2-percent by volume; ASTM D 2842.
 - g. Flammability: Flame spread less than 25; ASTM E 84.
 - h. Smoke Index: Less than 450: ASTM E 84
- 4. INSTALLATION: Apply primer to wood sheathing if recommended by foam manufacturer. Surfaces that are to be primed or receive spray foam application shall be dry, free of oils, dirt and other foreign matter or other contaminants that will interfere with total adhesion of the primer and foam. Apply foam insulation to thickness indicated on the Drawings and in accordance with manufacturer's recommendations.

If the sprayed foam skin is removed to correct surface irregularities or to remove excess foam thickness, respray the cut surface with a minimum of 1/2-inch thickness of foam to provide a protective foam skin.

- 5. CLEANUP: Remove overspray and masking materials.

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07 91 00 JOINT SEALANTS:

1. GENERAL: Provide acrylic caulking for interior of building and silicone sealant for exterior.
2. SUBMITTALS: Submittals shall be provided in accordance with SUBMITTALS paragraph of DIVISION 1 – General Requirements and the submittal table in DIVISION 11 project specifications.
3. MATERIAL: Add polyurethane sealant for exterior joints.
 - a. Acrylic Caulking: ASTM C 834; one (1) component; acrylic sealant; color to match adjacent construction.
 - b. Silicone Sealant: ASTM C 920, Type S, Grade NS, Class 25, one (1) component; low modulus silicone sealant, color to match adjacent areas when visible.
 - c. Firestop Sealant: Silicone based elastic firestop sealant, joint movement capability of plus or minus 25-percent, minimum 2-hour fire resistance approval by UL, equal to Hilti CP 601 Elastomeric Firestop Sealant.
 - d. Backup Material: Closed cell polyethylene foam round rods having highly flexible and compressive characteristics; compatible with joint compound.
4. INSTALLATION: Surface preparation and installation of backup material shall be in accordance with manufacturer's instructions.
 - a. Temperatures: Do not install sealant when ambient temperature or temperature of surfaces against which it will be placed is below 40-degrees Fahrenheit unless permitted by manufacturer's installation instructions.
 - b. Repairing: Joint compounds that are not homogeneous, do not bond to surfaces of joints, or are otherwise defective shall be removed from joints, and joints re-cleaned and re-caulked at the Contractor's expense.
5. SCHEDULE: Intended as a guide for caulk and sealant locations; however, each location is subject to approval.
 - a. Acrylic Caulk: Use for interior work only, gypsum board caulking, interior hollow metal frames and joints between dissimilar materials where little or no movement is expected.
 - b. Sealant: Use for joints in building exterior such as masonry control joints around metal frames and metal roofing.
 - c. Firestop Sealant: For use in sealing penetrations through battery room walls or ceiling.

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SECTION 08 00 00 – OPENINGS

08 11 13 HOLLOW METAL DOORS AND FRAMES:

1. GENERAL: Provide steel swinging doors, doorframes and other accessory material where shown on the Drawings, or required, for a complete installation. Steel door frames shall be grounded.
2. SUBMITTALS: Submittals shall be provided in accordance with SUBMITTALS paragraph of DIVISION 1 – General Requirements and the submittal table in DIVISION 11 project specifications.
3. PRODUCT HANDLING AND PROTECTION: Follow manufacturer's special storage and handling requirements.
4. MATERIAL:
 - a. General: Doors and frames shall be of sizes shown on the Drawings. Doors and frames shall be products of one (1) manufacturer. Panel reinforcement for doors shall be steel reinforcement only.
 - b. Exterior Steel Doors: Level 3 (extra heavy duty), Model 1 (full flush construction), and 1 3/4 inch thick, 16 gauge, in accordance with ANSI/SDI A250.8. Class (door type) as shown on the Drawings.

Fill spaces within exterior doors with glass fiber insulation having a minimum density of 1 1/2 pounds per cubic foot or polystyrene having a minimum density of 1 pound per cubic foot.
 - c. Interior Steel Doors: Level 2 (heavy duty), model 1 (full flush construction), 1 3/4-inches-thick, 18 gauge, in accordance with ANSI/SDI A250.8 Door type as shown on drawings.
 - d. Fire Door Cores: As required to provide fire-protection ratings indicated on drawings.
 - e. Steel Doorframes: Doorframes shall be welded and of types and sizes shown on the Drawings; in accordance with requirements of ANSI/SDI A250.8, except for gauge.
 - (1) Exterior Doorframes: Exterior doorframes shall be 14 gauge sheet steel.
 - (2) Interior Doorframes: Interior doorframes shall be 16 gauge sheet steel.
 - f. Steel Shop Primer: Manufacturer's standard, lead and chromate free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field applied coatings despite long exposure.
 - g. Accessories: Where indicated on drawings, provide louvers which comply with SDI 111C.
 - h. Caulking and Backup Material: In accordance with Section 07 91 00 Joint Sealants.
 - i. Frame Anchors: SDI standard, compatible with adjacent construction, and welded to doorframe.
 - j. Stiffeners: Shall be not less than 12-gauge steel.
5. FABRICATION:

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- a. General: Doors and frames shall be reinforced, drilled and tapped in shop to receive projecting hardware. Perform drilling and tapping for surface hardware in the field. Use templates furnished by hardware manufacturer to ensure correct fitting and installation of hardware.
 - b. Doors: Top and bottom of doors shall receive a flush end closure treatment. Surface sheets shall be supported by continuous, hat-shaped members not less than 20 gauge, spaced not more than 6-inches on center and internally spot welded to both surface sheets not more than 4-inches on center. Undercut each door leaf as required for proper clearance and installation of weather stripping and threshold.
 - c. Frames: Frames for installation in wall openings over 4-feet wide shall have a 12 gauge channel stiffener factory welded into the head. Frames for installation in exterior and interior walls shall be of welded construction.
 - d. Jamb Anchors: Provide four (4) welded anchors per jamb for frames up to 7-feet-high, and one (1) additional anchor per foot of height above 7-feet. In addition, provide sill anchors for all frames. Anchors shall be welded to back of frame, minimum of 0.042-inch (1.0 mm) thick.
 - e. Floor Anchors: Minimum 0.042-inch-thickness, clip-type with two (2) holes to receive fasteners.
 - f. Head Anchors: As recommended by door manufacturer.
 - g. Shop Finish: Exterior doors and frames shall be galvanized, followed by a phosphate treatment, and given the manufacturer's standard shop coat of non-bituminous priming paint. All exterior frames shall receive one (1) coat of bituminous water-resistant paint on the inside, unexposed surface.
6. INSTALLATION:
- a. Doors and Frames: Install doors and frames in true alignment with head level and jambs plumb. Install welded-type door frames at the time walls are constructed; brace and anchor in place. Insulate exterior door frames.
 - b. Hardware: In accordance with Section 08 71 00 Door Hardware.
7. FIELD PAINTING: After doors are installed, but before projecting hardware is installed, doors and doorframes shall be painted in accordance with Standard 12 – "Painting".
8. ADJUSTMENT: Before acceptance of work, test operation of doors and correct defects in operation.

08 71 00 DOOR HARDWARE:

- 1. GENERAL: Provide hardware for steel doors, complete with fasteners, anchors and other accessories for full operation of hardware. Exterior door locks shall be protected with astragals.
- 2. SUBMITTALS: Submittals shall be provided in accordance with SUBMITTALS paragraph of DIVISION 1 – General Requirements and the submittal table in DIVISION 11 project specifications.
- 3. MATERIAL:

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- a. Door Hardware: Table 11-1 specifies the door hardware types, or equal, which are acceptable. Refer to Division 11 of the project specifications for the door hardware schedule.
 - b. Keying:
 - (1) Doors requiring mechanical locks shall be keyed the same.
 - (2) Existing Keying System: A master keying system has been established with Best Access Systems. The keying system is either a 6-pin or 7-pin system; consult with the COR. The lock sets for doors shall be supplied with a permanent cylinder with temporary construction core for use during construction. The cylinder furnished shall be capable of accepting a Best Access Systems permanent core. When construction is complete, the Contractor shall turn over to WAPA the construction master and control key. WAPA will furnish and install the permanent cores.
 - c. Fasteners: Provide hardware with screws, bolts and other fasteners of suitable size and type to anchor hardware in position for long life under hard use. Provide expansion shields, toggle bolts, hex bolts and other anchors suitable for type of material to which hardware is applied. Fasteners shall be compatible with or match hardware material and finish.
4. INSTALLATION:
- a. General: Install hardware in accordance with manufacturer's recommendations, using proper templates.
 - b. Painting: Do not install projecting hardware until painting of doors and frames is complete.
 - c. Thresholds: Fit tight to doorframes, set in full beds of mastic and attach to concrete with machine screws in expansion anchors.
 - d. Closers: Provide parallel arms at out-swinging exterior doors to prevent exterior exposure. Size exterior door closers one (1) size oversized.
 - e. Astragal: Provide welded or bolted astragal for lock protection at all exterior doors.
 - f. Adjustment: Test operation of each door, verify lock location, adjust hardware, and correct defects in operation.

TABLE 11-1 – DOOR HARDWARE TYPES

TYPE	HARDWARE SCHEDULE DESIGNATION	DESCRIPTION	FINISH	MANUFACTURER'S CATALOG ITEMS	NUMBER REQUIRED PER DOOR
Hinges	H1	4 1/2-inch x 4 1/2-inch, brass, heavy weight, full mortise, template, five knuckles, four ball bearings, non-removable pin, and flat button tips.	619	Hager BB1199 NRP with safety stud. Stanley FBB199 NRP or equal.	3 per door up to 7-ft. height, 1 add'l hinge per ft. over 7-ft. height.
		Add concealed electrical power transfer equal to Securitron CEPT-10 Add regular hinges for interior doors			

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TYPE	HARDWARE SCHEDULE DESIGNATION	DESCRIPTION	FINISH	MANUFACTURER'S CATALOG ITEMS	NUMBER REQUIRED PER DOOR
Mortise Lockset	L1	Mortise lock set with knobs, roses, and cylinder rings; antifriction latch bolt, stops or toggle in face, deadbolt throw of 1-inch; screwless knob spindle; and cylinders with interchangeable tumbler core. Latch bolt by knob from either side except when knob outside is locked by stop or toggle in face, and by key outside when outer knob is locked. Deadbolt by key outside and turn knob inside. Rotating inside knob simultaneously retracts both latch bolt and deadbolt.	619	Best 45H7TA3H or equal.	1 for active leaf.
Electrified Lockset	L2	Mortise exit device with exterior cylinder and lever, capable of accepting Best 7 pin cylinder, touchbar monitor (REX, request to exit), electric latch retraction.	619	Corbin Russwin ED5657L-N9M57-M92 Best 12E72 cylinder or equal.	Add power supply to spec
Electric Power Transfer Device				Von Duprin EPT2 or Securitron CEPT-2 or equal	Check if 10 conductor req'd, these have 2 conductors
Latchset	L3	Heavy duty cylindrical latch set, levers on both sides to remain active at all times, no locking required.	619	Best 93KON15D or equal.	
Electric Strike	ES	UL1034 and UL10C listed ANSI Grade 1 Electric Strike, fail secure, latch bolt and deadlock monitoring.	619	Stanley ES5-D-LBM/LCM or equal.	Do we need this with electrified lock?
Surface bolts	SB1	Lever extension flush bolts with flat front, standard strike at top, and dustproof bottom strike for metal threshold.	619	Ives SB453-12-inches with dustproof strike, or equal.	1 set for top and bottom of inactive leaf.
Pull Plate	PP			Ives 8302	
Door closer	C1	Modern-type surface closer with cover for parallel arm installation on stop side of door; rack-and-pinion construction, with closing force range adjustable 15-percent or more over minimum spring load; adjustable back check; adjustable closing speed and latching speed; and hold-open parallel arm with holding range of 90 to 180°.	Matchi ng Paint Finish	Norton P8501H or equal.	1 for active leaf.
Kick down holder	DH1	Door mounted holder, 5-inch length with rubber tip.	619	Ives FS452 – 5 inches or equal.	1 for inactive leaf.
Doorstop	ST1	Stop with hook for installation on steel tube, projection of approx. 5 3/4 inches, and base diameter of 2 1/4 inches.	619	Ives WS449 or equal.	1 for inactive leaf.

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TYPE	HARDWARE SCHEDULE DESIGNATION	DESCRIPTION	FINISH	MANUFACTURER'S CATALOG ITEMS	NUMBER REQUIRED PER DOOR
Doorstop	ST2	Wall mounted wall bumper.	619	Ives WS402CVX or equal.	
Door Bottom Sweep	DBS	1-piece, aluminum rain drip with vinyl sweep, fastened to bottom of door.	Alum	Pemko 345DV or equal.	1 for each leaf.
Threshold	T1	1-piece, extruded aluminum threshold; silicone seal; 1/2-inch height; 5-inch minimum width; length equal to full width of door; notched ends at doorstops; countersunk screw holes spaced approximately 12-inches center-to-center with end holes not more than 3-inches from ends of thresholds; and flat-head machine screws that color match the thresholds.	Mill	Pemko 2001AS or equal.	1 continuous at sill.
Weather-stripping	W1	Self-adhesive silicone rubber weather-stripping.		Pemko S88D or equal.	Continuous at head and jambs.
Weather-stripping	W2	Rigid jamb weather stripping, installed on the doorframe stop, with silicone bulb type seal.		Pemko 2891	Continuous at head, jambs and meeting styles.
Astragal	AST 1	Minimum 1/8-inch x 2-inch steel astragal welded to door. Length as required to protect latch and deadbolt. Or off-the-shelf astragal.			
Exit Device	ED1	Rim exit device with blank escutcheon trim and lever on the exterior. Passage function, lever to remain active all the times.	619	Corbin Russwin ED5200A x N910? or equal.	
Exit Device	ED2	Rim exit device with secure bolt, exit only, no exterior trim.	619	Corbin Russwin ED5200S x	

5. **HARDWARE SCHEDULE:** Refer to the project specifications.

08 80 00 GLAZING:

1. **GENERAL:** Provide fixed glazing for hollow metal frame windows and hollow metal doors.
2. **SUBMITTALS:** Submittals shall be provided in accordance with SUBMITTALS paragraph of DIVISION 1 – General Requirements and the submittal table in DIVISION 11 project specifications.
3. **MATERIAL:**
 - a. **Insulated Security Glazing for Windows:** Two (2) lites of clear 1/4-inch-thick laminated glass with 0.060-inch interlayer meeting test requirements of ANSI Standard Z-97.1
 - b. **Insulated Units for Hollow Metal Doors:** Two (2) lites of clear 1/4-inch-thick laminated glass with 0.060-inch interlayer meeting test requirements of ANSI Standard Z-97.1.

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- c. Single Glazing for Interior Hollow Metal Doors: 1/4-inch-thick safety glazing; tempered, laminated or wired glass meeting test requirements of ANSI Standard Z-97.1.
- 4. INSTALLATION: In accordance with manufacturer's instructions. For windows and exterior doors, removable glazing stop shall be on the interior side.

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SECTION 09 00 00 – FINISHES

09 29 00 GYPSUM BOARD:

1. GENERAL: Provide material and work for the following:
 - a. Gypsum wallboard.
 - b. Accessories.
2. SUBMITTALS: Submittals shall be provided in accordance with SUBMITTALS paragraph of DIVISION 1 – General Requirements and the submittal table in DIVISION 11 project specifications.
3. MATERIAL STORAGE: Store gypsum wallboard inside under cover, flat and off the floor. Deliver material to site with manufacturer's labels intact.
4. ENVIRONMENTAL REQUIREMENTS: Maintain temperature at 55-degrees Fahrenheit to 70 degrees Fahrenheit during installation. Protect adjacent surfaces from damage and stains.
5. MATERIAL:
 - a. Fire-Retardant Gypsum Wallboard ASTM C 1396: Type X (fire-retardant core), plain face, plain back, tapered edge, 5/8-inch-thickness.
 - b. Accessories:
 - (1) Gypsum Wallboard Fasteners: Drywall screw fasteners shall be Phillip-head screw fasteners with a self-drilling point and self-tapping bugle head, for use with a power driven tool. Size of fasteners shall be as recommended by manufacturer.
 - (2) Metal Corners and Trim: Galvanized steel or other noncorrosive metal and of standard commercial quality.
 - (3) Control Joints: Equal to United States Gypsum Control Joint No. 093.
 - (4) Tape and Joint Cement: Material for treatment of joints in gypsum wallboard, including tape and compound, shall conform to requirements of ASTM C 475.
6. INSTALLATION:
 - a. Gypsum Wallboard:
 - (1) General: Do not apply gypsum wallboard to walls and ceiling until pipes, electrical conduit, insulation, and other features to be concealed are placed.

Where practicable, apply gypsum wallboard with long dimension perpendicular to studs. Butt board together tightly at joints and stagger end joints. Ends of board shall bear on a support with at least 5/8-inch bearing.

Install metal corners at outside corners and other locations where required to conceal exposed edges. Install metal trim at openings and other locations as required to conceal exposed edges of board. Install metal corners and trim in accordance with manufacturer's instructions.

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Install with screw fasteners of the type recommended by manufacturer. Screw heads shall be driven to provide a slight depression below the board surface. Do not drive screw fasteners closer than 3/8-inch from board edges.

- (2) Wall Attachment to Wood Studs: Fasten gypsum wallboard to each support with screws spaced not more than 12-inches on center in the field of board and at 12-inches on center staggered along abutting ends.
- (3) Ceiling Attachment: Fasten gypsum wallboard to each support with screw fasteners spaced not more than 12-inches on center in the field of board and 8-inches on center staggered along abutting ends.

- b. Joints: Following attachment of gypsum wallboard, tape joints in board in accordance with manufacturer's instructions. Install tape reinforcement at all inside corners.

Dimples at screw heads and other depressions in board surface shall receive three (3) coats of joint compound, applied as each coat is applied to joints.

- c. Control Joints: Isolate gypsum wallboard surfaces with a control joint or other means recommended by manufacturer for the following conditions:
 - (1) Where construction changes within the plane of wall or ceiling.
 - (2) Where gypsum wallboard run exceeds 30-feet.
- d. Repairing: Fill damaged surface areas as required with an approved filler material. Repair defective fastenings in accordance with manufacturer's instructions.

- 7. PAINTING: Paint exposed surfaces of gypsum wallboard and metal trim in accordance with Standard 12 – "Painting".

09 65 13 RESILIENT BASE:

- 1. GENERAL: Provide rubber cove base.
- 2. SUBMITTALS: Submittals shall be provided in accordance with SUBMITTALS paragraph of DIVISION 1 – General Requirements and the submittal table in DIVISION 11 project specifications.

- a. Samples: Submit one (1) color sample set for color selection of base.

- 3. MATERIAL:

- a. Rubber Cove Base: Vulcanized thermoset rubber cove base, 4-inches-high, and equal to Burke Base Rubber Wall Base Type TS, 1/8-inch cove base by Burke (www.burkeflooring.com).

Internal and external molded corners shall be furnished and installed for internal and external corners, respectively, where rubber cove base is required.

- b. Cement: Type recommended by rubber cove base manufacturer.
- 4. INSTALLATION: In accordance with manufacturer's instructions. Clean rubber base after installation.

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09 69 00 ACCESS FLOORING:

1. GENERAL:

- a. Provide access flooring system with high-pressure laminate finish. The system shall be grounded at four (4) corners of the control room.
- b. Base anchorage of control switchboard equipment and communication racks are required for all installations in accordance with Standard Drawings 31 2049-1 and 31 2049-2.
- c. Refer to Project Specifications and/or General Structural Notes on drawings regarding designation of IBC Building Occupancy Category (III for Substantial Hazard, or IV for Essential Facility) and IBC Seismic Design Category (A, B, C, D, E or F) as applicable to floor system design.
- d. Refer to Division 9 – Substation – Electrical regarding designation of IEEE Std. 693 Seismic Qualification Level (Low, Moderate or High) as applicable to floor system design.

2. SYSTEM DESCRIPTION:

- a. System: Elevated pedestal with stringers, rigid floor panels, seismic pedestal bases, seismic brace assemblies, mechanical and/or epoxy anchors, complete with accessories and high-pressure laminate finish.
- b. Floor Panel Size: 24-inches by 24-inches.
- c. Elevated Floor: Nominal height of 18-inches above subfloor, unless noted otherwise on drawings.
- d. Tolerances: Floor panel flatness, plus or minus 0.02-inches in any direction; floor panel length, plus or minus 0.02-inch; floor panel squareness, plus or minus 0.03-inch in diagonal direction.
- e. Acceptable Manufacturer: Tate Concore 1000 Bolted Stringer System or equal.

3. STRUCTURAL SYSTEM PERFORMANCE REQUIREMENTS: The access floor system shall be designed for gravity and lateral loads in accordance with the latest edition of the International Building Code, specific to the location of the installation. Design shall be based upon specified Occupancy and Seismic Design Categories. Design shall include concrete core floor panels, supporting stringers, pedestal bases, seismic pedestal bases, seismic brace assemblies, bolttable steel base plates, connections between system elements and mechanical or adhesive fastening to the concrete sub-floor.

IBC Seismic Design Category equal to C and higher, or IEEE Seismic Qualification Level equal to Moderate and High: Compliance with specified performance requirements of the entire access floor system shall be verified through design calculations or testing. A complete load path analysis shall be included in the calculations verifying that gravity and lateral loads can be successfully transmitted through the access floor system and anchored into the concrete sub-structure. Resolution of the specified lateral loads can be achieved by using a properly designed braced or cantilevered floor system provided calculations or certified test results reflect the method selected. Certified test results or design calculations and drawings shall be stamped and signed by a licensed civil or structural engineer.

Minimum performance and design load requirements for the entire access floor system, unless the International Building Code or local governing jurisdiction includes more stringent requirements, are as follows:

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- a. Floor System Uniform and Concentrated Live Loads: Static design concentrated live load equal to or greater than 1000-pounds; static design uniform live load equal to or greater than 350-pounds per-square-foot
 - b. Installations with IBC Seismic Design Category equal to A or B or IEEE Seismic Qualification Level equal to Low: Specific requirements do not apply regarding use of seismic pedestal bases or seismic brace assemblies for pedestals.
 - c. Installations with IBC Seismic Design Category equal to C and higher or IEEE Seismic Qualification Level equal to Moderate and High: Provide seismic pedestal bases (Tate system or equal) and/or seismic brace assemblies for pedestals (Tate system or equal); pedestal bases are to be positively connected to concrete floor slab utilizing anchors or adhesive as required by system manufacturer.
4. ELECTRICAL AND MECHANICAL SYSTEM PERFORMANCE REQUIREMENTS:
- a. Electrical Resistance: Electrical resistance from metal parts of panels to pedestals, between pedestals and bolted stringers, and between the metal understructure and building ground shall be less than 1-ohm.
 - b. Fire Rating: Class A flame spread rating in accordance with ASTM E 84
5. SUBMITTALS: Submittals shall be provided in accordance with SUBMITTALS paragraph of DIVISION 1 – General Requirements and the submittal table in DIVISION 11 project specifications.
6. MATERIAL:
- a. Provide materials as required to install the complete access floor system.
 - b. Pedestal Bases and Seismic Pedestal Bases: Galvanized steel with flat bottom base plate, threaded supporting rod, and vibration-proof locknut to permit 1 1/2-inch minimum adjustment.
 - c. Supporting Stringers: Bolted type, consisting of steel channels, box or T-sections.
 - d. Floor Panels: Galvanized-steel top sheet and bottom pan with concrete core.
 - e. Floor Panel Finish: As indicated in project specifications or on drawings.
 - f. Manufacturer's standard 1/16-inch thick melamine phenolic laminate in accordance with NEMA LD3. Panel finish to be factory applied. Edge panels with trim. Laminate shall be equal to Nevamar ST-6-1 gray Starlite.
 - g. Floor Panel Finish Adhesive: Moisture-resistant type recommended by floor finish manufacturer.
 - h. Lateral Bracing and Seismic Brace Assemblies: Provide materials required by manufacturer.
 - i. Panel Lifting Device: Manufacturer's standard type recommended for panel type.
 - j. Grounding Connectors: Manufacturer's standard grounding clips for panel and stringers and cable clamps as shown on the approved shop drawing detail.

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- k. Cable Cutout Protection: Manufacturer's standard edge trim, self-extinguishing. Provide supplemental pedestals at cutout locations as required by system manufacturer.

7. INSTALLATION:

- a. General: Install components in accordance with manufacturer's instructions. Floor panel layout shall be as shown on the architectural floor plan unless approved otherwise by the COR.
- b. Pedestals: Secure pedestal base plate to subfloor with adhesive or mechanical fasteners. Install additional pedestals where floor system grid pattern is interrupted, as required by system manufacturer.
- c. Seismic Pedestal Bases: Secure pedestal base plate to subfloor with adhesive or mechanical fasteners, as appropriate to the performance criteria in Section 3. Install additional pedestals where floor system grid pattern is interrupted, as required by system manufacturer.
- d. Seismic Brace Assemblies: Install in accordance with manufacturer's instructions, as appropriate to the performance criteria in Section 3.
- e. Supporting Stringers and Floor Panels: Install stringers and floor panels solidly on pedestals. Maximum out-of-level tolerance 1/16-inch in 10-feet. Seal field-cut panels with edge trim.
- f. Lateral Bracing: Install in accordance with manufacturer's instructions, as appropriate to the performance criteria in Section 3.
- g. Cable Cutouts: Field cut holes in floor panels, as directed by the COR, for installation of control equipment. Do not cut structural stringers spanning between tops of floor pedestals; do not cut stiffened perimeter sections of floor panels; and do not cut within 2 inch of floor panel edges in any direction. Include edging material for cable cutouts and for ten (10) cutouts to be made by WAPA in the future. Cutout detail requirements, including additional pedestals, shall be installed in accordance with manufacturer's requirements (Tate system or equal).
- h. Grounding: Provide positive electrical earth grounding of entire access floor system. Connect system to building ground at all four (4) corners of control room. Refer to the Arrangement, Conduit and Grounding Drawing (4000 series).
- i. Protection: Protect access flooring finish from rolling loads during equipment installation with 1/2-inch plywood, OSB or as approved by the COR.

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SECTION 22 00 00 – PLUMBING, GENERAL PURPOSE

1. GENERAL:

- a. Submittals: Submit in accordance with Section 01 00 00, “General Requirements”.
 - (1) Standard Products: Specified materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products.
 - (2) Service Support: The equipment items shall be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations shall be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.
 - (3) Manufacturer's Nameplate: Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.
- b. Delivery, Storage and Handling: Handle, store and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations and as approved by the COR. Replace damaged or defective items.
- c. Performance Requirements:
 - (1) Welding: Piping shall be welded in accordance with qualified procedures using performance-qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer, may be accepted as permitted by ASME B31.1. The COR shall be notified 24-hours in advance of tests, and the tests shall be performed at the worksite if practicable. Welders or welding operators shall apply their assigned symbols near each weld they make as a permanent record.
- d. Regulatory Requirements: Unless otherwise required herein, plumbing work shall be in accordance with ICC IPC. Energy consuming products and systems shall be in accordance with PL 109-58 and ASHRAE 90.1.
- e. Project/Site Conditions: The Contractor shall become familiar with details of the work, verify dimensions in the field and advise the COR of any discrepancy before performing any work.
- f. Accessibility of Equipment: Install all work so that parts requiring periodic inspection, operation, maintenance and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers and equipment requiring access, in locations freely accessible through access doors.

2. PRODUCTS:

- a. Materials: Material or equipment containing lead shall not be used in any potable water system. In line devices such as water meters, building valves, check valves, meter stops, valves, fittings and back flow preventers shall comply with PL 93-523 and NSF/ANSI 61, Section 8. End point devices such as lavatory faucets, supply stops and end point control valves used to dispense water for drinking must meet the requirements of NSF/ANSI 61, Section 9. Plastic pipe shall not be installed in air plenums.

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- (1) Pipe Joint Materials: Solder containing lead shall not be used with copper pipe. Joints and gasket materials shall conform to the following:
- (a) Malleable Iron ASTM A47/A47M, Grade 32510. Copper ASTM A536.
 - (b) Flange Gaskets: Gaskets shall be made of non-asbestos material in accordance with ASME B16.21. Gaskets shall be flat, 1/16-inch-thick and contain Aramid fibers bonded with Styrene Butadiene Rubber (SBR) or Nitro Butadiene Rubber (NBR). Gaskets shall be the full face or self-centering flat ring type. Gaskets used for hydrocarbon service shall be bonded with NBR.
 - (c) Brazing Material: Brazing material shall conform to AWS A5.8/A5.8M, BCuP-5.
 - (d) Brazing Flux: Flux shall be in paste or liquid form appropriate for use with brazing material. Flux shall be as follows: lead-free; have a 100-percent flushable residue; contain slightly acidic reagents; contain potassium borides; and contain fluorides.
 - (e) Solder Material: Solder metal shall conform to ASTM B32.
 - (f) Solder Flux: Flux shall be liquid form, non-corrosive and conform to ASTM B813, Standard Test 1.
 - (g) PTFE Tape: PTFE Tape, for use with Threaded Metal or Plastic Pipe.
 - (h) Flexible Elastomeric Seals: ASTM D3139, ASTM D3212 or ASTM F477
 - (i) Solvent Cement for Transition Joints Between ABS and PVC Non-Pressure Piping Components: ASTM D3138.
 - (j) Plastic Solvent Cement for ABS Plastic Pipe: ASTM D2235.
 - (k) Plastic Solvent Cement for PVC Plastic Pipe: ASTM D2564 and ASTM D2855
 - (l) Plastic Solvent Cement for CPVC Plastic Pipe: ASTM F493
 - (m) Flanged fittings including flanges, bolts, nuts, bolt patterns, etc., shall be in accordance with ASME B16.5 class 150 and shall have the manufacturer's trademark affixed in accordance with MSS SP-25. Flange material shall conform to ASTM A105/A105M. Blind flange material shall conform to ASTM A516/A516M cold service and ASTM A515/A515M for hot service. Bolts shall be high strength or intermediate strength with material conforming to ASTM A193/A193M.
 - (n) Plastic Solvent Cement for Styrene Rubber Plastic Pipe: ASTM D3122.
 - (o) Press Fittings for Copper Pipe and Tube: Copper press fittings shall conform to the material and sizing requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117. Sealing elements for copper press fittings shall be EPDM, FKM or HNBR. Sealing elements shall be factory installed or an alternative supplied fitting manufacturer. Sealing element shall be selected based on manufacturer's approved application guidelines.
 - (p) Copper tubing shall conform to ASTM B88, Type K, L or M.
 - (q) Heat-fusion joints for polypropylene piping: ASTM F2389.

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- b. Pipe Insulation Material: Insulation shall be as specified in Section 23 07 00 Thermal Insulation for Mechanical Systems.
- c. Pipe Hangers, Inserts and Supports: Pipe hangers, inserts and supports shall conform to MSS SP-58 and MSS SP-69.
- d. Valves: Valves shall be provided on supplies to equipment and fixtures. Pressure ratings shall be based upon the application.
 - (1) Wall Hydrants (Frostproof): ASSE 1019 with vacuum-breaker backflow preventer shall have a nickel-brass or nickel-bronze wall plate or flange with nozzle and detachable key handle. A brass or bronze operating rod shall be provided within a galvanized iron casing of sufficient length to extend through the wall so that the valve is inside the building and the portion of the hydrant between the outlet and valve is self-draining. A brass or bronze valve with coupling and union elbow having metal-to-metal seat shall be provided. Valve rod and seat washer shall be removable through the face of the hydrant. The hydrant shall have 3/4-inch exposed hose thread on spout and 3/4 inch male pipe thread on inlet.
 - (2) Relief Valves: Water heaters shall have a combination pressure and temperature (P&T) relief valve. The pressure relief element of a P&T relief valve shall have adequate capacity to prevent excessive pressure buildup in the system when the system is operating at the maximum rate of heat input. The temperature element of a P&T relief valve shall have a relieving capacity which is at least equal to the total input of the heaters when operating at their maximum capacity. Relief valves shall be rated according to ANSI Z21.22/CSA 4.4. Relief valves for systems where the maximum rate of heat input is less than 200,000-Btuh shall have 3/4-inch minimum inlets and 3/4 inch outlets. Relief valves for systems where the maximum rate of heat input is greater than 200,000-Btuh shall have 1-inch minimum inlets, and 1-inch outlets. The discharge pipe from the relief valve shall be the size of the valve outlet.
 - (3) Thermostatic Mixing Valves: Provide thermostatic mixing valve for lavatory faucets. Mixing valves, thermostatic type, pressure-balanced or combination thermostatic and pressure-balanced shall be line size and shall be constructed with rough or finish bodies either with or without plating. Each valve shall be constructed to control the mixing of hot and cold water and to deliver water at a desired temperature regardless of pressure or input temperature changes. The control element shall be of an approved type. The body shall be of heavy cast bronze, and interior parts shall be brass, bronze, corrosion-resisting steel or copper. The valve shall be equipped with necessary stops, check valves, unions and sediment strainers on the inlets. Mixing valves shall maintain water temperature within 5-degrees Fahrenheit of any setting.
- e. Fixtures: Fixtures shall be water conservation type, in accordance with ICC IPC. Fixtures for use by the physically handicapped shall be in accordance with ICC A117.1 Porcelain enameled ware shall have specially selected, white, acid-resisting enamel coating evenly applied on surfaces. No fixture will be accepted that shows cracks, crazes, blisters, thin spots or other flaws. Fixtures shall be equipped with appurtenances such as traps, faucets, stop valves and drain fittings. Each fixture and piece of equipment requiring connections to the drainage system shall be equipped with a trap. Brass expansion or toggle bolts capped with acorn nuts shall be provided for supports and polished chromium-plated pipe, valves and fittings shall be provided where exposed to view.
 - (1) Lavatories: Vitreous china lavatories shall be provided with two (2) integral molded lugs on the back-underside of the fixture and drilled for bolting to the wall in a manner similar to the hanger plate.

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- (2) Flush Valve Water Closets:
- (a) ASME A112.19.2/CSA B45.1, white vitreous china, siphon jet, elongated bowl, floor-mounted, floor outlet or wall mounted, wall outlet. Top of toilet seat height above floor shall be 14- to 15-inches, except 17- to 19-inches for wheelchair water closets. Provide wax bowl ring including plastic sleeve. Provide white solid plastic elongated open-front seat.
 - (b) Water flushing volume of the water closet and flush valve combination shall not exceed 1.6-gallonsperflush.
 - (c) Provide large diameter flush valve including angle control-stop valve, vacuum breaker, tail pieces, slip nuts and wall plates; exposed to view components shall be chromium-plated or polished stainless steel. Flush valves shall be non-hold open type. Mount flush valves not less than 11-inches above the fixture. Mounted height of flush valve shall not interfere with the handrail in ADA stalls.
- (3) Flush Valve Urinals: ASME A112.19.2/CSA B45.1, white vitreous china, wall-mounted, wall outlet, siphon jet, integral trap and extended side shields. Provide urinal with the rim 17-inches above the floor. Provide urinal with the rim 24-inches above the floor. Water flushing volume of the urinal and flush valve combination shall not exceed 1.0 gallons per flush. Provide ASME A112.6.1M concealed chair carriers with vertical steel pipe supports. Provide large diameter flush valve including angle control-stop valve, vacuum breaker, tail pieces, slip nuts and wall plates; exposed to view components shall be chromium-plated or polished stainless steel. Flush valves shall be non-hold open type. Mount flush valves not less than 11-inches above the fixture.
- (4) Flush Tank Water Closets: ASME A112.19.2/CSA B45.1, white vitreous china, siphon jet, round bowl, pressure assisted, floor-mounted, floor outlet. Top of toilet seat height above floor shall be 14- to 15-inches, except 17- to 19-inches for wheelchair water closets. Provide wax bowl ring including plastic sleeve. Water flushing volume of the water closet shall not exceed 1.28-gallons per flush.
- (5) Wall Hung Lavatories: ASME A112.19.2/CSA B45.1, white vitreous china, straight back type, minimum dimensions of 19-inches wide by 17-inches front to rear, with supply openings for use with top mounted center set faucets and openings for concealed arm carrier installation. Water flow rate shall not exceed 1.5-gpm when measured at a flowing water pressure of 60-psi. Provide ASME A112.6.1M concealed chair carriers with vertical steel pipe supports and concealed arms for the lavatory. Mount lavatory with the front rim 34-inches above floor and with 29-inches minimum clearance from bottom of the front rim to floor.
- (6) Countertop Lavatories: ASME A112.19.2/CSA B45.1, white vitreous china, self rimming, minimum dimensions of 19-inches wide by 17-inches front to rear, with supply openings for use with top mounted center set faucets. Furnish template and mounting kit by lavatory manufacturer. Provide aerator with faucet. Water flow rate shall not exceed 1.5-gpm when measured at a flowing water pressure of 60-psi. Mount counter with the top surface 34-inches above floor and with 29-inches minimum clearance from bottom of the counter face to floor.

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- (7) Emergency Eyewash and Shower: ANSI/ISEA Z358.1, floor supported free standing unit. Provide deluge shower head, stay-open ball valve operated by pull rod and ring or triangular handle. Provide eyewash and stay-open ball valve operated by foot treadle or push handle.
 - (8) Emergency Eye and Face Wash: ANSI/ISEA Z358.1, wall-mounted self-cleaning, non clogging eye and face wash with quick opening, full-flow valves, stainless steel eye and face wash receptor. Unit shall deliver 3-gpm of aerated water at 30-psig flow pressure, with eye and face wash nozzles 33- to 45-inches above finished floor. Provide copper alloy control valves. Provide an air-gap with the lowest potable eye and face wash water outlet located above the overflow rim by not less than the International Plumbing Code minimum.
 - (a) Backflow Preventers:
 - 1) Backflow prevention devices must be approved by the State or local regulatory agencies.
 - (9) Reduced pressure principle assemblies, double check valve assemblies, atmospheric (non-pressure) type vacuum breakers and pressure type vacuum breakers shall be meet the above requirements.
 - (10) Backflow preventers with intermediate atmospheric vent shall conform to ASSE 1012. Reduced pressure principle backflow preventers shall conform to ASSE 1013. Hose connection vacuum breakers shall conform to ASSE 1011. Pipe applied atmospheric type vacuum breakers shall conform to ASSE 1001. Pressure vacuum breaker assembly shall conform to ASSE 1020. Air gaps in plumbing systems shall conform to ASME A112.1.2.
- f. Drains:
- (1) Floor Drains: Floor drains shall consist of a galvanized body, integral seepage pan and adjustable perforated or slotted chromium-plated bronze, nickel-bronze or nickel brass strainer, consisting of grate and threaded collar. Floor drains shall conform to ASME A112.6.3.
- g. Traps: Unless otherwise specified, traps shall be without a cleanout.
- h. Water Heaters: Water heater types and capacities shall be as indicated. Each water heater shall have replaceable anodes. Each primary water heater shall have controls with an adjustable range that includes 90-degrees Fahrenheit to 160-degrees Fahrenheit. Hot water systems utilizing recirculation systems shall be tied into building off-hour controls. A factory pre-charged expansion tank shall be installed on the cold water supply to each water heater. Expansion tanks shall be specifically designed for use on potable water systems and shall be rated for 200-degrees Fahrenheit water temperature and 150 psi working pressure. The expansion tank size and acceptance volume shall be as indicated.
- i. Instantaneous Water Heater: Heater shall be crossflow design with service water in the coil and hot water in the shell. An integral internal controller shall be provided, anticipating a change in demand so that the final temperature can be maintained under all normal load conditions when used in conjunction with pilot-operated temperature control system. Normal load conditions shall be as specified by the manufacturer for the heater. Unit shall be manufactured in accordance with ASME BPVC SEC VIII D1 and shall be certified for 150 psi working pressure in the shell and 150-psi working pressure in the coils.

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- (1) Electric Instantaneous Water Heaters (Tankless): UL 499 and UL listed flow switch activated, tankless electric instantaneous water heater for wall mounting below sink or lavatory.
- (2) Phenolic Resin Coatings for Heater Tubes: The phenolic resin coating system shall be applied at either the coil or coating manufacturer's factory in accordance with manufacturer's standard proven production process. The coating system shall be a product specifically intended for use on the material the water heating tubes/coils are made of and shall be acceptable for use in potable water systems. The coating system shall be capable of withstanding temperatures up to 400-degrees Fahrenheit dry bulb; and meet the requirements of 21 CFR 175.

3. EXECUTION:

- a. General Installation Requirements: Piping located in air plenums shall conform to NFPA 90A requirements. Piping located in shafts that constitute air ducts or that enclose air ducts shall be noncombustible in accordance with NFPA 90A. Installation of plastic pipe where in compliance with NFPA may be installed in accordance with PPFA Fire Man. The plumbing system shall be installed complete with necessary fixtures, fittings, traps, valves and accessories. Water and drainage piping shall be extended 5-feet outside the building, unless otherwise indicated. A ball valve and drain shall be installed on the water service line inside the building approximately 6-inches above the floor from point of entry. Piping shall be connected to the exterior service lines or capped or plugged if the exterior service is not in place. Sewer and water pipes shall be laid in separate trenches, except when otherwise shown. Exterior underground utilities shall be at least 12-inches below the average local frost depth or as indicated on the Drawings. If trenches are closed or the pipes are otherwise covered before being connected to the service lines, the location of the end of each plumbing utility shall be marked with a stake or other acceptable means. Valves shall be installed with control no lower than the valve body.
- b. Water Heaters:
 - (1) Relief Valves: No valves shall be installed between a relief valve and its water heater. The P&T relief valve shall be installed where the valve actuator comes in contact with the hottest water in the heater. Whenever possible, the relief valve shall be installed directly in a tapping in the tank or heater; otherwise, the P&T valve shall be installed in the hot-water outlet piping. A vacuum relief valve shall be provided on the cold water supply line to the water heater and mounted above and within 6-inches above the top of the water heater.
 - (2) Heat Traps: Piping to and from each water heater shall be routed horizontally and downward a minimum of 2-feet before turning in an upward direction.
 - (3) Connections to Water Heaters: Connections of metallic pipe to water heaters shall be made with dielectric unions or flanges.
 - (4) Expansion Tank: A pre-charged expansion tank shall be installed on the cold water supply between the water heater inlet and the cold water supply shut-off valve. The Contractor shall adjust the expansion tank air pressure, as recommended by the tank manufacturer, to match incoming water pressure.
- c. Fixtures and Fixture Trimmings: Polished chromium-plated pipe, valves and fittings shall be provided where exposed to view. Angle stops, straight stops, stops integral with the faucets, or concealed type of lock-shield and loose-key pattern stops for supplies with threaded, sweat or solvent weld inlets shall be furnished and installed with fixtures. Where connections between copper tubing and faucets are made by rubber compression fittings,

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a beading tool shall be used to mechanically deform the tubing above the compression fitting. Exposed traps and supply pipes for fixtures and equipment shall be connected to the rough piping systems at the wall, unless otherwise specified under the item. Floor and wall escutcheons shall be as specified. Plumbing fixtures and accessories shall be installed within the space shown.

d. Painting:

- (1) Painting of New Equipment: New equipment painting shall be factory applied.

e. Tests, Flushing and Disinfection:

- (1) Plumbing System: The following tests shall be performed on the plumbing system in accordance with ICC IPC, except that the drainage and vent system final test shall include the smoke test. The Contractor has the option to perform a peppermint test in lieu of the smoke test. If a peppermint test is chosen, the Contractor must submit a testing procedure to the COR for approval.
- (2) Drainage and Vent Systems Test. The final test shall include a smoke test.
- (3) Building Sewers Tests.
- (4) Water Supply Systems Tests.
- (5) Defective Work: If inspection or test shows defects, such defective work or material shall be replaced or repaired as necessary and inspection and tests shall be repeated. Repairs to piping shall be made with new materials. Caulking of screwed joints or holes will not be acceptable.
- (6) System Flushing:
 - (a) During Flushing: Before operational tests or disinfection, potable water piping system shall be flushed with potable water. Sufficient water shall be used to produce a water velocity that is capable of entraining and removing debris in all portions of the piping system.
 - (b) After Flushing: System shall be drained at low points. Strainer screens shall be removed, cleaned and replaced. After flushing and cleaning, systems shall be prepared for testing by immediately filling water piping with clean, fresh potable water. Any stoppage, discoloration, or other damage to the finish, furnishings or parts of the building due to the Contractor's failure to properly clean the piping system shall be repaired by the Contractor. The water supply to the building shall be tested separately to ensure that any lead contamination found during potable water system testing is due to work being performed inside the building.
- (7) Operational Test: Upon completion of flushing and prior to disinfection procedures, the Contractor shall subject the plumbing system to operating tests to demonstrate satisfactory installation, connections, adjustments and functional and operational efficiency.
- (8) Disinfection:
 - (a) After all system components are provided and operational tests are complete, the entire domestic water distribution system shall be disinfected. Before introducing disinfecting chlorination material, entire system shall be flushed

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with potable water until any entrained dirt and other foreign materials have been removed.

- (b) Water chlorination procedure shall be in accordance with AWWA C651 and AWWA C652 as modified and supplemented by this specification. The chlorinating material shall be hypochlorites or liquid chlorine. The chlorinating material shall be fed into the water piping system at a constant rate at a concentration of at least 50-parts-per-million (ppm). Feed a properly adjusted hypochlorite solution injected into the system with a hypochlorinator or inject liquid chlorine into the system through a solution-feed chlorinator and booster pump until the entire system is completely filled.
- (c) Upon the specified verification, the system including tanks shall then be flushed with potable water until the residual chlorine level is reduced to less than 1-ppm. During the flushing period, each valve and faucet shall be opened and closed several times.

22 07 19 PLUMBING PIPING INSULATION:

1. GENERAL:

- a. Performance Requirements: Provide noncombustible thermal-insulation system materials, as defined by NFPA 220. Provide adhesives, coatings, sealants, facings, jackets and thermal-insulation materials, except cellular elastomers, with a flame-spread classification (FSC) of 25 or less, and a smoke-developed classification (SDC) of 50 or less. Determine these maximum values in accordance with NFPA 255. Provide coatings and sealants that are nonflammable in their wet state. Provide adhesives, coatings and sealants with published or certified temperature ratings suitable for the entire range of working temperatures normal for the surfaces to which they are to be applied.
- b. Submittals: Submit in accordance with Section 01 00 00, "General Requirements".

2. PRODUCTS:

Provide compatible materials which do not contribute to corrosion, soften or otherwise attack surfaces to which applied, in either the wet or dry state. ASTM C795 requirements for materials to be used on stainless steel surfaces. Provide materials that are asbestos free.

- (1) Insulation Materials: Provide materials with maximum value conductance as tested at any point, not an average. Replace or augment insulation conductance found by test to exceed the specified maximum by an additional thickness to bring it to the required maximum conductance and a complete finishing system.
- (2) Adhesives:
 - (a) Cloth Adhesives: Provide adhesives for adhering, sizing and finishing lagging cloth, canvas and open-weave glass cloth with a pigmented polyvinyl acetate emulsion conforming to the requirements of ASTM C916, Type I.
 - (b) Vapor-Barrier Material Adhesives: Provide adhesives for attaching laps of vapor barrier materials and presized glass cloth for attaching insulation to itself, to metal, and to various other substrates, of nonflammable solvent-base, synthetic-rubber type conforming to the requirements of ASTM C916, Type I, for attaching fibrous-glass insulation to metal surfaces.

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- (c) Cellular Elastomer Insulation Adhesive: For cellular elastomer insulation adhesive, provide a solvent cutback chloroprene elastomer conforming to ASTM C916, Type I, and be of a type approved by the manufacturer of the cellular elastomer for the intended use.
- b. Insulating Cement:
 - (1) General Purpose Insulating Cement: Provide general purpose insulating cement, conforming to ASTM C195. Ensure composite is rated for 1800-degrees Fahrenheit service, with a thermal-conductivity maximum of 0.85-Btu by inch per hour per square foot for each degree Fahrenheit temperature differential at 200-degrees Fahrenheit mean temperature for 1-inch thickness.
 - (2) Finishing Insulating Cement: Provide finishing insulating cement of a mineral-fiber, hydraulic-setting type conforming to ASTM C 449.
- c. Caulking: Provide elastomeric joint sealant for caulking specified insulation materials in accordance with ASTM C920, Type S, Grade NS, Class 25, Use A.
- d. Corner Angles: Provide nominal 0.016-inch aluminum 1- by 1-inch corner angle piping insulation with factory applied kraft backing. Ensure aluminum conforms to ASTM B209, Alloy.
- e. Jacketing:
 - (1) Aluminum Jacket: Provide aluminum jackets conforming to ASTM B209, Temper H14, minimum thickness of 0.016 inch, with factory-applied polyethylene and kraft paper moisture barrier on inside surface. Provide smooth surface jackets for jacket outside diameters less than 8-inches. Provide corrugated surface jackets for jacket outside diameters 8 inches and larger. Provide stainless steel bands, minimum width of 0.5 inch. Provide factory prefabricated aluminum covers for insulation on fittings, valves and flanges.
 - (2) Asphalt-Saturated Felt: Provide asphalt-saturated felt conforming to ASTM D226/D226M, without perforations, minimum weight of 10-pounds per 100-square-feet.
 - (3) Stainless Steel Jacket: Provide stainless steel jackets conforming to ASTM A167 or ASTM A240/A240M; Type 304, minimum thickness of 0.010-inch, smooth surface with factory-applied polyethylene and kraft paper moisture barrier on inside surface. Provide stainless steel bands, minimum width of 0.5-inch. Provide factory prefabricated stainless steel covers for insulation on fittings, valves and flanges.
 - (4) Glass Cloth Jacket: Provide plain-weave glass cloth conforming to ASTM D579, Style 141, weighing not less than 7.23-ounces per square yard before sizing. Factory apply cloth wherever possible. Provide leno weave glass reinforcing cloth, 26-end and 12 pick thread conservation, with a warp and fill tensile strength of 45- and 30 pounds per inch of width, respectively, and a weight of not less than 1.5-ounces per square yard.
 - (5) PVC Jacket: Provide 0.010-inch thick, factory-premolded, 1-piece fitting, pipe-barrel sheeting vapor-barrier jacketing polyvinylchloride that is self-extinguishing, high impact strength, moderate chemical resistance with a permeability rating of 0.01 grain per hour per square foot per inch of mercury pressure difference, determined in accordance with ASTM E96. Provide manufacturer's standard solvent weld type vapor-barrier joint adhesive. Conform to ASTM C1136 for, Type I, low-vapor

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transmission, high-puncture resistance vapor barrier for use on insulation for piping, ducts and equipment.

(a) Coatings:

- 1) Outdoor Vapor-Barrier Finishing: For coatings for outdoor vapor-barrier finishing of insulation surfaces, such as fittings and elbows, provide a non-asphaltic, hydrocarbon polymer, solvent-base mastic containing a blend of nonflammable solvents. Conform to the requirements of ASTM C1136 and ASTM C921 for coatings.
 - (6) Indoor Vapor-Barrier Finishing: Provide pigmented resin and solvent compound coatings for indoor vapor-barrier finishing of insulation surfaces conforming to ASTM C1136, Type II.
 - (7) Outdoor and Indoor Non Vapor-Barrier Finishing (NBF): Provide pigmented polymer emulsion type NBF recommended by the insulation material manufacturer for outdoor and indoor NBF coating of insulation surfaces for the surface to be coated and applied to specified dry-film thickness.
 - (8) Cellular-Elastomer Insulation Coating: Provide a polyvinylchloride lacquer approved by the manufacturer of the cellular elastomer finish coating.
 - (9) Coating Color: Conform to the color code specified for the coating color.
- f. Tape: Provide a knitted elastic cloth glass lagging specifically suitable for continuous spiral wrapping of insulated pipe bends and fittings and produce a smooth, tight, wrinkle-free surface. Conform to requirements of SAE AMS 3779, SAE AMS 3779, ASTM D579 and ASTM C921 for tape, weighing not less than 10-ounces per square yard.
- g. Hot-Water and Condensate-Return Piping: Provide mineral fiber insulation with glass cloth jacket, Type T-2. Insulate aboveground pipes, valve bodies, fittings, unions, flanges and miscellaneous surfaces.
- h. Cold-Water and Condensate-Drain Piping:
- (1) Insulate aboveground pipes, valve bodies, fittings, unions, flanges and miscellaneous surfaces.
 - (2) Provide 3/8-inch mineral fiber insulation with glass cloth jacket, Type T-2.
 - (3) Provide cellular-elastomer insulation conforming to ASTM C534, with water-vapor permeability not exceeding 0.1-grain per square foot per hour per inch mercury pressure-differential for 1-inch thickness.
 - (4) Provide flexible unicellular-elastomeric thermal insulation for cold water piping, Type T-3. Use expanded, closed-cell pipe insulation only aboveground, not for underground piping.
- i. Refrigerant Suction Piping: Provide cellular-elastomer insulation, Type T-3, with a nominal thickness of 3/4-inch. Insulate surfaces, including valve, fittings, unions and flanges.
- j. Condensate Piping, 350 PSIG: Provide calcium silicate insulation with glass cloth jacket, Type T-5 based on an 80-degrees Fahrenheit ambient temperature in still air with an insulation "K" factor of 0.37 at 200-degrees Fahrenheit mean temperature.

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- k. Condensate, Weather-Exposed: Provide calcium silicate insulation with weatherproof jacket, Type T-17. Insulate all systems.

3. EXECUTION:

a. Installation of Insulation Systems:

- (1) Install smooth and continuous contours on exposed work. Smoothly and securely paste down cemented laps, flaps, bands and tapes. Apply adhesives on a full coverage basis.
- (2) Apply insulation only to system or component surfaces that have been tested and approved.
- (3) Install insulation lengths tightly butted against each other at joints. Where lengths are cut, provide smooth and square and without breakage of end surfaces. Where insulation terminates, neatly taper and effectively seal ends or finish as specified. Direct longitudinal seams of exposed insulation away from normal view.
- (4) Apply materials in conformance with the recommendations of the manufacturer.
- (5) Clean surfaces free of oil and grease before insulation adhesives or mastics are applied. Provide solvent cleaning required to bring metal surfaces to such condition.
- (6) Submit installation drawings for pipe insulation, conforming with the adhesive manufacturer's written instructions for installation. Submit installation manual clearly stating the manufacturer's instructions for insulation materials.

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SECTION 23 00 00 – MECHANICAL

23 03 00 BASIC MECHANICAL MATERIALS AND METHODS:

1. GENERAL:

- a. Submittals: Submit in accordance with Section 01 00 00, "General Requirements".
- b. Quality Assurance:
 - (1) Material and Equipment Qualifications: Provide materials and equipment that are standard products of manufacturers regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship.
 - (2) Service Support: The equipment items shall be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations shall be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.
 - (3) Manufacturer's Nameplate: Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.
- c. Delivery, Storage and Handling: Handle, store and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations and as approved by the COR. Replace damaged or defective items.
- d. Electrical Requirements: Furnish internal wiring for components of packaged equipment as an integral part of the equipment. Extended voltage range motors will not be permitted. Controllers and contactors shall have a maximum of 120-volt control circuits and shall have auxiliary contacts for use with the controls furnished. When motors and equipment furnished are larger than sizes indicated, the cost of additional electrical service and related work shall be included under the section that specified that motor or equipment.
- e. Electrical Installation Requirements: Electrical installations shall conform to IEEE C2, NFPA 70, and requirements specified herein.
 - (1) Provide electrical components of mechanical equipment, such as motors, motor starters (except starters/controllers which are indicated as part of a motor control center), control or push-button stations, float or pressure switches, solenoid valves, integral disconnects and other devices functioning to control mechanical equipment, as well as control wiring and conduit for circuits rated 100-volts or less, to conform with the requirements of the section covering the mechanical equipment. Extended voltage range motors shall not be permitted. The interconnecting power wiring and conduit, control wiring rated 120-volts (nominal) and conduit and the electrical power circuits shall be provided, except internal wiring for components of package equipment shall be provided as an integral part of the equipment. When motors and equipment furnished are larger than sizes indicated, provide any required changes to the electrical service as may be necessary and related work as a part of the work for the section specifying that motor or equipment.
 - (2) High Efficiency Motors:

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- (a) High Efficiency Single-Phase Motors: Unless otherwise specified, single-phase fractional-horsepower alternating-current motors shall be high efficiency types corresponding to the applications listed in NEMA MG 11.
 - (b) High Efficiency Polyphase Motors: Unless otherwise specified, poly-phase motors shall be selected based on high efficiency characteristics relative to the applications as listed in NEMA MG 10. Additionally, poly-phase squirrel-cage medium induction motors with continuous ratings shall meet or exceed energy efficient ratings in accordance with Table 12-6C of NEMA MG 1.
 - (3) 3-Phase Motor Protection: Provide controllers for motors rated one (1) horsepower and larger with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage and overvoltage. Provide protection for motors from immediate restart by a time adjustable restart relay.
 - f. Instruction to Government Personnel: When specified in other sections, furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work. Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation.
 - g. Accessibility: Install all work so that parts requiring periodic inspection, operation, maintenance and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers and equipment requiring access, in locations freely accessible through access doors.
2. PRODUCTS: Not used.
3. EXECUTION:
- a. Painting of New Equipment: New equipment painting shall be factory applied and shall be as specified herein and provided under each individual section.
 - (1) Factory Painting Systems:
 - (a) Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125-hours in a salt-spray fog test, except that equipment located outdoors shall withstand 500 hours in a salt-spray fog test. Salt-spray fog test shall be in accordance with ASTM B117, and for that test the acceptance criteria shall be as follows: immediately after completion of the test, the paint shall show no signs of blistering, wrinkling or cracking and no loss of adhesion; and the specimen shall show no signs of rust creepage beyond 0.125-inch on either side of the scratch mark.
 - (b) The film thickness of the factory painting system applied on the equipment shall not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 120-degrees Fahrenheit, the factory painting system shall be designed for the temperature service.

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23 05 15 COMMON PIPING FOR HVAC:

1. GENERAL:

- a. Submittals: Submit in accordance with Section 01 00 00, "General Requirements".
- b. Quality Assurance:
 - (1) Material Qualifications: Provide materials that are standard products of manufacturers regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship.
- c. Delivery, Storage and Handling: Handle, store and protect materials to prevent damage before and during installation in accordance with the manufacturer's recommendations and as approved by the COR. Replace damaged or defective items.
- d. Accessibility: Install all work so that parts requiring periodic inspection, operation, maintenance and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers and equipment requiring access, in locations freely accessible through access doors.

2. PRODUCTS:

a. Pipe and Fittings:

(1) Type BCS, Black Carbon Steel:

- (a) Pipe 1/8 through 12-inches shall be Schedule 40 black carbon steel, conforming to ASTM A53.
- (b) Fittings 2-inches and under shall be 150-pounds per square inch, gage (psig) working steam pressure (wsp) banded black malleable iron screwed, conforming to ASTM A197 and ASME B16.3.
- (c) Unions 2-inches and under shall be 250-pounds per square inch, wsp female, screwed, black malleable iron with brass-to-iron seat and ground joint, conforming to ASME B16.39.
- (d) Fittings 2 1/2-inches and over shall be Steel butt weld, conforming to ASTM A234 and ASME B16.9 to match pipe wall thickness.
- (e) Flanges 2 1/2-inches and over shall be 150-pound forged-steel conforming to ASME B16.5, welding neck to match pipe wall thickness.

(2) Type GCS, Galvanized Carbon Steel:

- (a) Pipe 1/2 through 10-inches, and where indicated shall be Schedule 40 seamless or electric-resistance welded galvanized steel conforming to ASTM A53, Type E, Grade B (electric-resistance welded) or Type S (seamless).
- (b) Fittings 2-inches and under shall be 150-psig wsp banded galvanized malleable iron screwed, conforming to ASTM A197 and ASME B16.3
- (c) Unions 2-inches and under shall be 150-psig wsp female, screwed, galvanized malleable iron with brass-to-iron seat and ground joint.

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- a. The Contractor has the option of using 150-psig wsp banded galvanized malleable iron screwed fittings, conforming to ASTM A197 and ASME B16.3.
- (3) Type GCS-DWV, Galvanized Steel Drain, Waste and Vent:
- (a) Pipe (all sizes) shall be Schedule 40 seamless galvanized carbon steel, conforming to ASTM A53, Grade A.
 - (b) Furnace butt weld pipe is acceptable for sizes less than 2-inches.
 - (c) Risers 3-inches and larger shall be Type CISP-DWV.
 - (d) Fittings shall be galvanized, screwed, cast iron, recessed pattern drainage fittings, conforming to ASTM A126.
 - (e) Use long radius fittings wherever space permits. Short-turn tees, branches and ells may be used for vent piping and connections of branch lines to battery fixtures, except wall-hung water closets.
- (4) Type CPR, Copper:
- (a) Type CPR-A, Copper Above Ground:
 - 1) Tubing 2-inches and under shall be seamless copper tubing, conforming to ASTM B88, Type L (hard-drawn for all horizontal and all exposed vertical lines, annealed for concealed vertical lines).
 - 2) Fittings 2-inches and under shall be 150-psig wsp wrought-copper solder joint fittings conforming to ASME B16.22. Unions 2-inches and under shall be 150 psig wsp wrought-copper solder joint, conforming to ASME B16.22.
 - 3) Provide brazing rod with Classification BCuP-5, conforming to AWS A5.8.
 - 4) Solder must be 60-40 tin-antimony, alloy Sb-5, conforming to ASTM B32.
 - (b) Type CPR-U, Copper Under Ground:
 - 1) Provide Type K seamless copper tube piping, conforming to ASTM B88. Socket-joint fittings shall be wrought copper, conforming to ASME B16.22. Fittings for connection to corporation cocks shall be cast bronze, flared-type, conforming to ASME B16.26. Joints shall be brazed.
 - (c) Type CPR-INS, Copper Under Ground Insulated:
 - 1) Provide insulated Type K seamless copper tube piping conforming to ASTM B88M ASTM B88. Socket-joint fittings shall be wrought copper, conforming to ASME B16.22. Joints shall be brazed.
 - 2) Provide insulation not less than 2-inches thick, suitable for continuous service temperatures of not less than 250-degrees Fahrenheit. Insulation shall be factory-molded, closed-cell polyurethane foam of not less than 2.5-pounds per cubic foot density.
 - 3) Insulation shall be waterproofed with an extruded rigid Type II virgin polyvinylchloride, with minimum wall thickness of 60-mils through 4-

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inches outside diameter, 85-mils through 6.625-inches and 110-mils through 12.750 inches. Provide fitting covers fabricated from the same materials and thickness as adjacent pipe covering according to the manufacturer's directions.

b. Piping Specialties:

- (1) Dielectric Connections: Dissimilar pipe metals shall be electrically insulated from each other by couplings, unions or flanges commercially manufactured for that purpose and rated for the service pressure and temperature.
- (2) Hose Faucets:
 - (a) Construct hose faucets with 1/2-inch male inlet threads, hexagon shoulder and 3/4 inch hose connection, conforming to ASME A112.18.1/CSA B125.1. Hose coupling screw threads shall conform to ASME B1.21M ASME B1.20.7.
 - (b) Vandal proof, atmospheric-type vacuum breaker shall be provided on the discharge of all potable water lines.

c. Valves:

- (1) Ball Valves:
 - (a) Ball valves shall conform to MSS SP-72. Valves with ball seals held in place by spring washers are not acceptable. All valves shall have adjustable packing glands. Seats and seals shall be tetrafluoroethylene.

d. Drain, Vent and Gage Cocks:

- (1) Drain, vent and gage cocks shall be lever handle, ground key type, with washer and screw, constructed of polished ASTM B62 bronze and rated 125-psi wsp. End connections shall be rated for specified service pressure.
- (2) Pump vent cocks, and where spray control is required, shall be UL umbrella-hood type, constructed of manufacturer's standard polished brass. Cocks shall be 1/2 inch ips male, end threaded and rated at not less than 125-psi at 225-degrees Fahrenheit.

e. Gate Valves (GAV):

- (1) Gate valves 2-inches and smaller shall conform to MSS SP-72. Valves located in tunnels, equipment rooms, factory-assembled equipment and where indicated shall be union-ring bonnet, screwed-end type. Make packing of non-asbestos type materials. Valves shall be rising stem type.
- (2) Gate valves 2 1/2-inches and larger, shall be Type I, (solid wedge disc, tapered seats, steam rated); Class 125, 125-psig steam-working pressure at 353-degrees Fahrenheit saturation); and 200-psig, wog (nonshock), conforming to MSS SP-70 and to requirements specified herein. Valves shall be flanged, with bronze trim and outside screw and yoke (OS&Y) construction. Make packing of non asbestos type materials.

f. Globe and Angle Valves (GLV-ANV):

- (1) Globe and angle valves 2-inches and smaller, shall be 125-pound, 125-psi conforming to MSS SP-85 and to requirements specified herein. Valves located in

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tunnels, equipment rooms, factory-assembled equipment and where indicated shall be union-ring bonnet, screwed-end type. Disc shall be free to swivel on the stem in all valve sizes. Composition seating-surface disc construction may be substituted for all metal-disc construction. Make packing of non-asbestos type materials. Disk and packing shall be suitable for pipe service installed.

- (2) Globe and angle valves 2 1/2-inches and larger, shall be cast iron with bronze trim. Valve bodies shall be cast iron conforming to ASTM A126, Class A, as specified for Class 1 valves under MSS SP-70. Valve ends shall be flanged in conformance with ASME B16.1. Valve construction shall be OS&Y type. Make packing of non asbestos type materials.

g. Standard Check Valves (SCV):

- (1) Standard check valves in sizes 2-inches and smaller shall be 125-psi swing check conforming to MSS SP-71, except as otherwise specified. Provide lift checks where indicated. Swing-check pins shall be nonferrous and suitably hard for the service. Discs shall be composition type. Swing-check angle of closure shall be manufacturer's standard unless a specific angle is needed.
- (2) Check valves in sizes 2 1/2-inches and larger shall be cast iron, bronze trim, swing type. Valve bodies shall be cast iron, conforming to ASTM A126, Class A. Valve ends shall be flanged in conformance with ASME B16.1. Swing-check pin shall be AISI Type or approved equal corrosion-resistant steel. Angle of closure shall be manufacturer's standard unless a specific angle is needed. Valves shall have bolted and gasketed covers.
- (3) Provide check valves with external spring-loaded or lever-weighted; positive closure devices and valve ends shall be mechanical joint, push-on or flanged.

h. Supporting Elements:

- (1) Provide all necessary piping systems and equipment supporting elements, including but not limited to: building structure attachments; supplementary steel; hanger rods, stanchions and fixtures; vertical pipe attachments; horizontal pipe attachments; anchors; guides; and spring-cushion, variable or constant supports. All supporting elements shall be suitable for stresses imposed by systems pressures and temperatures and natural and other external forces normal to this facility without damage to supporting element system or to work being supported.
- (2) Supporting elements shall conform to requirements of ASME B31.3, MSS SP-58 and MSS SP-69 except as noted.

3. EXECUTION:

a. Pipe Installation:

- (1) Fabricate and install piping systems in accordance with ASME B31.3, MSS SP-69 and AWS WHB-2.9.
- (1) Connections between steel piping and copper piping shall be electrically isolated from each other with dielectric couplings (or unions) rated for the service.
- (2) Ream all pipe ends before joint connections are made.

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- (3) Screwed joints shall be made up with specified joint compound and not more than three (3) threads shall show after joint is made up.
- (4) Apply joint compounds to the male thread only and exercise care to prevent compound from reaching the unthreaded interior of the pipe.
- (5) Provide screwed unions, welded unions or bolted flanges wherever required to permit convenient removal of equipment, valves and piping accessories from the piping system for maintenance.
- (6) Securely support piping systems with due allowance for thrust forces, thermal expansion and contraction and shall not be subjected to mechanical, chemical, vibrational or other damage as specified in ASME B31.3.
- (7) Field welded joints shall conform to the requirements of the AWS WHB-2.9, ASME B31.3 and ASME BPVC SEC IX.

b. Valves:

- (1) Provide valves in piping mains and all branches and at equipment where indicated and as specified.
- (2) Provide valves to permit isolation of branch piping and each equipment item from the balance of the system.
- (3) Riser and down comer drains above piping shutoff valves in piping 2 1/2-inches and larger shall be provided. Tap and fit shutoff valve body with a 1/2-inch plugged globe valve.
- (4) Valves unavoidably located in furred or other normally inaccessible places shall be provided with access panels adequately sized for the location and located so that concealed items may be serviced, maintained or replaced.

c. Supporting Elements Installation:

- (1) Provide supporting elements in accordance with the referenced codes and standards.
- (2) Support piping from building structure. No piping shall be supported from roof deck or from other pipe.
- (3) Piping shall run parallel with the lines of the building. Space and install piping and components so that a threaded pipe fitting may be removed between adjacent pipes and so that there shall be no less than 1/2-inch of clear space between the finished surface and other work and between the finished surface of parallel adjacent piping. Hangers on different adjacent service lines running parallel with each other shall be arranged to be in line with each other and parallel to the lines of the building.
- (4) Install piping support elements at intervals specified hereinafter, at locations not more than 3-feet from the ends of each runout, and not over 1-foot from each change in direction of piping.
- (5) Load rating for all pipe-hanger supports shall be based on insulated weight of lines filled with water and forces imposed. Deflection per span shall not exceed slope gradient of pipe. Supports shall be in accordance with the following minimum rod size and maximum allowable hanger spacing for specified pipe. For concentrated loads such as valves, the allowable span must be reduced proportionately:

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PIPE SIZE (INS)	ROD SIZE (INS)	STEEL PIPE (FT)	COPPER PIPE (FT)
1 and smaller	3/8	8	6
1-1/4 to 1 1/2	3/8	10	8
2	3/8	10	8
2-1/2 to 3-1/2	1/2	12	12
4 to 5	5/8	16	14
6	3/4	16	16
8 to 12	7/8	20	20
14 to 18	1	20	20
20 and over	1-1/4	20	20

- (6) Provide vibration isolation supports where needed.
- (7) Vertical risers shall be supported independently of connected horizontal piping, whenever practicable, with fixed or spring supports at the base and at intervals to accommodate system range of thermal conditions. Risers shall be guided for lateral stability. For risers subject to expansion, provide only one rigid support at a point approximately one-third down from the top. Place clamps under fittings unless otherwise specified. Support carbon-steel pipe at each floor and at not more than 15 foot intervals for pipe 2-inches and smaller and at not more than 20-foot intervals for pipe 2 1/2-inches and larger.

d. Underground Piping Installation:

- (1) Prior to being lowered into a trench, all piping shall be cleaned, visually inspected for apparent defects and tapped with a hammer to audibly detect hidden defects.
- (2) Excavations shall be dry and clear of extraneous materials when pipe is being laid.
- (3) Cutting of piping shall be by wheel cutters or other machines designed specifically for that purpose. Electric-arc and oxyacetylene cutting will not be permitted.
- (4) Laying of pipe shall begin at the low point of a system. When in final acceptance position, it shall be true to the grades and alignment indicated, with unbroken continuity of invert. Blocking and wedging will not be permitted.
- (5) Make changes in direction with long sweep fittings.
- (6) Necessary socket clamping, piers, bases, anchors and thrust blocking shall be provided. Protect rods, clamps and bolting with a coating of bitumen.
- (7) Underground piping below supported or suspended slabs shall be supported from the slab with a minimum of two (2) supports per length of pipe. Protect supports with a coating of bitumen.

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- (8) Vertical downspouts; soil, waste and vent stacks; water risers; and similar work shall be properly supported on approved piers at the base and provided with approved structural supports attached to building construction.

23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC

1. GENERAL:

- a. Work Description: The work includes duct air leakage testing (DALT) and testing, adjusting and balancing (TAB) of new and existing heating, ventilating and cooling (HVAC) air and water distribution systems including equipment and performance data, ducts and piping which are located within, on, under, between and adjacent to buildings, including records of existing conditions.

Perform TAB in accordance with the requirements of the TAB procedural standard recommended by the TAB trade association that approved the TAB Firm's qualifications. Comply with requirements of AABC MN-1, NEBB PROCEDURAL STANDARDS or SMACNA 1780 (TABB) as supplemented and modified by this specification section. All recommendations and suggested practices contained in the TAB procedural standards are considered mandatory.

- b. Submittals: Submit in accordance with Section 01 00 00, "General Requirements".
- c. Quality Assurance:
 - (1) TAB Standard: Perform TAB in accordance with the requirements of the standard under which the TAB Firm's qualifications are approved, i.e., AABC MN-1, NEBB PROCEDURAL STANDARDS, or SMACNA 1780 unless otherwise specified herein. All recommendations and suggested practices contained in the TAB Standard are considered mandatory. Use the provisions of the TAB Standard, including checklists, report forms, etc., as nearly as practical, to satisfy the Contract requirements.
- d. Test Reports:
 - (1) Data from DALT Field Work:
 - (a) Report format: Submit report data on Air Duct Leakage Test Summary Report Forms as shown on Page 6-2 of SMACNA 1143.
 - (2) Certified TAB Reports:
 - (a) Report format: Submit the TAB Engineering Report. Report forms and report data must be typewritten. Handwritten report forms or report data are not acceptable.
- e. Warranty: Furnish workmanship and performance warranty for the DALT and TAB system work performed for a period not less than 1-year from the date of Government acceptance of the work; issued directly to the Government. Include provisions that if within the warranty period the system shows evidence of major performance deterioration, or is significantly out of tolerance, resulting from defective TAB or DALT workmanship, the corrective repair or replacement of the defective materials and correction of the defective workmanship is the responsibility of the TAB firm. Perform corrective action that becomes necessary because of defective materials and workmanship while system TAB and DALT is under warranty 7-days after notification, unless additional time is approved by the Contracting Officer. Failure to perform repairs within the specified period of time constitutes grounds for having the

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corrective action and repairs performed by others and the cost billed to the TAB firm. The Contractor must also provide a 1 -year contractor installation warranty.

2. PRODUCTS: Not used.

3. EXECUTION:

a. Work Descriptions of Participants: Comply with requirements of this section as specified.

b. Dalt Procedures:

(1) Instruments, Consumables and Personnel: Provide instruments, consumables and personnel required to accomplish the DALT field work. Calibrate and maintain instruments in accordance with manufacturer's written procedures.

(2) DALT Testing: Perform DALT on the HVAC duct sections of each system. Use the duct class, seal class, leakage class and the leak test pressure data indicated on the Drawings, to comply with the procedures specified in SMACNA 1143.

(3) Quality Assurance:

(4) If any of the duct sections checked for a given system are determined to have a leakage rate measured that exceeds the leakage rate allowed by SMACNA Leak Test Manual for an indicated duct construction class and sealant class, terminate data checking for that section. Make the necessary corrections.

(5) Certified Final DALT Report:

(a) On successful completion of all field checks of all systems, submit the Final DALT Report to the COR for approval.

(6) Prerequisite for TAB Field Work: Do not commence TAB field work prior to the completion and approval of the Final DALT Report.

c. Tab Procedures:

(1) TAB Field Work:

(a) Test, adjust and balance the HVAC systems until measured flow rates (air and water flow) are within plus or minus 5-percent of the design flow rates as indicated.

(b) That is, comply with the requirements of AABC MN-1 and AABC MN-4, NEBB PROCEDURAL STANDARDS, NEBB MASV, or SMACNA 1780 (TABB) and SMACNA 1858 (TABB), except as supplemented and modified by this section.

(c) Provide instruments and consumables required to accomplish the TAB work. Calibrate and maintain instruments in accordance with manufacturer's written procedures.

(2) Workmanship: This TAB work includes adjustment of balancing valves, balancing dampers, and sheaves. Further, this TAB work includes changing out fan sheaves and pump impellers if required to obtain air and water flow rates specified or indicated. If, with these adjustments and equipment changes, the specified or indicated design flow rates cannot be attained, contact the COR for direction.

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(3) TAB Reports:

- (a) Except as approved otherwise in writing by the COR, the TAB work and thereby the TAB report is considered incomplete until the TAB work is accomplished to within the accuracy range specified.

(4) Quality Assurance:

- d. Marking of Settings: Upon the final TAB work approval, permanently mark the settings of HVAC adjustment devices including valves, gauges, splitters and dampers so that adjustment can be restored if disturbed at any time. Provide permanent markings clearly indicating the settings on the adjustment devices which result in the data reported on the submitted TAB report.
- e. Marking of Test Ports: The TAB team is to permanently and legibly mark and identify the location points of the duct test ports. If the ducts have exterior insulation, make these markings on the exterior side of the duct insulation. Show the location of test ports on the as-built mechanical drawings with dimensions given where the test port is covered by exterior insulation.

23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS:

1. GENERAL:

a. System Description:

- (1) General: Provide field-applied insulation and accessories on mechanical systems as specified herein; factory-applied insulation is specified under the piping, duct or equipment to be insulated. Field applied insulation materials required for use on Government-furnished items be furnished and installed by the Contractor.
- (2) Submittals: Submit in accordance with Section 01 00 00, "General Requirements".
- (3) Quality Assurance:
 - (a) Installer Qualification: Qualified installers shall have successfully completed three (3) or more similar type jobs within the last 5-years.
- (4) Delivery, Storage and Handling: Materials shall be delivered in the manufacturer's unopened containers. Materials delivered and placed in storage shall be provided with protection from weather, humidity, dirt, dust and other contaminants. Insulation packages and containers shall be asbestos free.

2. PRODUCTS:

- a. Product Sustainability Criteria: For products in this section, where applicable and to extent allowed by performance criteria, provide and document the following:
 - (1) Reduce Volatile Organic Compounds (VOC) for Caulking, Sealant and Adhesive Materials.
 - (2) For interior applications, provide caulking, sealant and adhesive materials meeting the reduced VOC requirements.
 - (3) Recycled Content for Pipe and Ductwork Insulation Materials.

STANDARD 11 – BUILDINGS

- b. Standard Products: Provide materials which are the standard products of manufacturers regularly engaged in the manufacture of such products. Submit a complete list of materials, including manufacturer's descriptive technical literature, performance data, catalog cuts and installation instructions. The product number, k-value, thickness and furnished accessories including adhesives, sealants and jackets for each mechanical system requiring insulation shall be included. The product data must be copyrighted, have an identifying or publication number and shall have been published prior to the issuance date of this solicitation.
 - (1) Insulation System: Provide insulation systems in accordance with the approved MICA National Insulation Standards plates as supplemented by this specification. Provide field-applied insulation for HVAC air distribution systems and piping systems that are located within, on, under, and adjacent to buildings; and for plumbing systems. Provide CFC and HCFC free insulation.
 - (2) Surface Burning Characteristics: Unless otherwise specified, insulation must have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Flame spread, and smoke developed indexes, shall be determined by ASTM E84 or UL 723. Test insulation in the same density and installed thickness as the material to be used in the actual construction. Prepare and mount test specimens according to ASTM E2231.
 - (3) Materials: Provide insulation that meets or exceeds the requirements of ASHRAE 90.1. Insulation exterior shall be cleanable, grease resistant, non-flaking and non-peeling. Materials shall be compatible and shall not contribute to corrosion, soften or otherwise attack surfaces to which applied in either wet or dry state. Materials to be used on stainless steel surfaces shall meet ASTM C795 requirements. Materials shall be asbestos free. Provide product recognized under UL 94 (if containing plastic) and listed in FM APP GUIDE.

3. EXECUTION:

- a. General: Insulation shall only be applied to unheated and uncooled piping and equipment. Flexible elastomeric cellular insulation shall not be compressed at joists, studs, columns, ducts, hangers, etc. The insulation shall not pull apart after a 1- hour period; any insulation found to pull apart after 1-hour, shall be replaced.
- b. Pipe Insulation Systems Installation: Install pipe insulation systems in accordance with the approved MICA Insulation Stds plates as supplemented by the manufacturer's published installation instructions.
- c. Duct Insulation Systems Installation: Install duct insulation systems in accordance with the approved MICA Insulation Stds plates as supplemented by the manufacturers published installation instructions. Duct insulation minimum thickness and insulation level must meet or exceed the requirements of ASHRAE 90.1.
- d. Equipment Insulation Systems Installation: Install equipment insulation systems in accordance with the approved MICA Insulation Stds plates as supplemented by the manufacturers published installation instructions.

23 09 33 CONTROL SYSTEMS FOR HVAC

1. GENERAL:

- a. Submittals: Submit in accordance with Section 01 00 00, "General Requirements".

2. PRODUCTS:

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a. System Description:

- (1) Provide a lead-lag temperature control system that is complete in all details and includes all necessary accessories to maintain conditions indicated or specified.

b. Components and Equipment:

- (1) Provide components and equipment factory ordered. Earlier generation components or rebuilt equipment shall not be acceptable.
- (2) The controller and associated devices shall be energy efficient, microprocessor-based that do not require Contractor-generated software. The controller shall operate the unitary application, but automatic changeover shall be provided between heating and cooling modes. The fan shall be able to operate continuously during non-heating and non-cooling cycles.
- (3) Provide temperature sensors, sensor transmitters and controller output signals that are directly proportional to the variations in the measured variable.
- (4) Provide humidity sensors, sensor transmitters and controller output signals that are directly proportional to the variations in the measured variable.

c. Spans and Ranges:

- (1) Transmitters shall be calibrated to provide an output signal of 4 to 20 mA over the indicated span or range.
 - (a) Conditioned space temperature, from 50- to 100-degrees Fahrenheit.
 - (b) Duct temperature, from 40- to 130-degrees Fahrenheit.
 - (c) Outside air temperature, from minus 40- to 130-degrees Fahrenheit.
 - (d) Relative humidity, from 0- to 100-percent.

3. EXECUTION:

- a. General: Install in accordance with the manufacturer's instructions and as indicated.
- b. Accessibility: Components requiring periodic inspection, operation, maintenance and repair shall be installed and readily accessible.
- c. Quality Control: Perform testing in accordance with the manufacturer's instructions and as indicated.
- d. Closeout Activities: Provide written operating instructions and not less than 1 hour of operator training.

23 31 13 METAL DUCTS:

1. GENERAL:

- a. Submittals: Submit in accordance with Section 01 00 00, "General Requirements".

2. PRODUCTS: Include the manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information and fabrication site information within material, equipment and fixture lists.

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a. System Description:

- (1) Provide low-pressure systems ductwork and plenums where maximum air velocity is 2,000-feet per minute (fpm) and maximum static pressure is 2-inches water gage (wg), positive or negative.

b. Components:

- (1) Round Sheet Metal Duct Fittings: Submit offset fitting configurations for approval. Shop fabricate fittings.
 - (a) Fittings Construction: Manufacture as separate fittings, not as tap collars welded or brazed into duct sections.
 - (b) Provide 2-piece type miter elbows for angles less than 31-degrees, 3-piece type for angles 31- through 60-degrees and 5-piece type for angles 61- through 90 degrees. Ensure centerline radius of elbows is 1 1/2 times fitting cross section diameter.
 - (c) Provide conical type crosses, increasers, reducers, reducing tees and 90-degree tees.
 - (d) Ensure cutouts in fitting body are equal to branch tap dimension or, where smaller, excess material is flared and rolled into smooth radius nozzle configuration.
- (2) Reinforcement: Support inner liners of both duct and fittings by metal spacers welded in position to maintain spacing and concentricity.
- (3) Fittings: Make divided flow fittings as separate fittings, not tap collars into duct sections, with the following construction requirements:
 - (a) Sound, airtight, continuous welds at intersection of fitting body and tap
 - (b) Tap liner securely welded to inner liner, with weld spacing not to exceed 3-inches.
 - (c) Pack insulation around the branch tap area for complete cavity filling.
 - (d) Carefully fit branch connection to cutout openings in inner liner without spaces for air erosion of insulation and without sharp projections that cause noise and airflow disturbance.
 - 1) Continuously braze seams in the pressure shell of fittings. Protect galvanized areas that have been damaged by welding with manufacturer's standard corrosion-resistant coating.
 - 2) Construct 2-piece type elbows for angles through 35-degrees, 3-piece type for angles 36- through 71-degrees, and 5-piece type for angles 72-through 90 degrees.
 - 3) Provide conical type crosses, increasers, reducers, reducing tees and 90-degree tees.
- (4) Turning Vanes: Provide double-wall type turning vanes, commercially manufactured for high-velocity system service.

STANDARD 11 – BUILDINGS

- (5) Dampers: Construct low pressure drop, high-velocity manual volume dampers and high-velocity fire dampers in accordance with ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN IP, Chapter 32 and SMACNA 1966.
- (6) Flexible Connectors for Sheet Metal: Use UL listed connectors, 30-ounce per square yard, waterproof, fire-retardant, airtight, woven fibrous-glass cloth, double coated with chloroprene. Clear width, not including clamping section, is 6- to 8-inches.
 - (a) Provide leaded vinyl sheets as a second layer for sound attenuation. Ensure leaded vinyl is not less than 0.055-inch thick, weighing not less than 0.87-pound per square foot and capable of approximately 10-decibel attenuation in the 10- to 10,000-hertz range.
- (7) Duct Hangers: For duct hangers in contact with galvanized duct surfaces, provide galvanized steel painted with inorganic zinc.
- (8) Mill-Rolled Reinforcing and Supporting Materials:
 - (a) Provide mill-rolled structural steel conforming to 1 ASTM A36. Whenever in contact with sheet metal ducting, provide galvanized steel in accordance with ASTM A123.
 - (b) In lieu of mill-rolled structural steel, submit equivalent strength, proprietary-design, rolled-steel structural support systems for approval.
- (9) Flexible Duct Materials:
 - (a) Ensure flexible duct connectors comply with NFPA 90A, and conform with UL 181, Class 1 material.
 - (b) Provide zinc-coated ASTM A123 metal duct; bendable through 180-degrees without damage, with an inside bend radius not greater than 1/2 the diameter of duct.
 - (c) Provide wire-reinforced cloth duct consisting of a fibrous-glass cloth bonded to and supported by a corrosion-protected spring steel helix. Fabric may be a laminate of metallic film and fibrous glass. Ensure working pressure rating of ducting is not less than three (3) times maximum system pressure, and the temperature range is minus 20 to plus 175-degrees Fahrenheit.
 - (d) Provide wire-reinforced fibrous-glass duct consisting of a minimum 1-pound per cubic foot density fibrous glass, bonded to and supported by corrosion-protected spring helix. Vapor barriers are a minimum of 4 mil, pigmented polyvinylchloride film. Ensure duct is bendable without damage through 180 degrees with an inside bend radius not greater than two (2) duct diameters. Minimum wall thickness is 1-inch. Thermal conductivity is not greater than 0.23-Btu per hour per square foot per degrees Fahrenheit at 75 degrees Fahrenheit mean temperature. Working pressure range is from 1/2-inch wg to 1 1/2-inches wg. Working temperature ranges from minus 20- to plus 250 degrees Fahrenheit. Minimum sustained velocity without delamination is 2,400-fpm. Use materials conforming to NFPA 90A.
- (10) Manual Volume Dampers: Conform to SMACNA 1966 for volume damper construction.

STANDARD 11 – BUILDINGS

- (a) Equip dampers with an indicating quadrant regulator with a locking feature externally located and easily accessible for adjustment and standoff brackets to allow mounting outside external insulation. Where damper rod lengths exceed 30-inches, provide a regulator at each end of damper shaft.
 - (11) Gravity Backdraft and Relief Dampers: Construct frames of not less than 1 1/2- by 4 inch galvanized carbon steel. Solidly secure frames and mullions in place and seal with elastomer caulking against air bypass.
- c. Materials:
- (1) Galvanized Steel Ductwork Materials:
 - (a) Provide hot-dip galvanized carbon steel ductwork sheet metal of lock-forming quality, with regular spangle-type zinc coating, conforming to ASTM A924 and ASTM A653, Designation G90. Treat duct surfaces to be painted by annealing.
 - (b) Conform to ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN SI ASHRAE FUN IP, Chapter 32 and SMACNA 1966 for sheet metal thickness gages and reinforcement thickness.
 - (2) Brazing Materials: Provide silicon bronze brazing materials conforming to AWS A5.8.
 - (3) Mill-Rolled Reinforcing and Supporting Materials:
 - (a) Conform to ASTM A36 for mill-rolled structural steel. Wherever in contact with sheet metal ducting, galvanize to conforming with ASTM A123.
 - (b) In lieu of mill-rolled structural steel, submit for approval, equivalent strength, proprietary design, rolled-steel structural support systems.

3. EXECUTION:

- a. Preparation: For sheet metal surfaces to be painted, and surfaces to which adhesives are to be applied, clean surface of oil, grease and deleterious substances.

Ensure strength is adequate to prevent failure under service pressure or vacuum created by fast closure of duct devices. Provide leak tight, automatic relief devices.

- (1) Construction Standards:
 - (a) Provide sheet metal construction in accordance with the recommendations for best practices in ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN SI, ASHRAE FUN IP, Chapter 32, SMACNA 1966 and NFPA 90A.
 - (b) Design and fabricate supplementary steel in accordance with AISC 360 and AISC 325.

Where construction methods for certain items are not described in the referenced standards or herein, perform the work in accordance with recommendations for best practice defined in ASHRAE EQUIP IP HDBK.

STANDARD 11 – BUILDINGS

b. Installation:

Fabricate an airtight system. Include reinforcements, bracing, supports, framing, gasketing, sealing and fastening to provide rigid construction and freedom from vibration, airflow-induced motion and noise and excessive deflection at specified maximum system air pressure and velocity.

Provide offsets and transformations as required to avoid interference with the building construction, piping or equipment.

Make plenum anchorage provisions, sheet metal joints and other areas airtight and watertight by caulking, mating galvanized steel and concrete surfaces with a 2-component elastomer.

(1) Jointing:

- (a) Enclose dampers located behind architectural intake or exhaust louvers by a rigid sheet metal collar and sealed to building construction with elastomers for complete air tightness.
- (b) Provide outside air-intake ducts and plenums made from sheet metal with soldered watertight joints.

(2) Ducts:

- (a) Wherever ducts pass through firewalls or through walls or floors dividing conditioned spaces from unconditioned spaces, provide a flanged segment in that surface during surface construction.
- (b) Where interiors of ducting may be viewed through air diffusion devices, construct the viewed interior with sheet metal and paint flat black.
- (c) Ductwork Cleaning Provisions: Protect open ducting from construction dust and debris in a manner approved by the Contracting Officer. Clean dirty assembled ducting by subjecting all main and branch interior surfaces to airstreams moving at velocities two (2) times specified working velocities, at static pressures within maximum ratings. This may be accomplished by: filter-equipped portable blowers which remain the Contractor's property; wheel-mounted, compressed-air operated perimeter lances which direct the compressed air and which are pulled in the direction of normal airflow; or other means approved by the COR. Use water- and oil-free compressed air for cleaning ducting. After construction is complete, and prior to acceptance of the work, remove construction dust and debris from exterior surfaces.

c. Application:

(1) Low Pressure Sheet Metal Ducts:

Weld angle iron frames at corners and ends, whenever possible. Rivet or weld angle iron reinforcements to ducts not more than 6-inches on center, with not less than two (2) points of attachment. Spot welding, where used, is 3-inches on center.

Seal standard seam joints with an elastomer compound to comply with SMACNA 1966 Seal Class A, B or C as applicable.

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Limit cross breaking to 4-feet and provide on all ducts 8-inches wide and wider. Provide bead reinforcement in lieu of cross breaking where panel popping may occur. Where rigid insulation is applied, cross breaking is not required.

- (a) Longitudinal Duct Seams: Provide Pittsburgh lock corner seams.
 - (b) Joints and Gaskets: Bolt companion angle flanges together with 1/4-inch diameter bolts and nuts spaced 6-inches on center. Gasket flanged joints with chloroprene full-face gaskets, with Shore A 40 durometer hardness. Use one (1) piece gaskets, at joints.
 - (c) Flexible Duct Joints: Between flexible duct without sheet metal collars and round metal ductwork connections make joints by trimming the ends, coating the inside of the flexible duct for a distance equal to depth of insertion with elastomer caulk and by securing with sheet metal screws or binding with a strap clamp.
 - (d) Square Elbows: Provide single-vane duct turns in accordance with SMACNA 1966, use on ducts 12-inches in width and narrower.
 - (e) Provide double-vane duct turns in accordance with SMACNA 1966.
- d. Radius Elbows: Conform to SMACNA 1966 for radius elbows. Provide an inside radius equal to the width of the duct. Where installation conditions preclude use of standard elbows, the inside radius may be reduced to a minimum of 0.25 times duct width. Install turning vanes in accordance with the following schedule.

	RADIUS OF TURNING VANES IN PERCENT OF DUCT WIDTH		
WIDTH OF ELBOWS (INS)	VANE NO. 1	VANE NO. 2	VANE NO. 3
Up to 16	56	--	--
17 to 48	43	73	--
49 and over	37	55	83

Where two (2) elbows are placed together in the same plane for ducts 30 inches wide and larger, continue the guide vanes through both elbows rather than spaced in accordance with above schedule.

- (a) Outlets, Inlets and Duct Branches:

Install branches, inlets and outlets so that air turbulence is reduced to a minimum and air volume properly apportioned. Install adjustable splitter dampers at all supply junctions to permit adjustment of the amount of air entering the branch. Wherever an air-diffusion device is shown as being installed on the side, top or bottom of a duct, and whenever a branch take-off is not of the splitter type; provide a commercially manufactured 45-degree side-take-off (STO) fitting with manual volume damper to allow adjustment of the air quantity and to provide an even flow of air across the device or duct it services.

Where a duct branch is to handle more than 25-percent of the air handled by the duct main, use a complete 90-degree increasing elbow with an inside

STANDARD 11 – BUILDINGS

radius of 0.75 times branch duct width. Size of the leading end of the increasing elbow within the main duct with the same ratio to the main duct size as the ratio of the related air quantities handled.

Where a duct branch is to handle 25-percent or less of the air handled by the duct main, construct the branch connection with a 45-degree side take-off entry in accordance with SMACNA 1966.

(b) Duct Transitions:

Where the shape of a duct changes, ensure the angle of the side of the transition piece does not exceed 15-degrees from the straight run of duct connected thereto.

Where equipment is installed in ductwork, ensure the angle of the side of the transition piece from the straight run of duct connected thereto does not exceed 15-degrees on the upstream side of the equipment and 22 1/2-degrees on the downstream side of the equipment.

(c) Branch Connections: Construct radius tap-ins in accordance with SMACNA 1966.

(d) Access Openings:

Construct access door in accordance with SMACNA 1966, except that sliding doors may be used only for special conditions upon prior approval. Provide double-panel type doors.

Install access doors and panels in ductwork at controls or at any item requiring periodic inspection, adjustment, maintenance or cleaning.

Minimum access opening size is 12- by 18-inches, unless precluded by duct dimensions or otherwise indicated.

Make airtight access doors that leak by adding or replacing hinges and latches or by construction of new doors adequately reinforced, hinged and latched.

(e) Duct Access for Cleaning: Make duct access particularly suitable for commercial duct cleaning methods utilizing vacuum devices. Space access openings with a frequency and at points that permits ready access to duct internals with essentially no duct or insulation cutting. Where access through an air-diffusion device or through access doors specified herein is not available at a specific point, provide 8-inch diameter, 16-gage access plates not more than 10-feet on center. Where duct is insulated and vapor-sealed, provide mastic seals around circumference of access. When access plate is in place and insulated, externally identify the location.

(f) Manual Volume Dampers:

Provide balancing dampers of the splitter, butterfly or multi-louver type, to balance each respective main and branch duct.

For dampers regulated through ceilings provide a regulator concealed in a box mounted in the ceiling, with a cover finish aesthetically compatible with ceiling surface. Where ceiling is of removable construction, set regulators above the ceiling and mark the location on ceiling in a manner acceptable to the COR.

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(g) Flexible Connectors for Sheet Metal:

Connect air handling equipment, ducts crossing building expansion joints and fan inlets and outlets to upstream and downstream components by treated woven-cloth connectors.

Install connectors only after system fans are operative, and vibration isolation mountings have been adjusted. When system fans are operating, ensure connectors are free of wrinkles caused by misalignment or fan reaction. Width of surface is curvilinear.

(2) Rectangular Sheet Metal Ducts:

(a) Medium-Pressure Gages, Joints and Reinforcement:

Ensure minimum sheet metal gages, joints and reinforcements between joints are in accordance with ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN SI, ASHRAE FUN IP, Chapter 32 and SMACNA 1966.

Ensure sheet metal minimum thickness, transverse reinforcement between joints and joints of ducts are in accordance with the following:

LONGEST SIDE (INS)	SHEET METAL GAGE ALL SIDES	COMPANION ANGLE (INS)	REINFORCEMENT ANGLES 24-INCHES ON CENTER MAXIMUM
97 to 108	16	2 by 2 by 1/8, two tie rods along angle	Two 2 by 2 by 1/8, two tie rods along angle
109 to 132	16	2 by 2 by 3/16, two tie rods along angle	Two 2 by 2 by 3/16, two tie rods along angle
133 and longer	14	2 by 2 by 3/16, with tie rods every 48 inches	Two 2 by 2 by 3/16, with tie rods every 48 inches

(b) Duct Branch Transition:

Where a duct branch handles over 25-percent of the air transported by the duct main, use a complete 90 degree increasing elbow, with an inside radius of 0.75 times duct branch width. Ensure the size of the trailing end of the increasing elbow within the main duct has the same ratio to the main duct size as the ratio of the relative air quantities handled.

Where a duct branch is to handle 25-percent or less of the air handled by the duct main, provide a branch connection with an inside radius of 0.75 times branch duct width, a minimum arc length of 45 degrees, and an outside radius of 1.75 times duct branch width. Place arc tangent to duct main.

(c) High-Pressure Gages, Joints and Reinforcement:

Ensure sheet metal minimum thickness, joints and reinforcement between joints are in accordance with ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN IP, Chapter 32 and SMACNA 1966.

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Use the following types of ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN IP, Chapter 32 and SMACNA 1966 joints and seams.

(d) Transverse Joints:

- 1) Welded flange joint.
- 2) Companion angle flanged joint.

(e) Longitudinal Seams:

- 1) Approved lock seams, back brazed or continuously brazed seams for ducts with largest dimension up to 72-inches
- 2) Continuously welded or brazed seams for ducts with largest dimension greater than 72-inches

Sheet metal minimum thickness, transverse reinforcement between joint, and companion angle joints of ducts with longest side greater than 96 inches are in accordance with the following:

LONGEST SIDE (INS)	SHEET METAL GAGE ALL SIDES	COMPANION ANGLE (INS)	REINFORCEMENT ANGLES 24-INCHES ON CENTER MAXIMUM
97 to 108	16	2 by 2 by 1/8, two tie rods along angle	*Two 2 by 2 by 1/8, two tie rods along angle
109 to 132	16	2 by 2 by 3/16, two tie rods along angle	*Two 2 by 2 by 3/16, two tie rods along angle
133 and longer	14	2-1/2 by 2-1/2 by 3/16, with tie rods every 24-inches	*Two 2-1/2 by 2-1/2 by 3/16, with tie rods every 24-inches

(3) Round Sheet Metal Ducts:

(a) Duct Gages and Reinforcement:

Sheet metal minimum thickness, joints and reinforcement between joints shall be in accordance with ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN IP, Chapter 32 and SMACNA 1966.

Provide ducts with supplemental girth angle supports. Locate girth angles as follows:

DIAMETER (INS)	REINFORCEMENT-MAXIMUM SPACING (INS)
25 to 36	1-1/4 by 1-1/4, 1/8 thick, 72 inches on center
37 to 50	1-1/4 by 1-1/4, 1/8 thick, 60 inches on center
51 to 60	1-1/2 by 1-1/2, 1/8 thick, 48 inches on center

Use hex-shaped bolt heads and nuts, M8 5/16-inch diameter for ducts up to 50 inch diameter, and M10 3/8-inch diameter for 51-inch diameter ducts and larger.

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Continuously weld flanges to duct on outside of duct and intermittently welded with 1-inch welds every 4-inches on inside joint face. Remove excess filler metal from inside face. Protect galvanized areas that have been damaged by welding with manufacturer's standard corrosion-resistant coating.

(b) Duct Joints:

Provide duct joints manufactured by machine, with spiral locksets up to and including 60-inch diameters, and to dimensional tolerances compatible with fittings provided. Draw-band girth joints are not acceptable.

Prepare slip joints by coating the male fitting with elastomer sealing materials, exercising care to prevent mastic from entering fitting bore. Leave only a thin annular mastic line exposed internally. Use sheet metal screws to make assembly rigid, not less than four screws per joint, maximum spacing 6-inches. Do not use pop rivets. Tape and heat seal all joints.

(c) Duct Transitions:

Where the shape of a duct changes, ensure the angle of the side of the transition piece does not exceed 15 degrees from the straight run of duct connected thereto.

Where equipment is installed in ductwork, ensure the angle of the side of the transition piece from the straight run of duct connected thereto does not exceed 15 degrees on the upstream side of the equipment and 22 1/2-degrees on the downstream side of the equipment.

- (4) Transverse Reinforcement Joints: Provide transverse reinforcements that are spot welded 4-inches on center. Weld transverse reinforcement to form continuous frames.
- (5) Joint Gaskets: For flanged joints, use chloroprene full-face gaskets 1/8-inch thick, with Shore A 40 durometer hardness. Use 1-piece gaskets, at joints.
- (6) Radius Elbows: Fabricate elbow proportions and radius elbows in accordance with ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN IP, Chapter 32 and SMACNA 1966.
- (7) Duct Supports:

Install duct support in accordance with ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN IP, Chapter 32 and SMACNA 1966. Meet the minimum size for duct hangers as specified in ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN IP, Chapter 32 and SMACNA 1966. Provide two (2) hangers where necessary to eliminate sway.

Do not hang ductwork and equipment from roof deck, piping, or other ducts or equipment. Maximum span between any two (2) points is 10-feet, with lesser spans as required by duct assemblies, interferences and permitted loads imposed.

(a) Installation:

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Ensure hanger spacing gives a 20-to-1 safety factor for supported load. Maximum load supported by any two (2) fasteners is 100-pounds. Install hangers on both sides of all duct turns, branch fittings and transitions.

Friction rod assemblies are not acceptable.

(b) Strap-type Hangars:

Support rectangular ducts up to 36-inches by strap-type hangers attached at not less than three (3) places to not less than two (2) duct surfaces in different planes.

Perforated strap hangers are not acceptable.

(c) Trapeze Hangars:

Support rectangular ducting, 36-inches and larger, by trapeze hangers. Support ducts situated in unconditioned areas and required to have insulation with a vapor-sealed facing on trapeze hangers. Space hangers far enough out from the side of the duct to permit the duct insulation to be placed on the duct inside the trapeze. Do not penetrate the vapor-sealed facing with duct hangers.

Where trapeze hangers are used, support the bottom of the duct on angles sized as follows:

WIDTH OF DUCT (INS)	MINIMUM BOTTOM ANGLE SIZE (INS)
30 and smaller	1-1/4 by 1-1/4 by 1/8
31 to 48	1-1/2 by 1-1/2 by 1/8
49 to 72	1-1/2 by 1-1/2 by 3/16
73 to 96	2 by 2 by 1/4
97 and wider	3 by 3 by 1/4

(d) Duct Support:

Refer to Project Drawings and Division 11 of the project specifications for support of HVAC ductwork.

(e) Vibration Isolation:

Isolate the structure from duct support vibration at points indicated.

Provide vibration isolators in discharge ducting system for a distance not less than 50-feet beyond the air handling unit. Coordinate deflection of duct and equipment mountings.

(f) Flexible Connectors for Steel Metal:

Connect air-handling equipment, ducts crossing building expansion joints and fan inlets and outlets to upstream and downstream components with treated woven-cloth connectors.

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Install connectors only after system fans are operative and all vibration isolation mountings have been adjusted. When system fans are operating, ensure connectors are free of wrinkles caused by misalignment or fan reaction. Width of surface is curvilinear.

(g) Insulation Protection Angles:

Provide galvanized 20-gage sheet, formed into an angle with a 2-inch exposed long leg with a 3/8-inch stiffening break at outer edge, and with a variable concealed leg, depending upon insulation thickness.

Install angles over all insulation edges terminating by butting against a wall, floor foundation, frame and similar construction. Fasten angles in place with blind rivets through the protection angle, insulation and sheet metal duct or plenum. Install angles after final insulation covering has been applied.

(h) Duct Probe Access: Provide holes with neat patches, threaded plugs or threaded or twist-on caps for air-balancing pitot tube access. Provide extended-neck fittings where probe access area is insulated.

e. Field Quality Control:

(1) Ductwork Leakage Tests: Conduct complete leakage test of new ductwork in accordance with Section 23 05 93 Testing, Adjusting and Balancing for Hvac. Perform tests prior to installing ductwork insulation.

(a) Inspection: Inspect ductwork in accordance with SMACNA 1987.

23 37 13 DIFFUSERS, REGISTERS AND GRILLS:

1. GENERAL:

a. Submittals: Submit in accordance with Section 01 00 00, "General Requirements".

2. PRODUCTS:

a. Performance Requirements:

(1) Certify air diffusion devices having been tested and rated in accordance with Chapter 19 ,ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN IP and ASHRAE 113, where such Certification is required.

Submit equipment and performance data for air-diffusion devices consisting of sound data in terms of Noise Criteria (NC) index for the capacity range of the device.

b. Components:

(1) Air Diffusion Device Construction: Preclude flutter, rattle or vibration on air-diffusion device construction and mounting. Modify devices and provide accessories necessary for mounting in indicated surface construction.

(a)

(b) Select color from manufacturer's standard color chart which indicates the manufacturer's standard color selections and finishes for air-diffusion devices.

(c) Provide color as indicated on drawings.

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- (d) Provide supply diffusers with combination damper and equalizing grid.
- (e) Ensure dampers are extracting-splitter type, except as otherwise indicated.
- (f) Ensure air-diffusion device volume and pattern adjustments can be made from the face of the device. Make volume adjustments by removable key.
- (g) Provide gaskets for supply-terminal air devices mounted in finished surfaces.
- (h) Include within the material, equipment and fixture lists the manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information and fabrication site information.

3. EXECUTION:

a. Installation:

- (1) Install equipment as indicated and specified and in accordance with the Drawings and the manufacturer's recommendations.
- (2) Operations and Maintenance Manuals: Provide operation and maintenance manuals consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures and safety precautions.

23 81 00 UNITARY AIR CONDITIONING EQUIPMENT:

- 1. GENERAL: Related Requirements: Section 23 03 00 Basic Mechanical Materials and Methods, applies to this section with the additions and modifications specified herein.

a. Submittals: Submit in accordance with Section 01 00 00, "General Requirements".

b. Quality Assurance:

- (1) Detail Drawing: For refrigerant piping, submit piping, including pipe sizes. Submit control system wiring diagrams.

c. Safety: Design, manufacture and installation of unitary air conditioning equipment shall conform to ANSI/ASHRAE 15 and 34.

d. Posted Operating Instructions: Submit posted operating instructions for each packaged air conditioning unit.

- (1) Refrigerants: Refrigerants shall have an Ozone Depletion Potential (ODP) of 0.0. The ODP shall be in accordance with the "Montreal Protocol on Substances That Deplete the Ozone Layer".

- (2) Environmental Requirements: For proper Indoor Environmental Quality, maintain positive pressure within the building. Ventilation shall meet or exceed ASHRAE 62.1 and all published addenda. Meet or exceed filter media efficiency as tested in accordance with ASHRAE 52.2 Thermal comfort shall meet or exceed ASHRAE 55.

2. PRODUCTS:

- a. General: Provide and document Product Sustainability Criteria for products in this section, where applicable, and to the extent allowed by performance criteria.

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- b. Room Air Conditioners: AHAM RAC-1 and UL 484. Minimum energy efficiency ratio (EER) shall be in accordance with Energy Star Program Requirements Product Specification for Room Air Conditioners: Provide units removable from inside the building for servicing without removing the outside cabinet. Construct outside cabinets, including metal grilles to protect condenser coils, of zinc-coated steel or aluminum. Steel and zinc-coated surfaces shall receive at least one (1) coat of primer and manufacturer's standard factory-applied finish. Insulate cabinets to prevent condensation and run off of moisture. Provide mounting hardware made of corrosion resistant material or protected by a corrosion-resistant finish. Provide air filters of the throw-away type removable without the use of tools and arranged to filter both room and ventilating air. Remove condensate by means of a drain or by evaporation and diffusion. Provide with metal or plastic mounting flanges on each side, top and bottom of unit. For thru-the-wall installations provide zinc-coated steel flanged wall sleeves. Design wall sleeves to restrict driving rain. Mount compressors on vibration isolators. Minimum cooling capacity shall be not less than that indicated. Provide units listed in the AHAM RAC-1.
- (1) Units for Operation on 115 Volts: Provide 3-wire cords of manufacturer's standard length. If not existing, provide a receptacle within reach of the standard length cord. Cords shall have a 15- or 20-amp, 3-pole, 125-volt ground type plug to match receptacle.
 - (2) Units for Operation on 208 or 230 Volts: Provide 3-wire cords of manufacturer's standard length. If not existing, provide a receptacle within reach of the standard length cord. Cords shall have a 15-, 20- or 30-amp, 3-pole, 250-volt ground type plug to match receptacle.
 - (3) Controls: Mount controls in cabinet. Manual controls shall permit operation of either the fan or the fan and refrigerating equipment. Fan control shall provide two (2) fan speed settings. Automatic controls shall include a thermostat for controlling air temperature. Thermostat shall have an adjustable range, including 72- to 80 degrees Fahrenheit and shall automatically turn the refrigeration system on or off to maintain the preselected temperature within plus or minus 4-degrees Fahrenheit.
- c. Packaged Terminal Units:
- (1) Heat Pumps: ANSI/AHRI/CSA 310/380, UL 484, air-cooled, thru-wall type, AHRI certified and UL listed.
 - (2) Air Conditioners: ANSI/AHRI/CSA 310/380, UL 484, air-cooled, thru-wall type, AHRI certified and UL listed. Provide units with combination heating and cooling section with indicated capacity.
 - (3) Grilles: Provide manufacturer's standard anodized aluminum outdoor grilles and caulk and seal on all sides when required by manufacturer's instructions. Provide both horizontal and vertical adjustable deflection inside air supply grilles. Provide for air return under the front panel or a return air grille in the lower part of the front panel.
 - (4) Wall Sleeves and Mounts: Provide manufacturer's standard wall sleeves and mounts. Wall sleeves shall have seals designed to restrict driving rain and wind. Provide unit subbase of the same construction and finish as the sleeve to provide for concealed electrical connection, cord storage and equipped with unit leveling legs.
 - (5) Heating Section for Air Conditioners:

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- (a) Electric resistance heating elements with high temperature-limit safety device, factory-mounted and wired to chassis.
 - (b) Provide factory-furnished tee and manual air vent on return connection. Factory test coils at twice maximum operating pressure.
 - (c) Heating unit shall have internal thermal insulation having a fire hazard rating not to exceed 25 for flame spread and 50 for smoke developed as determined by ASTM E84.
- (6) Refrigeration Sections: Completely self-contained, slide-in assembly or removable chassis with welded, hermetically sealed, air-cooled refrigeration system, outdoor fan, indoor fan, control box and ventilation damper. Provide refrigeration sections capable of installation or removal without the use of tools. Refrigeration sections shall include refrigeration circuit tubing, wiring, and safety controls, and shall operate down to 35 degrees Fahrenheit outdoor temperature and 70-degrees Fahrenheit indoor temperature, without compressor short cycling while delivering not less than 100 percent of rated cooling capacity. Units shall have drains to the building exterior to eliminate excess driving rain. Condensate shall not drain onto building exterior or interior.
- (a) Compressors: Hermetic type with vibration isolation devices.
 - (b) Coils: Constructed of seamless copper or aluminum tubing with copper or aluminum fins bonded to tubes.
 - (c) Outdoor Fans: Direct connected centrifugal type with aluminum or plastic wheel and forward curved blades or direct connected aluminum propeller type. Design fans so that condensate will evaporate without drip, splash or spray on building exterior.
 - (d) Indoor Fans: Direct connected centrifugal type with aluminum, galvanized steel or plastic wheel and forward curved blades. Provide minimum 2-speed motor with built-in overload protection.
- (7) Ventilation Damper Assembly: Operated by automatic actuator. Dampers shall close on unit shutdown or loss of power and shall open on heating or cooling start-up.
- (8) Air Filters: Removable without use of tools and shall filter both recirculated and ventilating air.
- (9) Controls: Provide controls including, an adjustable thermostat, and switches, to regulate room air temperature through control of refrigerant compressors or heating elements. Controls shall at least have positions for off, high or low fan speed for heating and cooling and fan only operation.
- (a) Heat Pumps, Air to Air: CID A-A-50502, except as modified.
 - 1) Air Coils: Extended-surface fin and tube type with seamless copper or aluminum tubes with copper or aluminum fins securely bonded to the tubes. On coils with all-aluminum construction, provide tubes of aluminum alloy 1100, 1200 or 3102; provide fins of aluminum alloy 7072; and provide tube sheets of aluminum alloy 7072 or 5052.

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- (10) Supplemental Electric Heaters: Provide electrical resistance heaters integral with the unit. Heaters shall have a total capacity as indicated. Provide internal fusing for heaters.
 - (11) Compressors: For compressors above 20-tons, compressor speed shall not exceed 3450-rpm. For equipment over 10-tons, provide automatic capacity reduction of at least 50-percent of rated capacity. Capacity reduction may be accomplished by cylinder unloading, use of multiple, but not more than four (4) compressors, or a combination of the two (2) methods. Units with cylinder unloading shall start with capacity reduction devices in the unloaded position. Units with multiple compressors shall have a means to sequence starting of compressors. Provide compressors with devices to prevent short cycling when shutdown by safety controls. Provide reciprocating compressors with crankcase heaters, and vibration isolators.
 - (12) Mounting Provisions: Provide units that permit mounting as indicated.
 - (13) Temperature Controls: Provide controls as specified in CID A-A-50502 and as modified herein. Provide indoor thermostats of the adjustable type that conform to applicable requirements of UL 873. Provide manual means for temperature set-back. Provide thermostats capable of controlling supplemental heat as specified in CID A A 50502. Provide a manual selector switch or other means to permit the supplementary heater to be energized when the heat pump compressor and associated equipment are inoperative. Control supplementary heater with the room thermostat while bypassing the outdoor thermostat. Locate switch adjacent to or as an integral part of the room thermostat. An indicator light on the room thermostat or manual heat switch shall indicate when supplementary heaters are operating.
 - (14) Accessories: In addition to accessories specified in CID A-A-50502, provide the following accessories for heat pump units.
 - (a) Protective grille around outside unit coils.
 - (b) Start capacitor kit.
- d. Air Conditioners:
- (1) Single Package Type: Provide factory packaged combination heating and cooling units. Provide units suitable for outdoor installation. Provide capacity, electrical characteristics and operating conditions as indicated. Condensers shall provide not less than 10-degrees Fahrenheit liquid sub cooling at standard ratings. Air conditioners must include the Energy Star label affixed to the equipment.
 - (2) Split-System Type: Provide separate assemblies designed to be used together. Base ratings on the use of matched assemblies. Provide performance diagrams for units with capacities not certified by AHRI to verify that components of the air conditioning system furnished will satisfy the capacity requirement specified or indicated. Provide capacity, electrical characteristics and operating conditions as indicated. Condensers shall provide not less than 10-degrees Fahrenheit liquid sub cooling at standard ratings. Air conditioners must include the Energy Star label affixed to the equipment.
 - (3) Heaters: Provide as an integral part of the evaporator-blower unit.
 - (4) Compressors: For compressors over 20-tons, compressor speed shall not exceed 3450 rpm. For systems over 10-tons provide automatic capacity reduction of at least 50 percent of rated capacity. Capacity reduction may be accomplished by cylinder unloading, use of multi- or variable speed compressors, use of multiple, but not more

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than four (4) compressors, or a combination of the two (2) methods. Units with cylinder unloading shall start with capacity reduction devices in the unloaded position. Units with multiple compressors shall have means to sequence starting of compressors. Provide compressors with devices to prevent short cycling when shut down by safety controls. Device shall delay operation of compressor motor for at least 3-minutes but not more than 6-minutes. Provide a pumpdown cycle for units 20-tons and over. Provide reciprocating compressors with crankcase heaters in accordance with the manufacturer's recommendations. If compressors are paralleled, provide not less than two (2) independent circuits.

- (5) Coils: On coils with all-aluminum construction, provide tubes of aluminum alloy 1100, 1200 or 3102; provide fins of aluminum alloy 7072; and provide tube sheets of aluminum alloy 7072 or 5052. Provide a separate air cooled condenser circuit for each compressor or parallel compressor installation.
- (6) Fans: Provide belt-driven evaporator fans with adjustable pitch pulleys; except for units less than 5-ton capacity, direct drive with at least two (2) speed taps may be used. Select pulleys at approximately midpoint of the adjustable range.
- (7) Filters: Provide filters of the type specified in this section.
- (8) Filter Boxes: Provide when filters are not included integral with air conditioning units. Construct of not less than No. 20 US gage steel with track, hinged access doors with latches and gaskets between frame and filters. Arrange filters to filter outside and return air. Provide removable filter assemblies, replaceable without the use of tools.
- (9) Mixing Boxes: Provide of the physical size to match the basic unit and include equal sized flanged openings, sized to individually handle full air flow. Arrange openings as indicated. Provide openings with dampers of parallel or opposed blade type. Provide opposed blade type for modulating dampers and parallel type for 2-position dampers. Connect damper shafts together by one (1) continuous linkage bar. Arrange dampers for automatic or manual operation so that when one starts to close from its opened position, the other starts to open from its closed position.
- (10) Thermostats: Provide adjustable type that conforms to applicable requirements of UL 873. Provide combination heating-cooling type with contacts hermetically sealed against moisture, corrosion, lint, dust and foreign material. Design to operate on not more than 1.5-degrees Fahrenheit differential and of suitable range calibrated in degrees Fahrenheit. Provide adjustable heat anticipation and fixed cooling anticipation. Provide two (2) independent temperature sensing elements electrically connected to control the compressor and heating equipment, respectively. Accomplish manual switching for system changeover from heating to cooling or cooling to heating and fan operation through the use of a thermostat subbase. Provide system selector switches to provide "COOL", "OFF" and "HEAT" and fan selector switches to provide "AUTOMATIC" and "ON". Provide relays, contactors and transformers located in a panel or panels for replacement and service.
 - (a) Cooling:
 - 1) When thermostat is in "COOL" position with fan selector switch in "AUTO" position, compressor, evaporator fan and condenser fan shall cycle together.
 - 2) When thermostat is in "COOL" position with fan selector switch in "ON" position, compressor and condenser fan shall cycle together and evaporator fan shall run continuously.

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- (b) Heating:
 - 1) When thermostat is in “HEAT” position with fan selector switch in “AUTO” position, heater and supply air fan shall cycle together. Provide a separate thermostat to keep the fan running until the heater cools.
 - 2) When thermostat is in “HEAT” position with fan selector switch in “ON” position, heater shall cycle and supply air fan shall run continuously.
 - (c) Supply Air Fan:
 - 1) When fan selector switch is in “AUTO” position with thermostat in “OFF” position, fan shall not run.
 - 2) When fan selector switch is in “ON” position, fan shall run continuously.
- (11) Filters: Provide filters to filter outside air and return air and locate. Filters shall conform to UL 900.
- (a) Replaceable Type Filters:
 - 1) Throw-away frames and media, standard dust holding capacity, 350-fpm maximum face velocity and 2-inches thick.
 - 2) Filters shall have a minimum efficiency reporting value (MERV) of 8 when tested in accordance with ASHRAE 52.2.
 - (b) Coatings for Finned Tube Coils: Where stipulated in equipment specifications of this section, coat finned tube coils of the affected equipment as specified below. Apply coating at the premises of a company specializing in such work. Degrease and prepare for coating in accordance with the coating applicator's procedures for the type of metals involved. Completed coating shall show no evidence of softening, blistering, cracking, crazing, flaking, loss of adhesion or “bridging” between the fins.
 - (c) Motors and Starters: NEMA MG 1, NEMA ICS 1 and NEMA ICS 2. Variable speed. Motors less than 1-hp shall meet NEMA High Efficiency requirements. Motors 1-hp and larger shall meet NEMA Premium Efficiency requirements. Determine specific motor characteristics to ensure provision of correctly sized starters and overload heaters. Provide motors to operate at full capacity with a voltage variation of plus or minus 10-percent of the motor voltage rating. Motor size shall be sufficient for the duty to be performed and shall not exceed its full load nameplate current rating when driven equipment is operated at specified capacity under the most severe conditions likely to be encountered. When motor size provided differs from size indicated or specified, the Contractor shall make the necessary adjustments to the wiring, disconnect devices and branch circuit protection to accommodate equipment actually provided.
 - (d) Refrigerant Piping and Accessories: Provide accessories as specified in this section. Provide suction line accumulators as recommended by equipment manufacturer's installation instructions.
- (12) Factory Charged Tubing:

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- (a) Provide extra soft, deoxidized, bright annealed copper tubing conforming to ASTM B280, factory dehydrated and furnished with a balanced charge of refrigerant recommended by manufacturer of equipment being connected.
 - (b) Factory insulate suction line tubing with 3/8-inch minimum thickness of closed cell, foamed plastic conforming to ASTM C534 with a permeance rating not to exceed 1.0. Provide quick-connectors with caps or plugs to protect couplings. Include couplings for suction and liquid line connections of the indoor and outdoor sections.
- (13) Field-Assembled Refrigerant Piping: Material and dimensional requirements for field assembled refrigerant piping, valves, fittings and accessories shall conform to ANSI/ASHRAE 15 and 34 and ASME B31.5, except as herein specified. Factory clean, dehydrate and seal piping before delivery to the project location. Provide seamless copper tubing, hard drawn, Type K or L, conforming to ASTM B88, except that tubing with outside diameters of 1/4-inch and 3/8-inch shall have nominal wall thickness of not less than 7.62-mm 0.030-inch 0.032-inch, respectively. Soft annealed copper tubing conforming to ASTM B280 may be used where flare connections to equipment are required only in nominal sizes less than 1-inch outside diameter.
- (14) Fittings:
- (a) ASME B16.22 for solder-joint fittings. UL 109 for flared tube fittings.
 - (b) Brazing Filler Material AWS A5.8.
- (15) Pipe Hangers and Supports: MSS SP-69 and MSS SP-58, except as indicated otherwise.

3. EXECUTION:

a. Construction-Related Sustainability Criteria Perform and Document the Following:

(1) Equipment Installation:

Install equipment and components in a manner to ensure proper and sequential operation of equipment and equipment controls. Install equipment not covered in this section, or in manufacturer's instructions, as recommended by manufacturer's representative. Provide proper foundations for mounting of equipment, accessories, appurtenances, piping and controls including, but not limited to, supports, vibration isolators, stands, guides, anchors, clamps and brackets. Foundations for equipment shall conform to equipment manufacturer's recommendation, unless otherwise indicated. Set anchor bolts and sleeves using templates. Provide anchor bolts of adequate length and provide with welded-on plates on the head end embedded in the concrete. Level equipment bases, using jacks or steel wedges, and neatly grout-in with a non-shrinking type of grouting mortar.

Locate equipment to allow working space for servicing including shaft removal, disassembling compressor cylinders and pistons, replacing or adjusting drives, motors, or shaft seals, access to water heads and valves of shell and tube equipment, tube cleaning or replacement, access to automatic controls, refrigerant charging, lubrication, oil draining and working clearance under overhead lines. Provide electric isolation between dissimilar metals for the purpose of minimizing galvanic corrosion.

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- (a) Packaged Terminal Air Conditioners and Heat Pumps: Wall sleeve installation shall provide a positive weathertight and airtight seal.
 - (b) Unitary Air Conditioning System: Install as indicated, in accordance with requirements of ANSI/ASHRAE 15 and 34, and the manufacturer's installation and operational instructions.
 - (c) Room Air Conditioners: Install units in accordance with manufacturer's instructions. Provide structural mountings, closures and seals for weathertight assembly. Pitch unit as recommended by manufacturer to ensure condensate drain to drain pan without overflow.
- b. Piping: Brazing, bending, forming and assembly of refrigerant piping shall conform to ASME B31.5.
 - (1) Pipe Hangers and Supports: Design and fabrication of pipe hangers, supports and welding attachments shall conform to MSS SP-58. Installation of hanger types and supports for bare and covered pipes shall conform to MSS SP-69 for the system temperature range. Unless otherwise indicated, horizontal and vertical piping attachments shall conform to MSS SP-58.
 - (2) Refrigerant Piping:
 - (a) Cut pipe to measurements established at the site and work into place without springing or forcing. Install piping with sufficient flexibility to provide for expansion and contraction due to temperature fluctuation. Where pipe passes through building structure pipe joints shall not be concealed but shall be located where they may be readily inspected.
 - (b) Install piping to be insulated with sufficient clearance to permit application of insulation. Install piping as indicated and detailed, to avoid interference with other piping, conduit or equipment. Except where specifically indicated otherwise, run piping plumb and straight and parallel to walls and ceilings. Trapping of lines will not be permitted except where indicated. Provide sleeves of suitable size for lines passing through building structure. Braze refrigerant piping with silver solder complying with AWS A5.8. Inside of tubing and fittings shall be free of flux. Clean parts to be jointed with emery cloth and keep hot until solder has penetrated full depth of fitting and extra flux has been expelled. Cool joints in air and remove flame marks and traces of flux.
 - (c) During brazing operation, prevent oxide film from forming on inside of tubing by slowly flowing dry nitrogen through tubing to expel air. Make provisions to automatically return oil on halocarbon systems. Installation of piping shall comply with ASME B31.5.
 - (3) Returning Oil from Refrigerant System: Install refrigerant lines so that gas velocity in the evaporator suction line is sufficient to move oil along with gas to the compressor. Where equipment location requires vertical risers, line shall be sized to maintain sufficient velocity to lift oil at minimum system loading and corresponding reduction of gas volume. Install a double riser when excess velocity and pressure drop would result from full system loading. Larger riser shall have a trap, of minimum volume, obtained by use of 90- and 45-degree ells. Arrange small riser with inlet close to bottom of horizontal line and connect to top of upper horizontal line. Do not install valves in risers.

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- (4) Refrigerant Driers, Sight Glass Indicators and Strainers: Provide refrigerant driers, sight glass liquid indicators and strainers in refrigerant piping in accordance with this section when not furnished by the manufacturer as part of the equipment. Install driers in liquid line with service valves and valved bypass line the same size as liquid line in which dryer is installed. Size of driers shall be determined by piping and installation of the unit on location. Install dryers of 50-cubic-inches and larger vertically with the cover for removing cartridge at the bottom. Install moisture indicators in the liquid line downstream of the drier. Indicator connections shall be the same size as the liquid line in which it is installed.
- (5) Strainer Locations and Installation: Locate strainers close to equipment they are to protect. Provide a strainer in common refrigerant liquid supply to two (2) or more thermal valves in parallel when each thermal valve has a built-in strainer. Install strainers with screen down and in direction of flow as indicated on strainer's body.
- (6) Solenoid Valve Installation: Install solenoid valves in horizontal lines with stem vertical and with flow in direction indicated on valve. If not incorporated as integral part of the valve, provide a strainer upstream of the solenoid valve. Provide service valves upstream of the solenoid valve, upstream of the strainer and downstream of the solenoid valve. Remove the internal parts of the solenoid valve when brazing the valve.
 - (a) Auxiliary Drain Pans, Drain Connections and Drain Lines: Provide auxiliary drain pans under units located above finished ceilings or over mechanical or electrical equipment where condensate overflow will cause damage to ceilings, piping and equipment below. Provide separate drain lines for the unit drain and auxiliary drain pans. Trap drain pans from the bottom to ensure complete pan drainage. Provide drain lines full size of drain opening. Traps and piping to drainage disposal points shall conform to Section 22 00 00 Plumbing, General Purpose.
 - (b) Access Panels: Provide access panels for concealed valves, controls, dampers and other fittings requiring inspection and maintenance.
 - (c) Air Filters: Allow access space for servicing filters. Install filters with suitable sealing to prevent bypassing of air.
 - (d) Flashing and Pitch Pockets: Provide flashing and pitch pockets for equipment supports and flashing where piping or ductwork passes through exterior walls.
 - (e) Identification Tags and Plates: Provide equipment, gages, thermometers, valves and controllers with tags numbered and stamped for their use. Provide plates and tags of brass or suitable nonferrous material, securely mounted or attached. Provide minimum letter and numeral size of 1/8-inch high.
 - (f) Field Quality Control:
 - 1) Leak Testing:

Upon completion of installation of air conditioning equipment, test factory- and field installed refrigerant piping with an electronic-type leak detector. Use same type of refrigerant to be provided in the system for leak testing. When nitrogen is used to boost system pressure for testing, ensure that it is eliminated from the system before charging.

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Minimum refrigerant leak field test pressure shall be as specified in ANSI/ASHRAE 15 and 34, except that test pressure shall not exceed 150-psig on hermetic compressors unless otherwise specified as a low side test pressure on the equipment nameplate. If leaks are detected at time of installation or during warranty period, remove the entire refrigerant charge from the system, correct leaks and retest system.

- (7) Evacuation, Dehydration and Charging:
 - (a) After field charged refrigerant system is found to be without leaks or after leaks have been repaired on field-charged and factory-charged systems, evacuate the system using a reliable gage and a vacuum pump.
 - (b) Evacuate system in accordance with the triple-evacuation and blotter method or in accordance with equipment manufacturer's printed instructions and recharge system.
- (8) Start-Up and Initial Operational Tests: Test the air conditioning systems and systems components for proper operation. Adjust safety and automatic control instruments as necessary to ensure proper operation and sequence. Conduct operational tests for not less than 8-hours.

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SECTION 26 00 00 – ELECTRICAL

1. GENERAL: Material, installation, and workmanship must adhere to national and local requirements pertaining to safety, quality, and electrical codes.
 - a. This section lists specific standards to guide construction Contractors involved with the installation of building electrical systems at Western Area Power Administration (WAPA) facilities under the jurisdiction of the Department of Energy.
 - b. WAPA Construction and Equipment References:
 - (1) Equipment Standard 2.4, “Indoor AC and DC Distribution Boards”.
 - (2) Construction Standard 9, “Substation – Electrical”.
 - (a) Section 9.2, “Grounding, Conduit and Low Voltage Cable Systems”.
 - (b) Section 9.2.3, “Insulated Conductors and Cables”.
 - (c) Section 9.7.3, “Direct and Alternating Current Distribution Boards”.

26 05 00 COMMON WORK RESULTS FOR ELECTRICAL:

1. GENERAL:
 - a. Provide materials, equipment and accessories for AC service, panelboards, conduit, and wiring.
 - b. The Contractor shall remove temporary equipment used during the construction process.
2. DRAWINGS: General arrangement of equipment, devices, circuits, receptacles, switches, and panelboards.
 - a. Circuit breaker ampacity, wiring, and conduit sizes are based upon the nameplate ratings of the equipment specified by WAPA and the device distance from the associated panelboard.
 - b. Adjust circuit breaker ampacity, wiring, and conduit sizes to match the Contractor installed equipment nameplate ratings.
 - c. Review electrical and mechanical drawings for accuracy of dimensions, locations, levels and make necessary adjustments to conform to the requirements of these specifications.
3. SUBMITTALS: Submit material lists, equipment data sheets, and manufacturer’s specifications to WAPA for review.
 - a. Indicate on the equipment data sheets the model number and options selected for equipment submitted.
 - b. Justify proposed deviations on submittal correspondence.
4. CUTTING AND PATCHING: Fix damage to the building, piping, equipment, or any defaced finish with qualified personnel skilled in the specific repair required.
5. PAINTING: Repair damaged surfaces to match color and composition of manufacturer’s finish.
6. ACCEPTANCE DEMONSTRATION: Upon completion of the work and at a time designated by WAPA, demonstrate the proper operation of the electrical installation.

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7. CLEANUP:

- a. Remove from the premises any material, scrap and other waste caused by electrical installations.
- b. Thoroughly clean and remove residue, dirt and dust from luminaires and related items.
- c. Upon job completion ensure the building and premises are clean, orderly and secure.

26 05 26 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS:

1. GENERAL: Provide materials for bonding and/or grounding the following typical enclosures, cases, equipment, structures, and conduit:
 - a. AC and DC Distribution Panelboards.
 - b. Battery Chargers and Battery Racks.
 - c. Building Exterior Walls and Roof (if metal).
 - d. Cable Ladders.
 - e. Communications Racks.
 - f. Controlboards (vertical switchboards).
 - g. HVAC Equipment.
 - h. Raised Floor Pedestals.
 - i. Safety Switches.
 - j. Transformers.
 - k. Substation Ground Mat.
 - l. Entry Platforms and Door Frames.

26 05 53 IDENTIFICATION PLACARDS:

1. GENERAL: Major equipment components must have the following information permanently attached in a conspicuous location:
 - a. Manufacturer's name and address.
 - b. Equipment model and serial number.
2. Panelboards must have the printed schedule of the branch circuit directory stored in a clear plastic sheet protector and attached to the inside surface of the panelboard door.

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26 05 83 WIRING CONNECTIONS:

1. GENERAL: Install wiring devices in outlet boxes at the locations shown on the Drawings. Provide a stainless steel wallplate for the device installed.
2. MOUNTED HEIGHT: Dimension from finished floor to centerline of receptacle.

Luminaire Controls 44-inches

Receptacles:

Control Room 34-inches

Offices..... 18-inches

Exterior 36-inches

Workbench 48-inches

26 05 83.03 DOOR ALARMS:

1. GENERAL:
 - a. Provide material, devices, and accessories necessary for the proper operation of the door alarm contacts.
 - b. Door alarm wiring may terminate on a control board terminal block or in a communications rack relay.
2. MATERIAL:
 - a. Door Contacts:
 - (1) 0-250 V DC operating voltage.
 - (2) Form A high-security contacts.
 - (3) 3-feet of armored-cable leads.
 - b. Include hardware, wire, conduits, and junction boxes necessary to complete the installation.
3. INSTALLATION: Connect switch wiring as shown on Security Plan (3402) and Wiring Devices Schematic Drawings (3404).

26 06 20.16 ELECTRICAL EQUIPMENT AND CIRCUITS SCHEDULES:

1. GENERAL: Provide equipment for AC service, panelboards, conduits and wiring in accordance with the project specifications and the following building specific project drawings:
 - a. 3400 - Power Plan.
 - b. 3401 - Lighting Plan.
 - c. 3402 - Security Plan.
 - d. 3403 - Panelboards.
 - e. 3404 - Wiring Devices Schematic.
 - f. 3405 - Luminaire & Equipment Schedules.
 - g. 3406 through 3415 may be used to supply additional electrical information as required by each project.
 - (1) General notes
 - (2) Grounding plan
 - (3) One-line diagram
 - (4) Transformer details
 - (5) Elevation views for equipment line-up
 - (6) Location/geographical drawings for utility locations

NOTE: Drawings (1)-(6) are typical of a new project; remodeling projects may use different drawing numbers and titles.

26 09 23 LIGHTING CONTROL DEVICES:

1. MODULAR, TOGGLE, MOMENTARY, DIMMING:
 - a. Toggle style
 - b. On/Off push buttons (optional).
 - c. Momentary (optional).
 - d. Occupancy/daylight/motion sensing (optional).
2. Control Room Lighting status
 - a. Provide auxiliary relay for control room lighting status. Include enclosure.
3. LIGHTING CONTACTORS:
 - a. Control Room Digital Contactor:
 - (1) 16A digital contactor.
 - (2) Low voltage input controls line level switching.
 - (3) CAT 5 cable connections between controls (switches, occupancy sensors and photocells).
 - b. Control Room Mechanical Contactor:
 - (1) Configurable 1-8 poles.
 - (2) Mechanically held.
 - (3) 3-wire control.
 - (4) 30A per pole.
 - (5) One (1) N.O. auxiliary contact and one (1) N.C. auxiliary contact.
 - c. Perimeter Lighting:
 - (1) Configurable 1-8 poles.
 - (2) Mechanically held.

- (3) 2-wire control.
- (4) Hand-Off-Auto selector switch.
- (5) 30A per pole.
- (6) One (1) N.O. auxiliary contact and one (1) N.C. auxiliary contact.

d. (3) PHOTOCELLS

- (1) 120VAC input.
- (2) Minimum 600VA LED ballast.
- (3) Fail mode; On
- (4) Rated for outdoor use.

26 24 00.16 PANELBOARDS:

- 1. GENERAL: Refer to Drawing 3403.
 - a. Main circuit breaker (CB) rated for specified voltage and current.
 - b. Main lugs rated for specified voltage and current (optional).
 - c. 24, 30 or 42 spaces.
 - d. Includes front, box and adapter kit.
 - e. Power, neutral and equipment buses must be copper.
 - f. 22,000-Amperes interrupting capacity (22-KAIC).
 - g. Vertically mounted, bottom fed.

26 27 26 WIRING DEVICES:

1. RECEPTACLES:

- a. Building Interior:
 - (1) Duplex.
 - (2) Quad optional.
 - (3) NEMA 5-20R.
 - (4) Two-pole, 3-wire, grounding.
 - (5) Heavy duty.
- b. Building Exterior:
 - (1) Duplex.
 - (2) NEMA 5-20R, GFCI.
 - (3) Integrated Set/Reset buttons.
 - (4) No pass-thru.
 - (5) Heavy duty.

2. WALLPLATES:

- a. Building Interior:
 - (1) Stainless steel with satin finish.
 - (2) Stainless steel mounting screws.
- b. (2) Building Exterior:
 - (1) Maintain weatherproof integrity.
 - (2) Resist material breakdown when exposed to severe weather or rough environmental conditions.

(3) Provide protection from physical damage.

3. CIRCUIT BREAKERS:

- a. Rated for required voltage and current.
- b. NEC standard ampacity ratings.
- c. 22,000-Amperes interrupting capacity (22-KAIC) minimum.

26 51 13 INTERIOR LUMINAIRES, LAMPS AND BALLASTS:

1. MATERIAL:

- a. LED lamps.
- b. Dimming optional.
- c. Polycarbonate, wide angle, semi-diffuse lens.
- d. Ballast accessible.

2. ILLUMINANCE:

- a. Color Coordinated Temperature (CCT) ≥ 5000 K.
- b. Color Rendering Index (CRI) ≥ 75 .
- c. Lumens per Watt (LPW) ≥ 90 .

3. INSTALLATION:

- a. Verify installation position does not interfere with other equipment.
- b. Support luminaires only from structural elements capable of carrying the total weight, mounted rigidly to prevent motion action.
- c. Protect wiring with tape or tubing at points where abrasion is likely to occur. Provide chase nipples where field wiring passes through knockouts.
- d. Clean the luminaires, paying particular attention to reflective surfaces.

26 51 14 EXTERIOR LUMINAIRES, LAMPS AND BALLASTS:

1. MATERIAL:

- a. LED lamps.
- b. Polycarbonate lens.
- c. Full cutoff (DarkSky compliant).
- d. Rated for wet locations.

2. ILLUMINANCE:

- a. Color Coordinated Temperature (CCT) 3000 K.
- b. Color Rendering Index (CRI) ≥ 75 .
- c. Lumens per Watt (LPW) ≥ 90 .

3. INSTALLATION:

- a. Recessed in soffit.
- b. Wall mounted optional.

- c. Verify installation position does not interfere with other equipment.
- d. Support luminaires only from structural elements capable of carrying the total weight, mounted rigidly to prevent motion action.
- e. Protect wiring with tape or tubing at points where abrasion is likely to occur.
- f. Provide chase nipples where field wiring passes through knockouts.
- g. Clean the luminaires, paying particular attention to reflective surfaces.

26 53 00 EXIT SIGNS:

1. MATERIAL:

- a. LED illuminated green letters.
- b. LED emergency lights optional.
- c. Rated for branch circuit voltage and ampacity.
- d. Self-diagnostics, accessible test switch and an indicator lamp.
- e. Sealed, rechargeable battery requiring no maintenance for a minimum period of 5-years.

2. INSTALLATION:

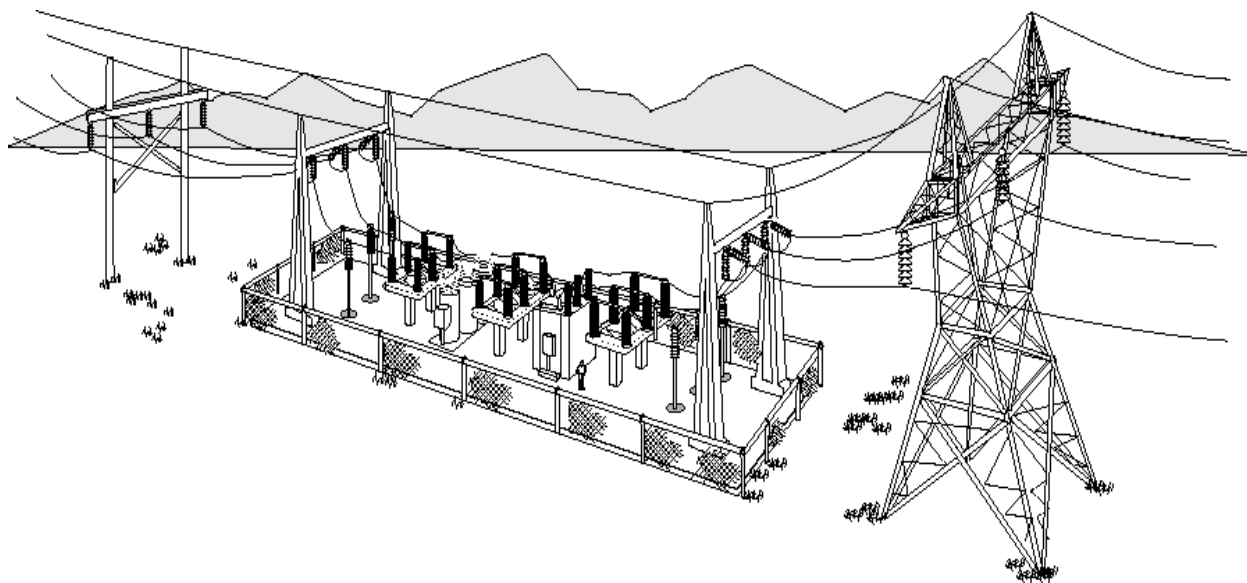
- a. Connect exit signs to the specified power source.
- b. Verify the signs operate independently of any light switches



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CONSTRUCTION STANDARDS

STANDARD 12 PAINTING



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STANDARD 12 – PAINTING

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STANDARD 12 – PAINTING

SECTION 12 – PAINTING REQUIREMENTS

12.1.1 PAINTING GENERAL:

1. GENERAL: Provide surface preparation, primer, paint and other related work and material needed to complete the required painting. Painting processes shall meet Federal, State and local air emission regulations.

Repair damaged areas of existing paint systems before applying intermediate coat and finish coats. For existing paint that does not match the colors listed below, the color shall be approved by the COR and be equivalent to the paint specified in this section.

2. SUBMITTALS: Electronically submit the following manufacturer's data to the COR:
 - a. Primers and Paints: Manufacturer's technical information including paint label analysis, preparation of surfaces, spread rates, thinning instructions, coverage of paint, recommended number of coats and application instructions.
 - b. Safety Data Sheets: Submit in accordance with Standard 1 – General Requirements, Section 1.4.1, "Safety and Health General".
3. CONTAINERS, LABELS AND STORAGE: Primer and paint shall be in sealed containers labeled with manufacturer's name, type of paint, brand name, color designation, date of manufacturing and instructions for mixing and reducing. Store primer and paint as recommended by the manufacturer.
4. PROTECTION: Protect nameplates, cover plates and other surfaces from paint and damage. Repair damage as a result of inadequate or unsuitable protection. Furnish drop cloths, shields or protective devices to prevent spraying or droppings from fouling surfaces not being painted, including surfaces within storage and preparation area.

12.1.2 SURFACE PREPARATION:

1. GENERAL: Surface preparation shall be in accordance with the manufacturer's technical information and as given below.
2. METAL SURFACES: Solvent clean surfaces by methods conforming to The Society Of Protective Coatings (SSPC), now a part of The Association for Materials Protection and Performance (AMPP), standard SSPC-SP 1. After solvent cleaning, prepare surfaces as follows:
 - a. Surfaces with weathered, gloss or semi-gloss paint shall be lightly sanded.
 - b. Surfaces with loose paint and other foreign matter shall be cleaned by hand tool methods conforming to SSPC-SP 2 followed, if required, by commercial grade sandblasting conforming to SSPC-SP 6.
 - c. Unpainted surfaces shall be cleaned by commercial grade sandblasting conforming to SSPC-SP 6.
 - d. Surfaces shall be re-cleaned with solvent.
3. GYPSUM WALLBOARD: Repair damaged surfaces in accordance with Standard 11 – Buildings, Section 09 29 00 Gypsum Board. Prior to sealing and painting, clean surfaces of dust and other foreign material.

STANDARD 12 – PAINTING

12.1.3 PAINT SYSTEMS:

1. GENERAL: Selected paint system for any particular item shall consist of specified primer coat(s), intermediate coat and finish coats from the same manufacturer.
2. ELECTRICAL EQUIPMENT: Indoor and outdoor electrical equipment shall have the manufacturer's standard ANSI 70 (gray), shop-applied, permanent paint system. Corrosion-resistant (galvanized, aluminum, copper and etc.) surfaces shall not be painted. The paint system shall provide a minimum of 10-years corrosion-free protection. Inspect equipment surfaces at time of delivery and notify the COR of any damage. Repair damaged paint surfaces as recommended by the equipment manufacturer. Painting repair for Government-furnished equipment shall be paid in accordance with the contract clause titled "Changes".
3. OUTDOOR ELECTRICAL EQUIPMENT (EXISTING), STEEL STRUCTURES, EXTERIOR SURFACE OF METAL OIL STORAGE TANKS AND STEEL MEMBERS IN CATTLE GUARDS:

Paint system shall be equal to one (1) of the following:

- a. Keeler & Long, Inc. (Ferrous Metal and Galvanized Surfaces):
 - (1) Intermediate Coat: Tri-Polar Primer KL6040 Series, white, flat, 2.5- to 3.5-mils dry film thickness.
 - (2) Finish Coats: Poly- Poly-Silicone Enamel KLPC1 Series, color sky gray, gloss, 1.5- to 2.5-mils dry film thickness.
- b. Tnemec Company (Ferrous Metal and Galvanized Surfaces):
 - (1) Intermediate Coat: F.C. Typoxy Series 27, color light gray, flat, 4.0- to 6.0-mils dry film thickness.
 - (2) Finish Coats: Endura-Shield Series 1074, color light gray, gloss, 2.0- to 3.0-mils dry film thickness.
4. BUILDING METALWORK: Exterior and interior metalwork paint system shall be equal to one (1) of the following:
 - a. PPG Industries, Inc. (Ferrous Metal Surfaces):
 - (1) Primer Coat: Rust Inhibitive Steel Primer 7-852, color white, 1.5- to 2.0-mils dry film thickness.
 - (2) First and Second Finish Coats: Industrial Gloss-Oil Interior/Exterior Enamels 7-814 Series, gloss, 1.5- to 2.0-mils dry film thickness per coat.
 - b. Sherwin-Williams Company (Ferrous Metal Surfaces):
 - (1) Primer Coat: Kem Kromik Universal Metal Primer B50WZ1 or B50HZ1, colors off white or buff, 3.0- to 4.0-mils dry film thickness.
 - (2) First and Second Finish Coats: Industrial Enamel, B54Z Series, gloss, 2.0- to 4.0-mils dry film thickness per coat.
 - c. PPG Industries, Inc. (Galvanized Surfaces):

STANDARD 12 – PAINTING

- (1) Primer Coat: Speedhide 6-209 Galvanized Steel Primer Interior/Exterior, color white, 2.0-mils dry film thickness.
 - (2) First and Second Finish Coats: Industrial Gloss-Oil Interior/Exterior Enamels 7-814 Series, gloss, 1.5- to 2.0-mils dry film thickness per coat.
- d. Sherwin-Williams Company (Galvanized Surfaces):
- (1) Primer Coat: Galvite HS B50WZ30, color off white, 3.0- to 4.5-mils dry film thickness.
 - (2) First and Second Finish Coats: Industrial Enamel, B54Z Series, gloss, 2.0- to 4.0-mils dry film thickness per coat.

Primer coat is not required when metalwork is furnished with the manufacturer's standard, shop-applied primer. Repair damaged areas of primer before applying first and second finish coats.

5. BUILDING GYPSUM WALLBOARD: Interior gypsum wallboard walls, ceilings and accessories shall be painted equal to one (1) of the following: replace Dryfall finish coat, too difficult to apply per Fritz McIlveen.

- a. PPG Industries, Inc.:
- (1) Primer Coat: Speedhide 6-2 Quick-Drying Interior Latex Primer-Sealer, color white, flat, 350- to 450-square-feet-per-gallon.
 - (2) First and Second Finish Coats: Speedhide 6-714 Latex Dry Fog Spray Paint, semi-gloss, 200- to 350-square-feet-per-gallon.
- b. Sherwin-Williams Company:
- (1) Primer Coat: PrepRite 200 Interior Latex Primer B28W200, color white, flat, 400-square-feet-per-gallon.
 - (2) First and Second Finish Coats: Super Save-Lite Dryfall Semi-Gloss B47W62, 260-square-feet-per-gallon each coat.

6. ACCEPTABLE MANUFACTURER'S OR EQUAL:

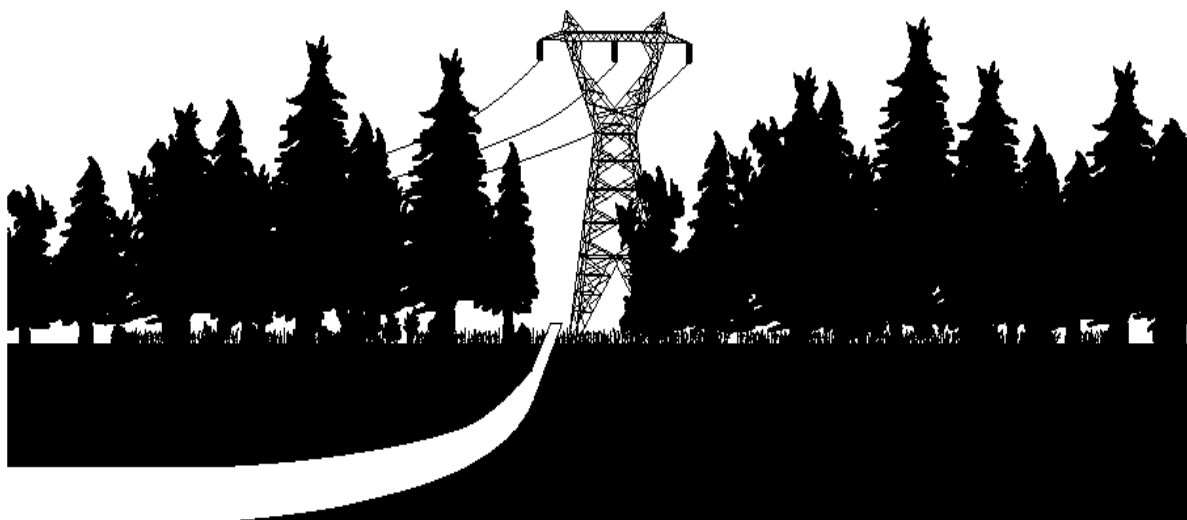
- a. Keeler & Long, Inc.
- b. PPG Industries, Inc.
- c. Sherwin-Williams Company.
- d. Tnemec Company, Inc.



Western Area
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CONSTRUCTION STANDARDS

Standard 13 ENVIRONMENTAL QUALITY PROTECTION



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STANDARD 13 – ENVIRONMENTAL QUALITY PROTECTION

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STANDARD 13 – ENVIRONMENTAL QUALITY PROTECTION

SECTION 13.1 – REQUIRED SUBMITTALS, REPORTS AND PLANS

1. FINAL PAYMENT: Final payment will not be processed until all required submittals listed in Section 13.2 have been received, reviewed, and accepted in writing by the COR.

STANDARD 13 – ENVIRONMENTAL QUALITY PROTECTION

SECTION 13.2 – CONTRACTOR FURNISHED DATA

1. **RECYCLED MATERIALS QUANTITY REPORT:** Submit quantities of recycled materials listed in Section 13.7, “Recycled Materials Quantities”, to the COR prior to submittal of final invoice.
2. **RECOVERED AND BIOBASED MATERIAL PRODUCTS REPORT:** Provide the COR the following information for purchases of items listed in Section 13.8, “Use of Recovered Material and Biobased Material Products”.
 - a. Quantity and cost of listed items with recovered or biobased material content and quantity and cost of listed items without recovered or biobased material content prior to submittal of final invoice.
 - b. Written justification of listed items if recovered material or biobased material products are not available: 1) competitively within a reasonable time frame; 2) meeting reasonable performance standards as defined in the Standards or Project Specifications; or 3) at a reasonable price.
3. **REFRIGERANT RECEIPT:** The Contractor must provide a record of all refrigerant usage, recycling or disposal on WAPA HVAC systems to the COR. In the event refrigerant is either charged into or removed and reclaimed from a WAPA HVAC system, the Contractor must provide either a record of usage or a receipt from the Environmental Protection Agency (EPA)-certified refrigerant reclaimer including whether it was either added to or reclaimed from the equipment, the date and the amount and type of refrigerant used to the COR prior to submittal of final invoice.
4. **WASTE MATERIAL QUANTITY REPORT:** Submit quantities of total project waste material disposal as listed in Section 13.9.8 to the COR prior to submittal of final invoice in accordance with Section 13.9.8, “Waste Material Quantity Report”.
5. **SPILL PREVENTION NOTIFICATION AND CLEANUP PLAN (Plan):** Submit the Plan as described in Section 13.11.2, “Spill Prevention Notification and Cleanup Plan”, to the COR for review and approval no later than 14 calendar days before the Notice to Proceed. Review of the plan is for the purpose of determining compliance with the specifications only and shall not relieve the Contractor of the responsibility for compliance with all Federal, State and local regulations.
6. **TANKER OIL SPILL PREVENTION AND RESPONSE PLAN:** Submit to the COR for review and approval no later than 14 calendar days before the Notice to Proceed.
7. **PESTICIDE USE PROPOSAL:** Submit a plan as described in Section 13.12.3, “Pesticide Use Proposal”, to the COR for review and approval a minimum of 14 calendar days prior to the date of intended pesticide application. Within seven (7) calendar days after application, submit a written report in accordance with Standard 2 – Sitework, Section 2.1.1_5, “Soil-Applied Herbicide”.
8. **TREATED WOOD UTILITY POLES AND CROSSARMS RECYCLING – CONSUMER INFORMATION SHEET RECEIPT:** Submit treated wood utility poles and crossarms - consumer information sheet receipts to the COR prior to submittal of final invoice (see 13.13, “Treated Wood Utility Poles and Crossarms Recycling or Disposal”).
9. **PREVENTION OF AIR POLLUTION:** Submit a copy of permits, if required, as described in 13.14, “Prevention of Air Pollution” to the COR no later than 30 calendar days prior to Notice to Proceed.
10. **EMISSIONS OF COVERED INSULATING GASES (E.G., SULFUR HEXAFLUORIDE (SF6) GAS, PERFLUOROCARBON (PFC) GAS):** A receipt from the covered insulating gas supplier stating that the gas was reclaimed, the amount of covered insulating gas and the date must be

STANDARD 13 – ENVIRONMENTAL QUALITY PROTECTION

submitted to the COR prior to submittal of final invoice in accordance with Section 13.14.4(3), "Certificates of Disposal and Receipts".

11. **ASBESTOS LICENSES OR CERTIFICATIONS:** Submit a copy of licenses, certifications, Demolition and Renovation Notifications and Permits for asbestos work as described in 13.15, "Handling and Management of Asbestos Containing Material" to the COR for review and approval no later than 30 calendar days before the Notice to Proceed. Work governed by this requirement shall not begin until written approval is received. Submit copies of certificates of disposal and/or receipts for waste to the COR prior to submittal of final invoice.
12. **LEAD PAINT NOTICES:** Submit a copy of lead paint notices with Contractor and recipient signatures as described in 13.16, "Material with Lead-based Paint" to the COR prior to submittal of final invoice. Submit copies of certificates of disposal and/or receipts for waste to the COR prior to submittal of final invoice.
13. **WATER POLLUTION PERMITS:** Submit copies of any water pollution permits as described in 13.17, "Prevention of Water Pollution" to the COR no later than 30 calendar days before the Notice to Proceed .
14. **PCB TEST REPORT:** Submit a PCB test report to the COR as described in 13.18, "Testing, Draining, Removal and Disposal of Oil-filled Electrical Equipment", prior to draining, removal or disposal of oil or oil-filled equipment that is designated for disposal no later than 30 calendar days before work.
15. **OIL AND OIL-FILLED ELECTRICAL EQUIPMENT RECEIPT:** Obtain and submit a receipt for oil and oil-filled equipment transported and disposed, recycled or reprocessed as described in 13.18, "Testing, Draining, Removal and Disposal of Oil-filled Electrical Equipment", to the COR prior to submittal of final invoice.
16. **OSHA PCB TRAINING RECORDS:** Submit employee training documentation records to the COR no later than 14 calendar days before the Notice to Proceed as described in 13.19.1.
17. **CLEANUP WORK MANAGEMENT PLAN:** Submit a Cleanup Work Management Plan as described in 13.19, to the COR for review and approval no later than 14 calendar days before the Notice to Proceed .
18. **POST CLEANUP REPORT:** Submit a Post-Cleanup Report as described in 13.19, to the COR prior to submittal of final invoice.

STANDARD 13 – ENVIRONMENTAL QUALITY PROTECTION

SECTION 13.3 – ENVIRONMENTAL REQUIREMENTS

Comply with Federal, State and local environmental laws and regulations. Noncompliance shall be corrected at no additional cost to WAPA. The sections in this Standard further specify the requirements.

STANDARD 13 – ENVIRONMENTAL QUALITY PROTECTION

SECTION 13.4 – LANDSCAPE PRESERVATION

1. **GENERAL:** Preserve landscape features in accordance with the contract clause titled "Protection of Existing Vegetation, Structures, Equipment, Utilities and Improvements". Exercise care to preserve the natural landscape and conduct activities to prevent any unnecessary destruction, scaring or defacing of the natural surroundings in the project vicinity. Except where clearing is required for permanent works, approved construction roads or excavation operations, vegetation must be preserved and must be protected from damage by project operations and equipment.
2. **CONSTRUCTION ROADS:** Location, alignment and grade of construction roads shall be subject to the COR's approval. When no longer required, surfaces of construction roads must be scarified to facilitate natural revegetation, provide for proper drainage and prevent erosion. If re-vegetation is required, use a native, certified weed free seed mixture recommended by local/county Natural Resources Conservation Service or other land managing agency as appropriate.
3. **CONSTRUCTION FACILITIES:** Shop, office, material lay down and material and equipment storage areas and yard areas must be located and arranged in a manner to preserve trees and vegetation to the maximum practicable extent and prevent impact on sensitive riparian areas and flood plains. Storage and construction buildings, including concrete footings and slabs, must be removed from the site prior to contract completion. The area will be re-graded as required so that all surfaces drain naturally, blend with the natural terrain, and are left in a condition that will facilitate natural revegetation, provide for proper drainage and prevent erosion or transport of sediment and pollutants. If re-vegetation is required, use seed mixtures as recommended by local/county Natural Resources Conservation Service or other land managing agency as appropriate.

STANDARD 13 – ENVIRONMENTAL QUALITY PROTECTION

SECTION 13.5 – PRESERVATION OF CULTURAL AND PALEONTOLOGICAL RESOURCES

1. **GENERAL:** Do not, at any time, remove, disturb or otherwise alter cultural resources or paleontological resources (fossils). Cultural resources may be of scientific or cultural importance and include, but are not limited to bones, pottery, projectile points (arrowheads), other stone or metal tools, surface features (stone circles, rock piles, etc.), glass, metal, ceramic or other historic objects, structures and buildings (including ruins). Paleontological resources can be of scientific importance and include mineralized animals and plants or trace fossils such as footprints. Both cultural and paleontological resources are protected by Federal Regulations during Federal construction projects.

The Contractor must restrict all ground disturbing activities to areas reviewed/investigated and approved by WAPA's Cultural Resource Specialists, as appropriate, and as specified in accordance with Standard 1 – General Requirements, Sections 1.3.1 Rights-of-way and 1.3.2 Access to the Work and Haul Routes.

2. **KNOWN CULTURAL OR PALEONTOLOGICAL RESOURCES:** The Contractor must ensure that all construction activities avoid the boundaries of specific environmentally sensitive area(s). Prior to the issuance of the notice to proceed, WAPA will provide location data for known environmentally sensitive area(s) in relation to the project area. Prior to any construction activity, WAPA will identify (in writing or on a map) or mark the environmentally sensitive area(s) on the ground. If avoidance is not possible, the Contractor shall notify WAPA no less than 45 calendar days in advance of their inability to avoid the environmentally sensitive area(s). Work shall not proceed within a 100-foot buffer area until written authorization is issued by the COR. The Contractor must instruct employees and subcontractors that vehicular or equipment access within these environmentally sensitive area(s) is prohibited. If access is absolutely necessary, the Contractor must first obtain approval from the COR in conjunction with the Cultural Resource Specialists. WAPA will remove environmentally sensitive markings during or following completion of construction activities.
3. **WORKING WITH CULTURAL, PALEONTOLOGICAL OR TRIBAL MONITORS:** For some projects, WAPA requires an archaeological, paleontological, and/or tribal monitor(s). The Contractor, its employees and subcontractors must work with the monitor(s) to ensure that environmentally sensitive areas are avoided. The monitor(s) must coordinate with the Contractor, its employees and subcontractors on upcoming schedule and site work. The monitor(s) will also conduct awareness training for the Contractor, its employees and subcontractors prior to any work in the field. Untrained personnel must not be allowed in the construction area. For sensitive areas requiring a monitor(s), the Contractor may not access those areas without a monitor being present.
4. **UNKNOWN CULTURAL OR PALEONTOLOGICAL RESOURCES:** On rare occasions cultural or paleontological resources, including buried human remains, may be inadvertently discovered during construction activities.
 - a. **Reporting:** If evidence of a cultural or paleontological site is discovered, cease all work within a 100-foot buffer immediately and notify the COR, of the location and nature of the findings. If a monitor(s) is present, the monitor(s) should also be notified. Work within that buffer may not be resumed until directed to do so by the COR, in conjunction with the Cultural Resource Specialists.
 - b. **Care of Evidence:** Do not remove, handle, alter or damage cultural resources or paleontological resources (fossils) or other associated objects uncovered during construction activities.
 - c. **Digital media** such as photography or videos shall not be taken during construction within environmentally sensitive areas. If construction equipment has cameras, any media taken and stored locally shall be managed by the Contractor and not distributed. If there is an

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inadvertent discovery, any media taken from construction equipment cameras shall be marked confidential and not distributed

5. SPECIAL CONSIDERATIONS: Refer to Division 13 of the Project Specifications for site-specific requirements including, but not limited to, known and unknown cultural or paleontological resources and the treatment of inadvertently discovered human remains. Disturbance of human remains is covered in most states by statutes that generally preempt Federal regulations. Those requirements are described in Division 13 specifications.
6. DEFINITIONS
 - a. Environmentally Sensitive Area – An area identified as having unique or significant natural resources, cultural resources, ecological processes, or features that require special protection due to their vulnerability to disturbance or their importance for biodiversity, ecosystem function, or human well-being. This can include archaeological sites, habitats for endangered species, wetlands, critical migratory bird stopovers, or areas of high ecological integrity.
 - b. Inadvertent Discovery - The unexpected encounter with cultural resources (e.g., archaeological artifacts, human remains, historic structures) during ground-disturbing project activities (e.g., construction, excavation) that were not previously identified or anticipated. Procedures for inadvertent discoveries typically involve halting work, assessing the find, and consulting with appropriate authorities.
 - c. Cultural Monitor - An individual, often with specialized knowledge in archaeology or cultural heritage, who observes ground-disturbing activities to identify and protect cultural resources that may be exposed during the work. Their role is to ensure compliance with cultural resource laws and regulations and to recommend appropriate actions if resources are encountered.
 - d. Cultural Resource - Any prehistoric or historic district, site, building, structure, or object considered important to a culture or community for scientific, research, traditional, or religious reasons. This broad category includes archaeological sites, historic buildings, sacred sites, and traditional cultural properties.
 - e. Cultural Resource Specialist - A professional with expertise in identifying, evaluating, documenting, and managing cultural resources. This can include archaeologists, architectural historians, ethnographers, and other experts who work to ensure compliance with cultural resource protection laws.
 - f. Paleontology - The scientific study of fossils, including the remains of ancient life (plants, animals, and other organisms) and their environments. Paleontological resources provide information about the history of life on Earth and past ecosystems.
 - g. Paleontology Monitor - An individual with expertise in paleontology who observes ground-disturbing activities to identify and protect paleontological resources (fossils) that may be exposed during the work. Their role is similar to that of a cultural monitor, but with a focus on fossils.
 - h. Tribal Monitor - An individual designated by a Native American tribe or indigenous community to observe ground-disturbing activities on ancestral lands or areas of tribal concern. Their role is to ensure that tribal cultural resources, traditional cultural properties, and ancestral remains are protected and that tribal perspectives are incorporated into the cultural resource management process.

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SECTION 13.6 – NOXIOUS WEED CONTROL

Comply with Federal, State and local noxious weed control regulations. At Contractor's expense, obtain required permits and conduct required notifications. Provide a "clean vehicle policy" while entering and leaving construction areas to prevent transport of noxious weed plants and/or seed. Transport only construction vehicles that are free of mud and vegetation debris to staging areas and the project right-of-way.

1. All seed mixes and mulch used for reclamation activities will be a native, certified weed free seed mixture recommended by local/county Natural Resources Conservation Service or other land managing agency as appropriate.
2. Vehicles and equipment (trailers, trucks, UTVs, etc.) will not be moved between work areas without first taking reasonable measures to ensure they are free of soil, seeds, vegetation matter, or other debris that could contain noxious weed seeds.
3. To prevent the transport of non-native and invasive plants and animals, including noxious weeds and aquatic nuisance species, work crews must thoroughly wash all vehicles and equipment (trailers, trucks, UTVs, etc.) before entering the action area and working on the project.

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SECTION 13.7 – RECYCLED MATERIALS QUANTITIES

1. GENERAL: All materials generated from the project that can be recycled, must be recycled. Record quantities of material by category that is salvaged, recycled, reused or reprocessed, including, but not limited to:
 - a. Transformers, Breakers: Weight without oil in pounds or metric tons.
 - b. Scrap Metals: Weight in pounds or metric tons. Examples include, but are not limited to:
 - (1) Aluminum Conductor – Steel Reinforced (ACSR).
 - (2) Stainless Steel.
 - (3) Copper.
 - (4) Iron/Steel.
 - (5) Aluminum.
 - (6) Lead.
 - (7) Zinc.
 - (8) Other Metals.
 - c. Precious Metals (e.g., Silver, Gold, Platinum): Weight in pounds or metric tons.
 - d. Oil: Gallons (separate by type - less than 2-parts per million (ppm) PCB, 2- to 50-ppm PCB, and 50 or greater ppm PCB).
 - e. Gravel, Asphalt or Concrete: Weight in pounds or metric tons.
 - f. Batteries: Weight in pounds or metric tons.
 - g. Treated Wood Utility Poles and Crossarms: Weight in pounds or metric tons.
 - h. Wood Construction Material: Weight in pounds or metric tons.
 - i. Cardboard: Weight in pounds or metric tons.
 - j. Porcelain/Ceramic Insulators: Weight in pounds or metric tons.
 - k. Glass: Weight in pounds or metric tons.
 - l. Fluorescent Bulbs: Weight in pounds or metric tons.
 - m. Ballasts: Weight in pounds or metric tons.
 - n. Mercury-Containing Equipment (MCE): Weight in pounds or metric tons.
 - o. Antifreeze and Freon: Weight in pounds or metric tons.
 - p. Tires: Weight in pounds or metric tons.
 - q. Plastic: Weight in pounds or metric tons.
 - r. Solvent: Weight in pounds or metric tons.
 - s. Construction and Demolition (C&D) Debris: Weight in pounds or metric tons.
2. RECYCLED MATERIAL QUANTITY REPORT: Submit quantities (pounds, metric tons, gallons) of all recycled material by category to the COR within 30 calendar days of recycling and prior to submittal of final invoice.

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SECTION 13.8 – USE OF RECOVERED MATERIAL AND BIOBASED MATERIAL PRODUCTS

1. **RECOVERED MATERIAL PRODUCTS:** If the products listed below or other products listed at <https://www.epa.gov/smm/comprehensive-procurement-guideline-cpg-program> are obtained as part of this project, purchase the items with the highest recovered material content possible unless recovered material products are not available: 1) competitively within a reasonable time frame; 2) meeting reasonable performance standards as defined in the Standards or Project Specifications; or 3) at a reasonable price.

Examples include, but are not limited to:

- a. Building Insulation Products.
- b. Carpet.
- c. Carpet cushion.
- d. Cement and Concrete Containing; coal fly ash, ground granulated blast furnace slag, cenospheres or silica fume.
- e. Consolidated and reprocessed latex paint.
- f. Floor Tiles.
- g. Flowable fill.
- h. Laminated Paperboard.
- i. Modular threshold ramps.
- j. Non-pressure pipe.
- k. Patio Blocks.
- l. Railroad grade crossing surfaces.
- m. Roofing materials.
- n. Shower and restroom dividers/partitions.
- o. Signage.
- p. Structural Fiberboard.

2. **BIOBASED MATERIAL PRODUCTS:** If the products listed at <https://www.biopreferred.gov/BioPreferred/faces/pages/ProductCategories.xhtml> are obtained as part of this project, purchase the items with the highest biobased content possible and no less than the percent indicated for each product unless biobased material products are not available: 1) competitively within a reasonable time frame, 2) meeting reasonable performance standards as defined in the Standards or Project Specifications, or 3) at a reasonable price.

NOTE: All station service and pole mounted transformers will be bio-based oil. WAPA large transformers will be evaluated on a best value basis using life cycle cost analysis.

3. **RECOVERED MATERIAL AND BIOBASED MATERIAL PRODUCTS REPORT:** Provide the COR the following information for purchases of those items listed above.

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Quantity and cost of listed items with recovered or biobased material content and quantity and cost of listed items without recovered or biobased material content prior to submittal of final invoice.

Written justification of listed items if recovered material or biobased material products are not available: 1) competitively within a reasonable time frame; 2) meeting reasonable performance standards as defined in the Standards or Project Specifications; or 3) at a reasonable price.

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SECTION 13.9 – DISPOSAL OF WASTE MATERIAL

1. GENERAL: Dispose or recycle waste material in accordance with applicable Federal, State and local regulations and ordinances. In addition to the requirements of the Contract Clause “Cleaning Up”, remove all waste material from the construction site. No waste will be left on WAPA property, right-of-way or easement. Burning or burying of waste material is not permitted.
2. HAZARDOUS, UNIVERSAL AND NON-HAZARDOUS WASTES: Manage and dispose of hazardous, universal and non-hazardous wastes in accordance with local, State and Federal regulations.
3. USED OIL: Used oil generated from the Contractor activities must be managed and disposed of in accordance local, state and federal regulations.
4. RECYCLABLE MATERIAL: See Section 13.7
5. REFRIGERANTS AND RECEIPTS: Refrigerants from air conditioners, water coolers, refrigerators, ice machines and vehicles must be reclaimed with certified equipment operated by certified technicians if the item is to be disposed. Refrigerants must be reclaimed and not vented to the atmosphere. A receipt from the reclaimer stating that the refrigerant was reclaimed, the amount and type of refrigerant and the date must be submitted to the COR prior to submittal of final invoice.
6. HALONS: Equipment containing halons that must be tested, maintained, serviced, repaired or disposed must be handled according to EPA, state, and/or local requirements and by technicians trained according to those requirements.
7. SULFUR HEXAFLUORIDE (SF₆)/PERFLUOROCARBONS: All covered insulating gases (e.g., SF₆ gas and other PFCs) must be reclaimed and must not be vented to the atmosphere. See Section 13.14.4(3). After use, all covered insulating gas cylinders must be weighed and reported to the COR prior to return to the manufacturer.
8. WASTE MATERIAL QUANTITY REPORT: Submit quantities and types of all materials disposed of as part of the project to the COR prior to submittal of final invoice.
 - a. Non-Hazardous Municipal Solid Waste (MSW) (i.e., trash): Description of waste and volume in cubic yards or weight in pounds.
 - b. Hazardous Wastes: Hazardous waste description, hazardous waste code and weight in pounds or volume in gallons.
 - c. Universal Wastes: Universal Waste category and weight in pounds.
 - d. PCB Wastes: Weight in KGs.
 - e. Industrial Wastes: Description of waste and weight in pounds.
 - f. Other regulated wastes (e.g., lead-based paint or asbestos): Weight in pounds (specify type of waste in report).

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SECTION 13.10 – CONTRACTOR'S LIABILITY FOR REGULATED MATERIAL INCIDENTS

1. **GENERAL:** The Contractor is solely liable for all expenses related to spills, mishandling or incidents of regulated material attributable to his actions or the actions of his subcontractors. This includes all response, investigation, cleanup, disposal, permitting, reporting and requirements from applicable environmental regulation agencies.
2. **SUPERVISION:** The actions of the Contractor employees and subcontractors must be properly managed at all times on WAPA property or while transporting regulated material and equipment.

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SECTION 13.11 – POLLUTANT SPILL PREVENTION, NOTIFICATION AND CLEANUP

1. **GENERAL:** Provide measures to prevent spills of pollutants and respond appropriately if a spill occurs. A pollutant includes any hazardous or non-hazardous substance that when spilled, will contaminate soil, surface water or groundwater. This includes, but not limited to any solvent, fuel, oil, paint, pesticide, engine coolants and similar substances. Report any spill to the COR immediately.
2. **SPILL PREVENTION NOTIFICATION AND CLEANUP PLAN:** Provide the Plan to the COR for review and approval no later than 30 calendar days before the Notice to Proceed. Include the following in the Plan:
 - a. **Spill Prevention Measures:** Describe the work practices or precautions that will be used at the jobsite to prevent spills. These may include engineered or manufactured techniques such as installation of berms around fuel and oil tanks; storage of fuels, paints and other substances in spill proof containers; and management techniques such as requiring workers to handle material in certain ways.
 - b. **Notification:** Most States and the EPA require by regulation that anyone who spills certain types of pollutants in certain quantities notify them of the spill within a specific time period. Some of these agencies require written follow up reports and cleanup reports. Include in the Plan the types of spills for which notification would be made, the agencies notified, the information the agency requires during the notification and the telephone numbers for notification.
 - c. **Employee Awareness Training:** Describe employee awareness training procedures that will be implemented to ensure personnel are knowledgeable about the contents of the Plan and the need for notification.
 - d. **Commitment of Manpower: Equipment and Material.** Identify the arrangements made to respond to spills, including the commitment of manpower, equipment and material.
 - e. If applicable, address all requirements of 40 C.F.R. Part 112 pertaining to Spill Prevention, Control and Countermeasures (SPCC) Plans developed for proposed work site.
3. **TANKER OIL SPILL PREVENTION AND RESPONSE PLAN:** Provide a Tanker Oil Spill Prevention and Response Plan as required by the Department of Transportation if oil tankers with volume of 3,500-gallons or more are used as part of the project. Submit the Tanker Oil Spill Prevention and Response Plan to the COR for review and approval no later than 30 calendar days before the Notice to Proceed.. Review of the Plan is for the purpose of determining compliance with the specifications only and shall not relieve the Contractor of the responsibility for compliance with all Federal, State and local regulations.
 - a. Mobile refuelers that operate solely within the confines of a non-transportation related facility subject to the SPCC rule must comply with the general secondary containment requirements during all periods of operation.

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SECTION 13.12 – PESTICIDES

1. **GENERAL:** The term “pesticide” includes herbicides, insecticides, rodenticides and fungicides. Pesticides must only be used in accordance with their labeling and applied by appropriately certified applicators.
2. **EPA REGISTRATION:** Use only EPA-registered pesticides that are approved by the COR for the intended use and location. Follow all applicable label directions.
3. **PESTICIDE USE PROPOSAL:** Provide a pesticide use proposal that contains: 1) pesticide(s) proposed (include mixtures and surfactants), 2) treatment site, 3) intended rate of application, 4) a copy of labels and Safety Data Sheets and 5) a copy of required applicator certifications. Submit the pesticide use proposal to the COR for review and approval no later than 30 calendar days before the Notice to Proceed. Review of the Plan is for the purpose of determining compliance with the specifications only and shall not relieve the Contractor of the responsibility for compliance with all Federal, State and local regulations. Within seven (7) calendar days after application, submit a written final report to the COR including the pesticide applicators report, in accordance with Standard 2 – Sitework, Section 2.1.1 5. “Soil-Applied Herbicide, (4) Final Report”.

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SECTION 13.13 – TREATED WOOD UTILITY POLES AND CROSSARMS RECYCLING OR DISPOSAL

Whenever practicable, treated wood utility poles and crossarms removed during the project must be recycled or transferred to the public for some uses. Treated wood utility poles and crossarms transferred to a recycler, landfill or the public must be accompanied by a written consumer information sheet for treated wood as provided by WAPA. Obtain a receipt, part of the consumer information sheet, from the recipient indicating that they have received, read and understand the consumer information sheet. Treated wood products transferred to right-of-way landowners must be moved off the right-of-way. Treated wood product scrap, poles and crossarms that cannot be donated or reused must be properly disposed in a landfill that accepts treated wood and has signed WAPA's consumer information sheet receipt. Submit treated wood utility poles and crossarms consumer information receipts to the COR and WAPA's Environmental Point of Contact prior to submittal of final invoice.

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SECTION 13.14 – PREVENTION OF AIR POLLUTION

1. **GENERAL:** Ensure that construction activities and the operation of equipment are undertaken to reduce the emission of air pollutants. Submit a copy of permits for construction activities, if required (e.g., “non-attainment” areas, State implementation plans or Class I air-sheds), from Federal, State or local agencies ” to the COR for review and approval no later than 30 calendar days before the Notice to Proceed. The Contractor must fulfill the conditions under any applicable locally prepared Environmental Impact Statements (EISs) or Environmental Assessments (EAs) conducted for the project under the National Environmental Protection Act (NEPA). If there are project specific conditions they will be outlined in the Division 13 document.
2. **MACHINERY AIR EMISSIONS:** The Contractor and subcontractor machinery must have and must use air emissions control devices as required by Federal, State or local Regulation or ordinance.
3. **DUST ABATEMENT:** Dust must be controlled. Oil must not be used as a dust suppressant. Dust suppressants must be approved by the COR prior to use.
4. **SULFUR HEXAFLUORIDE (SF₆)/PERFLUOROCARBONS (PFCs) EMISSIONS:**
 - a. **General:** WAPA complies with State, Federal and local regulations regarding Mandatory Greenhouse Gas Reporting 40 C.F.R. Part 98. The Contractor must provide the information required by this section to the COR as described.
 - b. The Contractor must record quantities of all covered insulating gases (e.g., SF₆ gas and other PFCs), including:
 - (1) Nameplate capacity in pounds of the covered insulating gas containing equipment.
 - (2) Record pounds of the covered insulating gas stored in containers, before transferring into energized equipment. Record the serial numbers of the cylinders/containers from which the gas is transferred.
 - (3) Record pounds of the covered insulating gas left in containers, after transferring into energized equipment. Record the serial numbers of the cylinders/containers from which the gas is transferred.
 - (4) Pounds of covered insulating gas purchased from equipment manufacturers or distributors. Record the serial numbers of the purchased cylinders/containers.
 - (5) Pounds of covered insulating gas returned to suppliers. Record the serial numbers of the returned cylinders/containers.
 - (6) Scales used to weigh cylinders must be accurate to within ±2-pounds and must have current calibration sticker.
 - c. **Contractor Field Quality Testing and Covered Insulating Gas Handling:**
 - (1) The Contractor must test all functions to verify correct operation and conduct a leak test. No gas leakage of covered insulating gases must be allowed from any equipment or storage containers.
 - (2) Atmospheric venting of covered insulating gas is not allowed.
 - (3) The Contractor must use cylinders with a current certified hydrostatic test certificate.

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- (4) The Contractor must remove all empty covered insulating gas cylinders and return to supplier.
- d. Certificates of Disposal and Receipts for Covered Insulating Gas:
 - (1) The Contractor can use WAPA's Reporting Form for reporting quantities listed above.
 - (2) The Contractor must return all used covered insulating gas cylinders to supplier and provide receipts from the supplier.
 - (3) The Contractor must submit all covered insulating gas Reporting Forms and copies of receipts to the COR prior to submittal of final invoice.
- 5. PROTECTION OF STRATOSPHERIC OZONE: The Contractor must comply with all State, Federal and local regulations regarding ozone depleting substances and the Protection of Stratospheric Ozone, including, but not limited to 40 C.F.R. Part 82. Contractors performing work on HVAC systems must be trained and certified according to the regulations, and releases of ozone depleting substances to the atmosphere must be prevented. The Contractor must provide reclaimed refrigerant receipts to the COR in accordance with section 13.2.3 of this document.
- 6. GENERATOR -SUPPLIED POWER:
 - a. The Contractor shall ensure that Portable generators installed for temporary use on a project meet engine standards specified by the Environmental Protection Agency. Additional local requirements may apply as well, and the Contractor shall be responsible to comply with those requirements also.
 - b. The Contractor shall ensure that all new stationary generators installed meet the most currently available tier for EPA standards.

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SECTION 13.15 – HANDLING AND MANAGEMENT OF ASBESTOS CONTAINING MATERIAL

1. **GENERAL:** The Contractor shall obtain the appropriate Federal, State, Tribal or local licenses or certifications prior to disturbing any regulated asbestos-containing material. If a building or portion of a building will be demolished or renovated, obtain an Asbestos Notice of and Permit for Demolition and Renovation from the State or Tribal Department of Environmental Quality, Division of Air Quality (or equivalent). The building(s) must be inspected by a State-Certified or Tribal accepted Asbestos Building Inspector. The inspector must certify the presence and condition of asbestos, or non-presence of asbestos, on site as directed on the State or Tribal Demolition and Renovation Notice/Permit. The inspections must be performed and notifications must be submitted whether asbestos is present or not. Submit a copy of licenses, certifications, Demolition and Renovation Notifications and Permits for asbestos work to the COR for review and approval no later than 30 calendar days before the Notice to Proceed.. Ensure: 1) worker and public safety requirements are fully implemented and 2) proper handling, transportation and disposal of asbestos containing material.
2. **TRANSPORTATION OF ASBESTOS WASTE:** Comply with Department of Transportation, EPA, and State and local requirements when transporting asbestos wastes.
3. **CERTIFICATES OF DISPOSAL AND RECEIPTS:** Obtain certificates of disposal for waste if the waste is a hazardous waste or receipts from a landfill approved to accept asbestos if the waste is a non-hazardous waste. Submit copies to the COR prior to submittal of final invoice.

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SECTION 13.16 – MATERIAL WITH LEAD-BASED PAINT

1. **GENERAL:** Comply with all applicable Federal, State and local regulations concerning work with lead-based paint, disposal of material painted with lead-based paint and management of these materials. OSHA and General Industry Standards apply to worker safety and right-to-know issues. Federal EPA and State agencies regulate waste disposal and air quality issues.
2. **TRANSFER OF PROPERTY:** If lead-based paint containing equipment or material is to be given away or sold for reuse, scrap or reclaiming, the Contractor must provide a written notice to the recipient of the material stating that the material contains lead-based paint and the Hazardous Waste regulations may apply to the waste or the paint in some circumstances. The new owner must also be notified that they may be responsible for compliance with OSHA requirements if the material is to be cut, sanded, abraded or stripped of paint. Submit a copy of lead paint notices with the Contractor and recipient signatures to the COR prior to submittal of final invoice.
3. **CERTIFICATES OF DISPOSAL AND RECEIPTS:** Obtain certificates of disposal for waste if the waste is a hazardous waste or receipts from a landfill if the waste is a non-hazardous waste. Submit copies to the COR prior to submittal of final invoice.

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SECTION 13.17 – PREVENTION OF WATER POLLUTION

1. GENERAL: Ensure that surface and groundwater is protected from pollution caused by construction activities and comply with applicable regulations and requirements. Ensure that streams, waterways and other courses are not obstructed or impaired unless the appropriate Federal, State or local permits have been obtained.
2. PERMITS: The Contractor must ensure that:
 - a. A National Pollutant Discharge Elimination System (NPDES) permit is obtained from the US EPA or State as appropriate if the disturbed construction area equals 1-acre or more. The Contractor is responsible for preparation and implementation of the associated Storm Water Pollution Prevention Plan (SWPPP). Disturbed areas include staging, parking, fueling, stockpiling and any other construction related activities. Refer to <https://www.epa.gov/npdes/npdes-stormwater-program> for directions and forms.
 - b. A dewatering permit is obtained from the appropriate agency if required for construction dewatering activities.
 - c. Copies of permits and plans, approved by the appropriate regulating agencies, are submitted to the COR no later than 30 calendar days before the Notice to Proceed.
3. EXCAVATED MATERIAL AND OTHER CONTAMINANT SOURCES: Control runoff from excavated areas and piles of excavated material, construction material or wastes (to include truck washing and concrete wastes) and chemical products such as oil, grease, solvents, fuels, pesticides and pole treatment compounds. Excavated material or other construction material must not be stockpiled or deposited near or on streambanks, lake shorelines, ditches, irrigation canals or other areas where run-off could impact the environment.
4. MANAGEMENT OF WASTE CONCRETE OR WASHING OF CONCRETE TRUCKS: Do not permit the washing of concrete trucks or disposal of excess concrete in any ditch, canal, stream or other surface water. Concrete wastes must be disposed in accordance with all Federal, State and local regulations. Concrete wastes must not be disposed of on any WAPA property, right-of-way easement or on any streets, roads or property without the owner's consent.
5. STREAM CROSSINGS: Crossing of any stream or other waterway must be done in compliance with Federal, State and local regulations. Crossing of some waterways may be prohibited by landowners, Federal or State agencies or require permits.

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SECTION 13.18 – TESTING, DRAINING, REMOVAL AND DISPOSAL OF OIL-FILLED ELECTRICAL EQUIPMENT

1. **SAMPLING AND TESTING OF INSULATING OIL FOR PCB CONTENT:** Sample and analyze the oil of electrical equipment (which includes storage tanks) for PCB's. Use analytical methods approved by EPA and applicable State regulations. Decontaminate sampling equipment according to documented good laboratory practices (these can be Contractor developed or EPA standards). Use only laboratories approved by WAPA. The COR will furnish a list of approved laboratories.
2. **PCB TEST REPORT:** Provide PCB test reports that contain the information below for disposing of oil-filled electrical equipment. Submit the PCB test report for COR approval prior to draining, removal or disposal of oil or oil-filled equipment that is designated for disposal.
 - a. Name and address of the laboratory.
 - b. Copies of Chain of Custody Form(s).
 - c. Description of the electrical equipment (e.g. transformer, breaker).
 - d. Serial number for the electrical equipment.
 - e. Date sampled.
 - f. Date tested.
 - g. PCB contents in parts per million (ppm) by Aroclor type.
 - h. Unique identification number of container into which the oil was drained (i.e., number of drum, tank, tanker, etc.)
3. **OIL CONTAINING PCB:** Comply with the Federal regulations pertaining to PCBs found at Title 40, Part 761 of the U.S. Code of Federal Regulations (40 C.F.R. Part 761).
4. **REMOVAL AND DISPOSAL OF INSULATING OIL AND OIL-FILLED ELECTRICAL EQUIPMENT:** Once the PCB content of the oil has been identified from laboratory results, the oil must be transported and disposed, recycled or reprocessed according to 40 C.F.R. Part 761 (if applicable), Resource Conservation and Recovery Act (RCRA) "used oil" and other applicable regulations. Used oil may be transported only by EPA-registered used oil transporters. The oil must be stored in containers that are labeled "Used Oil." Use only transporters and disposal sites approved by WAPA.
5. **OIL AND OIL-FILLED ELECTRICAL EQUIPMENT RECEIPT:** Obtain and submit a receipt for oil and oil-filled equipment transported and disposed, recycled or reprocessed to the COR prior to submittal of final invoice.

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SECTION 13.19 – REMOVAL OF OIL-CONTAMINATED MATERIAL

1. GENERAL: Removing oil-contaminated material includes excavating, stockpiling, testing, transporting, cleaning and disposing of these materials. Personnel working with PCBs must be trained in accordance with OSHA requirements. Submit employee training documentation records to the COR for review and approval no later than 30 calendar days before the Notice to Proceed.
2. CLEANUP WORK MANAGEMENT PLAN: Provide a Cleanup Work Management Plan that has been approved by applicable Federal, State or local environmental regulation agencies. Submit the plan to the COR for review and approval no later than 30 calendar days before the Notice to Proceed. Review of the Plan is for the purpose of determining compliance with the specifications only and shall not relieve the Contractor of the responsibility for compliance with all Federal, State and local regulations. The plan must address onsite excavation of contaminated soil and debris and include the following:
 - a. Identification of contaminants and areas to be excavated.
 - b. Method of excavation.
 - c. Level of personnel/subcontractor training.
 - d. Safety and health provisions.
 - e. Sampling requirements including quality control, laboratory to be used.
 - f. Management of excavated soils and debris.
 - g. Decontamination procedures for personnel and equipment.
 - h. Disposal methods, including transportation to disposal.
3. EXCAVATION AND CLEANUP: Comply with the requirements of Title 40, Part 761 of the U.S. Code of Federal Regulations (40 C.F.R. Part 761).
4. TEMPORARY STOCKPILING: Excavated material, stockpiled onsite during construction, must be stored on plastic with appropriate thickness and covered to prevent wind and rain erosion at a location designated by the COR.
5. SAMPLING AND TESTING: Sample contaminated debris and areas of excavation to ensure that contamination is removed. Use personnel with experience in sampling and with experience in PCB cleanup, if PCBs are involved. Use analytical methods approved by EPA and applicable State regulations.
6. TRANSPORTATION AND DISPOSAL OF CONTAMINATED MATERIAL: The Contractor is responsible and liable for the proper loading, transportation and disposal of contaminated material according to Federal, State and local requirements. Use only transporters and disposal sites approved by WAPA.
7. POST CLEANUP REPORT: Provide a Post-Cleanup Report that describes the cleanup of contaminated soils and debris. Submit the report to the COR prior to submittal of final invoice. The report must contain the following information:
 - a. Site map showing the areas cleaned.
 - b. Description of the operations involved in excavating, storing, sampling, testing and disposal.
 - c. Sampling and analysis results including 1) Name and address of the laboratory, 2) sample locations, 3) sample dates, 4) analysis dates, 5) contents of contaminant (e.g. PCB or total petroleum hydrocarbons) in ppm.
 - d. Certification by the Contractor that the cleanup requirements were met according to local, state and federal requirements.

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- e. Copies of any manifests, bills of lading and disposal certificates.
- f. Copies of correspondence with regulatory agencies that support completion of the cleanup.

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SECTION 13.20 – CONSERVATION OF BIOLOGICAL RESOURCES

1. **GENERAL** Federal laws regulate the taking, possession, transportation, sale, purchase, barter, exportation, and importation of wildlife (50 CFR § 10.1). Contractor and subcontractor personnel will use precautions to avoid impacts on animals and plants. Additionally, all ground disturbing activities will be restricted to areas specified in accordance with Standard 1 – General Requirements, Sections 1.3.1 Rights-Of-Way and 1.3.2 Access to the Work and Haul Routes.
2. **ENDANGERED SPECIES ACT OF 1973 (ESA):** The ESA prohibits the take of threatened or endangered animal and plant species, as well as destruction of designated critical habitat (50 CFR § 17.21). Contractor and subcontractor(s) will follow conservation measures necessary for ESA compliance. These measures would most likely be determined during WAPA's Section 7 consultation process and included in applicable Division 13 or NEPA documents.
3. **MIGRATORY BIRDS TREATY ACT OF 1918 (MBTA):** The MBTA protects migratory birds, their nests, eggs/chicks, and parts thereof from being pursued, hunted, taken, captured, killed, possessed, sold, bartered, shipped, exported, or imported without a permit (16 USC 703-712). Impacts to migratory bird nests will be avoided during nesting season(s), as identified in applicable Division 13 or NEPA documents. If actions must occur in suitable nesting habitats during an applicable nesting season, WAPA will survey the potentially suitable nesting habitats within the construction area for active migratory bird nests prior to work and will establish appropriate buffers around nests to avoid disturbance. If work must occur in these buffers, the COR may choose to delay work until the nest is no longer active or to implement other conservation measures (i.e. WAPA's Special Purpose Utility Permit) to remain compliant.
4. **BALD AND GOLDEN EAGLES PROTECTION ACT OF 1940 (BGEPA):** The BGEPA protects bald and golden eagles, their eggs/chicks, and nests (both active and inactive) from being taken, possessed, sold, purchased, bartered, transported, exported, or imported (16 USC 668a-668d). Appropriate buffer distances, particularly around known nests or wintering areas, should be identified in the applicable Division 13 or NEPA documents.
5. **KNOWN OCCURRENCE OF PROTECTED SPECIES, PROTECTED HABITATS, OR UNIQUE HABITATS:** Prior to the Notice to Proceed, WAPA will provide information on presence and distribution, as well as avoidance and minimization information, for relevant protected species, protected habitats, and unique habitats. Personnel unfamiliar with these avoidance and minimization measures will not be allowed in the construction area. Marked avoidance areas will be maintained throughout the duration of work until the COR approves their removal. If access in an avoidance area is needed, Contractor and subcontractors must first obtain written permission from the COR before any work is performed in the avoidance area. A biological monitor may be required to accompany Contractors or subcontractors inside avoidance buffers.
6. **UNKNOWN OCCURRENCE OF PROTECTED SPECIES, PROTECTED HABITATS, OR UNIQUE HABITATS:** If unanticipated protected species, protected habitats, or unique habitats are discovered in proximity to the project site, Contractors and subcontractors will immediately notify the COR and provide the location and nature of the findings. Contractor and subcontractor personnel will immediately stop all actions within 660-feet¹ of the protected species, protected habitat, or unique habitat and will not restart actions until directed to do so by the COR. The

¹ This distance is derived from the bald eagle avoidance distance outlined in the National Bald Eagle Management Guidelines ([USFWS 2007](#)). It aligns with the combined average flight initiation distance (the distance at which animals start moving away from a threat) of 14 species intended to serve as general guidelines for establishing buffers from critical wildlife areas ([USDA 2008](#)). The USFWS used the same distance as a conservation measure for the reintroduction of California condors ([USFWS 2021](#)), further vetting/maintaining its relevance as an accepted avoidance buffer. The distance may be adjusted by the COR based on species-specific requirements relative to the action at hand.

STANDARD 13 – ENVIRONMENTAL QUALITY PROTECTION

Division 13 or NEPA documents may include species-specific buffers and/or conservation measures more applicable than the general 660-foot avoidance buffer.

7. SPECIAL CONSIDERATIONS: Refer to Division 13 of the Project Specifications for site-specific requirements including, but not limited to, protected species, habitats, migratory birds and eagles.
8. DEFINITIONS
 - a. Active or Inactive Nests² – The definition may vary slightly from Act to Act, but fundamentally an active nest is one containing viable eggs and/or chicks. A nest becomes active when the first egg is laid and remains active until fledged young are no longer dependent on the nest. Nests that are empty, contain no viable eggs, or are being built but do not yet have an egg in them are considered inactive.
 - b. Biological Monitor - An individual with applicable knowledge/capabilities in biology, ecology, or wildlife management who observes actions (e.g., construction, land disturbance) to ensure compliance with environmental regulations, particularly those related to protected species and their habitats. Their role often involves documenting observations, identifying potential impacts, and communicating with field crews to prevent harm to sensitive species/habitats.
 - c. Protected Habitats – Areas with legal protections that are vital to the survival and recovery of protected species. Under the ESA, this specifically refers to critical habitat, which is defined as specific areas essential for the conservation of a listed species and which may require special management considerations or protection (50 CFR § 402.02). Protected habitats may also include areas with conservation easements restricting surface rights or uses.
 - d. Protected Species - Any species (flora or fauna) afforded legal protection under applicable laws typically due to species' rarity, vulnerability, or ecological importance. This includes but is not limited to, species listed as endangered or threatened under the ESA, migratory birds under the MBTA, and bald and golden eagles under BGEPA.
 - e. Take – This term is defined slightly different from Act to Act, but fundamentally means to disturb, harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct (50 CFR § 10.12). Also, habitat modifications or degradations that significantly impair essential behavioral patterns (i.e., breeding, feeding, or sheltering) may also be considered as take.
 - f. Unique Habitats³ - occupying relatively small areas, having formed under unusual combinations of geology, soil chemistry, hydrology, and/or other factors, and typically supporting uncommon/rare plant assemblages. Unique habitats include but are not limited to: sand dunes, vernal pools, peatlands/fens.

² Citation: [U.S. Fish and Wildlife Service. 2018. Destruction and Relocation of Migratory Bird Nest Contents. Memorandum from Assistant Migratory Bird Director to Regional Directors.](#)

³ Citation: [Pipp, A., R. Fimbel, E. Bergstrom, S. Shelly, S. Cooper, A. Clausen, K. Newlon, P.C. Rogers, B. Skinner, W. Velman, T. Luna, D. Longknife Jr., C. Werk, and M. Crawford. 2024. Montana Native Plant Conservation Strategy: Part 1. Vascular Species and Habitats of Greatest Conservation Need. Developed in conjunction with the Montana Native Plant Conservation Strategy Partnership. Montana Natural Heritage Program, Helena, Montana. 310 pp.](#)



Western Area
Power Administration

CONSTRUCTION STANDARDS

STANDARD 14 COMMUNICATION FACILITIES



2026

SAFETY
A HABIT TO LIVE BY

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SECTION 14.1 – COMMUNICATION TOWER OR MONOPOLE

14.1.1 GENERAL:

1. **GENERAL:** Tower or Monopole shall be designed and furnished by a company regularly engaged in the manufacture of communication facilities.
2. **REQUIREMENTS:** Bolts, nuts, locknuts, antenna pipe mounts, climbing ladders, including a safety climbing system, waveguide ladders, work platforms, rest platforms, embedded material and other appurtenances including all associated hardware shall be considered as part of the communication tower or monopole.

14.1.2 CONTRACTOR-FURNISHED DRAWINGS AND DATA:

1. **GENERAL:** Before beginning fabrication of the material, furnish electronic drawings and data for the communication tower or monopole. Prior to shipment of material, furnish “Final Approval Electronic Drawings” for the communication tower or monopole. Before final payment is made, furnish “Final As-built Electronic Drawings” for the communication tower or monopole. Refer to the contract clause titled “Specifications and Drawings for Construction” for additional requirements, except that shop detail drawings may be considered proprietary data as outlined in 14.1.2.6 below.
2. **CHANGES:** Make all changes in Contractor-furnished electronic drawings, designs and construction details which WAPA determines necessary to make the finished construction conform to these specifications. Revise the electronic drawings to reflect all changes.
3. **APPROVAL TIME:** Time allowed for approval of electronic drawings and data submitted to WAPA for approval is specified in Division 1 Specific Requirements paragraph “Commencement, Prosecution and Completion of Work” paragraph of the “General Requirements” Division. The revised electronic drawings and marked up electronic data sheets will be returned to the Contractor marked to indicate required changes, if any, and whether the electronic drawings or data are approved or not approved. WAPA's approval shall not relieve the Contractor from meeting the specifications requirements nor the responsibility for design and drawing correctness. Refer to Division 1 of the Project Specifications regarding acceptable version and format of electronic AutoCAD drawings.
4. **UNITS OF MEASUREMENT:** Units of measurement shall be in United States Standard units; and all wording, signs, symbols and other designations shall be in English.
5. **DESIGN CALCULATIONS AND DATA:** Submit for approval one (1) electronic copy of the following design calculations and data for the communication tower or monopole:
 - a. General dimensions and weight.
 - b. Hand calculations of dead and live loads for all loading cases and points of application of all loads.
 - c. Member loads for each loading case and the capacity needed for and furnished by each member; ground line shears and axial loads; and all other design data required for the foundation design. Accuracy and correctness of the design is the sole responsibility of the Contractor.
 - d. Maximum deflection for all loading cases.
 - e. Maximum twist and sway at all initial and future antenna attachment points.

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- f. Size, description and quantity of bolts at each connection.
 - g. Orientation referenced to true north.
 - h. Computer analysis with complete description of the computer program used.
 - i. Antenna and side strut layouts.
 - j. Data certifying that the manufacturer has:
 - (1) Successfully designed and manufactured similar items of comparable magnitude and purpose to those to be furnished under these specifications for a period of not less than 3-years.
 - (2) Manufacturing facilities adequate for manufacturing the type and size of tower or monopole to be furnished under these specifications.
6. APPROVAL DRAWINGS: Submit an electronic copy of the following:
- a. Shop Detail Drawings:
 - (1) Drawings: Shop detail drawings of all members, including climbing and waveguide ladders, safety-climbing device, work and rest platforms, pipe mounts, other appurtenances and connections. Shop detail drawings may be stamped "Proprietary Data" and will be used only for repair, modification or replacement of communication material provided under these specifications.
 - (2) Proprietary Data: Shop detail drawings that the manufacturer considers proprietary data will only be used as specified in subparagraph 1) above. Proprietary data will not be disclosed for any reason, including disclosure under the Freedom of Information Act, without prior written approval from the manufacturer.
 - b. Erection drawings for each type and height of structure showing the following:
 - (1) Marking and position of each member and, for each bolted joint, the number and size of bolts and the number and size of any ring fills.
 - c. Complete bill of materials, listing all material for the tower or monopole or the portion shown there on, including bolts. The bill of materials shall show the number of pieces required; the description of each piece, including size and length; the mark number of each piece; the weight of each piece; and the Drawing number on which the shop detail of each piece can be found. The total weight shall be noted on the Drawing.
 - d. Mounting details of antennas and reflectors.
 - e. Guys:
 - (1) Guy pretension.
 - (2) Guy location, attachment details and all hardware information.
 - (3) Guy anchor and installation details.
 - (4) Guy azimuth.
 - f. Both the shop detail drawings and erection drawings shall show the following information:
 - (1) Controlling dimensions of each structure.
 - (2) WAPA specifications number, bid item number and revision dates.

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- (3) WAPA job title.
- (4) Type of material and finish.
- (5) Name of site.
- (6) Changes or revisions and revision date.

Check drawings for accuracy and completeness before being submitted before submitting. WAPA will not thoroughly check details and intermediate dimensions.

7. FINAL APPROVAL DRAWINGS: Prior to shipment of material, furnish an electronic copy of all drawings listed in 14.1.2.6 above. The Drawings shall show all changes and revisions, with revision dates, made up to the time the material is ready for shipment.
8. FINAL AS BUILT DRAWINGS: Before final payment is made under the contract, deliver to WAPA the final electronic copy of all drawings listed in 14.1.2.6 above, with all revisions found necessary to correct errors or reflect changes discovered during field erection.
9. DISTRIBUTION OF DRAWINGS AND DATA:
 - a. Design Calculations, Data and Approval Drawings: Send one (1) electronic copy to the Civil Engineer.
 - b. Final Approval Drawings: Send one (1) electronic copy to the Civil Engineer.
 - c. Final As-Built Drawings: Send one (1) electronic copy to the Civil Engineer.

14.1.3 DESIGN REQUIREMENTS:

1. DESIGN LOADINGS: Design to be reliable, serviceable and to resist, without permanent distortion or excess sway and twist, all loading conditions and those loads required for manufacturing, handling, transporting and installing. For the loading and twist and sway analysis, parabolic antennas shall be treated as solid antennas without radomes. All tower members shall be sized for wind loads acting both perpendicular to the tower face and to the apex of two (2) faces. The structural analysis must utilize ANSI/TIA-222-X Risk Category III (Essential Communications) load factors. Future antenna loading shall be modeled at the azimuths creating the maximum stress ratio (MSR) for legs and bracing.
2. STRUCTURAL ANALYSIS AND DESIGN:
 - a. General: Design to withstand the maximum of all loads, specified in 14.1.3.1 above, without exceeding the allowable unit stresses in members. Design in accordance with the basic assumptions and the latest requirements of the following:
 - (1) TIA-222-H, "Structural Standards for Steel Antenna Towers and Antenna Supporting Structures".
 - (2) EIA-195-C, "Electrical and Mechanical Characteristics for Terrestrial Microwave Relay System Antennas and Passive Reflectors".
 - (3) Amphenol (Andrew) Bulletin No.1015F.
 - (4) AISC "Manual of Steel Construction, Latest Edition (Part 5, Specifications and Codes)".
 - (5) ASCE Standard 10, Latest Edition "Design of Lattice Steel Transmission Structures".
 - (6) ASCE Standard 48 Latest Edition – "Design of Steel Transmission Pole Structures".

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(7) AISI “Specifications for the Design of Cold-Formed Structural Members”.

In the event of conflicting requirements in these standards, the more stringent shall apply.

- b. Criteria: Design based on an analysis of stress and combination of stresses due to moment, shear, torsion, guys and axial loads.
 - c. Twist and Sway: Twist and sway, as defined in TIA-222-H, shall not exceed plus or minus 0.5 degree at the antenna attaching points with the loading in 14.1.3.1 above. In addition, the tower shall not exceed the combined twist and sway requirement of 0.5-degrees under the full design wind speed loading in 14.1.3.1 above. Torsion stabilizers shall be provided as necessary for guyed towers.
 - d. Designer's Qualifications: Design and drawings shall be supervised and certified by a registered Professional Engineer competent in structural analysis and communication facilities design. The designer shall also check and certify the shop detail and erection drawings.
 - e. Shielding: Shielding will not be allowed on antennas, ladders and waveguides.
3. COMPONENTS: Components shall meet the following minimum thickness requirements:
- a. Main Leg Members: 1/4-inch for rolled shapes; 3/16-inch for round, square and rectangular tubes.
 - b. Compression Members with Calculated Stress: 3/16-inch for rolled shapes; 1/8-inch for round, square and rectangular tubes.
 - c. Members with No Calculated Stress: 1/8-inch.
 - d. Connection Bolts: Connection bolts shall not be less than 1/2-inch in diameter.
 - e. Monopole: The monopole cross section may be circular or a regular polygon having not more than 12 sides.
4. DETAILS OF DESIGN:
- a. Self-Supporting Towers: Self-supporting towers shall be three- or four-legged towers with horizontal members at not more than 20 foot intervals on each tower face. Tower face width shall not be less than 56-inches between connection bolts. All load carrying members that are bolted should have a minimum of two (2) bolts for each connection. Legs and diagonal bracing shall be angles or tubular. Ends of diagonal tube bracing shall be left open. Horizontal bracing shall be angle. Cover top of tube legs and provide a 1/2-inch-minimum-diameter drain hole at the base of each leg.
 - b. Guyed Towers:
 - (1) General: Guyed towers shall be triangular and have a minimum face width of 56 inches between connection bolts and shall be limited to bolted angular construction. Provide horizontal members at 4-foot maximum intervals on each face of the tower. The shaft of guyed towers shall be supported on a pivot mount to prevent bending forces from being transmitted to the foundation. Determine the number, size and location of all guys and anchors required for the guyed towers. Guy anchors shall be at least 10-feet10 feet inside property lines. Prior to final tensioning, provide to the COR, data including tensioning procedures, sequences and temperature corrections

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for initial tension values of all guy wire sizes. The temperature range of the guy chart shall be from 0-degrees to 100-degrees Fahrenheit in 10-degree increments.

- (2) Guy Design: Determine the guy size, location and arrangement best suited for each tower. Locate guys to provide minimum tower twist and sway. Guys shall have a minimum 3/8-inch diameter.
- (3) Structural Analysis and Design: Guys shall be treated as elastic members in the structural analysis of the towers. The modules of elasticity for guy material shall be taken as 23,000-ksi. Loads in the guys shall not exceed 60-percent of the minimum rated breaking strength of the guys.

Guy tensions under conditions of no wind, no ice and 90-degrees Fahrenheit temperature shall be a minimum of 10-percent of the minimum rated breaking strength of the guy. Determine the tensions required under the wind and temperature conditions at the time of guy tensioning in order to meet this requirement.

- (4) Guy Hardware and Attachments: Guy hardware and attachments shall be capable of supporting the minimum rated breaking strength of the guys. Turnbuckles shall be used on the guy anchor plate end for cable adjustment. The turnbuckles shall have a working load that is 60-percent of the minimum rated breaking strength of the attached guy. Each guy shall be attached to the guy anchor plate in a separate hole. Provide two (2) extra guy attachment holes and one (1) working hole in each guy anchor plate.
 - (5) Guy Cable Markers: Provide high visibility guy cable markers as directed, at locations where guy cables enter the ground. Guy cable markers shall extend a minimum of 10 feet up the guy cable.
- c. Pipe Mounts for Antennas: Provide standard 4 1/2 inch-outside-diameter, Schedule 80 pipe mounts, 72-inches long, for the attachment of the parabolic microwave antennas for the initial antennas and future antennas with azimuth assignments. Large antennas may require longer pipe mounts to spread out the load to the tower. Pipe mounts shall be designed and installed for the plumb position. Provide two (2) 4 by 4 by 1/4 minimum side strut attachment angles for each parabolic microwave antenna. Connect side strut attachment angles to the legs with a minimum of two (2) U-bolts. The angles shall have one (1) leg down and the other leg out of the tower face for climbing purposes. Connection of the side strut mounting hardware shall be made to these separate angular members. Connecting the side struts directly to tower members will not be permitted. No side strut shall go through the face of a tower unless authorized by WAPA. All side strut pipes shall be installed within a plus or minus 30-degree angular limitation. Provide standard 2 7/8 inch-outside-diameter, Schedule 80 pipe mounts, 60-inches long, for the attachment of the VHF/UHF antennas for the initial and future antennas.

The limit of movement of antenna pipe mounts shall not exceed plus or minus 0.1 degree for all antennas.

- d. Waveguide Ladder: Waveguide ladders shall be designed such that the maximum vertical spacing between cable attachment points is 4-feet. Use of tower legs or diagonals with beam clamps is not acceptable.

Waveguide ladder cross-members shall be drilled to accept and support a minimum of eight (8) elliptical waveguide hangers in a horizontal line at each attachment point. Unless otherwise approved, the holes shall be spaced at 4-inches on center.

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- e. Waveguide Attachments: Drill holes at a vertical spacing of 4-feet to accept the 3/8-inch, stainless-steel threaded rods and clip in type for waveguide hangers.
- f. Climbing Ladder: Provide an inside-mounted climbing ladder for the full height of the tower. Provide a face-mounted climbing ladder for the full height of the monopole complete with work rungs located 4-feet below and handholds located at the centerline of each parabolic antenna. The ladder shall be mounted as close to the building as possible and oriented so that the climber faces the building. Ladder, work rungs and handholds, shall be designed to support a minimum of the current OSHA load and impact requirements. One (1) fall protection anchorage shall be designated 4- to 8-feet above the centerline of each antenna location and at the top of the tower on each leg. The anchorages shall be capable of handling 5000-pounds each. Tower shall be designed to handle one (1) 5,000-pound load on any of these anchorages. Ladder shall have round 3/4-inch diameter solid steps spaced at 12-inches center to center. Steps shall be corrugated, knurled or dimpled to minimize slipping. Coating with skid-resistant material is not acceptable. Spacing of side rails shall be 16-inch clear width. Provide a minimum of 7-inches clearance on the back side of the ladder between any structural member or appurtenance. Ladder shall be stabilized at the bottom end by means of a concrete foundation, unless on a guyed tower. The ladder shall be vertical or can slope away from the climber as the climber ascends the ladder. On 3 legged towers the ladder shall be corner mounted in the tower's apex. Ladder sections shall be spliced together to form a continuous ladder and be bolted to the tower every 5 feet. If no tower members are available to attach to every 5-feet then an additional support frame shall be provided, which is based on the unsupported distance between horizontal tower members. The ladder shall be attached every 5-feet to this ladder support frame and the frame attached to the horizontal tower members. The design for this shall be submitted with the tower design. Ladder side rails shall be made of flat plate and be a minimum size of 2 1/2-inches by 3/16-inch. For waveguide ladders attached to the climbing ladder, place holes for waveguide runs in the center of the side rail, midway between the ladder rungs. Ladder supports shall not protrude beyond the face of the ladder.
- g. Safety Climbing Device: Provide on the climbing ladder a fall prevention device consisting of a single; center-mounted 3/8-inch steel tensioned cable, running the entire length of the ladder. The device shall be designed to support the minimum of the current OSHA load and impact requirements. The device shall be securely fastened at the top and bottom of the ladder and at intervals in between using the appropriate cable retainers, per the manufacturer's instructions. The device shall allow at least two (2) climbers to utilize the system at the same time. The device shall be attached at the top of the climbing ladder to a minimum of four (4) ladder rungs for strength. Provide three safety sleeves or sliders that are detachable from the cable and have an anti-fall instant gripping locking mechanism. The sleeves shall be designed so that they cannot be installed on the cable incorrectly or upside down. The sleeves shall automatically travel around or through the cable attachments and guides. Acceptable safety devices are the Vi-Go Climbing System, manufactured by Miller Fall Protection, Latchways system or an approved equivalent. Rail or tube-type systems are not acceptable.
- h. Work Platforms: The platform shall encompass the entire interior area of the tower. Work platforms shall have a trap door providing a minimum 28-inch by 28-inch clear opening. The trap door shall be equipped with a securing device that locks automatically when the trap door is opened completely. This device shall ensure that the door remains in the open position and prevents it from being slammed shut accidentally by wind, personnel or equipment. This device shall be easy to unlatch when the trap door is to be closed. The trap door shall be constructed such that it is easy for one (1) person to open with one (1) hand. Each work platform shall consist of a level welded rectangular steel grating inside the tower that will carry at least two (2) people. The minimum safe concentrated load shall be 640-pounds, based on the unsupported span of the grating. In addition, the deflection shall be 1/4-inch or less under a uniform load of 100-pounds per square foot or 1/2-inch or

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less under the concentrated loading of 640-pounds. Work platforms shall include handrails and toe boards around the perimeter that meet OSHA requirements.

- i. Rest Platforms: Rest platforms shall be placed at intervals no greater than 100-feet. Each rest platform shall consist of a level welded rectangular steel grating inside the tower that will allow sitting or standing room for at least one (1) person with a minimum width of 15 inches. Work platforms may be used for rest platforms.
- j. Ice Shields: Ice shields shall be large enough to protect the feed horns and radomes. Use the same welded steel rectangular grating as the work and rest platforms.
- k. Passive Repeaters: Self-supporting steel structures shall have mounting units for alignment of reflectors. Each unit shall have maximum adjustment ranges of plus or minus 4 degrees about either axis and plus or minus 2-degrees about both axes simultaneously. The units shall be designed to meet rigidity specifications of EIA 195-C for the required operations.
- l. Connections:
 - (1) General: The length of connection bolts under the head shall be long enough for full thread engagement of a heavy hex nut and either a palnut or MF locknut. Locknuts shall be provided for all bolts. Bolts, nuts, washers and locknuts required for assembling the material in the field shall be furnished in quantities sufficient to compensate for normal field losses, provided the excess quantities do not exceed 2 percent of the actual requirement. All connections shall be designed to minimize eccentricities. For angle shapes, the bolt holes shall be placed as close to the heel of the angle as possible.
 - (2) Bolt-Hole Spacing: Unless otherwise approved, the minimum spacing from center to center of bolt holes shall be as shown in Table 14-1. Where practical, the spacing shall be not less than 3-diameters. Wherever possible, the distance from the center of a bolt to the face of the outstanding leg of an angle or other member shall be such as to permit the use of a socket wrench in tightening the bolt.
 - (3) Distance of Bolt Hole to Edge of Piece: Unless otherwise approved, the distance between the edge of any piece and the center of a bolt hole shall not be less than shown in Table 14-1, where applicable.

TABLE 14-1 – BOLT HOLE CLEARANCES

SIZE OF BOLT (INS)**	MINIMUM EDGE DISTANCE (INS)		MINIMUM CENTER TO CENTER (INS)
	ROLLED OR FLAME-CUT*	SHEARED	
1/2	3/4	7/8	1 1/4
5/8	7/8	1 1/8	1 1/2
3/4	1	1 1/4	1 7/8

*Where flame-cuts are made by mechanically guided torch.

**1/2-inch bolts can be used on guyed towers only.

In detailing the gauge lines, allowance shall be made for mill tolerances in the width of the legs or flanges to ensure that the specified minimum edge distances will be met.

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- (4) Slip-Critical Connections: Bolts, if any, in slip-critical connections and in other connections requiring full pre-tensioning shall be noted in the design and identified on the erection drawings. Include requirement for providing full pretension on the erection drawings.

14.1.4 MATERIAL:

1. STRUCTURAL STEEL: All structural steel shall be galvanized.
2. STANDARD-STRENGTH STEEL: ASTM A 36 or ASTM A 36M.
3. STRUCTURAL STEEL PIPE: ASTM A 53, Grade B or ASTM A501, Grade A or B.
4. HIGH-STRENGTH STEEL: ASTM A 572, Grade 50. High strength steel plate shall have minimum longitudinal impact strength of 15-foot-pounds at minus 20-degrees Fahrenheit as determined by the Charpy "V" Notch Impact Test in accordance with ASTM A 67. ASTM A36M that meets the required yield can also be used with approved Mill Tests.
5. BOLTS AND NUTS: Bolts and nuts shall be galvanized and conform to ASTM A 325, Type 1.
6. WASHERS: Beveled washers shall be malleable iron or steel, galvanized. Other washers shall be steel or wrought-iron, galvanized.
7. LOCKNUTS: Square, regular Type MF No.1, or regular palnut locknuts. Locknuts shall be galvanized.
8. ARC-WELDING ELECTRODES: In accordance with the latest edition of AWS "Specifications for Iron and Steel Arc-Welding Electrodes" and suitable for the base material, positions and other use conditions.
9. ZINC DUST-ZINC OXIDE PAINT: ASTM A 780. Zinc dust-zinc oxide paint shall have a minimum zinc content of 94-percent (dry film weight).
10. GRATING: Welded rectangular steel grating with a minimum 1 1/2 inch by 3/16 inch bearing bar and cross bars at a maximum 4 inch spacing that meets Federal Specification RR G 661a. End banding bars are required.
11. GUY WIRES: ASTM A 475 89, extra-high-strength grade.
12. GUY HARDWARE, STEEL GUY ANCHOR SHAFT AND ATTACHMENTS: Guy hardware and attachments shall be of the type and manufacturer's rated strength as specified on the approved shop detail and erection drawings. Steel guy hardware, steel guy anchor shaft and attachments shall be galvanized.
13. GUY WIRE SLEEVES: Shall be "SiteGuard Guyline Guardians" as manufactured by Honeywell, or approved equal.
14. GALVANIZING AND DULLING: Shall be in accordance with Standards DIVISION 4 "Substation Metalwork and Transmission Line Lattice Structures".

14.1.5 QUALITY CONTROL, FABRICATION AND WELDING:

Shall be in accordance with the latest TIA-222-H and standards DIVISION 4 "Substation Metalwork and Transmission Line Lattice Structures".

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14.1.6 ERECTION:

1. GENERAL: Material shall be installed or erected in accordance with the erection drawings and these specifications. Erection and installation shall be in accordance with the applicable provisions of the AISC “Manual of Steel Construction, Ninth Edition (Part 5, Specifications and Codes)”. No steel shall be erected on a foundation until 7-days after the last concrete placement in the foundation, nor until backfill has been placed and compacted where and as required.
2. ANCHOR BOLTS AND EMBEDDED MATERIAL: Set accurately to the grade and alignment designated on the approved drawings.
3. BASE PLATES: Set level, in exact position. Leveling shall be done in accordance with the Contractor's approved drawings. Grout is not recommended. Anchor bolts shall be designed to carry the required loading from the structure. If approved by WAPA and where grout is required, the grout shall be in accordance with the “Grouting Mortar” paragraph of the “Concrete” Division.
4. STRUCTURAL STEEL: Transport and handle to avoid bending or damage to the material and galvanizing. Pieces bent in handling may be used only if they are straightened in a manner approved by the COR.
5. GUYED TOWERS: Guys and anchors shall be installed in the locations shown on the Contractor's approved drawings. Preforms shall be used to terminate the cables. “Haven” type grips with serrate jaws will damage cable and shall not be used to tension guy cable. Guys shall be pre-tensioned as shown on the Contractor's approved drawings. Guys shall be one (1) continuous piece of cable. Splicing of guy cable will not be permitted.

Turnbuckles shall provide a minimum of 16-inches of take-up and shall have not less than 2 inches of exposed threads inside the buckle body and provide a minimum of 6-inches of take up after final tensioning. Turnbuckles shall be safety tied to prevent movement exceeding one-half turn.

6. ERECTING TOWER: Tower may be erected by assembling in sections on the ground and hoisting successive sections into place or may be built up in place by individual members, at the option of the Contractor. If erected by assembling in sections, initial bolting shall be adequate for dead load, live load and erection stresses, but shall not be so tight as to prevent aligning and fitting adjacent sections or members.

A reasonable amount of drifting is allowed. “A reasonable amount of drifting” is defined as drifting without causing hole elongation or deformation of members. Reaming for correction of mismatched holes will not be permitted. If shop errors are discovered, the COR will decide whether the errors may be field-corrected, or the members returned to the manufacturer for correction or replacement.

Repair galvanizing damaged due to drifting, repair operations or field-drilling in accordance with the “Galvanizing” paragraph of the “Metalwork” Division and use the zinc dust-zinc oxide paint specified in the “Material” paragraph of this Subdivision.

Misalignment or misfit of adjacent sections or members attributable to the adopted method of erection shall be corrected by adjusting erection methods as necessary to eliminate trouble.

Slings or devices used for lifting tower sections or members shall be of such material or shall be protected in such a way as to prevent damaging or overstressing members.

Erected tower shall have less than 1-inch of twist per 100-feet and be within 3/4-inch of plumb per 100-feet of tower height.

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7. BOLTING:

- a. General: Bolts shall be torqued and locked within the shortest practicable time after all material has been installed. Connections shall lay flat where they are bolted together. No gaps between butt flanges or connections are acceptable after the bolts are tensioned. Where incomplete bolting is a major contributing factor to damage prior to final acceptance, repair or replace the material, as directed by the COR.
- b. Torquing of Bolts: Connection bolts shall be entered clear to the head. Bolts shall be shear/bearing-type connections shall be tightened to the snug-tight condition. The snug tight condition is defined as the tightness that exists when all plies in a joint are pulled into firm contact by the full effort of a man using an ordinary spud wrench. Bolts identified on the erection drawing in slip-critical and other connections requiring full pre-tensioning shall be pre-approved by WAPA, tightened to the torque required, noted and torque shown on the Drawings.
- c. Locknuts: Type “MF” locknuts shall be tightened sufficiently to flatten its concave face to full contact against the structural nut. Palnut locknuts shall be given one-third turn beyond contact with the structural nut.
- d. Wrenches: Only wrenches approved by the COR shall be used on the work, and the use of any wrench which may deform the nut or cut or flake the galvanizing will not be permitted.

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SECTION 14.2 – FOUNDATIONS

14.2.1 GENERAL:

Design and construct reinforced concrete foundations required for communication tower or monopole, waveguide supports and climbing ladder. Complete construction of the communication tower or monopole foundations prior to constructing the service building foundation. The concrete shall be in accordance with Division 3 “CONCRETE” and Standard 3 “CONCRETE”. All self-supporting or guyed tower foundations shall be drilled or augured shaft type, stem and pad type or pad type, suitable for the structure type, loading and soil conditions. All foundations shall have a vertical depth that extends below frost depth.

14.2.2 GUY ANCHORS:

Guy anchors shall be a concrete vertically drilled auger or dead man type. A belled shaft type is not acceptable. Dead man type shall have a concrete collar around the steel shaft from the anchor to 1 foot 0 inches above the ground surface to prevent corrosion of the steel. Guy anchors shall develop a minimum of 80-percent of the resultant of the minimum rated breaking strength of all attached guys. The design for the concrete anchor shall have careful consideration given to the uplift shear and moment capacities. Complete and comprehensive calculations shall be provided showing that the concrete guy anchor can reliably carry all design loads. The concrete guy anchor shaft shall be a steel framework embedded in the center auger. This steel guy anchor shaft shall transfer the load from the guy anchor plate to the concrete guy anchor.

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SECTION 14.3 – WAVEGUIDE BRIDGE, SUPPORTS AND ENTRY PANELS

14.3.1 WAVEGUIDE BRIDGE AND SUPPORTS:

1. GENERAL: Design, provide and install waveguide bridge and supports from the communication tower or monopole to the service building. Design for 50-psf ice loading.

Submit drawings and data outlined in the “Contractor-Furnished Drawings and Data” paragraph of the “Communication Tower or Monopole” Subdivision.

2. WAVEGUIDE BRIDGE: The waveguide bridge shall be of the solid or grated type, to accommodate a trapeze kit capable of holding at least 12 runs and mounted to the waveguide bridge. The trapeze kits should be mounted in 4 ft intervals. The waveguide bridge shall be installed from the waveguide ladder to the waveguide entry port of the service building along the shortest route possible. At the tower, the waveguide bridge shall terminate at the waveguide ladder with an approximate 45-degree upward angle by means of a vertical hinge splice to accommodate the bending radius of the waveguide. The waveguide bridge shall be self-supporting and not attached to the building. It shall terminate within 6 inches of the exterior edge of the service building, centered directly above the top edge of the waveguide entry port. The waveguide bridge shall have a minimum of two (2) supports, one (1) near the tower and one (1) near the building. Waveguide bridge shall be supported at maximum intervals of 10-feet and any single change in horizontal direction shall not exceed 45-degrees.
3. WAVEGUIDE BRIDGE SUPPORTS: The waveguide bridge supports shall consist of pipe columns, at the locations shown on the approved Contractor-furnished drawings. The pipe columns shall be an anchor-bolt type.

14.3.2 WAVEGUIDE ENTRY PANEL INTO SERVICE BUILDING:

1. GENERAL:

- a. Exterior Wall Openings:

- (1) Existing Buildings: Construct an opening in the exterior wall of the existing building in accordance with the architectural and structural drawings, of the dimensions required for installation of the waveguide entry panels. The opening shall be provided without damaging existing construction or compromising the structural integrity of the building. The waveguide entry panel shall be securely attached and sealed to the exterior wall surface.
- (2) New Buildings: Construct an opening in the exterior wall of the new building in accordance with the architectural and structural drawings, of the dimensions required for installation of the waveguide entry panels. The waveguide entry panel shall be securely attached and sealed to the exterior wall surface.

- b. Waveguide Entry Components:

- (1) Panels: Install waveguide entry panels, with manufacturer's standard power-coated finish, on the interior and exterior surfaces of the building wall. The installation shall be weathertight.
- (2) Sealing Caps: Sealing caps shall be provided for all waveguide entry ports on the outside and inside waveguide entry panels.

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- (3) Boots for Entry Ports: Provide boots including plugs, jackets, donuts, clamps and other accessories as required by the Project Specifications for a complete installation of the waveguide.
- (4) Insulation: Provide un-faced fiberglass batt insulation in all cavities, the full thickness of the wall.
- (5) Sealant: Use exterior grade sealant as specified in Division 11 or as approved by the COR. Sealant shall be applied to the back side of the waveguide entry panel such that it is compressed against the exterior wall surface, without voids, when the panel is fastened in place.

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SECTION 14.4 – TOWER LIGHTING

14.4.1 GENERAL:

Provide Obstruction Lighting (Federal Aviation Administration (FAA) Style A, D, or E, as indicated) for 24 hour operation on each tower, unless otherwise indicated in the specifications.

The lighting systems shall be in accordance with the latest edition of FAA Advisory Circular 70/7460-1M entitled "Obstruction Marking and Lighting". Wiring shall be in accordance with the latest edition of the National Electric Code.

The lighting systems shall include strobe beacons and side marker lights (as applicable), controllers, mounts, wiring, conduit, junction boxes and all other accessories required for complete weatherproof enclosed lighting systems.

14.4.2 SUBMITTALS:

1. **SHOP MANUALS:** Two (2) complete shop manuals shall be submitted to the COR for operation and maintenance procedures, including diagrams, schematics and a complete parts list with manufacturer's part number and ordering information.
2. **APPROVAL DATA:** Approval data on the strobe beacons, side marker lights (as applicable) and controllers shall be submitted to the Civil Engineer and the COR.

14.4.3 MATERIAL:

1. **OBSTRUCTION LIGHTS:** Shall be Light Emitting Diode (LED) type strobes, beacons and marker lights and have a warranted life of at least 5-years and a flash head life expectancy of at least 10-years, including lightning damage.
 - a. Shall meet FAA AC No. 150/5345-43F requirements.
 - b. Shall be certified to meet Occupational Safety and Health Administration (OSHA) safety standards such as ETL or another OSHA Nationally Recognized Testing Laboratory (NRTL).
 - c. Shall not create appreciable electromagnetic interference (EMI) while in operation.
 - d. Shall operate in a temperature range of -40-degrees Celsius to 55-degrees Celsius.
 - e. Shall be designed with the obstruction lights alone placed on the tower with the remainder of the unit, including the power supply, controller and separate photocell, placed at or near ground level.
 - f. Dialight Vigilant Series LED based L-864 Beacon, L-865/L-864 Dual (Red/White) Strobe, and L-810 Red Obstruction lights, or approved equals.
2. **CONTROLLER:** Shall be powered using standard 120/240VAC and/or 48V DC supply. The controller shall have available a dry contact output to support alarm functions. It shall also have an optional Simple Network Management Protocol (SNMP) interface or gateway (internal or external) capable of allowing remote monitoring of all controller dry contact alarms.

14.4.4 INSTALLATION:

1. **OBSTRUCTION LIGHTS:** Beacons, strobes and side marker lights shall be mounted to provide 360-degree horizontal visibility.

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2. CONTROLLER: The controller, power supply and separate photocell shall be mounted at or near ground level.

14.4.5 ACCESSORIES AND EQUIPMENT:

Attach all obstruction lighting equipment, components and accessories to the tower utilizing the manufacturer's approved method(s).

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SECTION 14.5 – GROUNDING SYSTEM

14.5.1 GENERAL:

Provide a complete grounding system for the communication tower, climbing ladder, waveguide bridge supports, propane fuel tanks and new communications equipment buildings. Connect the ground system to the existing site ground system as indicated on the Drawings.

14.5.2 TOWER, WAVEGUIDE SUPPORT, FUEL TANK AND BUILDING GROUNDING:

The Contractor shall install the site grounding system consisting of ground rods, waveguide bridge support risers, building ground ring, fuel tank ring (where applicable), building risers and interconnection to any existing station ground systems. Refer to grounding system standard drawings.

1. **GROUNDING CABLE:** All cable for the waveguide bridge support risers, building ground ring, fuel tank ring, building risers and interconnection to existing ground system will be 4/0 AWG [JS1.1][SJ1.2][JS1.3]bare copper. All buried grounding cable shall be a minimum of 18-inches below finished grade. All grounding system cable shall have a minimum bend radius of 8-inches. **WARNING:** This 4/0 AWG requirement exceeds the standard commercial NEC/Motorola R56 specification of #2 AWG. This is a mandatory requirement for substation fault current survivability. No substitution is permitted.
2. **GROUNDING RINGS:** The grounding rings shall be installed around the perimeter of the building foundations. The grounding ring and associated grounding rods shall be a minimum of 2-feet to the outside of the foundation (if allowed by respective foundation locations). Roads, driveways and other obstructions may dictate the exact location of the grounding rings. Final location of the grounding system will be approved by the COR.
3. **GROUNDING CABLE CONNECTIONS:** All connections between grounding cable and grounding rods, other segments of grounding cable (i.e. risers, bus bar grounding straps, tower legs, bridge supports, etc.) and the existing station ground will be made using exothermic welds. See Drawing 31 1060, "Substation Standards Grounding Details" for typical connections.
4. **GROUNDING RODS:** All grounding rods will be 5/8-inches by 10-feet copper (Valmont Part No. B1382 or equal). As a minimum, grounding rods will be located at each building corner outside the foundation perimeter and spaced no more than 20-feet apart. For buildings with a length of greater than 20-feet, additional grounding rods will be installed equidistant from any two (2) grounding rods located at the building corners along the ground ring.
5. **DAMAGE TO EXISTING GROUND CABLE:** Existing ground cables are shown on the Drawings in approximate locations. Use caution in excavating near the existing ground cables. Repair all ground cables damaged during construction as directed by the COR.

14.5.3 LIGHTNING PROTECTION:

Provide one (1) lightning rod at the top of the tower or monopole, only if the tower or monopole is the tallest object (tower, tree, building, other structure, etc.) in an area around its base defined by a radius of half the height of the tower or monopole, or above 150ft.

1. **MATERIAL:** The lightning rod shall be a 5/8-inch by 10-feet galvanized steel rod attached to the top of one (1) of the tower legs or the monopole.
2. **INSTALLATION:** Install the rod in accordance with the manufacturer's instructions and in a plumb position. When installed on a tower leg, it shall not be installed on the same leg with a current or proposed VHF/UHF mobile antenna also on it. The lightning rod should have an exothermic bond to the tower leg which it is installed to .

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14.5.4 GROUNDING SYSTEM TESTING:

Ground system resistivity and continuity testing will be conducted by the contractor. Test results and a site report will be provided for each communications facility. Any discontinuity in the grounding system will be the responsibility of the contractor to repair.

1. **GROUND MAT RESISTIVITY TEST:** If the communication ground mat is not connected to any existing substation ground mat, the Contractor shall test the overall ground mat resistivity using the industry standard fall of potential method. If the site ground mat is small (less than 100 feet measured diagonally), or a traditional fall of potential method is too difficult to perform due to terrain and other obstructions, the fall of potential method can be modified and the 62-percent method can be used. For example: If the remote current probe is 1000-feet from the communication site ground mat then the voltage probe shall be placed at 620-feet from the communication site grounding system. The remote current probe shall be located as far from the communication site as practicable. The COR shall be consulted to determine the best testing method based onsite configuration and location.

If the communication ground mat is attached to an existing substation ground mat, the COR shall be consulted before any ground mat testing is initiated.

2. **GROUND BOND INTEGRITY TESTING:** Since communication sites are typically single point grounded and all metal must be bonded together to insure that any GPR will not create a difference of potential that can harm communication equipment, all below grade bonding connections shall be electrically tested and verified that they have adequate connectivity with the ground mat. Below grade bonds should be at micro-ohm resistivity levels. Above grade bonding connections shall have a visual inspection to verify that bonding connections have proper exothermic weld or cold flow compression (where allowed) characteristics such as both metals (pigtail and weld or compression fitting) are homogeneous and having no voids or any evidence of corrosion or oxidation. Consult WAPA Power System Maintenance Manual (PSSM), Chapter 8, Section 4.1.3 as a reference and to provide context for below grade electrical continuity testing.

NOTE: Electrical bonding continuity testing shall be performed by testing methods used in the WAPA PSMM Chapter 8, Section 4.1.3 and Section 4.12 or similar. The Contractor may use AEMC clamp-on testers or similar, Ductor test equipment and methods or similar or any micro ohm meter type device – it is the option of the Contractor. No matter what method is chosen the contractor will provide WAPA micro-ohm readings of all the below grade ground riser connections.

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SECTION 14.6 – ANTENNA SYSTEM

14.6.1 GENERAL:

1. **OPERATING ENVIRONMENT:** All interior equipment shall operate to the guaranteed specifications over an ambient temperature range of 0-degrees Celsius to 40-degrees Celsius with non-condensing humidity of 95-percent at 40-degrees Celsius. Storage temperature ranges of -40-degrees Celsius to +65-degrees Celsius shall not affect equipment operation.
2. **POWER:** Pressurization equipment shall operate on 120 VAC power with standby generator backup. The standby generator backup shall be provided by the Site Owner. The generator AC power voltage shall remain within ± 10 -percent and frequency shall remain with ± 3 -Hz.
3. **SERVICE:** The equipment shall be designed for a service lifetime of not less than 15-years.
4. **SUBMITTALS:** The Drawings and data required for these specifications include form, fit and function data and manuals, instructional material and other drawings and data needed by WAPA for installation, operation and routine maintenance. These drawings and data are included in the term "instruction book". All documents, including typical and contract-specific drawings and data shall be pre-punched and inserted into standard letter-sized 3-ring binders or equivalent binding. All documentation shall be submitted to the Communications Engineer and a copy of the transmittal letter to the COR.
 - a. **Review Documentation:** The Contractor shall provide two (2) sets of drawings and instruction books for review and comment with the proposal. The information will be used to verify compliance with the requirements of this solicitation, specification and resulting contract.
 - b. **Final Documentation:** Complete sets of final instruction books and included drawings shall be shipped with the equipment. This includes one (1) per site, one (1) maintenance and one (1) engineering office copy.
 - c. The review and final documentation shall include:
 - (1) Antenna drawings and specifications.
 - (2) Waveguide/coaxial cable drawings and specifications.
 - (3) Pressurization equipment drawings and specifications.
 - (4) Miscellaneous equipment drawings and specifications.
 - (5) Installation instructions.
 - (6) Operating instructions.
 - (7) Trouble shooting guide.
 - (8) Replacement and replaceable parts list.

14.6.2 ANTENNAS AND MOUNTS:

1. **ANTENNAS:** All parabolic microwave antennas shall be standard FCC category A rated units with radomes unless otherwise specified. Antennas supplied shall be Amphenol (Andrew) P series or equivalent. The antennas shall have a designed operating range of 4400-4940 MHz for those specified as a 4-GHz antenna and an operating range of 7125-8400 MHz for those specified as a 7-GHz antenna. All antennas for operating in the VHF or UHF frequency bands will be furnished by WAPA unless otherwise specified.
2. **ANTENNA MOUNTING:** All parabolic microwave antennas shall be equipped with a minimum of one (1) side strut, and for antennas greater than 8-feet in diameter, a minimum of two (2) side struts shall be utilized. The Contractor shall furnish miscellaneous material, including antenna mounts, tie-backs, struts, brackets and other items required for assembling and installing the

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antennas. All mounting of antennas operating in the VHF or UHF frequency bands will be completed by WAPA unless otherwise specified.

3. **ADJUSTMENT AND ALIGNMENT OF ANTENNAS:** Antennas and mounting structures shall be installed in the center of their adjustment range for azimuth and elevation. Final alignment of the antennas will be performed by WAPA.

14.6.3 COMMUNICATION TRANSMISSION LINES:

1. **WAVEGUIDE:** Contractor shall supply and install premium elliptical waveguide with an operating range of 4400-4940 MHz for antennas specified at 4-GHz and an operating range of 7125-8400 MHz for antennas specified at 7-GHz. Amphenol (Andrew) EWP43 and EWP77, respective to the operating range specified, or equivalent premium waveguide shall be provided, unless otherwise specified.
2. **COAXIAL CABLE:** Contractor shall supply and install 1/2-inch foam dielectric 50-ohm coaxial cable with an operating range of 150 - 420 MHz for antennas specified as operating in the VHF or UHF frequency bands. Amphenol (Andrew) LDF4-50A or equivalent coaxial cable shall be provided, unless otherwise specified. The Contractor shall supply and install 7/8-inch foam dielectric 50 ohm coaxial cable with an operating range of 820 - 960 MHz for antennas specified as operating in the High UHF frequency bands. Amphenol (Andrew) LDF5-50A or equivalent coaxial cable shall be provided, unless otherwise specified.
3. **HARDWARE AND INSTALLATION:** Contractor shall supply and install all necessary transmission line installation hardware and accessories, including without limitation waveguide connectors, pressure windows, hangers, grounding kits, adapters and miscellaneous installation hardware. The radio end of the waveguide will be connected directly to the radio if at all possible. In certain situations, a small section of flex may be required to make the connection from the waveguide to radio as approved by the COR. Bends and twists in the flex section will be minimized as to minimize losses. All installation materials and hardware shall be supplied in types and quantities sufficient to meet the requirements of the transmission line manufacturer and the project specifications for mounting and connection of premium transmission lines, including, without limitation, the observance of minimum bending radius.
4. **COMMUNICATION TRANSMISSION LINE GROUNDING:**
 - a. All waveguide and coaxial cable shields shall be grounded at (34) locations (54) or more on towers taller than 200-feet), using appropriate transmission line grounding kits:
 - (1) At the top of the vertical run 12-inches – 18-inches below the bend to the horizontal run to the antenna connector.
 - (2) At the bottom of the vertical run 12-inches – 18-inches above the bend to the horizontal run under the ice bridge.
 - (3) Just outside the building entrance.
 - (4) Just inside the building entrance.
 - (5) Midway on the vertical run when the vertical run is 200-feet, and every 75-feet – 100 feet on towers taller than 200-feet.
 - b. The contractor shall provide a main grounding bus bar to accommodate the connections described in 14.6.3.4. [WJ2.1]above. This copper bus bar shall have an exothermic weld to the bar and the tower leg, attached to the tower in a downward sweeping angle. This copper bar shall be a minimum of 1/4-inch by 4inches by 12-inches and have insulated standoffs.

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It shall be pre-drilled with 7/16-inch holes to accept 2 whole lugs from the main ground wire (No. 4/0 provided by site owner) and the waveguide grounding kits. Refer to standard Drawing 31 1503, detail A.

- c. The waveguide ground clamp and ground strap are to be installed in such a manner that they make a connection to a continuous electrical conductor that shall have the least amount of bending possible (8-inches minimum) to reduce the impedance of the bend to lightning current.

Bus bars that are used to bundle multiple waveguide grounding straps, flat copper plate (1/4 inch minimum thickness) shall be used for the bus bars. The bus bar dimensions shall be large enough (height by width) such that the path of the current from the waveguide grounding straps to the grounding conductor shall comply with the 8-inch radius of bend rule. The bus bar shall be installed on an angle of approximately 45-degrees and the ground strap attachment point to the vertical waveguide shall be between 12- and 60 inches away from the start of the bend. Refer to standard Drawing 31 1503, detail B.

- 5. TESTING: After all waveguide supports and clamps have been put in place and tightened, all antenna-feedline systems shall be sweep tested per Section 14.6.3.7.3 of this standard.

6. PRESSURIZATION EQUIPMENT:

a. General:

- (1) The Contractor shall supply and install automatic dehydrator/pressurization equipment at each site where required by the project specification. The dehydrator shall be the Amphenol (Andrew) MT-300 or 600 series or equivalent, sized appropriately for the total current and future volume of the waveguide at the site it will service, and shall be installed on a suitable wall-mount shelf. The dehydrator shall be set to operate between 1.5- and 6.5-pounds per square inch gage (psig) and 115 VAC. The Contractor shall provide all required pressurizing accessories including without limitation manifolds, fittings, hose, pressure gauge and shutoff valve for each waveguide run, and miscellaneous installation hardware including one (1) extra change of desiccant.
- (2) Manifolds shall be sized to accommodate new and existing pressurized waveguides, as well as two (2) additional spare ports.
- (3) Each pressurization system shall include sensors to provide separate dry form C or solid-state contacts which will provide low pressure, high pressure, excess run, power failure and humidity alarms. The high-pressure alarm contacts shall operate at pressures higher than 5-pounds per square inch. The alarm contacts shall be set for low alarm at 1.0-psig, and the high alarm shall be set for 7.0-psig.

- b. Testing: Each waveguide run shall be tested for leakage after installation. Pressurizer/dehydrator shall be operated until gauge pressure reaches between 6.5- and 8-psi for the waveguide under test and the line shutoff valve at the manifold shall then be closed. Loss of pressure shall not exceed 1-psi in 24-hours, corrected for variations caused by changes in temperature. After tests are completed, waveguide pressure should be set to 3-psig.

7. INSTALLATION, TURN-UP AND TEST:

a. General:

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- (1) The Contractor shall provide all materials, tools, test equipment, labor, supervision, shipping, travel and other items required to install, align and test the equipment described in the project specification. The Contractor shall supply adequate equipment spares to allow for failures during installation, turn-up and test without using WAPA's spare units supplied under the project specification.
 - (2) The Contractor shall submit to WAPA a detailed schedule for system installation, test and turn-up as specified in Section 1.1.4, "Construction Program". This schedule shall be coordinated with WAPA's COR.
 - (3) The Contractor shall follow the Original Equipment Manufacturer's initial start-up and test procedures. The original manufacturer's log shall be filled out completely. Where the original equipment manufacturer's warranty exceeds the Contractor's warranty, the registration document required by the manufacturer shall be submitted by the Contractor on behalf of WAPA using WAPA's business address.
 - (4) Any manufacturer's warranty voided by failure on the part of the Contractor to follow the Original Equipment Manufacturer's instructions shall become the Contractor's responsibility to fulfill.
- b. Installation: Equipment shall be installed in and on existing equipment shelters and towers. Specifics regarding exact antenna placement on towers (i.e. leg, azimuth, etc.) and location of racks in buildings will be provided in site specific drawings and data tables.
- c. Field Test and Alignment:
- (1) The Contractor shall apply power to all equipment and perform manufacturer's required initial turn-up tests. Results of this testing shall be recorded and made part of the site records and the system test record. When the manufacturer's warranty exceeds the Contractor's warranty the Contractor shall comply with 14.6.3.7.1.
 - (2) All antenna transmission line subsystems shall be sweep-tested for return loss and verified to be greater than 29-dB for no less than 80-percent of the frequency band of operation. Results of this testing shall be recorded and made part of the site records and the system test record. The center 100MHz of the operational frequency band of the waveguide shall be swept to produce a TDR report showing the effects of connectors, waveguide bends and other abnormalities in the overall waveguide system.
 - (3) Antenna alignment shall be performed without the use of terminal equipment to be installed later.
 - (4) A Spectrum Analyzer interference measurement shall be made at the radio end of the antenna-feeder subsystem, after antenna alignment, of the spectrum centered on the receiver frequencies and extending at least one (1) radio channel-width above and below the assigned channels. A second measurement shall cover the frequency band of operation. This measurement shall be made with the lowest possible noise floor and recorded via photograph or plotter output and included in the test records.
 - (5) WAPA representatives shall witness and participate in system testing as part of system acceptance and field training. Notification to Project Manager of scheduled start date of system testing shall be made in accordance with Standard 1 – General Requirements, Section 1.2.3 "Material Inspection".

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- (6) The Contractor shall submit a complete test report including results of testing within 30 days of successful test completion. The test report shall include original field test data, test data summaries for each site, evaluation of test data, overall evaluation of performance for each waveguide segment, description of all discrepancies noted during testing and measures taken for correction and recommendations for system maintenance and operation.

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SECTION 14.7 – TOWER INSPECTION AND MAINTENANCE

14.7.1 GENERAL:

Furnish labor, materials and equipment required for comprehensive inspection and maintenance of guyed and self-supported communication towers for WAPA.

1. **INSPECTION AND ROUTINE MAINTENANCE:** Perform inspections and routine maintenance in accordance with these specifications, to include but not limited to inspections of: the tower, guy wires, foundation and anchors, antenna system, electrical, lightning protection systems and grounding. Routine maintenance to be performed with inspections shall be conducted in accordance with 14.7.2.
2. **NON-ROUTINE MISCELLANEOUS MAINTENANCE:** If maintenance other than routine maintenance listed in 14.7.2 is required, the Contractor shall provide a written estimate to the COR for review and approval prior to performing such maintenance to ensure adequate funding for obligation and payment purposes. The estimate shall include the applicable labor rate(s), multiplied by the estimated hours to perform the maintenance and any required materials at cost. No maintenance work shall be performed until approved by the COR.
3. **REPORTS:** An electronic copy of the inspection report only (PDF file format, no photographs) shall be provided via e-mail to the Project Communication Engineer as well as the COR at the e-mail addresses provided with the contact information for this project. The Contractor shall also furnish a completed inspection report (PDF file format) with photos (JPEG file format) and a completed Tower Antenna Inventory Form for each tower, within 30-working-days of inspection on Computer Disc (CD). The disc should be sent via U.S. mail to the Project Communication Engineer at the address provided.

14.7.2 INSPECTION AND MAINTENANCE WORK REQUIREMENTS:

1. **FOUNDATIONS AND ANCHORS:**
 - a. Inspect and note condition of concrete bases and anchor concrete.
 - b. Inspect and note anchor for erosion and creeping.
 - c. Visually inspect and note condition of anchor head welds.
 - d. Inspect and note anchor rod head for cracks, splits, bends, twist or corrosion.
 - e. Excavate to a depth of 1-foot below the surface, inspect and note anchor rods not embedded in concrete for corrosion.
 - f. Inspect anchor fencing for damaged fabric, missing hardware, bent or broken posts, corrosion or missing locks or security issues.
 - g. Inspect guy anchors for vegetation overgrowth.
2. **TOWER:**
 - a. Measure and record plumb and twist.
 - b. Visually inspect all tower hardware. Replace missing hardware, broken clips, tighten loose hardware (except antenna or reflector adjustments hardware and feed line hardware in WNMO) and check for air leaks. Hardware associated with antenna reflectors and feed lines found loose shall be documented in the inspection report.

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- c. Hand-inspect 100-percent of bolted connections with a wrench, tighten and re-torque those found loose (note number of connections found loose) and re-torque a minimum of 10 percent of the bolts on the tower.
 - d. Inspect for cracked, bent, twisted or missing members and areas that show signs of fatigue.
 - e. Inspect and note condition of tower main members and guy plates.
 - f. Inspect and note condition of safety climbing device.
 - g. Inspect and note galvanized finish for damage or fading. Repair damage to galvanized coating on tower structure members.
 - h. Inspect and clean all weep holes in pipe legs and bracing for proper drainage.
 - i. Inspect and note condition of work platforms and hatches.
3. GUY WIRES:
- a. Inspect and note broken strands, wear/abrasion and/or corrosion.
 - b. Inspect and note condition of thimbles, turnbuckles and clamps.
 - c. Inspect and note bolted clamps for tightness.
 - d. Inspect and note condition of turnbuckles.
 - e. Re-tension guys to appropriate specifications as to plumb the tower and eliminate twist according to tower erection section 14.1.6.(6).
4. ANTENNA SYSTEMS:
- a. Inspect and note visible damage or distortion.
 - b. Inspect and note hardware conditions – do not adjust or tighten hardware that affects antenna adjustment (tilt and azimuth).
 - c. Inspect radomes and note any visible damage and missing hardware. Replace missing radome hardware.
 - d. Measure and note the resistance of radome heater(s), if equipped.
 - e. Inspect and note waveguide/coaxial cable supports, ice/waveguide bridge, retainers and grounds. Also inspect waveguide/coaxial cable for dents and condition of flex sections.
 - f. Inspect reflectors and note visible damage, loose hardware, bent members and tower attachment. Do not adjust reflector tilt or azimuth.
 - g. Inspect and note condition of ice shields, if mounted.
5. ELECTRICAL:
- a. Inspect and note condition of electrical conduit, pull boxes, vents and drains and mechanical connections of conduit system to tower.

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- b. Inspect tower lights and note loose or missing mounting bolts, loose sockets and inspect for proper operation of tower lights.
6. LIGHTNING PROTECTION SYSTEMS:
- a. Inspect lightning protection systems on towers and note condition of rods or brushes, ground wires and connection to ground cable at the base of the tower. Not all towers have lightning protection installed.
7. GROUNDING:
- a. Inspect and note condition of all ground cable and ground connections above ground.
8. TOWER PHOTOGRAPHS AND INVENTORY FORM:
- a. The Contractor shall at a minimum, take the photographs listed below for each tower. Photographs shall be in full color and a minimum of 3-megapixels each. Photographs shall be included on the CD with completed inspection report submitted to the applicable Government point of contact as indicated in 14.7.1.3.
 - (1) Minimum of three (3) photos at various angles and at a distance from the tower such that the entire tower is in a single frame.
 - (2) One (1) photo taken directly up each face of the tower, showing the majority of the antennas on that face of the tower.
 - (3) One (1) photo taken directly up the center of the tower.
 - (4) Photo(s) of waveguide/coax entry port(s) including associated ground bar/system taken from both inside and outside the building.
 - (5) One (1) photo of the waveguide/coax ladder from each side of the ladder.
 - (6) One (1) photo of foundation on tower or each leg.
 - (7) Photos of visible tower and waveguide grounding.
 - (8) One (1) photo of each antenna.
 - (9) Photos of tower lighting (if applicable).
 - (10) One (1) photo of tower light controller (if applicable).
 - (11) Photo of tower nameplate if found.
 - (12) Photos of any problems found.
 - (13) Photos of each guy point on the tower (if applicable).
 - (14) Photos of each guy anchor (if applicable).
 - b. The Contractor shall complete the Tower Antenna Inventory Form upon completion of inspections and submit the completed form along with all tower photographs taken to the Project Communication Engineer no later than 30-days after completion of tower inspections.

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14.7.3 INSPECTION AND MAINTENANCE PERFORMANCE:

1. GENERAL: The Contractor shall perform all the services described in Section 14.7 of this specification in compliance with accepted industry standards, guidelines and practices and in accordance with any quality assurance program normally used by the Contractor.
2. STANDARD: The standards by which performance of the tower inspection and maintenance will be assessed are outlined in the guide paragraphs of the project specification for each site(s) involved in the project.

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Tower Antenna Inventory Form

Site Name: _____

Date: _____

Number	Destination (if known)	Azimuth (est +/-15 deg)	Height (ft)	Diameter/ Length (ft)	Type *	Radome (Y/N)	Radome Heater (Y/N)	Feedline **	Leg ***
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

* Antenna Types: Solid, Grid, Dipole, Yagi, Paraflector, Collinear

** Feedline Types: 1/2", 7/8", EW43, EW63, EW77

*** Legs are numbered starting from #1 at the first leg clockwise from true north and increasing in number while continuing clockwise around the tower.

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SECTION 14.8 – EMERGENCY AND STANDBY POWER SYSTEMS

14.8.1 GENERAL:

1. SCOPE: This portion of the standard covers performance requirements for emergency and standby power systems providing an alternate source of electrical power.
2. APPLICATION: This portion of the standard shall apply to the new installations of emergency and standby power systems. Existing systems shall not be required to be modified to conform unless the nonconformity presents a distinct hazard to life.
3. REFERENCED PUBLICATIONS: The documents or portions of publications that are referenced shall be considered part of the requirements of this standard.
 - a. National Fire Protection Association (NFPA) Publications:
 - (1) NFPA 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.
 - (2) NFPA 54, National Fuel Gas Code.
 - (3) NFPA 58, Liquefied Petroleum Gas Code.
 - (4) NFPA 70, National Electrical Code.
 - (5) NFPA 110, Emergency and Standby Power Systems.
4. DEFINITIONS: The following definitions shall apply to the terms used in this portion of the standard:
 - a. Battery, Lead-Acid.
 - b. Valve-Regulated (VRLA): A lead-acid battery consisting of sealed cells furnished with a valve that opens to vent the battery whenever the internal pressure of the battery exceeds the ambient pressure by a set amount. In VRLA batteries, the liquid electrolyte in the cells is immobilized in an absorptive glass mat (AGM cells or batteries) or by the addition of a gelling agent (gel cells or gelled batteries).
 - c. Vented (Flooded): A lead-acid battery consisting of cells that have electrodes immersed in liquid electrolyte. Flooded lead-acid batteries may have a provision for the user to add water to the cell and are equipped with a flame arresting vent which permits the escape of hydrogen and oxygen gas from the cell in a diffused manner such that a spark, or other ignition source, outside the cell will not ignite the gases inside the cell.
 - d. Emergency Power Supply (EPS): The source of electric power of the required capacity and quality for an emergency power supply system (EPSS).
 - e. Emergency Power Supply System: A complete functioning EPS system coupled to a system of conductors, disconnecting means and over-current protective devices, transfer switches and all control, supervisory and support devices up to and including the load terminals of the transfer equipment needed for the system to operate as a safe and reliable source of electric power.
 - f. Switch: Automatic Transfer Switch (ATS), Self-acting equipment for transferring the connected load from one power source to another power source.

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Bypass Isolation Switch. A manually operated device used in conjunction with an automatic transfer switch to provide a means of directly connecting load conductors to a power source and disconnecting the automatic transfer switch.

5. CLASSIFICATION OF EMERGENCY POWER SUPPLY SYSTEMS.

The EPSS shall provide a source of electrical power of required capacity, reliability and quality to loads for a length of time as specified.

The class defines the minimum time, in hours, for which the EPSS is designed to operate at its rated load without being refueled or recharged. See Table 14.8.1(a).

The type defines the maximum time, in seconds, that the EPSS will permit the load terminals of the transfer switch to be without acceptable electrical power. See Table 14.8.1(b).

Table 14.8.1(a) – Classification of EPSSs

CLASS	MINIMUM TIME
Class 0.083	0.83-hr (5-min)
Class 0.25	0.25-hr (15-min)
Class 2	2-hr
Class 6	6-hr
Class 48	48-hr
Class X	Other time, in hours, as required by application, code or user

Table 14.8.1(b) – Designation Types of EPSSs

DESIGNATION TYPE	POWER RESTORATION
Type U	Basically uninterruptible (UPS systems)
Type 10	10-sec
Type 60	60-sec
Type 120	120-sec
Type M	Manual stationary or non-automatic – no time limit

This standard recognizes two (2) levels of equipment installation, performance and maintenance.

- a. Level 1 systems shall be installed where failure of the equipment to perform could result in loss of human life or serious injuries.
- b. Level 2 systems shall be installed where failure of the EPSS to perform is less critical to human life and safety.

All equipment shall be permanently installed.

14.8.2 EMERGENCY POWER SUPPLY:

1. ENERGY CONVERTERS: Energy converters shall consist only of rotating equipment. Rotating equipment shall consist of a generator driven by an Otto cycle (spark ignited) prime mover.

Where used for Level 1 applications, the prime mover shall not mechanically drive any equipment other than its operating accessories and its generator.

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Seismic design category C, D, E or F, as determined in accordance with ASCE 7, shall require a Level 1 EPSS Class X (minimum of 96-hours of fuel supply).

The EPS shall be heated as necessary to maintain the water jacket and battery temperature determined by the EPS manufacturer for cold start and load acceptance for the type of EPSS.

The energy converters shall have the required capacity and response to pick up and carry the load within the time specified in Table 14.8.1(b) after loss of primary power.

Liquefied petroleum gas intended for Level 1 use shall not be used for any other purpose.

2. ROTATING EQUIPMENT: Prime movers and accessories shall comply with NFPA 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines, except as modified in this standard.

Proper derating factors, such as altitudes, ambient temperature, fuel energy content, accessory losses and site conditions as recommended by the manufacturer of the generator set shall be used in determining whether or not brake power meets the connected load requirements.

Solenoid valves, where used, both in the fuel line closest to the generator set and in the water-cooling lines, shall operate from battery voltage.

Solenoid valves with electric operation shall include a manual bypass valve. The manual bypass valve shall be visible, accessible and its purpose identified. The manual bypass valve shall not be the valve used for malfunction or emergency shutdown.

The prime mover shall be provided with the following instruments:

- a. Oil pressure gauge to indicate lubricating oil pressure. Engines with splash-lubricated systems shall not require this gauge.
- b. Temperature gauge to indicate cooling medium temperature. Air-cooled engines shall not require this gauge.
- c. Hour meter to indicate actual total running time.
- d. Battery-charging meter indicating performance of prime mover–driven battery charging means.
- e. Other instruments as recommended or provided by the prime mover manufacturer where required for maintenance.

The instruments shall be placed on an enclosed panel, located in proximity to or on the energy converter, in a location that allows maintenance personnel to observe them readily. The enclosed panel shall be mounted by means of anti-shock vibration mountings if mounted on the energy converter.

The generator set shall be fitted with an integral accessory battery charger, driven by the prime mover and automatic voltage regulator and capable of charging and maintaining the starting battery unit (and control battery, where used) in a fully charged condition during a running condition.

A battery charger driven by the prime mover shall not be required, provided the automatic battery charger has a high–low rate capable of fully charging the starting battery during running conditions.

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3. **STARTING EQUIPMENT:** Starting shall be accomplished using either an electric starter or a stored energy starting system.

A complete cranking cycle shall consist of an automatic crank period of approximately 15 seconds followed by a rest period of approximately 15-seconds. Upon starting and running the prime mover, further cranking shall cease.

Otto cycle prime movers of 15-kW and lower shall be permitted to use continuous cranking methods.

Each prime mover shall be provided with both of the following:

- a. Storage battery units as specified in Table 14.8.2.
- b. A storage rack for each battery or battery unit.

Additionally:

- a. The battery units shall have the capacity to maintain the recommended cranking speed through two (2) complete periods of cranking limiter time-outs as specified in Table 14.8.2.

Table 14.8.2 – Starting Equipment

REQUIREMENTS	LEVEL 1	LEVEL 2
Battery Unit	X	X
Battery Certification	X	NA
Cycle Cranking	X	O
Cranking Limiter Time-outs		
Cycle Crank (3-cycles)	75-sec	75-sec
Continuous crank	45-sec	45-sec
Float-type Battery Charger	X	X
Recharge Time	24-hr	36-hr
Low Battery Voltage Alarm Contacts	X	X

X: Required, O: Optional, NA: Not applicable.

- b. The batteries shall be of the nickel-cadmium or lead-acid type.
- c. Lead-acid batteries shall be furnished as charged when wet. Drain-dry batteries or dry charged lead-acid batteries shall be permitted.
- d. When furnished, vented nickel-cadmium batteries shall be filled and charged and shall have listed flip-top, flame arrester vent caps.
- e. The manufacturer shall provide installation, operation and maintenance instructions and for batteries shipped dry, electrolyte mixing instructions.
- f. Batteries shall not be installed until the battery charger is in service.
- g. All batteries used in this service shall have been designed for this duty and shall have demonstrable characteristics of performance and reliability acceptable to the authority having jurisdiction.
- h. Batteries shall be prepared for use according to the battery manufacturer's instructions.

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In addition to the prime mover driven charger an automatic battery charger shall be supplied for recharging or maintaining a charge, or both, on the starting or control battery unit, or both.

The automatic battery charger output and performance shall be compatible with the batteries furnished.

4. CONTROL FUNCTIONS: A control panel shall be provided and shall contain the following:
 - a. Automatic remote start capability.
 - b. Run-Off-Automatic switch.
 - c. Shut down under any of the following conditions:
 - (1) Failing to start after specified cranking time.
 - (2) Over speed.
 - (3) Low lubricating-oil pressure.
 - (4) High engine temperature.
 - (5) Operation of remote manual stop station.
 - d. Individual alarm indication to annunciate any of the conditions listed.
 - e. Controls to shut down the prime mover upon removal of the initiating signal or manual emergency shutdown.
 - f. Instruments for Level 1 applications shall contain the following:
 - (1) An AC voltmeter for each phase or a phase selector switch.
 - (2) An AC ammeter for each phase or a phase selector switch.
 - (3) A frequency meter.
 - (4) A voltage-adjusting rheostat to allow ± 5 -percent voltage adjustment.

14.8.3 TRANSFER SWITCH EQUIPMENT:

1. GENERAL: Transfer switches shall transfer electric loads from one (1) power source to another. The electrical rating shall be sized for the total load that is designed to be connected.

Each transfer switch shall be in a separate enclosure or compartment. The switch, including all load current-carrying components, shall be designed to withstand the effects of available fault currents. Each switch shall be listed for emergency service as a completely factory-assembled and factory-tested apparatus.

2. SOURCE MONITORING: Transfer to the EPS shall be inhibited until the voltage and frequency are within a specified range to handle loads to be served. Sensing equipment shall not be required in the transfer switch, provided it is included with the engine control panel. Frequency-sensing equipment shall not be required for monitoring the public utility source where used as an EPS.

A program timing device shall be provided to exercise the EPS. Transfer switches shall transfer the connected load to the EPS and immediately return to primary power automatically in case of an EPS failure. Exercising timers shall be permitted to be located at the engine control panel in lieu of inside the transfer switches.

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14.8.4 ENVIRONMENTAL CONSIDERATIONS:

1. GENERAL: When the normal power source is not available, the EPS shall be permitted to serve optional loads other than system loads, provided that the EPS has adequate capacity or automatic selective load pickup and load shedding are provided as needed to ensure adequate power to the Level 1 loads, the Level 2 loads and the optional loads, in that order of priority.

When normal power is available, the EPS shall be permitted to be used for other purposes such as peak load shaving, internal voltage control, load relief for the utility providing normal power or cogeneration.

2. LOCATION: The EPS shall be installed in a separate room for Level 1 installations. EPSS equipment shall be permitted to be installed in this room.

The room shall have a minimum 2-hour fire rating or be located in an adequate enclosure located outside the building capable of preventing the entrance of snow or rain.

No other equipment, including architectural appurtenances, except those that serve this space, shall be permitted in this room.

3. MOUNTING: Rotating energy converters shall be installed on solid foundations to prohibit sagging of fuel, exhaust or lubricating oil piping and damage to parts resulting in leakage at joints.

Such foundations or structural bases shall raise the engine at least 6-inches above the floor or grade level and be of sufficient elevation to facilitate lubricating-oil drainage and ease of maintenance.

Vibration isolators shall be installed either between the rotating equipment and its skid base or between the skid base and the foundation or inertia base.

4. HEATING AND VENTILATING: With the EPS running at rated load, ventilation air flow shall be provided to prevent the EPS room temperature from exceeding 120-degrees Fahrenheit.

The ambient air temperature in the EPS equipment room or outdoor housing containing Level 1 rotating equipment shall be not less than 40-degrees Fahrenheit.

Ventilation air supply and discharge for radiator-cooled EPS shall have a maximum static restriction of 0.5-inches of water column in the discharge duct at the radiator outlet.

5. LIGHTING: The Level 1 or Level 2 EPS equipment location(s) shall be provided with battery-powered emergency lighting. This requirement shall not apply to units located outdoors in enclosures that do not include walk-in access.

The emergency lighting charging system and the normal service room lighting shall be supplied from the load side of the transfer switch.

14.8.5 ROUTINE TESTING:

1. GENERAL: Consideration shall be given to temporarily providing a portable or alternate source whenever the emergency generator is out of service.

At least two (2) sets of instruction manuals for all major components of the EPSS shall be supplied by the manufacturer(s) of the EPSS.

For Level 1 systems, instruction manuals shall be kept in a secure, convenient location, one (1) set near the equipment and the other set in a separate location.

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Provide spare parts as recommended by the manufacturer.

2. MAINTENANCE AND OPERATIONAL TESTING: The EPSS shall be maintained to reasonably ensure that the system can supply service within the time specified for the type and the time duration specified for the class.

A routine maintenance and operational testing program shall be initiated immediately after the EPSS has passed acceptance tests or after completion of repairs that impact the operational reliability of the system.

The operational test shall be initiated at an ATS and shall include testing of each EPSS component on which maintenance or repair has been performed, including the transfer of each automatic and manual transfer switch to the alternate power source, for a period of not less than 30-minutes under operating temperature.

Transfer switches shall be subjected to a maintenance and testing program that includes all of the following operations:

- a. Checking of connections.
- b. Inspection or testing for evidence of overheating and excessive contact erosion.
- c. Removal of dust and dirt.
- d. Replacement of contacts when required.

Storage batteries used in connection with systems shall be inspected weekly and maintained in full compliance with manufacturer's specifications.

Maintenance of lead-acid batteries shall include the monthly testing and recording of electrolyte specific gravity. Battery conductance testing shall be permitted in lieu of the testing of specific gravity when applicable or warranted.

Defective batteries shall be replaced immediately upon discovery of defects.

Generator sets shall be exercised at least once a month with the available EPSS load for 30 minutes or until the water temperature and the oil pressure have stabilized.

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SECTION 14.9 – LIQUEFIED PETROLEUM GAS

14.9.1 GENERAL:

1. SCOPE: This portion of the standard applies to the storage, handling and use of LP-Gas.
2. APPLICATION: This portion of the standard shall apply to the installation of all LP-Gas systems including containers, piping and associated equipment, when delivering LP-Gas to a standby generator for use as fuel gas.
3. REFERENCED PUBLICATIONS: The documents or portions of publications that are referenced shall be considered part of the requirements of this standard.
 - a. National Fire Protection Association (NFPA) Publications:
 - (1) NFPA 13, Standard for the Installation of Sprinkler Systems.
 - (2) NFPA 54, National Fuel Gas Code.
 - (3) NFPA 58, Liquefied Petroleum Gas Code.
 - (4) NFPA 101, Life Safety Code.
 - b. American Petroleum Institute (API) Publications:
 - (1) API-ASME, Code for Unfired Pressure Vessels for Petroleum Liquids and Gases.
 - (2) API Publication 1632, Cathodic Protection of Underground Petroleum Storage Tanks and Piping Systems.
 - c. American Society of Mechanical Engineers (ASME) Publications:
 - (1) ASME Boiler and Pressure Vessel Code.
 - (2) ASME B31.3, Process Piping.
 - d. American Society for Testing and Materials International (ASTM) Publications:
 - (1) ASTM A 53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - e. Underwriters Laboratories Inc. (UL) Publications:
 - (1) ANSI/UL 21, Standard for LP-Gas Hose.
 - (2) ANSI/UL 125, Standard for Valves for Anhydrous Ammonia and LP-Gas (Other than Safety Relief).
 - (3) ANSI/UL 132, Standard for Safety Relief Valves for Anhydrous Ammonia and LP-Gas.
 - (4) ANSI/UL 144, Standard for LP-Gas Regulators.
4. DEFINITIONS: The following definitions shall apply to the terms used in this portion of the standard:
 - a. API-ASME Container: A container constructed in accordance with the pressure vessel code jointly developed by the American Petroleum Institute and the American Society of Mechanical Engineers.

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- b. ASME Code: The American Society of Mechanical Engineers Boiler and Pressure Vessel Code.
- c. ASME Container: A container constructed in accordance with the ASME Code.
- d. Container: Any vessel, including cylinders, tanks, portable tanks and cargo tanks, used for the transporting or storing of LP-Gases.
- e. Container Appurtenances: Devices installed in container openings for safety, control or operating purposes.
- f. Fixed Piping System: Piping, valves and fittings permanently installed in a location to connect the source of the LP-Gas to the utilization equipment.
- g. Liquefied Petroleum Gas (LP-Gas): Any material having a vapor pressure not exceeding that allowed for commercial propane that is composed predominantly of the following hydrocarbons, either by themselves or as mixtures: propane, propylene, butane (normal butane or isobutene) and butylenes.
- h. LP-Gas System: An assembly consisting of one (1) or more containers with a means for conveying LP-Gas from a container to dispensing or consuming devices that incorporates components that control the quantity, flow, pressure and physical state (liquid or vapor) of the LP-Gas.
- i. Maximum Allowable Working Pressure (MAWP): The maximum pressure at which a pressure vessel is to operate is described by the ASME Boiler and Pressure Vessel Code.
- j. Mounded Container: An ASME container designed for underground service installed above the minimum depth required for underground service and covered with earth, sand or other material; or an ASME container designed for above-ground service installed above grade and covered with earth, sand or other material.
- k. Piping Systems: Pipe, tubing, hose and flexible rubber or metallic hose connectors with valves and fittings made into complete systems for conveying LP-Gas from one (1) point to another in either the liquid or the vapor state at various pressures.
- l. Pressure Relief Device: A device designed to open in order to prevent the rise of internal pressure in excess of a specified value.
- m. PSI: Pounds per square inch.
- n. PSIA: Pounds per square inch, absolute.
- o. PSIG: Pounds per square inch gauge.
- p. Regulator:
 - (1) First-Stage Regulator: A pressure regulator for LP-Gas vapor service designed to reduce pressure from a container to 10.0-psig or less.
 - (2) Second-Stage Regulator: A pressure regulator for LP-Gas vapor service designed to reduce first-stage regulator outlet pressure to 14-inch water column (w.c.) or less.
- q. SCFM: Standard cubic feet per minute.

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- r. Sources of Ignition: Devices or equipment that, because of their modes of use or operation, are capable of providing sufficient thermal energy to ignite flammable LP-Gas vapor–air mixtures when introduced into such a mixture or when such a mixture comes into contact with them and that will permit propagation of flame away from them.
- s. Standard Cubic Foot (SCF): The volume of gas in cubic feet at the standard atmospheric conditions for 60-degrees Fahrenheit and 14.7 PSIA.
- t. Valve:
 - (1) Emergency Shutoff Valve: A shutoff valve incorporating thermal and manual means of closing that also provides for remote means of closing.
 - (2) Filler Valve: A valve that is designed to allow liquid flow into a container.
 - (3) Pressure Relief Valve: A type of pressure relief device designed to both open and close to maintain internal fluid pressure.
- u. Water Capacity: The amount of water at 60-degrees Fahrenheit required to fill a container.

14.9.2 CONTAINERS:

1. GENERAL: Containers shall be designed, fabricated, tested and marked (or stamped) in accordance with the regulations of the U.S. Department of Transportation (DOT); the ASME Boiler and Pressure Vessel Code, Section VIII, “Rules for the Construction of Unfired Pressure Vessels”; or the API-ASME Code for Unfired Pressure Vessels for Petroleum Liquids and Gases, except for UG-125 through UG-136.

Existing containers that show excessive denting, bulging, gouging or corrosion shall not be utilized for service.

ASME containers installed underground, partially underground or as mounded installations shall incorporate provisions for cathodic protection and shall be coated with a material recommended for the service that is applied in accordance with the coating manufacturer’s instructions.

2. SERVICE PRESSURE: The maximum allowable working pressure (MAWP) for ASME containers shall be in accordance with Table 14.9.2:

Table 14.9.2 – Maximum Vapor Pressure and Maximum Allowable Working Pressure (MAWP)

MAXIMUM VAPOR PRESSURE	MAWP	MAWP
at 100°F	ASME (CURRENT CODE) ^a	API-ASME (EARLIER CODE)
psig	psig	psig
80	100	100
100	125	125
125	156	156
150	187	187
175	219	219
215	250	250
215	312	312

^a ASME Code, 1949 edition, paragraphs U-200 and U-201, and all later editions.

All ASME containers complying with the 1946 edition and paragraphs U-68 and U-69 of the 1949 edition shall be removed from service.

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3. CONTAINER OPENINGS: ASME containers shall be equipped with openings for the service for which the container is to be used.

ASME containers of more than 30-gallons through 2000-gallons water capacity that are designed to be filled volumetrically shall be equipped for filling into the vapor space.

ASME containers of 125-gallons through 2000-gallons water capacity shall be provided with an opening for an actuated liquid withdrawal excess-flow valve with a connection not smaller than 3/4-inch national pipe thread.

ASME containers in storage or use shall have pressure relief valve connections that have direct connection with the vapor space of the container.

ASME containers to be filled on a volumetric basis shall be fabricated so that they can be equipped with a fixed maximum liquid level gauge(s) that is capable of indicating the maximum permitted filling level(s).

4. CONTAINER MARKING: The markings specified for ASME containers shall be on a stainless steel metal nameplate attached to the container, located to remain visible after the container is installed.
- a. The nameplate shall be attached in such a way as to minimize corrosion of the nameplate or its fastening means and not contribute to corrosion of the container.
 - b. Where the container is buried, mounded, insulated or otherwise covered so the nameplate is obscured, the information contained on the nameplate shall be duplicated and installed on adjacent piping or on a structure in a clearly visible location.
 - c. Stationary ASME containers shall be marked with the following information:
 - (1) Service for which the container is designed (e.g., underground, aboveground or both).
 - (2) Name and address of container supplier or trade name of container.
 - (3) Water capacity of container in pounds or U.S. gallons.
 - (4) MAWP in pounds per square inch.
 - (5) Wording that reads "This container shall not contain a product that has a vapor pressure in excess of ____-psig at 100°F" (see Table 14.9.2).
 - (6) Outside surface area in square feet.
 - (7) Year of manufacture.
 - (8) Shell thickness and head thickness.
 - (9) OL (overall length), OD (outside diameter) and HD (head design).
 - (10) Manufacturer's serial number.
 - (11) ASME Code symbol.
 - (12) Minimum design metal temperature ____ °F at MAWP ____ psi.

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- (13) Type of construction “W”.
 - (14) Degree of radiography “RT-___”.
 - d. Warning labels shall include information on the potential hazards of LP-Gas.
5. CONTAINER APPURTENANCES AND REGULATORS: Container appurtenances and regulators shall be fabricated of materials that are compatible with LP-Gas and shall be resistant to the action of LP-Gas under service conditions. The following materials shall not be used:
- a. Gray cast iron.
 - b. Nonmetallic materials, for bonnets or bodies of valves or regulators.
 - c. Pressure-containing metal parts of appurtenances shall have a minimum melting point of 1,500-degrees Fahrenheit, except for the following:
 - (1) Fusible elements.
 - (2) Approved or listed variable liquid level gauges used in containers of 3,500-gallons water capacity or less.
 - d. Container appurtenances shall have a service pressure of at least 250-psig.
 - e. Gaskets used to retain LP-Gas in containers shall be resistant to the action of LP-Gas:
 - (1) Gaskets shall be made of metal or other material confined in metal having a melting point over 1500-degrees Fahrenheit or shall be protected against fire exposure.
 - (2) When a flange is opened, the gasket shall be replaced.
 - (3) Aluminum O-rings and spiral-wound metal gaskets shall be permitted.
 - (4) Gaskets for use with approved or listed liquid level gauges for installation on a container of 3,500-gallons water capacity or less shall be exempt from the minimum melting point requirement.

ASME containers shall be equipped with one (1) or more pressure relief valves that are designed to relieve vapor.

ASME containers for LP-Gas shall be equipped with direct spring-loaded pressure relief valves conforming with the applicable requirements of ANSI/UL 132, Standard for Safety Relief Valves for Anhydrous Ammonia and LP-Gas or other equivalent pressure relief valve standards.

14.9.3 REGULATORS:

First-stage regulators shall have a maximum outlet pressure setting of 1.0-psig. Second-stage regulators and integral 2-stage regulators shall have a maximum outlet pressure setting of 16-inch water column (w.c.).

Regulators shall be designed to drain condensate from the regulator spring case when the vent is directed vertically down. Pipe or tubing used to vent regulators shall be metal pipe or tubing.

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14.9.4 PIPE, TUBING AND FITTINGS:

Piping, pipe fittings and valves shall comply with NFPA 54.

Piping shall be wrought iron or steel (black or galvanized), brass, copper, polyamide or polyethylene. Tubing shall be steel, stainless steel, brass, copper, polyamide or polyethylene.

Fittings for metallic pipe and tubing shall be steel, brass, copper, malleable iron or ductile (nodular) iron. Fittings shall have a minimum pressure rating of 250-psig.

Fittings for polyamide and polyethylene pipe and tubing shall be heat fusion type, compression-mechanical type or factory-assembled transition type.

14.9.5 VALVES OTHER THAN CONTAINER VALVES:

Pressure-containing metal parts of valves shall be of steel, ductile (nodular) iron, malleable iron or brass. All materials used, including valve seat discs, packing, seals and diaphragms, shall be resistant to the action of LP-Gas under service conditions.

Valves shall have a service pressure rating of 250-psig. Manual shutoff valves, emergency shutoff valves, excess-flow check valves and backflow check valves used in piping systems shall comply with the provisions for container valves.

Valves shall be recommended for LP-Gas service by the manufacturer.

14.9.6 INSTALLATION OF LP-GAS SYSTEMS

1. GENERAL: LP-Gas containers shall be located outside of buildings. Containers shall be located with respect to the adjacent containers, important buildings, group of buildings or line of adjoining property that can be built upon, in accordance with Table 14.9.6:

Table 14.9.6 – Separation Distances Between Containers, Important Buildings and Line of Adjoining Property That Can Be Built Upon

WATER CAPACITY PER CONTAINER	ABOVEGROUND CONTAINERS	BETWEEN CONTAINERS
GAL	MINIMUM DISTANCE (FT)	MINIMUM DISTANCE (FT)
125 - 250	10	0
251 - 500	10	3
501 - 2,000	25	3

The 25-foot minimum distance from ASME containers of 501-gallons through 2000-gallons water capacity to buildings, a group of buildings, or the line of adjoining property that can be built upon shall be reduced to 10-feet for a single ASME container of 1200 gallons or less water capacity where such container is at least 25 feet from any other LP-Gas container of more than 125-gallons water capacity.

Containers shall not be stacked one (1) above the other. The area under containers shall be graded or shall have dikes or curbs installed so that the flow or accumulation of flammable liquids with flash points below 200-degrees Fahrenheit is prevented.

LP-Gas containers shall be located at least 10-feet from the centerline of the wall of diked areas containing flammable or combustible liquids.

An aboveground LP-Gas container and any of its parts shall not be located within 6-feet of a vertical plane beneath overhead electric power lines that are over 600 volts, nominal.

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2. CONTAINERS: Aboveground containers shall be painted.

Containers shall be installed so that all container operating appurtenances are accessible. To prevent flotation due to possible high flood waters, aboveground containers shall be securely anchored.

Horizontal ASME containers shall be placed on masonry or other noncombustible structural supports located on concrete or masonry foundations with the container supports.

Containers of 2000-gallons water capacity or less shall not be mounted with the outside bottom of the container shell more than 5-feet above the surface of the ground.

In locations where the monthly maximum depth of snow accumulation is more than the height of aboveground containers, excluding the dome cover, the following requirements shall apply:

- a. A stake or other marking shall be installed higher than the average snow cover depths, up to a height of 15-feet.
- b. The container shall be installed to prevent its movement resulting from snow accumulation.

3. CONTAINER APPURTENANCES: Pressure relief devices shall be installed so that the relief device is in direct contact with the vapor space of the container.

Pressure relief devices shall be so installed that any gas released is vented away from the container upward and unobstructed to the open air.

Shutoff valves shall not be installed between pressure relief devices and the container unless a listed pressure relief valve manifold is used.

Shutoff valves shall not be installed at the outlet of a pressure relief device or at the outlet of the discharge piping where discharge piping is installed.

4. REGULATORS: All first-stage and second-stage regulators shall be designed, installed or protected so their operation will not be affected by the elements (freezing rain, sleet, snow, ice, mud or debris).

Single-stage regulators shall not be installed in piping systems.

5. PIPE, TUBING AND FITTINGS: All metallic LP-Gas piping shall be installed in accordance with ASME B 31.3. Metallic pipe joints shall be permitted to be threaded, flanged, welded or brazed. Metallic tubing joints shall be flared or brazed.

Buried metallic pipe and tubing shall be installed underground with a minimum 12-inch of cover. The minimum cover shall be increased to 18-inch if external damage to the pipe or tubing from external forces is likely to result. If a minimum 12-inch of cover cannot be maintained, the piping shall be installed in conduit or shall be bridged (shielded). Buried metallic pipe shall not use as a grounding electrode.

Polyamide and polyethylene pipe, tubing and fittings shall be installed outdoors underground only.

Polyamide and polyethylene pipe and tubing shall be installed underground with a minimum 12 inch of cover. The minimum cover shall be increased to 18-inch if external damage to the pipe or tubing from external forces is likely to result. If a minimum 12-inch of cover cannot be maintained, the piping shall be installed in conduit or shall be bridged (shielded).

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After assembly, piping systems (including hose) shall be tested and proven free of leaks at not less than the normal operating pressure. Piping shall be pressure tested in accordance with NFPA 54. Tests shall not be made with a flame.

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SECTION 14.10 – STATIONARY COMBUSTION ENGINES

14.10.1 GENERAL:

1. SCOPE: This portion of the standard establishes criteria for minimizing the hazards of fire during the installation and operation of stationary combustion engines.
2. APPLICATION: This portion of the standard shall apply to new installations and to existing equipment and installations that are modified. This annex also applies to portable engines that remain connected for use in the same location for a period of 1-week or more.
3. REFERENCED PUBLICATIONS: The documents or portions of publications that are referenced shall be considered part of the requirements of this standard.
 - a. National Fire Protection Association (NFPA) Publications:
 - (1) NFPA 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.
 - (2) NFPA 54, National Fuel Gas Code.
 - (3) NFPA 58, Liquefied Petroleum Gas Code.
 - (4) NFPA 70, National Electrical Code.
 - (5) NFPA 110, Emergency and Standby Power Systems.
4. DEFINITIONS: The following definitions shall apply to the terms used in this portion of the standard:
 - a. Class I Fuel: For the purpose of this standard, any liquid fuel having a flash point below 100-degrees Fahrenheit.
 - b. Enclosure: A cover intended to protect an engine and related equipment.
 - c. Engines: Prime movers such as internal combustion engines, external combustion engines, gas turbine engines, rotary engines and free piston engines using either gaseous fuels or liquid fuels or combinations thereof.
 - (1) Engines for Emergency Use: Engines that operate under limited-use conditions to support critical operations in the protection of life, property or both.
 - (2) Reciprocating Engines: An engine that uses a spark plug to ignite a fuel-air mixture (e.g., otto cycle engine).
 - d. Gas Train: The portion of the fuel gas supply piping starting with and including the equipment isolation valve and extending to the point at which the fuel enters the prime mover.
 - e. Hazardous Location: An area where flammable or combustible gases or liquids or combustible dusts or flyings usually exist.

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- f. Valve:
 - (1) Automatic Safety Shutoff Valve (ASSV): A valve that, upon shutdown conditions, will automatically stop the flow of gas to the engine or turbine.
 - (2) Equipment Isolation Valve: The manually operated valve that isolates the balance of the gas train and the prime mover from the gas supply.
- g. Zero Governor Regulator: A gas pressure regulator equipped with a counter spring beneath the valve that requires an external impulse signal such as top loading with pressure or generating vacuum in the downstream piping.

14.10.2 ENGINE LOCATIONS:

1. GENERAL REQUIREMENTS: Engines shall be situated so that they are readily accessible for maintenance, repair and firefighting.

The air supply shall be designed to meet at least the minimum requirements for combustion, cooling and ventilation and to prevent flue gas products from being drawn from stacks or flues of boilers or other combustion devices.

Combustible materials shall not be stored in rooms or enclosures housing engines.

2. ENGINE ROOMS: Engine rooms located within structures shall have interior walls, floors and ceilings of at least 1 hour fire resistance rating.

Engine rooms shall have ventilation that is adequate to prevent a hazardous accumulation of flammable vapors or gases, both when the engine is operating and when it is shut down.

Openings from an engine room to other sections of the structure shall be provided with automatic or self-closing fire doors or dampers corresponding to the rating of the walls in which they are located.

Rooms containing engines utilizing a Class I fuel shall be located on an exterior wall, the construction of which shall provide ready accessibility for fire-fighting operations through the provision of doors, access openings, windows, louvers or lightweight, noncombustible wall panels.

Dedicated detached structures shall be of noncombustible or fire-resistive construction.

Dedicated detached structures shall be located at least 5-feet from openings in walls and at least 5 feet from structures having combustible walls. A minimum separation shall not be required where any of the following conditions exist:

- a. The exposing wall of the detached structure has a fire resistance rating of at least 1-hour.
 - b. The exposed wall of the adjacent structure has a fire resistance rating of at least 1-hour.
 - c. The detached structure is protected by an automatic fire protection system.
3. ENGINES LOCATED OUTDOORS: Engines, and their weatherproof enclosures, that are installed outdoors shall be located at least 5-feet from openings in walls and at least 5-feet from structures having combustible walls. A minimum separation shall not be required where either of the following conditions exist:
 - a. The adjacent wall of the structure has a fire resistance rating of at least 1-hour.

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- b. The weatherproof enclosure is constructed of noncombustible materials and it has been demonstrated that a fire within the enclosure will not ignite combustible materials outside the enclosure.
- 4. FOUNDATIONS: Engines shall be supported on foundations or secured to a noncombustible framework.
- 5. ELECTRICAL INSTALLATIONS: Electrical installations in rooms containing engines shall comply with NFPA 70, National Electrical Code.

Engine rooms or other locations shall not be classified as hazardous locations as defined in Article 500 of NFPA 70, National Electrical Code, solely by reason of the engine fuel, lubricating oil or hydraulic fluid.

14.10.3 FUEL SUPPLY

- 1. GAS PIPING: LP-Gas systems, whether liquid or vapor phase, shall be installed in accordance with the provisions of NFPA 58, Liquefied Petroleum Gas Code.

Plastic pipe shall not be used to carry fuel within a room housing an engine(s).

Approved metallic flexible connectors shall be permitted for protection against damage caused by settlement, vibration, expansion, contraction or corrosion.

- 2. GAS TRAINS: Gas trains shall contain the following safety components:
 - a. An equipment isolation valve.
 - b. A regulator, if the prime mover does not operate at the gas supply pressure.
 - c. Two (2) ASSVs.
 - d. A manual leak test valve for each ASSV or an alternative means of proving the full closure of the ASSV.
 - e. A low-pressure switch for engines with a 2.5-million BTU per hour, full-load input or greater.
 - f. A high-pressure switch (manual reset) for engines with a 2.5-million BTU per hour, full-load input or greater.
 - g. Any other components or equipment that the manufacturer requires for safe operation.
- 3. REGULATORS: A gas pressure regulator shall vent to atmosphere outside the structure at a point at least 5-feet away from any structure opening.
 - a. The following devices shall not be required to be vented to the outside when installed in accordance with their listing:
 - (1) Any regulator or zero governor that operates with gas pressure on both sides of the diaphragm.
 - (2) A full lock-up regulator.
 - (3) A regulator with a listed vent-limiting device.

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- (4) Such vents and any connected piping shall be sized to vent the required volume of gas.

4. VALVES:

a. Manual Shutoff Valves:

- (1) Multiple manual shutoff valves shall be permitted in the gas train to allow additional isolation for maintenance reasons.
- (2) If the shutoff valve is locked open, the key shall be secured in a well-marked, accessible location near the valve.
- (3) A manual shutoff valve in a remote location shall be provided to isolate the fuel supply.

b. Equipment Isolation Valves: In multiple-engine installations, the equipment isolation valve shall be located no further from the engine than the first takeoff or branch pipe that serves only that engine.

c. Automatic Safety Shutoff Valves (ASSVs): The ASSVs shall stop the flow of fuel within 1 second in the event the engine stops from any cause. The ASSV shall fail closed without an externally applied source of power.

It shall be permissible to replace one (1) of the ASSVs with one (1) of the following devices, provided the device will automatically shut off the flow of fuel within 1-second if the engine stops from any cause:

- (1) Carburetion valve.
- (2) Zero governor-type regulating valve.
- (3) Auxiliary valve.
- (4) Where a carburetion valve or zero governor-type regulating valve is used as one (1) of the required ASSVs, the downstream manual leak test valve shall not be required.

14.10.4 LUBRICATING SYSTEMS:

1. GENERAL REQUIREMENTS: Lubricating oil reservoirs shall include the following protective devices:

- a. A flame arrester on the vent pipe, if the vent terminates in the exhaust gas path.
- b. A high-oil-level alarm if the reservoir is filled automatically.
- c. A remote shutdown switch for auxiliary lubricating oil pumps, if provided.

The vent pipe shall not terminate in a location where the vapors can be drawn into the engine combustion air supply.

2. RECIPROCATING ENGINES: On engines where crankcase explosions can be a hazard, explosion venting shall be provided or means shall be used to maintain a nonflammable atmosphere in the crankcase.

Auxiliary reservoir oil supply chambers, if used, shall be vented through either separate vents or a common venting system.

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Engines designed to operate with a negative pressure in the crankcase and equipped with a separate lubricating oil sump shall be provided with check valves in the venting system from the sump.

14.10.5 ENGINE EXHAUST SYSTEMS:

1. **DESIGN AND CONSTRUCTION:** Engine exhaust systems shall be designed and constructed such that the system can withstand the anticipated exhaust gas temperatures.

Exhaust systems shall be designed and constructed to withstand the intended service.

Exhaust systems shall be designed and constructed to withstand forces caused by the ignition of unburned fuel or shall have provisions to relieve those forces without damaging the exhaust system.

Low points in exhaust systems shall have drains.

2. **INSTALLATION:** Exhaust systems shall be connected to the engine to prevent the escape of sparks, flame or flue gas within the structure.

Engine exhaust systems shall have one (1) or more flexible connectors if necessary, to minimize the risk of a leak in the engine exhaust system because of engine vibration or thermal expansion.

3. **EXHAUST SYSTEM TERMINATION:** Exhaust systems shall terminate outside the structure at a point where hot gases, sparks or products of combustion will discharge to a safe location.

Exhaust system terminations shall not be directed toward combustible material or structures or into atmospheres containing flammable gases, flammable vapors or combustible dusts.

Where necessary to prevent personnel burns, exhaust systems shall be guarded.

Exhaust pipes and ducts passing directly through combustible roofs shall be guarded at the point of passage by ventilated metal thimbles that extend not less than 9-inches on each side (above and below) of roof construction and are at least 6-inches in diameter larger than the exhaust pipe or duct.

Exhaust pipes and ducts passing directly through combustible walls or partitions shall be guarded at the point of passage by one (1) of the following methods:

- a. Metal ventilated thimbles not less than 12-inches larger in diameter than the exhaust pipe or duct.
- b. Metal or burned fire clay thimbles constructed of brickwork or other approved fireproofing materials providing not less than 8-inches of insulation between the thimble and combustible material.

14.10.6 CONTROL AND INSTRUMENTATION

Each engine shall be equipped with an automatic engine speed control.

Engines of 7.5-kW (10-hp) or more shall be equipped with protective devices or with equivalent provisions to shut down the engine when any of the following conditions occur:

- a. Engine overspeed.
- b. High jacket water temperature or high cylinder temperature.

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- c. Low lubricating oil pressure or, in the case of a splash-lubricated engine, low oil level.
- d. High lubricating oil temperature.

Each engine shall also have provision for shutting down the engine at the engine and from a remote location.

Engines that have lubricating oil pumps that are not directly driven by the engine shall also have provision for shutting down the lubricating pump from a remote location.

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SECTION 14.11 – FIBER OPTIC SYSTEMS

1. GENERAL

a. Definitions

- (1) Fiber Optic Distribution Cable (FODC).
- (2) Optical Ground Wire (OPGW).

2. MATERIAL: All fiber optic communications equipment shall be commercially manufactured off the-shelf items.

- a. Fiber Optic Underground Conduit, Buried: Where applicable, buried conduit system shall be SDR-11, 2 inch, tone-able, high density polyethylene (HDPE) conduit, orange in color, with heavy duty pull-tape, smooth exterior wall and ribbed interior wall, Carlon HDPE P/N A15BJ1JNNBxxxx, or equal, where xxxx is length as needed. Conduit system shall have a complete, easily accessible, tone-able link (for locating purposes), from TOS to cable trench, or fiber optic vault, as shown in standard drawings. Conduit system may include overhead to underground transition risers, cable transition seals or caps and fiber optic route markers (as applicable). Conduit system shall be airtight, to allow for installing the FODC using compressed air.
- b. Fiber Cable Storage Brackets: Coil bracket AFL CB-44-3AL, or equivalent, at all splice locations, on the transmission line and take-off-structures at substations.
- c. Inner-Duct: Furnish and install flexible fiber optic inner duct where fiber cable (excluding OPGW) is not in conduit. This includes but is not limited to: cable installed in telco ladder rack (overhead cable tray) and under raised computer floor. Inner duct shall be corrugated (for maximum flexibility), orange, 1.5-inch inner diameter and have a preinstalled pull tape. Inner duct shall be crush resistant, UL listed and designed for riser applications per NEC article 770.182 and resistant to the spread of fire per UL 2024, Vertical-Tray Flame Test (Riser). Install inner duct couplers and connectors to attach inner duct to conduit and to neatly terminate the installation.

3. FIBER OPTIC TESTING: Perform fiber optic testing in accordance with the following:

- a. Factory Tests of FODC and OPGW: Factory tests shall be performed on each fiber of every reel at the factory. Results shall be recorded and included in the packaging with the cables. Product data sheets showing the cable characteristics including dispersion, index of refraction, dimensional quality and tensile strength shall be provided from the manufacturer.
- b. Pre-installation Field Tests of FODC and OPGW: Contractor shall notify COR at least 14 days prior to pre-installation field tests to enable WAPA observers to be present. The Contractor shall test all fibers of each reel of FODC and OPGW upon delivery to ensure the fiber was not damaged during shipment and handling.
 - (1) Contractor shall submit optical time domain reflectometer (OTDR) charts (on CD: raw test data and PDF formatted chart data) at 1310-nm and 1550-nm (single-mode fiber), 850 nm (multi-mode fiber), showing launch conditions and all other parameters used in setup, time and date, as well as a diagram of the test setup. For these tests, each fiber, in turn, shall be mechanically spliced to a single-mode launch fiber, minimum of 1 km in length, which is connected to the OTDR (record length of launch cable). The OTDR charts shall illustrate and quantify the losses of each length of fiber and stress points on the fiber. Review the traces carefully and explain unusual discontinuities in detail. The OTDR testing waveforms, in native format from the test set, shall be stored on an optical disk and included with the required submittals, as well as, PDF formatted

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waveforms via email to WAPA-A7930. If OTDR testing is performed using equipment other than Wavetek or Tektronics, the Contractor shall supply WAPA with legitimate test set vendor software necessary to view and manipulate the native test set waveforms.

- c. Post-Installation Field Tests of FODC and OPGW: Contractor shall notify COR at least 7 days prior to the post-installation field tests to enable WAPA observers to be present. Perform end-to-end testing from each fiber patch panel appearance, at each end of the completed fiber path. These tests shall include:
 - (1) Contractor shall submit optical time domain reflectometer (OTDR) charts (on CD: raw test data and PDF formatted chart data) at 1310-nm and 1550-nm (single-mode fiber), 850 nm (multi-mode fiber), showing launch conditions and all other parameters used in setup, time and date, as well as a diagram of the test setup. For these tests, each fiber, in turn, shall be mechanically spliced to a single-mode launch fiber, minimum of 1 km in length, which is connected to the OTDR (record length of launch cable). These charts shall illustrate and quantify the losses at each splice, length of fiber and stress points on the fiber. These tests shall document all splices along the optical path. Contractor to review the traces carefully and explain unusual discontinuities in detail. OTDR measurements shall be made in both directions and the splice loss results bidirectionally averaged. Bidirectional averaged values shall be clearly displayed in a separate table that identifies each splice location by transmission line and structure number. Bidirectionally averaged splice loss shall not exceed 0.10dB and shall not exceed 0.15dB in either direction. Submit OTDR results for every fiber of the completed fiber system. The OTDR testing waveforms, in native format from the test set, shall be stored on an optical disk and included with the required submittals, as well as PDF formatted waveforms via email to WAPA-A7930. If the OTDR testing is performed using equipment other than Wavetek or Tektronics, the Contractor shall supply WAPA with legitimate test set vendor software necessary to view and manipulate the test set waveforms.
 - (2) Optical loss testing (end to end): Perform continuity and attenuation tests at 1310 nm and 1550 nm (single-mode fiber), 850 nm (multi-mode fiber), using an optical loss test set pair (power meter pair), on each complete fiber path. Testing shall demonstrate/verify continuity, fiber sequence integrity (i.e., fiber 1 to 1, fiber 2 to 2, etc.) and quantify overall end-to-end losses for each fiber.
- d. Instrument Calibration: All test equipment shall be calibrated with certification traceable to the National Institute of Standards and Technology relative to their intended use. Vendor to provide test equipment model number, serial number and calibration dates of test equipment as part of the test data package.
- e. Qualifications of Splicing and Testing Personnel: The fiber optic tester shall have a minimum of 1-year testing and operations experience with the OTDR test equipment used for tests required in this specification, and shall be able to use all necessary test equipment without reference to test equipment instruction books while performing the required tests specified herein. All personnel performing splicing shall be certified to do so by the Electronic Technician Association or equivalent training program.

4. FIBER OPTIC COMMUNICATION DRAWINGS AND DATA:

- a. All drawings and technical data, shown in Table 14.11-1, are required to be furnished by the Contractor and shall be in English. The Drawings and data shall be complete and accurate in their content. Originals and all copies shall be legible.

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TABLE 14.11-1 – Fiber Optic Drawings and Data Schedule

TYPE OF DRAWINGS, DATA and SOFTWARE	DELIVERY TIME	TYPE OF MATERIAL
Fiber optic material data	40-days after NTP*	Catalog sheets
Factory tests	With shipment	Test results
OTDR software to read and manipulate raw OTDR files	With Test Results	Software and license from OTDR vendor
Pre-Installation test: 1. Test setup diagram 2. Test Equipment (Make/Model/SN/Calibration date)	14-days after completion of tests	OTDR data CD (raw data & PDF), Test setup diagram & Software to read and evaluate raw OTDR files.
Post-installation field test results 1. Preliminary test data 2. Final test report	1. 1-2-days after testing 2. 14-days after completion of tests	OTDR data CD (raw data & PDF), Test setup diagram & Software
Post-installation test: 1. Test setup diagram 2. Test Equipment (Make/Model/SN/Calibration date)	14-days after completion of tests	PDF file format
Certification of personnel for fiber optic testing	40-days after NTP*	Copy of certification

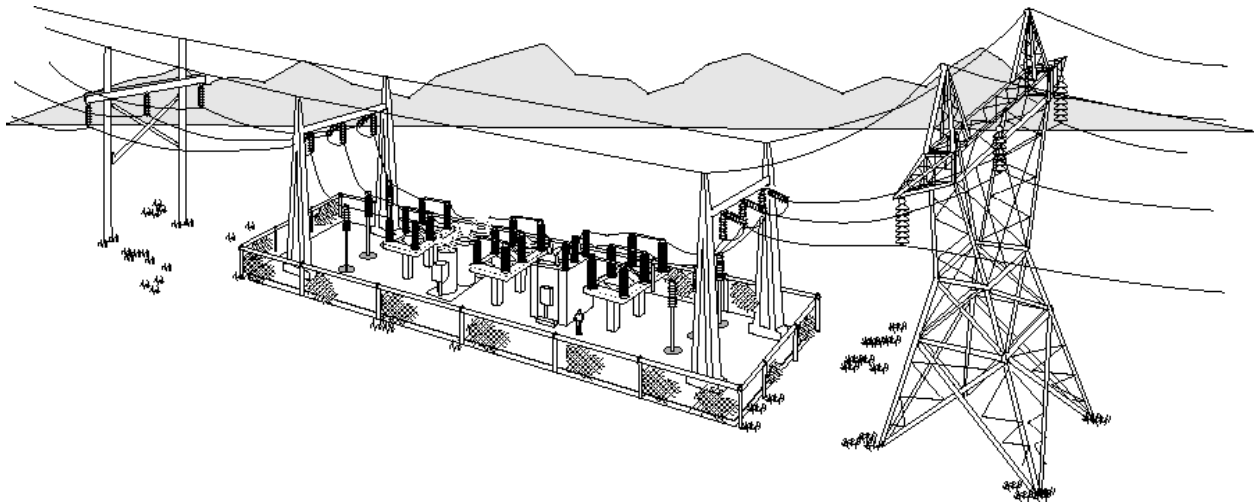
* NTP = Notice to Proceed



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CONSTRUCTION STANDARDS

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SECTION 15.1 – GENERAL:

1. **SPECIFICATION DRAWINGS:** Specification drawings included herein are reduced reproductions and are not to scale. Some specification drawings show details of fabrication and other information not a part of the work. Disregard information and details, which are not applicable.
2. **CONSTRUCTION DRAWINGS:** Construction drawings are the specification drawings and any additional drawings required for use in construction. The construction drawings will be issued after contract award and may include amendment changes and other details, which make the drawings suitable to use for construction purposes.
3. **STANDARD DRAWINGS:** Where details shown on standard drawings included herein differ from project specification drawings or text, the details of project specification drawings or text shall govern.
4. **INFORMATIONAL DRAWINGS:** Some specification drawings have the words “FOR INFORMATION ONLY” appearing above the title block. These drawings show some information, which may be required for bidding purposes. These drawings do not show items to be furnished or work to be performed.
5. **EXISTING INSTALLATION DRAWINGS:** Some specification drawings have the words “Existing Installation” appearing above the title block. These drawings show the existing installations prior to modifications and may show some new work to be performed.
6. **REFERENCE DRAWINGS:** Reference drawings referred to on specification drawings, and not included herein, are not necessary for bidding purposes.
7. **CONTRACTOR'S RESPONSIBILITY:** Check all drawings and advise WAPA of any errors or omissions.
8. **ADDITIONAL AND REVISED DRAWINGS:** After award of contract, construction drawings will be furnished; and the specifications drawings may be supplemented by additional or revised general and detail drawings. Additional or revised drawings may show dimensions and details necessary for construction purposes more completely than are shown on the specification drawings for features of the work and for material and equipment not purchased prior to bid opening. Perform the work in accordance with the additional general and detail drawings or revisions furnished by WAPA at the applicable prices bid in the Bidding Schedule.
9. **ADDITIONAL COPIES OF DRAWINGS:** After award of contract, WAPA will furnish the following:
 - a. Additional copies of the specifications which include reduced-size drawings.
 - b. Up to four (4) additional copies of the specifications and full-size prints of construction drawings may be provided by WAPA at the request of the Contractor.
10. **PLAN AND PROFILE DRAWINGS, SAG TABLES AND CHARTS:** Plan and profile drawings, sag tables, charts and other drawings required for construction will be furnished to the Contractor as soon as possible after Notice to Proceed.
11. **Maps showing total area needed for construction purposes and for long-term operation and maintenance purposes.** Maps should show the following:
 - a. Delineate areas that would be disturbed or modified and to what extent, such as bladed, excavated, overland travel, trampled, etc.

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- b. Access roads, to include cut and fill.
- c. Area needed for each structure to construct and operate and should include area needed for guy wires.
- d. Maps should be at a scale adequate to show enough detail to locate disturbance areas relative to topography or known structures and objects, and to show a land owner the level of disturbance to be expected.
- e. Maps should include:
 - (1) Aerial imagery
 - (2) Standard map legend items, such as established roads, towns, cities, land status – to include private land, city, county, federal, and tribal land identification.
 - (3) Transmission infrastructure standards, such as pole numbers.
- f. Maps should be in digital format, such as PDF, and include the GIS data.

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SECTION 15.2 – AS-BUILT DRAWINGS:

1. **GENERAL:** The Contractor shall keep one (1) complete set of full-size construction drawings at the jobsite solely for the purpose of recording as-built conditions. The Drawings shall be marked to show any change or variation in the actual construction, which does not match the construction drawings. The as-built set of drawings shall not be used for construction purposes.
2. **RECORDING INFORMATION:** Record information on the Drawings concurrently with construction progress. Do not conceal work until the required information is recorded. Mark all drawings affected by the actual work which varies from the construction drawings.
3. **MARKING OF DRAWINGS:** As-built drawing marking shall be as follows:
 - a. Additions and notes in red.
 - b. Deletions in green.
 - c. Explanation notes in blue.
4. **DRAWING REVIEW:** The marked set of as-built drawings shall be available for inspection at all times. Prior to all progress payments, the Contractor and WAPA shall review the marked drawings to verify that all as-built conditions have been recorded. Progress payments may be withheld until the Drawings are updated.
5. **AS-BUILT INFORMATION TO BE RECORDED:** Mark drawings with all actual construction which does not match the construction drawings including:
 - a. Field changes of dimension and detail.
 - b. Changes made by modifications.
 - c. Details not shown on original drawings.
 - d. Other information required to describe the as-built construction.
6. **SUBMITTALS:** Deliver complete set of marked as-built drawings to the COR for approval prior to the date of submission of your final invoice. See Section G, paragraph titled “Administrative Time”.

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SECTION 15.3 – LIST OF STANDARD DRAWINGS:

<https://www.wapa.gov/DoingBusiness/SellingToWestern/Pages/what-western-buys.aspx>