



Appendix B-4
Scope Book

2026 Request for Proposals
for
Developmental Combined-Cycle
Combustion Turbine Capacity and
Energy Resources
for
Entergy Texas, Inc.

ETI CCCT Plant
BOT Scope Book
February 11, 2026

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The following Sections attached hereto as Section A.1 through A.18 are adopted and fully incorporated by reference as if it were reproduced in its entirety.

SECTIONS:

Section A.1 – Project Requirements**

Section A.2 – Project Execution Plan Requirements and Milestone Schedule**

Section A.3 – Terminal Points List**

Section A.4 – Construction Requirements*

Section A.5 – Combustion Turbine Generator (CTG)**

Section A.6 – Heat Recovery Steam Generator (HRSG)**

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Section A.9 – Site Requirements and Design Criteria**

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Section A.17 – High Voltage Transmission Line Requirements and Design Criteria*

Section A-18 – Approved Manufacturers List*

- * ETI's requirements for this Section are included in this Scope Book.
- ** ETI's requirements for this Section are included in this Scope Book with Seller input.
- *** Section to be inserted by Seller as part of Proposal.

B-4.1

PROJECT SCOPE BOOK

The Scope Book is an exhibit to and part of the BOT Acquisition Agreement between the applicable Seller and Buyer (i.e., the Agreement). The Scope Book includes each of the Sections forming part of the Scope Book. This Appendix B-4 to the 2026 ETI CCCT RFP is a draft model version of the Scope Book for use in the RFP and remains under EAL's review. The priority of documentation and terms forming part of the Agreement (including the Scope Book) and ancillary agreements will be set forth in the Agreement. This Appendix B-4 should be reviewed in connection with Appendix B-3 to the RFP (Model CCCT BOT Term Sheet). For purposes of the RFP, in the event of a conflict that cannot be reasonably reconciled between the terms of Appendix B-3 to the RFP and this Appendix B-4, the terms of Appendix B-3 shall prevail and govern.

The Scope Book describes certain requirements with respect to the Work (which will be as defined in the Agreement). The Work requires Seller to provide, among other things, development, design, engineering, procurement, construction, contracting, permitting, commissioning, testing, performance verification, quality control, operation, maintenance, repair, replacement, and Buyer personnel training with respect to the Project and the project site in accordance with the terms of the Agreement (including the Scope Book). Notwithstanding anything to the contrary in the Scope Book, all Work to be performed by or for Seller pursuant to the Scope Book shall be performed in accordance with the performance standard (as generally described in Appendix B-3 (BOT Term Sheet) to this RFP and as fully defined in the Agreement).

The Purchase Price set forth in the Agreement will be established based upon the total Project requirements for Work supplied by Seller and is intended to include all Work requirements for the Project. The Scope Book is not intended to be a comprehensive list of every component or Work element required to complete the overall Project. The supplies or particular work elements that are not detailed in the Scope Book and any revisions to details that are not contained within the Scope Book, but that are agreed upon by the Parties with documented authority during the design review process, will not serve as a basis for adjustment to the Purchase Price. The terms for adjusting the Purchase Price are set forth exclusively in the Agreement.

B-4.1.1

PROJECT DESCRIPTION

The Project will be located on [a site within MISO LRZ-9]. The Project will consist of commercially-proven CCCT technology with a capacity from 650 to 800 MW at Summer Conditions. Operating parameters will include a maximum heat rate of 12,000 Btu/kWh at full output without supplemental duct-firing (if included as part of the facility). The Project will be fully permitted, and the CTG(s), STG(s), and HRSG(s) will have the agreed upon equipment warranties.

The project will utilize natural gas. Pipeline-quality natural gas will be supplied via one or more lateral pipelines interconnected to the Project with sufficient operating pressure to serve the project site. The Project shall be capable of running at full design capability utilizing the interconnection pipeline(s).

A more detailed description of the Project is contained in Section A.1 (“Project Requirements”).

B-4.1.2 PROJECT OBJECTIVES

B-4.1.2.1 Seller shall work to complete the Project in accordance with the following “Project Objectives”:

Without limiting the other terms of the Agreement, the Project will be designed taking into consideration the following objectives:

- Ensure safe operations, maintainability, and construction.
- Achieve a thirty (30)-year Project life.
- Facilitate maintenance work and provide access to all equipment according to the Project Standard (including Occupational Safety and Health Administration).
- Minimize operator surveillance.
- Provide reliable power to the grid meeting the latest NERC reliable power standards to minimize false trips.
- Achieve compliance with all Permit requirements (including local, states and federal permits must be secured) and guarantees required by the Agreement, including this Scope Book.
- Achieve specified requirements for Project output capacity, heat rate, reliability, emission limits, noise limits, and other Project performance criteria.
- Minimize adverse local community impacts.
- Minimize changes throughout engineering, design, procurement, and construction.

B-4.2 SCOPE BOOK

B-4.3 ENGINEERING & DESIGN

Seller shall be responsible for all engineering and design of the Project in accordance with this Scope Book and the remainder of the performance standard. If, during the Work, Seller discovers any conflicts between this Scope Book and the remainder of the performance standard, Seller shall promptly disclose to Buyer any such conflicts, which shall be resolved according to the Agreement. Seller shall cause all design and engineering materials, documents, drawings and calculations pertaining to the Project (collectively, the “Engineering Materials”) to be prepared by qualified, and authorized professional engineers licensed in the state in which Project is constructed.

Seller is responsible for assuring that the Scope Book for the Project, including Seller’s technical specifications referenced elsewhere in the Agreement or its Sections and any Buyer approved changes made by Seller thereto, will provide adequate and accurate information, and Seller is responsible for assuring that its

Contractors and Subcontractors deliver their respective scopes of supply in a manner that will meet the Project Objectives set forth in this Scope Book and will be in accordance with the Project Warranty and Performance Guarantees.

B-4.3.1 ENGINEERING MATERIALS REVIEW

All Engineering Materials (including the design basis and documents of conceptual, basic, and detailed design) must comply with this Scope Book and otherwise with the performance standard and shall be new, not used. Engineering design packages for conceptual design related to the Project, including for major procurement selection (“Phase A Deliverable”), for Permit applications or submissions (“Phase B Deliverables”), and, prior to issuance thereof, drawings for construction (“Phase C Deliverables”) shall be submitted for review and approval by Buyer in accordance with the dates therefor set forth in the Project Schedule. Within fifteen (15) Business Days after receipt of any Phase A Deliverable, and within ten (10) Business Days after receipt of any Phase B Deliverable, Phase C Deliverable, or subsequent revision to a Phase A Deliverable, Buyer may submit comments to Seller with respect to such Engineering Materials. In the event that Buyer does not provide comments within such fifteen (15) Business Day period, as applicable, such Engineering Materials shall be deemed approved. If Buyer provides comments within such fifteen (15) Business Day period, as applicable, Seller shall modify such Engineering Materials in response to any Buyer comments that identify errors or omissions in design or failures to comply with the performance standard, including this Scope Book, or the other terms of the Agreement, and Seller shall consider in good faith all other comments Buyer provides within such fifteen (15) Business Day period, as applicable. Seller shall resubmit the applicable revised Engineering Materials to Buyer within ten (10) Business Days after receiving Phase A comments from Buyer. Seller shall maintain a log of comments received from Buyer and how they have been addressed and shall submit such log to Buyer with the revised Engineering Materials. This procedure shall be repeated until such Engineering Materials are approved by Buyer. Seller shall not implement any portion of the Work based on any Engineering Materials until the same has been approved by Buyer; provided, however, that Seller shall be entitled to address issues identified in one design phase in the next subsequent design phase if necessary, for Seller to preserve the Project Schedule. Any change proposed to the Engineering Materials after approval thereof shall be subject to further approval by Buyer according to the process in this Section 3.2.

For the avoidance of doubt, and without limiting the performance standard, the Engineering Materials shall not include equipment that does not comply with Section A-18 (Approved Manufacturers List).

B-4.3.2 CERTAIN APPLICABLE STANDARDS

Without limiting any other aspect of the performance standard (including other standards that may be listed elsewhere in this Scope Book or the Agreement), the Project (including its design) shall comply with the standards listed in this Appendix and its Sections to the extent applicable to the Work being performed.

B-4.3.3 ENGINEERING DELIVERABLES

All engineering deliverables and services shall be provided by Seller to Buyer in accordance with the Project Execution Plan and the remainder of the performance standard. The latest version of the following deliverables with respect to the Project shall be delivered to Buyer as provided below. Updates to any such deliverable shall be delivered to Buyer as completed (with the final version of each such deliverable delivered to Buyer no later than Final Completion). Prior to the final versions, Seller shall provide such deliverables in native file format, if possible, but otherwise in PDF file format. The final version of all deliverables shall be provided (no later than Final Completion) in native file format. Final drawings must adhere to the Drawing Specification as shown in Section A.16.2.6. The listings in this Section 3.3 are not intended to and do not include all deliverables from Seller to Buyer required by this Scope Book or the Agreement. Nothing in this Section 3.3 shall limit Seller's obligation to provide to Buyer any additional deliverable that may be required by this Scope Book or the Agreement. Items denoted "X" in Table A.1-1 must be completed/accepted by the Buyer to achieve the stated Contractual Milestones.

B-4.3.4 SYSTEM DESCRIPTIONS

System descriptions of as-built systems included in Table A.1-1 shall be provided by Seller to Buyer based on draft examples supplied by Buyer to Seller at Mechanical Completion, with the final version of such system descriptions provided to Buyer by Final Completion.

B-4.3.5 OPERATING PROCEDURES

Project-specific operating procedures shall be provided by Seller based on examples provided by Buyer of procedures currently in use at existing facilities. The operating procedures are listed in Section A.4.

The operating procedures shall be task-oriented procedures in Buyer's format. They shall be initially issued by Seller prior to the Closing and reviewed with Buyer prior to initial issue. Following the Closing, the operating procedures shall be revised as necessary during the course of the Work to reflect the as-built status of Project systems and equipment and to take into account any comments from Buyer. The operating procedures shall be finalized by Final Completion and shall not be considered finalized until they reflect the final as-built status of Project systems and equipment and are approved by Buyer.

B-4.3.6 FIRE PROTECTION SYSTEM

Without limiting the performance standard, the Project (including facilities, systems, and equipment) shall have a fire protection system that meets all applicable Laws and Section A.11 - Fire Protection Requirements and Design Criteria.

B-4.3.7 STORM WATER DRAINAGE SYSTEM

Without limiting the performance standard, the Project shall have a storm water drainage system that meets all applicable Laws (including local, state, and federal requirements) and permits. The storm water drainage system shall be a combination of piped storm water, catch basins, buried pipes, culverts, swales, and sheet flow.

B-4.4 ADDITIONAL REQUIREMENTS

This Section 4 describes certain general requirements for the Project. Such requirements are the sole responsibility of Seller.

B-4.4.1 GENERAL

Seller shall furnish a safe, quality built, timely, complete, functional Project while safeguarding the environment and adhering to the performance standard, including all Laws and applicable Permits, Good Industry Practices, and the other requirements of this Scope Book and the Agreement. Seller shall utilize safe work practices throughout the Project's execution and have in place and maintain effective safety and quality control programs. Seller shall strictly follow all installation and instruction manuals of the OEMs in the performance of the Work.

B-4.4.2 PROCUREMENT PLAN

Seller shall provide procurement of goods and services needed for the Project in accordance with the Project Procurement Plan described in Section A.2 ("Project Execution Plan Requirements"), Section 7 ("Procurement Plan"), which addresses the purchase of equipment, material, goods and services.

B-4.4.3 SCOPE OF APPLICABILITY OF PROCUREMENT PLAN

The policies, responsibilities, standard procedures, and instructions included in the Procurement Plan shall apply to all procurement activities conducted by Seller to fulfill its obligations as detailed in the Agreement.

B-4.4.4 CONSTRUCTION

Seller shall (whether directly or otherwise through, for example, its EPC Contractor) arrange for and manage the construction of the Project in accordance with the Project Execution Plan (PEP) and the Agreement.

Seller will comply with the EPC Contractor's project health & safety plan until Substantial Completion has been achieved and the facility is turned over to Buyer.

Seller will liaise with representatives of the Buyer throughout the duration of the Project to demonstrate compliance with the PEP.

B-4.4.5 MOBILIZATION PLAN

Seller is responsible for the mobilization of field forces and all necessary construction facilities at the Project Site, including temporary office trailers as necessary or advisable for completion of the Work. Seller shall provide a temporary area lighting system sufficient for construction activities at the Project Site and to provide safe access to the Work areas during early morning and late evening hours of operation.

Seller is also responsible for the preparation and maintenance of unloading and laydown areas, Project Site craft parking areas, storage facilities, temporary buildings and other necessary facilities, as may be required.

Seller shall adequately prepare the laydown/office/parking areas to minimize any adverse effects from weather or other hazards to facilities or stored materials. Where required by the equipment manufacturer(s), air-conditioned storage including provisions for heaters, and covered indoor climate-controlled storage shall be provided by Seller. Any action taken by Seller for Project Site preparation shall not increase the risk that the Project Site could cause flooding to the adjacent properties.

B-4.4.6 SITE CONDITIONS

Seller shall take appropriate surface water, erosion, and dust control measures for the Project Site and the other areas where Seller is performing Work, including Project access roads utilized to perform Work, laydown areas, and craft parking areas, in accordance with the erosion and sedimentation Permit issued by the local conservation district or other relevant Governmental Authority and the performance standard.

Hazardous Substances shall be stored in accordance with applicable federal and state Environmental Protection Agency (EPA) requirements and other Laws and applicable Permits, and Project Site spill control measures shall be implemented in accordance with the performance standard.

Seller shall be responsible for all site development activities, including obtaining site survey, site preparation, necessary permits, and site security. Seller is responsible for all required construction power, potable water, and sanitary water supply and disposal. Refer to Section A.1.

B-4.4.7 RIGGING/EQUIPMENT PLANS

Seller is responsible for lifting, rigging, unloading and transporting of all equipment associated with the Project.

Seller shall prepare a comprehensive lifting and rigging plan for all major equipment/components lifts during construction. A rigging and lifting plan shall be developed and approved for all high-risk engineered lifts or critical lifts (including but not limited to lifting activity that requires the use of custom designed “below the hook” lifting devices, blind lifts, multiple cranes, lifts requiring greater than 75% of the lifting

capacity, or establishment of safeguards to control movement in the vicinity of energized facilities). Rigging and lifting plans for each high-risk engineered/critical lift shall be provided to the Buyer for approval at least four weeks in advance of when the lift is scheduled to take place. All rigging and lifting plans shall be prepared and sealed by a Professional Engineer licensed in the state where the Project is located.

Seller shall evaluate any special equipment requirements, including major crane needs prior to mobilization.

B-4.4.8 GENERAL CLEANING

Through Substantial Completion, Seller shall maintain the Project Site in a clean and orderly state. Seller shall remove all excess materials and ensure that all Work and maintenance areas, and all Work area access paths, remain unobstructed and in good, safe condition. After Substantial Completion, Seller shall be responsible for ensuring that any area where it is performing Work is kept clean and orderly and returned to at least substantially the same condition as existed prior to its performance of such Work (excluding any condition whose repair was a part of the Work).

B-4.4.9 DEMOBILIZATION

Upon completion of all required Work, Seller shall completely demobilize trailers, equipment, and other construction facilities or items, remove all temporary service connections, protect all equipment, systems, connections, and property for future use, and, unless otherwise instructed by Buyer, remove any Hazardous Substances and all non-hazardous construction debris, chemical wastes, etc. in strict accordance with Laws and applicable Permits and otherwise with the performance standard. Any lay down, construction parking, and/or work areas constructed on a temporary basis shall be retained for future use.

B-4.4.10 SECURITY

Seller shall develop and implement the Project Site Security Plan as required by the Agreement. Without limiting the foregoing, the Project Site Security Plan shall include:

- a) Installing security gates at all Project entrances with signs indicating an emergency contact telephone number;
- b) Plan and install permanent and temporary site security fencing and, as required, Seller shall provide remaining perimeter fence around the construction laydown/parking areas and the construction offices area for the duration of construction and Commissioning.
- c) Implementing a reasonably designed Project entrance gate procedure to provide controlled and monitored access;
- d) Staffing Project gate entrance as required by gate guards who maintain a date-and-time sign-in log for all deliveries and visitors;

- e) Providing security personnel with a telephone at the guard shacks and with mobile communication capability; and
- f) Providing security with emergency contact information and with communication capability with local emergency and law enforcement agencies for assistance in the event of a construction emergency.

B-4.4.11 SITE WORK, EXCAVATION, FILL, AND GRADING

Seller shall be responsible for the proper handling, storage (spoils pile(s)), and disposal, as applicable, of excavated soil materials in compliance with the procedures outlined in the Agreement for the handling and disposal of waste and/or contaminated Hazardous Substances.

All excavations shall be protected from the elements. Once foundations are stripped, Seller shall use all reasonable means to backfill the excavations adjacent to foundations. Any washouts or other deviations shall be immediately Remedied. Refer to Section A.14 for additional requirements.

B-4.4.12 COMMUNITY RELATIONS

Seller shall make best efforts to manage for all community relations for and with respect to the Project through Substantial Completion. Seller shall use best efforts to undertake such works and other activities as necessary or advisable to engender and maintain, and shall use best efforts to perform the Work and its other obligations under the Agreement in a manner that is intended to engender and maintain, a positive perception of the Project within, and a harmonious relationship with, the surrounding community, such that Buyer could reasonably be expected to inherit that perception and relationship at the Closing and thereafter preserves the same through Substantial Completion and, to the extent based on Seller's or Seller Service Providers' acts or omissions, thereafter.

B-4.4.13 FACILITIES FOR BUYER

Seller shall, starting at the start of physical construction on the Project Site and continuing until Substantial Completion, provide construction utilities and services stated in Section A.4 - Construction Requirements and A.16.1 - Division of Responsibilities Matrix.

B-4.4.14 LESSONS LEARNED

Buyer shall supply a lessons learned knowledge database to Seller.

Seller shall evaluate and incorporate lessons learned into the planning, work processes and work activities of this project.

B-4.4.15 ACRONYMS

Refer to the Section A.1 for acronyms, abbreviations, and definitions as used in the Scope Book and its Sections.



SECTION A.1

PROJECT REQUIREMENTS

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SECTION A.1
PROJECT REQUIREMENTS

A.1.1 PROJECT SCOPE

A.1.1.1 Introduction

A.1.1.1.1 Section A.1 describes the scopes of work assigned to the respective Parties, the schedule for performance of the Project, the methods for establishment of detailed Project schedules, and the general requirements of the Project. Major OEM Equipment Technical Specifications for the Combustion Turbine Generator (CTG), the Heat Recovery Steam Generator (HRSG), the Steam Turbine Generator (STG) and Generator Step-Up (GSU) Transformers are identified in Sections A.5 through A.8, respectively.

A.1.1.2 Description

A.1.1.2.1 The Project is based on the use of natural gas fired combustion turbine(s), heat recovery steam generator(s) and SCR with or without duct firing, and steam turbine generator(s) in a Combined Cycle Combustion Turbine (CCCT) configuration.

A.1.1.2.2 An air-cooled condenser or water-cooled condenser will be used for steam cycle heat rejection and recovery of condensate. The Facility closed cooling water system will utilize auxiliary heat exchangers for heat rejection. Local heat rejection will be accomplished via dedicated fin-fan coolers.

A.1.1.2.3 The HRSG SCR reagent shall be 29% aqueous ammonia.

A.1.1.2.4 The Project requires new Administration/Control/Warehouse, Demin/Wastewater Treatment, Steam/Water Sampling, and Fire Pump, and buildings. New Fire/Service Water and Demineralized Water tanks shall be field erected.

A.1.1.2.5 Not Used.

A.1.1.2.6 The Project actual heat balance load cases shall be based on meteorological data specified in Section A.9. Seller shall be responsible for providing revised heat balance load cases based on site data.

A.1.1.2.7 Not Used.

A.1.1.2.8 The Project shall be designed for a 30-year operating life. Redundancy shall be built into the Facility design to meet the reliability and availability requirements set forth herein. In general, the failure of a single piece of equipment should not cause a reduction in plant electric generation unless redundancy is specified elsewhere within Exhibit A. Major Equipment may be provided without full redundancy based on space availability, functional requirements, and operating experience, in accordance with the OEM's standard package arrangement and in accordance with Buyer's direction for cost efficient system design.

A.1.1.2.9 The Project shall be designed for local operation as the primary operating method, with capability for remote operation.

A.1.1.2.10 Design for Safety

Seller's design and engineering shall incorporate the Design for Safety principles. Design for Safety focuses on the early identification of potential construction, maintenance and operating personnel safety and health hazards, and eliminating or reducing these hazards through the design and engineering details. The designs supporting these principles include, but are not limited to:

- Addition of permanent safety eyewash and shower stations
- Use of permanent anti-slip ladder rungs
- Access stairs with a 11" minimum tread depth and 7" maximum riser height
- Locating components and instruments requiring routine access to be accessible from grade or platforms

A key component in Design for Safety includes regularly holding detail design reviews and soliciting input from Buyer, Seller, and Buyer's Engineer. OSHA's website has useful links on Design for Safety.

A.1.1.3 Work by Seller

A.1.1.3.1 Seller shall engineer, procure, design, build, construct, commission and test a complete, fully operational combined cycle generating plant in compliance with the BOT contract requirements (including the Scope Book), applicable laws and permits. Seller's scope is intended to include all Work requirements for the Project except for those expressly stated herein as being completed by Buyer or others. The data, diagrams, schematics, layouts, and arrangements are preliminary or conceptual in nature for Seller's reference and are not intended to be final or provide a comprehensive list of every component or Work element required to complete the Project. Seller's complete scope of Work shall include the tasks identified in this specification. A summary of Seller's scope of Work shall include, but is not to be limited to, the following:

A.1.1.3.2 Combustion turbine-generator (CTG) unit(s): the unit(s) shall be complete with all auxiliary equipment, accessories, and appurtenances (see Section A.5) and shall operate on pipeline natural gas only. The CTG shall be provided with dry low NOx combustors and evaporative inlet air cooling system. The OEM control system shall be provided for the CTG.

A.1.1.3.3 Heat recovery steam generator (HRSG) unit(s): three pressure, horizontal gas flow, reheat HRSG(s) with or without duct firing system, selective catalytic reduction (SCR) system, NO_x/CO catalyst, exhaust stack and all necessary accessories and appurtenances (see Section A.6).

- A.1.1.3.4 Steam turbine-generator (STG) unit(s): reheat, condensing steam turbine unit(s) with all necessary accessories and appurtenances (see Section A.7). The OEM control system shall be provided for the STG.
- A.1.1.3.5 Generator step-up transformers: three-phase, two winding, 60 Hz, step- up, outdoor, oil-immersed type, cooling class ONAN/ONAF/ONAF with all necessary accessories and appurtenances (see Section A.8).
- A.1.1.3.6 Steam condenser/condensate system: air cooled condenser or water cooled condenser with all necessary accessories and appurtenances for normal operation and steam turbine bypass conditions. System will include a condensate collection tank and condensate pumps, air ejector system, and a fin cleaning system.
- A.1.1.3.7 Closed Cooling water system: closed cooling water pumps, auxiliary heat exchangers, and associated chemical feed equipment. Circulating water system (if required): multi-cell mechanical draft cooling tower with bypass piping, circulating water pumps, and interconnecting circulating water piping.
- A.1.1.3.8 Critical piping systems: High Pressure Steam (HPS), Cold Reheat Steam (CRS), Intermediate Pressure Steam (IPS), Hot Reheat Steam (HRS), and Low-Pressure Steam (LPS) piping including safety relief valves, boiler feed piping, boiler feed pump including recirculation system, and steam turbine bypass piping including steam conditioning and pressure reducing valves.
- A.1.1.3.9 Fuel gas supply system, including fuel gas conditioning, metering equipment, filters, drain tanks, strainers, pressure and flow control valves, dewpoint and performance heaters and all interconnecting piping and valves. Fuel gas compression is not included in the scope of work.
- A.1.1.3.10 Aqueous ammonia unloading, storage and distribution, including all pumps and interconnecting piping and valves.
- A.1.1.3.11 Raw water source shall be determined by Seller.
- A.1.1.3.12 Potable Water source shall be determined by Seller.
- A.1.1.3.13 Balance of mechanical systems for a complete Project.
- A.1.1.3.14 Seller shall provide all hydrogen and carbon dioxide interconnecting piping, valves, electrical and instrumentation.
- A.1.1.3.14.a. Seller shall provide one (1) Carbon Dioxide Storage Tank along with necessary equipment as outlined in Section A.10.

- A.1.1.3.15 Electrical systems, components, and equipment up to and including the connection to the Termination Points identified in Section A.3 shall be provided, including, but not limited to, the following:
 - A.1.1.3.15.a. Dead-end structure(s) at the line side of the high voltage circuit breaker for connection to the high voltage transmission line.
 - A.1.1.3.15.b. Motorized disconnect and ground switches for both sides of Buyer supplied high voltage circuit breakers.
 - A.1.1.3.15.c. Generator circuit breaker for the CTG and associated disconnects.
 - A.1.1.3.15.d. Generator Step Up and Unit Auxiliary transformer.
 - A.1.1.3.15.e. MV/LV switchgear and motor control centers.
 - A.1.1.3.15.f. Isolated phase bus duct with supports.
 - A.1.1.3.15.g. Non-segregated bus or cable bus with supports.
 - A.1.1.3.15.h. Protective relaying and metering.
 - A.1.1.3.15.i. Lighting.
 - A.1.1.3.15.j. Batteries, chargers, and Uninterruptible Power Supply (UPS).
 - A.1.1.3.15.k. Station Direct Current (DC) distribution system.
 - A.1.1.3.15.l. Communications between the Facility Switchyard and DCS.
 - A.1.1.3.15.m. Cathodic protection and grounding systems.
 - A.1.1.3.15.n. Standby Diesel Generator.
 - A.1.1.3.15.o. Balance of electrical systems for a complete Project.
 - A.1.1.3.15.p. Not Used
- A.1.1.3.16 Control and instrumentation systems, components and equipment shall include, but not be limited to, the following:
 - A.1.1.3.16.a. Combustion Turbine Generator (CTG) control system
 - A.1.1.3.16.b. Steam Turbine Generator (STG) control system
 - A.1.1.3.16.c. HRSG direct reading drum level indicators

- A.1.1.3.16.d. Continuous emissions monitoring system (CEMS)
- A.1.1.3.16.e. Facility DCS, including all necessary supervisory, control and data acquisition systems.
- A.1.1.3.16.f. I&C and metering equipment
- A.1.1.3.16.g. Control room equipment including:
 - A.1.1.3.16.g.1 Control systems consoles (desks) for separate operator and engineering HMIs associated with the CTG controls, STG controls, BOP DCS controls, CEMS Data Acquisition System (DAS), select control system servers, etc.
 - A.1.1.3.16.g.2 All hard-wired backup systems for CTG and STG emergency trip, natural gas emergency shutoff, and as required by code.
 - A.1.1.3.16.g.3 Main Fire Alarm Control Panel and interconnection with local panels and detectors
- A.1.1.3.16.h. All Facility local instrumentation
- A.1.1.3.16.i. All alarms, sirens, local fire panels and detectors; local and wide area network fiber and raceway extending to all Project buildings and enclosures; telecommunication cable; and Critical Infrastructure interconnecting cable, fiber and raceway to all secure access gates, doors, enclosures, and panels.
- A.1.1.3.16.j. Balance of instrument and control systems for a complete Project
- A.1.1.3.17 Civil/Structural/Architectural Work shall include, but not be limited to, the following:
 - A.1.1.3.17.a. Project site preparation and surveying
 - A.1.1.3.17.b. Additional Geotechnical investigation(s) deemed necessary by Seller to support Facility design
 - A.1.1.3.17.c. Excavation
 - A.1.1.3.17.d. Bedding and backfill
 - A.1.1.3.17.e. Sanitary piping and lift stations
 - A.1.1.3.17.f. Storm and Plant drainage systems
 - A.1.1.3.17.g. Construction of all temporary roads and hard standings required within the temporary and permanent work areas, and of the permanent roads

- A.1.1.3.17.h. All piles (if required), rigid inclusions (if required), soil improvements (if required), reinforced concrete slabs and foundations for all Project components and buildings
- A.1.1.3.17.i. All necessary embedments, anchor bolts, shear bars, and baseplates
- A.1.1.3.17.j. Pre-engineered buildings, enclosures and HVAC required for compliance with interior temperature and humidity specifications
- A.1.1.3.17.k. Guard shack and electric power
- A.1.1.3.17.l. Architectural components and features for all buildings within the scope of supply
- A.1.1.3.17.m. Steel structures, including support steel, pipe racks, platforms, handrails, stairs, and ladders
- A.1.1.3.17.n. Concrete masonry walls
- A.1.1.3.17.o. Asphalt roads and area surfacing
- A.1.1.3.17.p. Fencing and gates
- A.1.1.3.17.q. Road for deliveries
- A.1.1.3.17.r. Repair of roads, transportation routes, infrastructure, public and private property, and areas on-site and off-site, damaged by Seller or his Subcontractors directly or as a result of high usage and excessive shoulder use
- A.1.1.3.17.s. Balance of civil / structural systems to complete the Project
- A.1.1.3.17.t. The Process Wastewater discharge location and all required permitting
- A.1.1.3.18 Project Conditions
 - A.1.1.3.18.a. Seller shall not interrupt utilities serving facilities occupied by Buyer or others unless permitted in writing by Buyer and then only after arranging to provide temporary utility services according to requirements indicated.
 - A.1.1.3.18.b. If Seller uncovers any unmarked or unknown facilities during excavation, Seller shall report the findings to Buyer and receive instructions before proceeding.
 - A.1.1.3.18.c. Seller shall make a field check of the affected areas of the Project site for the purposes of verifying existing conditions that may affect the Work, such as possible errors in work done by others, and dimensions and other matters relating to the interconnections of the Work with the work of others.

- A.1.1.3.18.d. Seller's Work shall include a thorough investigation of the potential interferences and difficulties that it may encounter in the proper and complete execution of the Work, including the field location and identification of underground or embedded utilities within and adjacent to the limits of the construction. Seller shall advise Buyer immediately of the discovery of any conditions, including the existence of underground or embedded utilities or structures that may affect the timely and safe execution of the Work.
- A.1.1.3.18.e. Not Used.
- A.1.1.3.18.f. Not Used.
- A.1.1.3.18.g. When excavated and/or exposed soil is thought to be contaminated, Contactor shall immediately notify Buyer for resolution prior to proceeding.
- A.1.1.3.19 Construction, Start-Up, and Commissioning Services:
 - A.1.1.3.19.a. Permitting and permitting support in accordance with Contract Agreement Exhibit D, including providing to Buyer information, preliminary design data, commissioning, testing, and operating details needed by the agencies to obtain operating permits, including all testing, reporting and verification.
 - A.1.1.3.19.b. Distribution of construction power from low-side terminals of Seller's construction power transformer.
 - A.1.1.3.19.c. Construction power transformer(s) primary side drop and usage meter by Buyer; primary underground raceway and wire, secondary raceway wiring, and all secondary equipment, wiring, and raceways by Seller. Transformer(s), foundation, and containment (if required) to be provided by Seller and to remain for future use by Buyer at project completion.
 - A.1.1.3.19.d. Seller is responsible for supply of demineralized water to support start-up and commissioning functions. Rental of demineralizer trailers is acceptable.
 - A.1.1.3.19.e. Not Used
 - A.1.1.3.19.f. Not Used
 - A.1.1.3.19.g. All temporary facilities, services, and utilities for staff and construction, including office trailers, remote parking, secure remote laydown, equipment, and facilities. See Section A.4.
 - A.1.1.3.19.h. Security for construction site
 - A.1.1.3.19.i. Temporary security fencing and gates including temporary fencing and gates that will become permanent.

- A.1.1.3.19.j. Tie-ins as noted in Section A.3
- A.1.1.3.19.k. Daily Project site clean-up through the Substantial Completion Payment Date as defined by the BOT Definitive Agreement
- A.1.1.3.19.l. Maintenance of site safety
- A.1.1.3.19.m. Transport, packing, protection, preservation, customs clearance, unloading handling and storage of materials and equipment, per manufacturer's recommendation and procedures.
- A.1.1.3.19.n. Obtaining construction and transportation related licenses, permits, and authorizations, including those offsite
- A.1.1.3.19.o. Painting and protective coatings, including field finish and touch-up painting.
- A.1.1.3.19.p. Water treatment equipment and rentals needed to support the construction, startup, and commissioning through Substantial Completion.
- A.1.1.3.19.q. Manufacture, fabrication, and factory testing and inspections
- A.1.1.3.19.r. On-site testing, inspections, and verifications
- A.1.1.3.19.s. Electrical and plumbing connections for Buyer's temporary facilities (installed by Seller)
- A.1.1.3.19.t. Removal of temporary works after main works are completed
- A.1.1.3.19.u. Operational and maintenance spare parts through the Substantial Completion
- A.1.1.3.19.v. Special tools and equipment for testing and maintenance
- A.1.1.3.19.w. All necessary lifting and handling equipment (including necessary hoists and lifting beams) for operation and maintenance.
- A.1.1.3.19.x. Formal and structured operation and maintenance training services as outlined in Section A.4.17
- A.1.1.3.19.y. Equipment preventive maintenance in accordance with OEM requirements and first fill and topping off of oils, lubricants, gases, and other consumables through Substantial Completion. Seller shall ensure that all gases can be purchased by Buyer. Seller shall ensure tank levels shall be at least 90% full at Substantial Completion.
- A.1.1.3.19.z. Seller shall provide Buyer with documentation of all preventive maintenance work performed prior to Substantial Completion including preventative maintenance work performed while equipment is in storage or laydown.

- A.1.1.3.19.aa. Cleaning, flushing, testing, check-out, pre-commissioning, commissioning, start-up, and performance testing services in accordance with manufacturer's recommendations and test procedures developed for the Project, prior to the Substantial Completion and turnover.
- A.1.1.3.19.bb. Not Used
- A.1.1.3.19.cc. Not Used
- A.1.1.3.19.dd. Construction power transformer(s) to be sized and provided by Seller. Construction power transformer(s) may be left on permanent pad following completion of facility in place of the Distribution alternate power transformer in this section.
- A.1.1.4 Responsibilities of Buyer and Others
- The services, equipment, system(s), and/or structures listed below shall be excluded from Seller's Scope of Work and will be provided by Buyer/Others:
- A.1.1.4.1 Securing environmental permits, easement approvals, letters of no objection, government approvals, and operating licenses that will be held by Buyer. This does not include Seller responsible permits, licenses, and registrations required by Seller as identified in Contract Agreement Exhibit D. Contactor shall copy Buyer on all correspondence of site development permit applications (e.g., storm water management), submit corresponding meeting notes to Buyer, and their status within their respective jurisdiction permitting process.
- A.1.1.4.2 Buyer provided hydrogen tube trailers.
- A.1.1.4.3 Delivery, supply, and management of fuel gas consumed in Commissioning, startup, and operations.
- A.1.1.4.4 Buyer shall provide primary side wiring to the metering/dip pole for the construction power transformer.
- A.1.1.4.5 Transmission interconnection studies
- A.1.1.4.6 Generator tie line(s) and any work within the interconnecting switchyard.
- A.1.1.4.7 Spare parts for Buyer's inventory
- A.1.1.4.8 Coordinating the work activities of Buyer's other contractors working on Buyer's Site, whether or not related to this Project. NOTE: Seller will be required to participate in Buyer's interface management program.
- A.1.1.4.9 Water rights and consent, connection fees, and water supply metering for the permanent and construction supply of water to the site

- A.1.1.4.10 Rights-of-way to the Facility Site
- A.1.1.4.11 Furnish and install as part of the telephone/communication system (LAN) telecom racks, electronic equipment, and telephones; servers, switches, and routers; and network cabinet Ethernet and fiber patch cables within cabinets. Buyer will provide a security appliance (e.g. data diode), if required, and security suite which will connect to the DCS. See Section A.16.4.12 – LAN Communication Conceptual Design for details.
- A.1.1.4.12 Buyer will provide the remote terminal unit (RTU) cabinets. Seller shall install the cabinets and supply and install all interface cabling with plant equipment. Buyer will provide the RTUs, programming, and make final connections.
- A.1.1.4.13 Buyer will provide Seller with specifications for the revenue metering cabinets. Seller shall supply and install the cabinets and all interface cabling with plant equipment. Buyer will provide the meters, programming, and make final connections to the metering (total of four (4) Buyer supplied revenue meters).
- A.1.1.4.14 Buyer will be responsible for the specification of security hardware and software. Buyer will be responsible for the supply and installation of badge readers, cabling, servers, and required software. Buyer will be responsible for the supply and installation of all security cameras, cabling, and associated servers. Seller shall ensure that all buildings are equipped with the necessary space allocation needs, power supply, conduit, fiber, and power wiring to facilitate Buyer's installation. Seller shall supply and install camera poles, foundations, and conduits to these poles as necessary to accommodate the design. See Section A.16.4.12 LAN Communication Conceptual Design for camera locations.
- A.1.1.4.15 Buyer will provide fuel (natural gas, diesel for the permanent diesel generators and fire pump), water, ammonia, CO₂, H₂ and water treatment chemicals through Substantial Completion. Seller will be responsible for greases, lube oils, hydraulic fluids, calibration gases, demin trailers, N₂, glycol, high voltage breaker SF₆ gas, chemicals for the HRSG cleaning, analyzer reagents and other consumables through Substantial Completion.
- A.1.1.4.16 Buyer will provide High Voltage Breakers without SF₆ gas.
- A.1.1.4.17 Buyer will supply, install, connect, and commission Vibration Monitoring equipment and software to connect to the Seller OEM supplied Bently Nevada 3500 monitoring systems for the CTG and STG. The Buyer provided interface card shall be inserted into the available serial port within the Bently Nevada 3500 chassis.
- A.1.1.4.18 Not Used
- A.1.1.4.18.a. Not Used
- A.1.1.4.18.b. Not Used

A.1.1.4.18.c. Not Used

A.1.1.4.18.d. Not Used

A.1.1.4.19 Buyer will provide Seller the design/functional requirements for the Dynamic Disturbance Recorder (DDR) cabinet for NERC PRC-002 compliance. Seller shall adapt design to plant systems, procure, install and commission the DDR system.

A.1.1.5 Abbreviations and Definitions

The following terms and acronyms are used as defined below.

A.1.1.5.1 Abbreviations:

A.1.1.5.2 Not Used.

TCEQ – Texas Commission on Environmental Quality

AC – Alternating Current

ACHE – Air Cooled Heat Exchanger

AGC — Automatic Generation Control

AMS — Asset Management System

BES – Bulk Electric System

BFW — Boiler Feedwater

BTU — British Thermal Unit

CEMS — Continuous Emissions Monitoring System

CO — Carbon Monoxide

CO₂ — Carbon Dioxide

CPM — Critical Path Method

CQP — Construction Quality Procedure

CRS – Cold Reheat Steam

CSA – Civil, Structural, Architectural

CTG – Combustion Turbine (CT) Generator

CS – Carbon Steel

CSP – Construction and Startup Procedures

CWA – Clean Water Act

DAS – Data Acquisition System

DC – Direct Current
DCS – Distributed Control System
DTN – Design Traffic Number
FTE – Full Time Employees and Equivalent
gpm – Gallons per Minute
GSU – Generator Step-up
GVTC – Generator Verification Test Capacity
H₂ – Hydrogen Gas
HHV – Higher Heating Value
HMI – Human Machine Interface
HP – High Pressure
HPS – High Pressure Steam
HRS – Hot Reheat Steam
HRSG – Heat Recovery Steam Generator
HVAC – Heating, Ventilating, and Air Conditioning
I&C – Instrumentation and Controls
IFA – Issued for Approval
IFB – Issued for Bid
IFC – Issued for Construction
IFD – Issued for Design
IFF – Issued for Fabrication
IFI – Issued for Information
IFP – Issued for Purchase
IFR – Issued for Review
IMS – Integrated Master Schedule
IPB – Isolated Phase Bus
IP – Intermediate Pressure
IPS – Intermediate Pressure Steam
kV – Kilovolt
kW – Kilowatt

kWH – Kilowatt Hour
LHV – Lower Heating Value
LP – Low Pressure
LPS – Low pressure steam
MCC – Motor Control Center
MDL – Master Document List
MECL – Minimum Emission Compliant Load
MSS – Maintenance, Startup and Shutdown
MW – Megawatt
N2 – Nitrogen
NECF – Net Electrical Capacity Factor
NOx – Nitrogen Oxides
OEM – Original Equipment Manufacturer
P&ID – Piping and Instrumentation Diagram
PCB – Polychlorinated Biphenyls
PCV – Pressure Control Valve
PDC – Power Distribution Center
PEP – Project Execution Plan
PMB — Performance Measure Baseline
PM10 — Particulate Matter 10 Microns Diameter and Less
PM2.5 — Particulate Matter 2.5 Microns Diameter and Less
ppmvd — Parts per Million, Volumetric Dry
PRV — Pressure Relief Valve
PLC — Programmable Logic Controller
PSF — Pounds per Square Feet
psia — Pounds per Square Inch Absolute
psig — Pounds per Square Inch Gauge
PTC — Performance Test Code, ASME Publication
QA/QC — Quality Assurance/Quality Control
QMS — Quality Management System

RGS — Rigid Galvanized Steel Conduit
RTD – Resistance Temperature Detector
SCR – Selective Catalytic Reduction for NOx Control
SFC – Static Frequency Converter
SO2 – Sulfur Dioxide
SOFR – System Operation / Functionality Review
SRV — Safety Relief Valve
ST — Steam Turbine
STG — Steam Turbine Generator
TCS — Turbine Control System
UAT — Unit Auxiliary Transformer
UL — Underwriters Laboratories
UPS — Uninterruptible Power Supply
VOC — Volatile Organic Compounds
WBS — Work Breakdown Structure

A.1.1.5.3 Definitions:

- A.1.1.5.3.a. Air Emissions Standards — Air Emissions Standards are legal requirements governing air pollutants released into the atmosphere that set quantitative limits on the permissible amount of specific air pollutants that may be released from specific sources over specific timeframes. The Air Emissions Standards for the Project will be set forth in the federal/state air permit(s) issued for the Project.
- A.1.1.5.3.b. Air Emissions Tests (and Air Emissions Testing Procedures)"Air Emissions Tests" means the testing required to demonstrate that emissions are within the Guaranteed Emission Limits as specified in Section A.1.6.1.6. "Air Emissions Testing Procedures" are the Air Emissions Tests procedures to be developed by Seller.
- A.1.1.5.3.c. Baseline Schedule — The Level III CPM Project Schedule to be prepared by Seller, subject to Approval by Buyer.
- A.1.1.5.3.d. Commissioning — All activities that occur on Project systems after the completion of construction such as equipment checkout, testing, flushes, preliminary and initial operation, and functional testing prior to system turnover to Buyer and prior to the Performance Test.

- A.1.1.5.3.e. Demonstration Test – The tests specified in Section A.1.9 to demonstrate the capability and response of the plant. The Demonstration Test consists of separate and discrete tests that are defined as follows:
 - A.1.1.5.3.e.1 Load Demonstration Tests - The tests specified in Section A.1.9.1,
 - A.1.1.5.3.e.2 Turbine Run Back and Trip Testing - The tests specified in Section A.1.9.2,
 - A.1.1.5.3.e.3 CTG Island Mode Demonstration Test - The test specified in Section A.1.9.3,
 - A.1.1.5.3.e.4 Plant Operating Startup Demonstration Test - The test specified in Section A.1.9.4,
 - A.1.1.5.3.e.5 Plant Operating Shutdown Demonstration Test - The test specified in Section A.1.9.5,
 - A.1.1.5.3.e.6 NERC Compliance Testing - The test specified in Section A.1.9.6.
 - A.1.1.5.3.e.7 MISO Generation Verification Test Capacity (GVTC) as specified in Section A.1.9.7
 - A.1.1.5.3.e.8 MISO Automatic Generation Control (AGC) test as specified in Section A.1.9.8
- A.1.1.5.3.f. Full Notice to Proceed (FNTP) - Refer to the BOT Definitive Agreement for definition.
- A.1.1.5.3.g. Guaranteed Emission Limits – Refer to the BOT Definitive Agreement for definition.
- A.1.1.5.3.h. Guarantee Test Conditions - The conditions to which the as-tested Net Electrical Output and Net Heat Rate values, determined during the Performance Test, shall be corrected.
- A.1.1.5.3.i. Not Used
- A.1.1.5.3.j. Mechanical Completion – Refer to the BOT Definitive Agreement for definition.
- A.1.1.5.3.k. Net Electrical Output (NEO) - The net electrical output (kW) as measured at the high voltage side of the GSU transformers.
- A.1.1.5.3.l. Net Heat Rate (NHR) - The net Project heat rate HHV (BTU/kWH) defined as the total fuel heat consumption (HHV) divided by the Net Electrical Output.
- A.1.1.5.3.m. Not Used
- A.1.1.5.3.n. Performance Guarantee – The guaranteed Net Electrical Output and Net Heat Rate, as specified in Section A.1.6.1.1
- A.1.1.5.3.o. Performance Test – The test to measure Net Electrical Output and Net Heat Rate for purpose of correction to the Guarantee Test Conditions and comparison to the Performance Guarantee.

- A.1.1.5.3.p. Project Schedule — Also referred to as the Integrated Master Schedule or IMS, the Project Schedule is a linked network of time phased Project-planned discrete activities keyed to contractual requirements and the Project's statement of Work, and shall contain critical target dates, Project milestones, contractual events, Project decision points, deliverables and their related activities to plan, status, and monitor progress of the Work.
- A.1.1.5.3.q. Qualitative Risk Analysis (QRA) – A project management technique concerned with discovering the probability of a risk event occurring and the impact the risk will have if it does occur.
- A.1.1.5.3.r. Reliability Test - Refer to the BOT Definitive Agreement for definition.
- A.1.1.5.3.s. Reliability Factor (RF) — The calculated reliability factor used to determine the success of the Reliability Test.
- A.1.1.5.3.t. Specifications — Documents providing a detailed and precise description of characteristics and features.
- A.1.1.5.3.u. Start of Commissioning — Date of first turnover by Seller's construction department to Seller's commissioning department for Commissioning
- A.1.1.5.3.v. Substantial Completion - Refer to the BOT Definitive Agreement for definition.
- A.1.1.5.3.w. Water Effluent Discharge Limits - Enforceable parameters that dictate temperature(s) and the amount of pollution a facility may discharge on a designated Outfall basis as set forth in the Federal/State Pollutant Discharge Elimination System Permit (NPDES)
- A.1.1.5.3.x. Facility – Facility shall hold the same meaning as “Project”, as defined in the BOT Definitive Agreement.
- A.1.1.5.3.y. Not Used.
- A.1.1.5.3.z. Not Used.
- A.1.1.5.3.aa. Island Mode
- A.1.1.5.3.aa.1 An operating state in which the generating facility is disconnected from the grid and the CTG is powering all necessary plant (house) loads required to maintain unit in operation without the external power sources or onsite emergency generation or batteries.
- A.1.1.5.3.aa.2 Islanded is the status of plant when operating in Island Mode.
- A.1.1.5.3.aa.3 Islanding is the transient state or actions required to take plant from normal plant operating mode to Island Mode.

A.1.2 GENERAL REQUIREMENTS

A.1.2.1 Responsibilities following FNTF:

A.1.2.1.1 Seller shall prepare the overall, comprehensive Project Execution Plan (PEP) and provide to Buyer for review. Seller shall be responsible for establishing the work breakdown structure (WBS), Project Schedule development, Project Controls Systems setup, and engineering activities to support purchase of equipment and construction activities.

A.1.2.1.2 Seller shall implement an enterprise collaboration software package and provide training and access to Buyer and parties designated by Buyer for generating, managing, and logging Project communication, requests for information, releases of engineering and design deliverables, comments, and resolution of comments on deliverables, etc.

A.1.2.1.3 Seller shall perform a multi-day detailed planning session to further expand the logic of the Project Schedule. The planning session will address Engineering, Procurement, Subcontracts, Construction, Commissioning, Safety, and Project Management. Thereafter, Seller and Buyer shall participate in a Level III Schedule and Schedule Basis QRA.

A.1.2.1.4 Seller shall commence all Engineering, construction planning, and permitting activities as necessary.

A.1.2.1.5 Seller may execute releases to Subcontractors, including the Major Equipment manufacturers for engineering, material orders and fabrication, as required to support delivery dates.

A.1.2.1.6 Not Used

A.1.2.1.7 Not Used

A.1.2.1.7.a. Perform any activities including, but not limited to: geotechnical, geophysical, and site survey work.

A.1.2.1.7.b. Not Used

A.1.2.1.7.c. Not Used

A.1.2.1.8 Seller shall commence full mobilization of construction personnel to the site and perform clearing and grubbing including tree removal and shredding. Seller shall also begin all major site grading activities, and utility tie.

- A.1.2.2 Seller is responsible for developing the construction and design basis arrangements for temporary facilities and Project laydown, fabrication and parking areas and structures, buildings, and equipment based on the conceptual arrangements and layouts. Changes to the conceptual arrangements shall be mutually agreeable to both Seller and Buyer.
- A.1.2.3 Operating Requirements
- A.1.2.3.1 The Facility shall operate reliably, safely, and efficiently during the Facility's design life and in accordance with all terms herein. The adequacy of the overall system design to meet these requirements is the responsibility of Seller.
- A.1.2.3.2 The Facility shall be designed for cycling, partial and baseload operation while maintaining compliance with the Guaranteed Emission Limits. The definition of cycling generally follows industry standards and, as a minimum, includes the following:
- A.1.2.3.2.a. Two shifting operation where the Facility experiences daily startup and shutdown
- A.1.2.3.2.b. Shutdown on weekends
- A.1.2.3.2.c. Load following operation where the output of the Facility will vary significantly to provide regulation and other ancillary services.
- A.1.2.3.2.d. Sporadic operation where the Facility may be shut down for extended periods, and upon startup, operate for extended periods.
- A.1.2.3.3 The Facility shall be capable of operating in all of the above modes while maintaining compliance with the Guaranteed Emission Limits.
- A.1.2.3.4 During unit shutdowns, the residual heat within the HRSG shall be used to provide auxiliary steam to maintain condenser vacuum and STG sealing steam for Hot Starts. It is the intent to maintain vacuum and sealing steam as long as possible during Warm Start, limited by residual heat in the HRSG.
- A.1.2.3.5 In addition, the Units shall be capable of frequent startups and shutdowns as well as occasional load trips. The intended profile for starts and hours of operation is as follows.

- A.1.2.3.5.a. Starts per year:
- | | |
|---|----------|
| No. of Cold Starts (for the CTG and the STG):
Offline > 64 hours, including ambient rotor conditions | 10/year |
| No. of Ambient Starts (for the CTG and the STG): | 10/year |
| No. of Warm Starts (for the CTG and the STG):
Offline > 8 hours and < 64 hours | 40/year |
| No. of Hot Starts (for the CTG and the STG):
Offline < 8 hours | 200/year |
| No. of combustion turbine starts (CT): | 250/year |
- The HRSG shall accommodate quantity of starts, with HRSG starts defined based upon the HP drum conditions.
- A.1.2.3.5.b. Hours of operation: up to 8,760 hrs./yr. for the CTG, HRSG and STG
- A.1.2.3.6 The Facility will be capable of operating without restriction during winter ambient and summer ambient conditions defined in Section A.9, as clarified in Section A.16.4.1.
- A.1.2.3.7 The facility shall be capable of long-term operation at any CTG load condition above MECL, and short-term operation at any CTG load condition below MECL. In addition, the Facility shall be capable of operating over the range of CTG MECL to full load with duct burners in service above 95% GT load, under AGC in compliance with the Guaranteed Emission Limits herein.
- A.1.2.3.8 The Facility shall be capable of safe, reliable, stable, and efficient operation in AGC while in compliance with the Guaranteed Emission Limits and noise limits. Plant design shall take into account the operating modes included in the Preliminary Heat Balances in Section A.16.4.1.
- A.1.2.3.9 Island Mode Operation: in the event of a transmission grid disturbance/blackout, the plant shall automatically isolate from the grid and continue to operate with the CTG unit producing power for house loads on an indefinite basis, as described in Section A.12.
- A.1.2.4 Engineering and Design
- A.1.2.4.1 Seller shall engineer and design the Project in accordance with this specification.
- A.1.2.4.2 The intent of this specification is to provide Seller with minimum requirements for plant design. Seller shall optimize the plant during detailed design phase, while meeting the minimum requirements herein.

- A.1.2.4.3 Overall facility design shall be optimized for the CTG exhaust gas conditions over the full range of operating conditions. Plant operation mode of 1x0 and 1x1 shall be controllable. This shall include optimization of the HRSG attemperators / desuperheaters.
- A.1.2.4.4 Safety shall be a primary and ongoing engineering and design consideration, including attention to the safety of operators, maintenance personnel, and Project and construction staff. Adequate lighting, ventilation and noise dampening shall be incorporated into operation and maintenance spaces. Seller shall comply with OSHA requirements.
- A.1.2.4.5 Overall facility design shall minimize operator surveillance. All systems and equipment shall be operable from the control room under normal operating conditions. This includes daily startups from CTG minimum emissions compliant load to full load, as well as shutdowns. Local operator intervention for extended duration shutdowns is acceptable.
- A.1.2.4.6 Seller shall develop overall plant heat balances based upon site conditions in Section A.9. Seller shall incorporate the CTG, HRSG and STG equipment thermal design characteristics into an overall Plant heat balance model.
 - A.1.2.4.6.a. Seller shall develop, at minimum, heat balance cases based upon the site conditions in Section A.9 for minimum, average, and maximum temperatures and humidity, ISO conditions, MECL, and Guarantee cases to establish a basis for plant operation for the various range of ambient conditions, GT load, Evaporative Cooler status, Duct Burner status, and STG on at its maximum capability for each case except for ones that indicate ST Bypass.
 - A.1.2.4.6.b. Seller shall include an allowance for up to 10 additional heat balance cases.
- A.1.2.4.7 Seller shall develop the following five (5) water balance cases based upon the site conditions in Section A.9. Water Balance shall represent average and maximum flow rates for the following cases:

- A.1.2.4.7.a. Annual Average
- A.1.2.4.7.b. Summer Average
- A.1.2.4.7.c. Summer Extreme
- A.1.2.4.7.d. Winter Extreme
- A.1.2.4.7.e. Min/Max Flow cases for permitting (not time averaged)
- A.1.2.4.7.f. Not Used.
- A.1.2.4.8 Seller shall be responsible for assuring that any Specifications prepared by Seller for the Project provide adequate and accurate information. Seller is responsible for assuring that its Subcontractors deliver their respective scopes of supply in a manner that will be consistent with Seller's warranty and Project Performance Guarantees.
- A.1.2.4.9 All engineering work including studies, reports, designs, calculations, drawings and specifications for procurement and construction shall be sealed in accordance with the regulations of the State in which the Project is located.
- A.1.2.4.10 All designs and Specifications prepared by Seller shall be consistent with Seller's warranty and the Project Performance requirements.
- A.1.2.4.11 Project 3D Model
 - A.1.2.4.11.a. Seller's detailed design shall originate in Seller's 3D model of substructures, foundations, structural steel, above and below grade piping, equipment, components, and facilities. The 3D model shall include regularly updated 3D models provided by OEMs and equipment suppliers and shall have sufficient detail to provide for clearance and interference checking; crane placement for safe construction and maintenance lifts; Seller material take-off; and constructability, access, ergonomic, maintainability and safety reviews.
 - A.1.2.4.11.b. Seller shall schedule monthly 3D model reviews and provide notification to Buyer so that Buyer can attend and/or remotely participate in these reviews. Seller shall maintain and update following each model review a disposition log (i.e., action item list), of Buyer 3D model comments.
 - A.1.2.4.11.c. The 3D model shall be updated regularly in order to reflect the most recent Seller, OEM and equipment supplier design and shall be made available to Buyer to review at all times. The 3D model shall reflect actual design of the Facility.
- A.1.2.4.12 Seller shall further optimize the suggested Facility layout, as long as the design proposed is consistent with the requirements of this specification. Seller shall give consideration to

constructability and ensuring adequate operability and maintainability of the Facility. Equipment access requirements shall follow the standard access provided in Section A.16.4.9.

- A.1.2.4.13 Seller's scope of work shall terminate at the interface points listed in Section A.3. Buyer will be responsible for designing and installing any pipe, supports, and piping tie-in beyond the interface point. Seller shall make all tie-in connections at the interface points.
- A.1.2.4.14 The Facility shall be designed with the objective of maintaining high reliability, availability, and the level of automation necessary to minimize operator intervention, and to support remote operations. Ease of trouble shooting, preventative maintenance, and equipment accessibility and removal shall also be included in the design.
- A.1.2.4.15 Where required to perform normal maintenance functions, facilities such as equipment removal monorails shall be provided. Wherever practical, meters, valves and instruments shall be located such that they can be operated and easily accessed from grade or local operating platform. Where equipment, meters, valves, and instruments normally requiring operator access must be located in elevated locations, access platforms, handrails, and stairs shall be provided.
- A.1.2.4.16 Minimum clearance and equipment removal access:
 - A.1.2.4.16.a. Minimum clearance over walkways and platforms shall be 7'-6".
 - A.1.2.4.16.b. Minimum clearance under major interconnecting structures shall be 22 ft for truck and crane movement.
 - A.1.2.4.16.c. Pulling, jacking, and lifting supports and devices shall be provided for removal of the CTG and STG generator rotors. All lifting devices and beams shall be clearly stenciled with rated lifting capacity.
 - A.1.2.4.16.d. Adequate provisions for removal of major equipment, such as, the generator rotor, turbine, and accessories, for maintenance and laydown must be considered in the general arrangement proposed by Seller. The proposed layout must accommodate concurrent maintenance on the steam turbine and the combustion turbine with separate cranes.
- A.1.2.4.17 Equipment, valves, instruments, testing devices and other mechanical components shall be designed and installed for ease of operation and maintenance.
- A.1.2.4.18 Equipment or other items which contain PCBs, lead (excluding batteries), mercury, ceramic fiber, asbestos, or asbestos bearing materials are prohibited from use.
- A.1.2.4.19 Seller shall prepare a complete set of System Descriptions. Each system description shall include the following content:

- A.1.2.4.19.a. The design criteria and functions to be satisfied by the system.
- A.1.2.4.19.b. A description of the system and its major equipment and components, and the performance characteristics.
- A.1.2.4.19.c. A detailed description of system operating limitations and capacities, setpoints, consumables, and precautions which include startup, shutdown, and normal operations.
- A.1.2.4.19.d. A description of system safety features and safety precautions for operation or maintenance required to prevent personnel injury.
- A.1.2.4.19.e. A description of system boundaries.
- A.1.2.4.20 Seller shall develop and coordinate a System Operations / Functionality Review (SOFR) to allow Buyer and Buyer's Representative to review the proposed design for O&M considerations, safe isolation, double block and bleed implementation, etc. The systems shall be mutually agreed upon between Buyer and Seller. Comments and action items developed during this review shall be incorporated into design by Seller.
- A.1.2.5 Plant Identification, Numbering and Labelling Conventions
 - A.1.2.5.1 See Section A.10 for equipment, component, pipe, valve and instrumentation identification and numbering.
 - A.1.2.5.2 Permanent instruction plates, nameplates and labels shall be provided for all items of the Facility giving particulars of duty, size, serial number and full information for identification and operation. Warning labels and emergency equipment shall have red lettering. Labels shall be of sufficient size to carry a full description of the Facility item and a unique item alphanumeric identification, as shown on Seller's drawings.
 - A.1.2.5.3 Seller shall be responsible for providing signs, fire extinguishers, marking of high sound areas requiring hearing protection, and other items and signage needed to meet OSHA regulations and otherwise ensure minimal risk to personnel health and safety while at the Project site. Text on signage installed for these purposes shall be in both English and Spanish.
- A.1.2.6 Procurement
 - A.1.2.6.1 The systems, equipment and materials supplied by Seller and Sub-contractors shall be new and undamaged from the OEM and suppliers using technology with a proven historical design, performance and reliability record suitable for the environment in which they will be located and shall be designed and manufactured for a Project design life of 30 years.

- A.1.2.6.2 Seller shall provide a Procurement Plan to outline purchase, transportation including special provisions for heavy haul loads, delivery, unloading and storage of equipment, material and goods and purchase of services needed for the Project. This shall be finalized prior to FNTF.
- A.1.2.6.3 Seller's Procurement Plan shall apply to all procurement activities conducted by Seller to fulfill the terms of the specification.
- A.1.2.6.4 The Procurement Plan shall be used during the engineering, construction, and Commissioning phases of the Project. Following the guidelines outlined in this Procurement Plan, Seller's procurement team shall to the maximum extent practicable and in an expedited manner procure equipment, material, goods and services or the type normally specified for heavy industrial applications.
- A.1.2.6.5 Seller shall ensure that the specific requirements herein are included in Seller's specifications and complied with by the selected manufacturer. Seller shall be responsible for obtaining Buyer's concurrence with resolutions to any exceptions taken by Subcontractors prior to accepting the exceptions, which may be withheld in Buyer's sole discretion. Buyer's concurrence or comments will be forwarded to Seller within ten (10) Business Days of the date they are received by Buyer.
- A.1.2.6.6 Packing, Handling and Shipping procedures shall describe how equipment, components and materials shall be secured and protected from adverse weather (including saltwater intrusion) and transit conditions, including shock and vibration movements. This supplement specific shipping requirements outlined in throughout this specification.
- A.1.2.6.7 Seller is responsible for the cost and arrangement of all equipment and material shipping, transportation, and delivery to the site.
- A.1.2.6.7.a. Not Used
- A.1.2.6.7.a.1 Not Used
- A.1.2.6.7.a.2 Not Used
- A.1.2.6.7.a.3 Not Used
- A.1.2.6.8 Buyer reserves the right to attend tests of components, equipment, and controls (FAT) at the suppliers' manufacturing/assembly facilities.
- A.1.2.6.9 Equipment that requires additional bracing for shipment should have the temporary bracing clearly identified.

- A.1.2.7 Sourcing of Materials and Subcontracts
 - A.1.2.7.1 Steel from China shall not be used without Buyer approval.
 - A.1.2.7.2 Not Used
 - A.1.2.7.3 Seller may use foreign vendors or Engineered Equipment Suppliers that use internationally recognized standards in the design and supply of materials or equipment. These standards include but are not limited to DIN, JIS, GB, etc.
 - A.1.2.7.4 For equipment, components, commodities, and materials whether sourced, milled, cast, fabricated and/or manufactured in the U.S. or outside of the U.S., Seller shall have direct QA/QC oversight and surveillance of its subcontractors so that all requirements, including the technical, Code and Standards and QA/QC requirements, of this Specification are met. Seller shall follow requirements identified in Section A.18 (Approved Vendors List) of the Contract.
 - A.1.2.7.5 Not Used
- A.1.2.8 Lifting Beam and Lifting Facilities
 - A.1.2.8.1 Lifting and trolley beams shall be provided to facilitate handling of plant equipment and components that are required to be removed for replacement, maintenance, cleaning, and overhaul.
 - A.1.2.8.2 The structural integrity of all lifting lugs shall be documented by calculation. Vendor furnished bolt on lifting devices shall be proof tested at the fabrication facility before shipment to the site.
- A.1.2.9 Special Tools
 - A.1.2.9.1 Seller shall supply a complete set of any special tools and other equipment necessary for the dismantling, re-erection, and adjustment of the plant. This shall include any special lift jigs, frames and stands necessary to remove and support the major items of Plant. The tools provided shall be in new condition, adequately labeled as to their use and contained in stout and suitable padlocked boxes. Any special slings required shall be provided and clearly marked by embossed labels to show safe working loads. Test certificates shall be provided where applicable.
- A.1.2.10 Spare Parts
 - A.1.2.10.1 Seller shall supply Buyer with a priced list with lead time of operational spare parts recommended by Project equipment suppliers to support two (2) years of operation twelve (12) months prior to Substantial Completion Scheduled Date, but no later than six

(6) months prior to Start of Commissioning. Seller shall include the OEM part numbers on the operational spare parts list.

A.1.2.10.2 Seller shall provide startup and commissioning spare parts as part of its fixed Contract Price Work as required to achieve Substantial Completion.

A.1.2.10.3 If any equipment fails prior to Substantial Completion, Seller may negotiate with Buyer to obtain spare parts from Buyer's inventory of spares at the Project that have been purchased by Buyer so that the equipment that failed may be returned to operating condition, provided that Seller places a concurrent purchase order for the expedited replacement on behalf of Buyer at Seller's expense of any such spare parts previously purchased by Buyer.

A.1.3 PROJECT MANAGEMENT AND CONTROLS

A.1.3.1 See Exhibit Q for Project Management and Controls requirements.

A.1.4 DOCUMENT DELIVERABLES AND SUBMITTAL REQUIREMENTS

A.1.4.1 Seller's Master Drawing and Document List and Data Schedule (MDL)

A.1.4.1.1 Within eight weeks (40 working days) after FNTTP, Seller shall provide Buyer with an initial MDL, for the Major Equipment scope of Work only. This document schedule shall be updated and resubmitted on a monthly basis for the duration of the Work and/or until all drawings have been completed, and shall contain the following information:

A.1.4.1.1.a. Seller or Supplier Name, including all Sub-Contractors for the Project, and identified Equipment or Service Provided

A.1.4.1.1.b. Seller Drawing or Document Number, OEM Drawing or Document Number, OEM Company Name, Title, and Revision, Unit Number, System Code, Drawing Type, and Discipline

A.1.4.1.1.c. Purpose of Submittal – For Buyer's Review, For Information, For Record

A.1.4.1.1.d. Drawing or Document First Submittal Scheduled Dates and Actual Dates

A.1.4.1.1.e. Drawing or Document Re-Submittal Scheduled Dates and Actual Dates.

A.1.4.1.1.f. Not Used

A.1.4.1.2 The MDL shall individually list all submittals identified herein and in the referenced standards.

- A.1.4.1.3 The initial submittal of the MDL shall include as many titles, drawings numbers, etc., as are known at the time of the submittal. For drawings and data where exact titles or numbers are not known, Seller shall list all the types of drawings or data that will be submitted along with the specified schedule information. In essence, the initial submittal of the list shall be complete in terms of it specifying the type and quantity of documents to be submitted with the only undefined information being the precise document titles or numbers that are not known at the time of the submittal.
- A.1.4.1.4 Not Used.
- A.1.4.2 Submittals for Buyer Information, Review and Record (e.g., “as-built” drawings)
A complete list of submittals is presented in Table A.1-1.
- A.1.4.3 Software Licenses
- A.1.4.3.1 In connection with the permanent equipment provided by Seller, any software license in Seller's possession necessary for the operation and maintenance of such equipment shall be passed on to Buyer on or before Substantial Completion or Seller shall grant Buyer a non-exclusive royalty-free right to use such software license for the operation and maintenance of such equipment.
- A.1.4.4 Format and Identification of Documents
- A.1.4.4.1 Documents submitted for Buyer information, review and/or approval shall be provided electronically as a PDF or TIF file. Informal native files (Excel, Access) will be provided for the project list per Buyer request.
- A.1.4.4.2 Engineering document identification shall be in accordance with the project tagging procedure, included in Section A.16. Major Equipment identification will be per OEM tagging standards.
- A.1.4.4.3 Final and For Record (“as installed and constructed”) drawings issued to Buyer for record purposes shall be in electronic formats and in accordance with Buyer procedure EPG-DC-DWG-02, External Drawing & CAD Standard in Section A.16.2.6.
- A.1.4.4.3.a. Not Used
- A.1.4.4.4 Final record submittals shall be in PDF or TIF file formats. Drawing files shall be submitted electronically with the Project name, station name, station unit number, drawing numbers and revision numbers, and CAD file names, identified in a separate electronic drawing list. The electronic drawing list shall be compatible with Microsoft Access.
- A.1.4.4.5 Document Review Process

- A.1.4.4.5.a. Following the initial release of an engineering document, Seller and its sub-contractors shall on subsequent revised releases clearly state the purpose and date of the revision and identify the changes made to the document since the previous release by scoping with circumscribed “clouding”, or in the case of text by line markings, notated with the current revision level.
- A.1.4.4.5.b. Drawing and documents submitted for review shall be noted on the transmittal letter "For Review". Buyer shall be given ten (10) working days after receipt by Buyer to return comments. Work will proceed and the drawings or documents will be deemed “No Exception Taken”, if Buyer has not responded within 10 working days to avoid impact to the Project Schedule. Seller shall provide a written disposition of Buyer's comments within ten (10) working days after receipt by Seller. After the drawings or documents are approved or reviewed by Buyer, the drawings or documents shall be returned to Seller with one of the following status notations:
- No exception taken: Proceed with fabrication or construction in accordance with the Contract.
 - Revise as noted and resubmit: Proceed in accordance with the contract after incorporating noted revisions.
 - Revise and resubmit: Does not meet contract requirements. Hold fabrication and/or construction.
 - For information only.
- A.1.4.4.5.c. Buyer retains the right to review all documents.
- A.1.4.4.5.d. After Seller returns any written disposition on Buyer’s comments, if there are still any unresolved comments Buyer and Seller shall work together to resolve the comment(s) within (15) working days.
- A.1.4.4.5.e. Any unresolved comments on any documents shall be resolved and updated prior to Substantial Completion.
- A.1.4.4.5.f. Not Used
- A.1.5 GOVERNING CODES, STANDARDS AND REGULATIONS
- A.1.5.1 Extent
- A.1.5.1.1 In performing the Work, Seller shall comply with the codes and standards set forth herein (the “Codes and Standards”).

- A.1.5.1.2 Design specifications and construction of the Facility shall be in accordance with all applicable laws including (1) applicable laws, regulations, codes and standards of the Federal Government and the State in which the Project is located, including Environmental Laws and those set forth below and, (2) and applicable local (including county and city) laws, regulations, codes, and ordinances, including those set forth below.
- A.1.5.1.3 Publications of the nationally recognized organizations listed in Section A.1.5.2 and A.1.5.3 are applicable to the engineering, design, manufacture, and testing of the Equipment. All references to publications are to the latest issue of each together with all latest addenda, amendments, or additions thereto as of the Effective Date, except as otherwise specified in this specification. References shall be made in accordance with the abbreviations listed below.
- A.1.5.1.4 In the event that conflicts arise between the codes, standards of practice, specifications or manufacturer recommendations described herein and codes, laws, rules, decrees, regulations, standards, etc., of the locality where the equipment is to be installed, the more stringent code shall apply. Seller shall provide a written position of any such conflict clarifications to Buyer in writing.
- A.1.5.1.5 Alternative international codes and standards may be used upon Buyer's approval. Seller shall supply a hard copy or electronic copy, in English, of each alternative code of practice or design standard that is proposed by Seller as being appropriate for use on the Project. In general, material to be used for all installations shall meet the requirements of appropriate ASTM standards. Alternative equivalent international or local materials may be proposed for use, but they are subject to approval by Buyer.
- A.1.5.2 Federal and State Codes
- | | |
|--------|---|
| ACoE | Army Corps of Engineers |
| TCEQ | Texas Commission on Environmental Quality |
| CAAA | Clean Air Act and Amendments |
| CERCLA | Comprehensive Environmental Response, Compensation and Liability Act of 1980 |
| CFR | Code of Federal Regulations |
| DHS | Department of Homeland Security |
| EPA | Environmental Protection Agency |
| FAA | Federal Aviation Administration Regulations |
| FERC | Federal Energy Regulatory Commission |
| NERC | North American Electric Reliability Corporation |
| OSHA | Title 29, Code of Federal Regulations (CFR), Part 1910 Occupational Safety and Health Standards |

A.1.5.3 Industry Codes and Standards

AASHTO	American Association of State Highway and Transportation Officials
ABMA	American Boiler Manufacturers Association
ACI	American Concrete Institute
AGA	American Gas Association
AIA	American Institute of Architects
AISC	American Institute for Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
ANSI	American National Standards Institute
API	American Petroleum Institute
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning
ASME	American Society of Mechanical Engineers
ASTM	ASTM International
ASNT	American Society of Nondestructive Testing
AWWA	American Water Works Association
AWS	American Welding Society
CRSI	Concrete Reinforcing Steel Institute
FCI	Fluid Control Institute
FM	Factory Mutual
HEI	Heat Exchange Institute
HI	Hydraulic Institute
IAPWS	International Association for the Properties of Water and Steam
IBC	International Building Code
ICC	International Code Council
IEC	International Electromechanical Commission
IPC	International Plumbing Code
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers

IPC	International Plumbing Code
ISA	International Society of Automation
ISO	International Organization for Standardization
JIS	Japanese Industrial Standard
JEAC	Japan Electric Association Code
JEC	Japanese Electrical Committee
JEM	Standards of The Japan Electrical Manufacturers Association
JCS	Japanese Cable Makers Association Standard
JCMS	Japanese Cable Makers Standard
MIA	Masonry Institute of America
MSS	Manufacturers Standardization Society
NAAMM	National Association of Architectural Metals Manufacturers
NACE	National Association for Corrosion Engineers
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NESC	National Electric Safety Code
NETA	International Electrical Testing Association, Inc.
NFPA	National Fire Protection Association
PCA	Portland Cement Association
PFA	Pipe Fabrication Institute
PCI	Precast/Prestressed Concrete Institute
SDI	Steel Deck Institute
SMACNA	Sheet Metal and Air Conditioner Contractors National Association
SSPC	Society for Protective Coatings
SSPWC	Standard Specifications for Public Works Construction
TEMA	Thermal Insulation Manufacturers Association
UL	Underwriters Laboratories

NERC North American Electric Reliability Corporation

Reliability Standards shall be used in the design of the facility. The applicable standards and Seller's responsibilities are detailed in sections A.16.2.5 for NERC-CIP and A.16.2.9 for NERC generation facilities with specific NERC Standard references provided in related sections.

A.1.6 PLANT PERFORMANCE GUARANTEES AND COMPLIANCE TESTING

A.1.6.1 Guarantees

The guarantees provided in this section are for reference pending final negotiations based on Seller's proposal.

A.1.6.1.1 Guaranteed Net Electrical Output (Capacity) and Guaranteed Net Heat Rate

The performance guarantees listed in Table A.1.6.1.1.a are subject to the Guarantee Test Conditions stated in Section A.1.6.1.2.

Table A.1.6.1.1.a – Performance Guarantees when firing 100% Natural Gas

Guaranteed Net Electrical Output	By Seller (kW)
Guaranteed Net Heat Rate	By Seller (Btu/kWh, HHV)

A.1.6.1.2 Performance Guarantees provided in Section A.1.6.1.1 are based on the Guarantee Test Conditions shown in this section, Table A.1.6.1.2.a. All Performance Test results shall be corrected for deviation from the Guarantee Test Conditions.

Table A.1.6.1.2.a – Guarantee Test Conditions

Conditions for Guarantees	Net Plant Performance
Ambient Dry Bulb Temperature (°F)	97.0
Ambient Relative Humidity	56.0
Evaporative Cooler Status	On (if applicable)
Duct Burner Status	On (if applicable)

Conditions for Guarantees	Net Plant Performance
Barometric Pressure (psia)	[By Seller (based on project site conditions)]
Generator Power Factor (Both STG and CTG)	0.85 Lagging
Frequency	60 hz
Fuel	Natural Gas
Fuel Gas Temperature at Seller Terminal Point (°F)	By Seller
Fuel Gas Pressure at Seller Terminal Point (psig)	By Seller
HRSG Blowdown	0%
CTG Load	100% Load
CTG and STG Condition	New and Clean ⁽¹⁾
Auxiliary Power	By Seller
Performance Test Uncertainty Tolerance	Performance test uncertainty shall be calculated as part of the performance test procedure to verify compliance with ASME Performance Testing Codes. Performance test uncertainty shall not be used as a test tolerance for plant performance testing.

Notes:

1. New and clean condition means that the actual operating hours from the initial firing of the combustion turbine are less than 200 hours. A performance degradation correction is applied to correct as-tested results when the actual operating hours of the combustion turbine exceed

200 hours. The degradation correction shall be based on equivalent degradation hours (EDH) and shall include degradation due to plant trips, load rejections and rapid load changes, even if such events occur before the combustion turbine attained 200 actual operating hours.

2. No tolerance will be applied prior to comparing the Performance Test results with the performance guarantee.

A.1.6.1.3 The performance guarantees stated in Section A.1.6.1.1 include the auxiliary consumption of equipment supplied by Seller as needed for steady state operation.

A.1.6.1.4 Not Used

A.1.6.1.5 Not Used

A.1.6.1.6 Guaranteed Emission Limits

For each of the pollutants listed in Table A.1.6.1.6.a, the corresponding emissions guarantee shall be the value listed in Table A.1.6.1. 6.a. Emissions are subject to the conditions specified in Section A.1.6.1.7.

Table A.1.6.1.6.a Guaranteed Emission Limits

Pollutant	Units	Emissions Limit (MECL to 100% Load)	Condition
NO _x	ppmvd @ 15% O ₂	By Seller	3-hr rolling average
CO	ppmvd @ 15% O ₂	By Seller	3-hr rolling average
VOC	ppmvd @ 15% O ₂	By Seller	Average of 3 x 1-hr stack test runs
NH ₃	ppmvd @ 15% O ₂	By Seller	1-hr average
H-CHO (Formaldehyde)	ppbvd@ 15% O ₂	By Seller	Average of 3 x 1-hr stack test runs
PM/PM ₁₀ /PM _{2.5}	lb/MMBtu	By Seller	Average of 3 stack test runs
Opacity ⁽⁶⁾		By Seller	Averaged over 6-min period

Pollutant	Units	Emissions Limit (MECL to 100% Load)	Condition
Notes: 1. Values are 'not to exceed.' 2. VOC is expressed as non-methane and non-ethane and are based on the molecular weight of methane. 3. Values are referenced at the HRSG stack. 4. Emissions contributions outside of Seller's control shall be corrected for. 5. Testing to demonstrate compliance with Emissions Guarantees will be conducted at time durations less than 24 hours as determined by Seller test procedure. 6. Should the performance test conclude the measured opacity at the HRSG stack outlet exceeds 5% following test method 40 CFR Part 60, Appendix A, Test Method 9 with all other HRSG emissions guarantees in compliance, then Buyer agrees to initiate a petition in accordance with CFR Title 40-Chapter I-Subchapter C-Part 60-Subpart A- 60.11 Section 6-8.			

A.1.6.1.7 Emissions Guarantee Basis

A.1.6.1.7.a. The emissions guarantees provided in the Facility's air permit are subject to the fuel properties in Seller's fuel specification. If the sulfur content or fuel bound nitrogen content exceeds the value indicated in Seller's fuel specification, the emissions guarantees shall be adjusted accordingly.

A.1.6.1.7.b. Not Used.

A.1.6.1.7.c. Emergency Diesel Generator and Fire Pump Diesel Engine PM10 emissions will be satisfied by supplier provided documentation. No actual source testing will be performed by Seller.

A.1.6.1.8 Not Used.

A.1.6.2 Mechanical Completion

A.1.6.2.1 Prior to initiating Performance Testing, Seller is required to verify Mechanical Completion by the submittal of turnover and Commissioning procedures that all equipment and systems necessary for Performance Testing are ready for initial operation, and may be operated in a manner in which they are normally intended to operate, without damage to the Project or any other property and without injury to any person. Seller must complete turnover, testing and Commissioning procedures, such as hydrostatic and pneumatic pressure tests, high pot tests, insulation resistance and continuity test, calibrations, relay settings, component and circuit testing, clean-outs, and flushes, and completed system startup testing and back feed, in accordance with prudent industry practice, Buyer approved procedures as identified herein, and the other applicable requirements of the OT Contract.

- A.1.7 Guarantee Test Conditions and Procedures
- A.1.7.1.1 Not Used
- A.1.7.1.2 Buyer shall assist Seller in the coordination of the Performance Test requirements as defined in the Contract and this Exhibit. Scheduling of the Performance Test shall be coordinated with Buyer. Without limiting the Contract, Seller may not conduct Performance Tests or energize or synchronize the Facility to the electric grid prior to the Closing.
- A.1.7.1.3 All tests shall be conducted with the combustion turbine operating as described in the specific test procedure. Corrections to the Performance Test results will be made based on the actual Higher Heating Value (HHV) of fuel sampled during the Performance Test. Fuel supplied for the Performance Test shall be confirmed to meet minimum manufacturer's fuel specification requirements, prior to initiating the Performance Test.
- A.1.7.1.4 General Test Requirements
- A.1.7.1.4.a. During all testing, the Project equipment will be operated within the normal design limits of the equipment and in a manner consistent with prudent industry practices for continuous long-term operation. However, cycle isolation shall be allowed as specified in the Performance Test procedure.
- A.1.7.1.4.b. During all testing, the steam turbine inlet temperature and the combustion turbine control temperature shall not exceed the manufacturer's recommended temperature for continuous long-term operation.
- A.1.7.1.4.c. All systems shall be in their normal operating mode for the entire duration of the Performance Test and the Reliability Test, as required for normal operation.
- A.1.7.1.4.d. During all testing, the control system must be in the normal continuous long-term operation mode. No software points shall be forced, and no hardware points shall be jumpered or have lifted leads.
- A.1.7.1.4.e. The Project shall be operated during the Performance Test, the Reliability Test, the Turbine Run Back and Trip Test, the CTG Island Mode Demonstration Test, the Plant Operating Startup Demonstration Test, and the Plant Operating Shutdown Demonstration Test. Seller shall be responsible for all maintenance until Substantial Completion is achieved. After the transfer of care, custody, and control of the Project to Buyer, operation and maintenance of the Project shall be under the direction and control of Buyer.
- A.1.7.1.5 The Turbine Run Back and Trip Testing may be performed either during the Reliability Test or separately, at Seller's election. All tests must be performed in compliance with the Guaranteed Emission Limits, as determined by a certified continuous emissions

monitoring system (CEMS), excluding operation below MECL, maintenance, startup, and shutdown (MSS). Testing for non-continuous constituents will only be done during the prescribed emissions measurement period utilizing grab samples. The Performance Test shall be invalidated in the event of failure to achieve compliance with the Guaranteed Emission Limits for the duration of the Performance Test.

- A.1.7.1.5.a. The initial draft of the project Performance Test procedures and the Air Emissions Testing Procedures shall be submitted to Buyer by Seller at least 180 days prior to the scheduled Performance Test date for review by Buyer and Buyer's Engineer. Seller shall design the Performance Test and shall conform to the requirements of the Contract and applicable ASME PTC, to demonstrate compliance with the Performance Guarantee. Seller shall design the Air Emissions Testing Procedures according to applicable regulatory codes to demonstrate compliance with the Guaranteed Emission Limits. Buyer and Buyer's Engineer will review and submit comments to Seller, if any, within 30 Days of receiving such procedures. If Buyer provides comments with respect to such procedures, Seller will promptly incorporate such comments that are mutually agreed to between Buyer and Seller.
- A.1.7.1.5.b. Seller to provide the Performance Test procedure that shall include correction curves. The Performance Test procedure will be reviewed and mutually agreed upon by Buyer and Seller.
- A.1.7.1.5.c. Seller shall include in the test procedure a checklist of cycle isolation manual and automatic drain valves that are normally closed during operations. These valves shall be checked and verified closed prior to conducting the test.
- A.1.7.1.5.d. Using the agreed upon Performance Test procedures, the raw data shall be corrected to the Guarantee Test Conditions using the agreed Performance Test correction curves and Performance Test procedure.
- A.1.7.1.5.e. An adjustment for plant performance degradation, based on the number of combustion turbine fired hours as calculated according to the combustion turbine supplier's procedures, shall be included in the overall adjustment.
- A.1.7.1.6 Performance Test
- A.1.7.1.6.a. The guaranteed Net Electrical Output and guaranteed Net Heat Rate will be demonstrated during the Performance Test using station and/or temporary instrumentation and generally following the ASME PTC, as applicable. The Performance Test will be conducted in general accordance with ASME PTC 46.
- A.1.7.1.6.b. The Net Electrical Output and Net Heat Rate test will be conducted within a continuous twenty-four (24) hour period. The Performance Test will consist of four one-hour, uninterrupted, individual, periods for evaluation of Net Electrical Output and Net Heat Rate. At least three of the four one-hour test periods shall meet the minimum test stability

criteria of AMSE PTC 46. The results of the selected three (3) one-hour test periods, as corrected, shall be averaged to determine Net Electrical Output and Net Heat Rate. The measurement uncertainty associated with the test results will be evaluated in accordance with ASME PTC 19.1 ("Measurement Uncertainty"). The Measurement Uncertainty calculation will only be used to determine whether the project Performance Test meets the requirements of ASME PTC 46. If the results are not consistent (as detailed below), individual evaluation periods may be repeated until repeatable results are obtained. Any interruption of an individual evaluation period, within Seller's responsibility, will require that such evaluation period be repeated at Seller's cost (excluding fuel costs).

- A.1.7.1.6.c. An individual evaluation period is considered consistent if (i) the Net Electrical Output value, corrected to the Guarantee Test Conditions, is within one percent (1.00%) of the average of all submitted evaluations and (ii) the Net Heat Rate value, corrected to the Guarantee Test Conditions, is within two percent (2.00%) of the average of all submitted evaluations.
- A.1.7.1.6.d. The as-tested Net Electrical Output and Net Heat Rate values determined during the Net Electrical Output and Net Heat Rate Test shall be corrected to the Guarantee Test Conditions using the methodology and correction curves as described in the Performance Test procedure.
- A.1.7.1.6.e. If the CTG supplier provides a new correction curve for the combustion turbine after the integrated Dry Low NO_x (DLN) tuning at the site, it will be integrated in the Performance Test procedures subject to Buyer review and approval.
- A.1.7.1.6.f. After the as-tested values for each of the Performance Test runs are determined, corrections to the as tested Net Electrical Output and Net Heat Rate shall be performed by Seller for each test period in accordance with this Section and the Performance Test procedures to determine an average of the corrected results. If the actual test conditions differ from the Guarantee Test Conditions, corrections shall be made for each of the Guarantee Test Conditions, and in particular the following:
 - A.1.7.1.6.f.1 Generator power factor and frequency
 - A.1.7.1.6.f.2 Fuel composition, heating value and chemical and physical characteristics, including analysis.
 - A.1.7.1.6.f.3 Barometric pressure
 - A.1.7.1.6.f.4 Ambient relative humidity
 - A.1.7.1.6.f.5 Ambient dry bulb temperature; Cooling tower inlet wet bulb temperature
 - A.1.7.1.6.f.6 Degradation

- A.1.7.1.6.f.7 Evaporative Cooler Status (On/Off)
- A.1.7.1.6.f.8 Duct Burner Status (On/Off)
- A.1.7.1.6.f.9 Cycle Leakage
- A.1.7.1.6.f.10 Fuel gas temperature at supply point at the specified pressure
- A.1.7.1.6.g. During the Net Electrical Output and Net Heat Rate Test, the Project will be stabilized for at least one (1) hour and followed by actual test data taken during each 1-hour interval (selected 1-hour intervals used for evaluation are to be mutually agreed upon in order to minimize the magnitude of correction). Raw test data will be made available to Buyer and Buyer's designated representatives for each 1-hour interval, after completion of the Performance Test. Raw test data taken during these intervals cannot be corrected from its raw form.
- A.1.7.1.7 Emissions Testing
 - A.1.7.1.7.a. Continuous Emissions Monitoring System (CEMS) equipment shall be tested and certified in accordance with the Air Permit and applicable requirements of 40 CFR Parts 60 and 75, and their applicable appendices, prior to the start of Performance Testing. The CEMS must be in service throughout the tests. Alternatively, if the Facility CEMS is not available for Performance Testing, portable CEMS equipment that meets TCEQ and US EPA reference testing standards may be utilized. Onsite acceptance tests shall include onsite functional acceptance tests (OFATs) and onsite performance specification tests (PSTs). Turnover of Seller's CEMS shall be after successful completion of the EPA onsite performance and certification testing stipulated in 40 CFR 60 and 40 CFR 75, and when all documentation and report writing are completed and accepted by both the EPA and local/state authorities as certified. Buyer will review linearity and software calculations.
 - A.1.7.1.7.b. Air Emissions Tests shall be conducted concurrently with the Net Electrical Output and Net Heat Rate Tests as much as practical according to the Air Emissions Testing Procedure.
 - A.1.7.1.7.c. Seller shall meet guarantees, based on measurement at the HRSG stack(s).
 - A.1.7.1.7.d. Air Emissions Testing Procedures will be based upon use of data obtained from the Continuous Emissions Monitoring System CEMS and/or certified stack testing as mutually agreed upon. It is intended that the CEMS equipment shall be fully tested and certified prior to conducting the Performance Test. The Project specific test procedure shall be developed in accordance with regulatory codes.

- A.1.7.1.7.e. It is the intent of Buyer that the Air Emissions Tests will be run in accordance with the latest editions of the EPA Methods listed below:
 - A.1.7.1.7.e.1 EPA Method 20 or 7E shall be used to measure NO_x.
 - A.1.7.1.7.e.2 EPA Method 10 shall be used to measure CO.
 - A.1.7.1.7.e.3 EPA Method 18 & 25A shall be used to measure total VOC emissions.
 - A.1.7.1.7.e.4 EPA Test Method CTM-027 shall be used to measure NH₃ emissions.
 - A.1.7.1.7.e.5 EPA Test Method 323 or equivalent shall be used to measure H-CHO emissions.
 - A.1.7.1.7.e.6 EPA Test Method 201A/202 or equivalent shall be used to measure PM₁₀ emissions.
 - A.1.7.1.7.e.7 EPA Test Method 9 shall be used to measure Opacity emissions.
- A.1.7.1.7.f. Compliance with Guaranteed Emission Limits that can be continuously monitored are required during the Performance Test.
- A.1.7.1.7.g. Before Substantial Completion, the Air Emissions Tests shall be repeated if directed by the TCEQ. If Seller has already demonstrated compliance with Guaranteed Emission Limits during the Performance Test, such additional Air Emissions Tests shall be Buyer's responsibility.
- A.1.7.1.7.h. Air Emissions Testing shall demonstrate compliance with all emission limits defined in Table A.1.6.1.6.a.
- A.1.7.1.8 Measurement and Test Results
 - A.1.7.1.8.a. Calibration tests shall be made on all temporary test instruments prior to initiating the Net Electrical Output and Net Heat Rate Test. These calibration test data will be recorded and made a matter of record. All calibrated temporary test instruments necessary to conduct the tests shall be provided by Seller. All calibration services, calibration gases, gas analysis, etc. necessary to conduct the Project Performance Test and report on the results shall be provided at Seller's cost.
 - A.1.7.1.8.b. Seller shall provide scaffolding (as required), material and labor for installation of test instrumentation, and removal of temporary instruments.
 - A.1.7.1.8.c. Within fourteen (14) days after receipt of the analysis of the test fuel, Seller shall deliver to Buyer a letter report certifying the Performance Test results. Within seven (7) days after receipt of such letter report, Buyer shall give notice to Seller either accepting the Performance Test results or specifying in what respects such letter report is incomplete, incorrect, or unacceptable.

- A.1.7.1.8.d. Within thirty (30) days after receipt of the analysis of the test fuel, Seller shall deliver to Buyer a detailed report (the "Performance Test Report"). Within ten (10) days after Buyer's receipt of the Performance Test Report, Buyer shall give notice to Seller either accepting the Performance Test Report or specifying in what respects such report is incomplete, incorrect, or unacceptable. In the event that Buyer gives notice to Seller specifying that the Performance Test Report is incomplete or incorrect, Seller shall promptly provide additional information required by Buyer.
- A.1.7.1.8.e. If the project Performance Test criteria is not met, then an additional test period will be added to the end of the Performance Test; or the Performance Test will be stopped and re-started.
- A.1.7.1.9 Not Used.
- A.1.8 RELIABILITY TEST
- A.1.8.1 Test Procedure
- A.1.8.1.1 The Project Reliability Test will be conducted over a period of three days (the "Measurement Period") after Substantial Completion in accordance with the test procedures. The intent of the Reliability Test is to demonstrate that the Project can continuously generate and deliver electric power to the utility grid during the Measurement Period while operating the combustion turbine and steam turbine, in accordance with the Guaranteed Emission Limits (demonstrated by the CEMS in accordance with Air Emissions Testing Procedures) and operating on gas fuel.
- A.1.8.1.2 Any turbine trip caused by equipment or services under the control of Seller shall result in a failed test requiring restarting the Reliability Test. The Measurement Period will be suspended during any period when Buyer fails to provide the fuel or personnel (in accordance with the Contract) for purposes of the test, or if Buyer causes a turbine trip. The Measurement Period shall also be suspended during any outage caused by a Force Majeure event and any curtailment by Buyer, provided that, during such period of Force Majeure or curtailment, Seller shall not take any corrective action unless Buyer approved. If any such corrective action is taken by Seller during such Force Majeure or curtailment period without Buyer approval, the Reliability Test shall be rerun by Seller at no cost (other than fuel and Buyer labor costs) to Buyer.
- A.1.8.1.3 The three-day Reliability Test Measurement Period shall be seventy-two (72) rolling hours with one hundred forty-four (144) half-hour periods of operation over which the Project shall demonstrate an overall Reliability Factor (RF), as defined below, of 94.5 percent. The Reliability Test shall commence after Substantial Completion and shall be completed no later than 12 months following Substantial Completion. The Reliability Test may not commence until a mutually agreed upon punch list of items which affect the safety and operation of the Project have been completed by Seller.

A.1.8.1.4 Reliability Factor Calculation

A.1.8.1.4.a. The three-day Reliability Factor ("RF"), will be determined as follows:

$$RF = (A + B + C) / (144) \times 100\%$$

Where:

A= The summation of the half-hour operating periods during which the Project operates between the Project Maximum and Minimum Limits defined below and a) meets the actual demand of Net Electrical Output; or b) under utility dispatch operation, meets the utility dispatch requirements.

This includes start-up, shut down and ramping required by Project or utility dispatch operation. During startup and ramping, Seller recommended loading limits shall not be exceeded. The Project shall be considered at the demand load while it is controlling or ramping to the load demanded.

This also includes the half-hour operating periods during which the demand of Net Electrical Output is higher than the Maximum Limit, provided the Project operates at the Maximum Limit.

B= The summation of the half-hour operating periods during which the Project operates between the Project Maximum and Minimum Limits defined below, but a) does NOT meet the actual demand of Net Electrical Output; or b) under utility dispatch operation, does NOT meet the utility dispatch requirements. The Project shall be considered at the demand load while it is controlling or ramping to the load demanded.

$$B = \sum (n1 \times NECF1 + n2 \times NECF2 \dots ni \times NECFi)$$

where

ni is the number of half-hour periods (If NECFi is less than 0.7, enter 0 for that ½ hour period)

$$NECF = \text{Actual Net Project Electrical Output} / \text{Demand}$$

C = The summation of the half-hour operating periods during which the Project is not operating or not synchronized to the grid, but is available and capable of operation or synchronization but not capable of achieving minimum Net Electrical Output or dispatch requirements due to a) no dispatch or Project demand; b) failure or limitations of system/equipment not supplied by Seller; or c) Buyer's error.

Those half-hour increments during which the Project demand or utility dispatch demand is below the Project minimum load limit shall be disregarded and a number of half-hour increments equal to those disregarded shall be added to the end of the testing period to reach a total of 72 hours.

- A.1.8.1.5 Maximum Limit shall be defined as the combustion turbine operating at base load and the steam turbine in operation with no bypass.
- A.1.8.1.6 Minimum Limit shall be defined as the combustion turbine operating at no less than manufacturer's minimum turndown load within emissions compliance and with steam turbine in operation within manufacturer's minimum turndown load.
- A.1.8.1.7 The dispatch schedule during the Measurement Period shall not include more than 4 starts and 2 stops. Any dispatched starts beyond 4 during the Measurement Period that results in a failed start will not be counted as a failed period and will be excluded. A number of periods equal to those excluded shall be added to the end of the testing period to reach the total 72 hours.
- A.1.8.1.8 The plant shall be operated in accordance with a dispatch schedule coordinated between Buyer, Seller, and with the approval of the transmission system operator.
- A.1.8.1.9 Automatic Generation Control (AGC) will be in-service during the testing periods.
- A.1.8.1.10 Emissions compliance as indicated by the certified Continuous Emission Monitoring System (CEMS) shall be met during the Reliability Test. No credit shall be taken for any period not meeting the Guaranteed Emission Limits, except operation below MECL, MSS and during calibration of CEMs analyzers.
- A.1.8.1.11 The Reliability Test shall be deemed successful if the Reliability Factor calculated for the Measurement Period meets or exceeds the guaranteed value of 94.5%. If the calculated reliability is less than the guaranteed value, Seller shall take appropriate remedial action. Following such remedial action, the Reliability Test shall be repeated, and Reliability Factor calculated for the new Measurement Period. Once the required Reliability Factor for a Measurement Period is achieved in the most recent Reliability Test, the test will be deemed successfully completed.
- A.1.8.2 Conditions Applicable for the Reliability Test
- A.1.8.2.1 Excluded are outage hours which are not under Seller's control, including but not limited to those caused by low fuel gas supply pressure, grid frequency variations outside of the operating manuals and instruction manuals, Buyer's error, equipment not supplied or installed under this Specification, acts of Buyer or its agents or its other Sellers and SubSellers (not including Seller's SubSellers), Force Majeure events and Buyer's failure to comply with its obligations under the terms of the Contract. If the unit is shut down or derated due to any of the reasons listed above, the test will be interrupted for the duration of the shutdown or derating. When the test is restarted and the unit has reached dispatched load, the clock shall be restarted at the number of hours achieved just before the shutdown or derating occurred. The achievement of the Reliability Factor is based upon the anticipated operating parameters of the Project (e.g., duty cycle, fuel specifications etc.) specified in the Contract.

- A.1.8.2.2 Seller shall not be liable for the outage hours arising from Buyer's failure to adhere to the operating manuals, instruction manual and other written operational recommendations of Seller. If the unit is shut down or is derated due to any of the reasons listed above, the test will be interrupted for the duration of the shut down or derating. When the test is restarted and the unit has reached dispatched load, the clock shall be restarted at the number of hours achieved just before the shutdown or derating occurred, except as stated above.
- A.1.8.2.3 Buyer shall maintain an operator log sheet, following a mutually agreeable format, indicating in detail performance parameters, cycles, and maintenance actions. Buyer shall report key performance parameters to Seller on a daily basis. Seller shall be entitled to inspect the operator log sheet.
- A.1.8.2.4 Seller shall have a field representative present during performance of the Reliability Test.
- A.1.8.2.5 Buyer shall use all reasonable efforts to notify Seller as soon as possible following any forced outage or if the unit is incapable of achieving a target load within the minimum allowable load to base load capabilities of the unit.
- A.1.8.2.6 To the extent forced outage hours are accumulating due to remedial actions for which Seller is not responsible, Buyer shall perform such remedial actions diligently.
- A.1.8.2.7 Within 45 days of completion of a successful Reliability Test, Seller shall provide a written report to Buyer detailing the results of the test, calculations of corrected output and calculations of the Reliability Factor, including a notification of Reliability Factor guarantee compliance.
- A.1.9 PROJECT DEMONSTRATION TEST
- A.1.9.1 Load Demonstration Tests
- A.1.9.1.1 Seller shall demonstrate the following load carrying capability no later than 12 months after Substantial Completion.
- A.1.9.1.1.a. The combustion turbine operating at manufacturer's minimum turndown load within emissions compliance and with steam turbine in operation.
- A.1.9.1.1.b. Not Used
- A.1.9.1.1.c. Steam bypass operation with the combustion turbine operating at base load with steam turbine in full bypass and duct burners off.
- A.1.9.1.2 The load demonstration test shall be considered successful if the adjusted plant load is accomplished for a minimum period of one hour with controls in normal automatic mode,

emissions are in compliance with the Guaranteed Emission Limits herein, and all loops remain within the design operating parameters of the plant.

A.1.9.2 Turbine Run Back and Trip Testing

A.1.9.2.1 Turbine Run Back and Trip Test to be completed no later than 12 months after Substantial Completion will be designed to demonstrate plant response to the trip of a major balance of plant component, run back to reduced load, and Plant operation under individual combustion turbine and steam turbine trip conditions. The test shall be considered successful if the trip response and load runback is accomplished with controls in normal automatic mode and emissions are in compliance with the Guaranteed Emission Limits except operation below MECL, MSS and, all critical process parameters are maintained within defined operating limits and remain stable during transition and continuous load conditions.

A.1.9.2.2 The test scenarios to be demonstrated shall be conducted at the maximum Net Electrical Output and include:

A.1.9.2.2.a. Trip of one (1) closed cooling water pump. Standby pump starts. The combustion turbine and steam turbine shall maintain their current load. A successful test is demonstrated by maintaining their current load for two (2) hours and all control loops shall remain in automatic during this two (2) hour period.

A.1.9.2.2.b. Trip of one (1) circulating water pump (if utilized). Combustion turbine shall runback to the manufacturer's minimum turndown load within emissions compliance, steam turbine remains in operation, and all control loops shall remain in automatic. A successful test is demonstrated by maintaining the minimum turndown load for two (2) hours and all control loops shall remain in automatic during this two (2) hour period.

A.1.9.2.2.c. Not Used

A.1.9.2.2.d. Trip of one (1) condensate pump. Standby pump starts. Combustion turbine and the steam turbine shall maintain their current load. A successful test is demonstrated by maintaining the current load for two (2) hours and all control loops shall remain in automatic during this two (2) hour period.

A.1.9.2.2.e. Not Used

A.1.9.2.2.f. Not Used

- A.1.9.2.2.g. Trip of the steam turbine while operating at maximum Net Electrical Output defined as the combustion turbine operating at base load and the steam turbine in operation with no bypass. A successful test is demonstrated by the combustion turbine remaining at the combustion turbine's maximum Net Electrical Output, and the steam bypass valves going into service with duct burners off. This operating condition shall be maintained for two (2) hours and all control loops shall remain in automatic during this two (2) hour period.
- A.1.9.2.2.h. Not Used
- A.1.9.3 CTG Island Mode Demonstration Test
- A.1.9.3.1 Seller shall perform an Island Mode Demonstration Test no later than 12 months after Substantial Completion. This test will demonstrate the CTG control capability for an Island Mode event. The Island Mode allows the CTG unit to continue operating in the event that the transmission grid (i.e., bulk power system) is lost due to an outage (e.g. blackout). The test shall be considered successful if the plant automatically transitions to Island Mode for a simulated grid loss and for manual initiation events and CTG is maintained operational for two (2) hours followed by operator initiated automatic synchronizing back to the transmission system. During this test, or during Island Mode operation, the emissions need not be in compliance with the Guaranteed Emission Limits or Minimum Emission Compliance Limits (MECL).
- A.1.9.4 Plant Operating Startup Demonstration Test
- Seller shall define and demonstrate plant operating startup times and durations prior to Substantial Completion. Demonstration of tests must be done with all control loops in automatic, the unit shall not runback or trip, and all loops shall remain within the operating parameters of the plant.
- A.1.9.4.1 The time limits for each plant condition from combustion turbine flame on to valves wide open (HP and IP) on the steam turbine at the HRSG maximum condition with steam turbine bypass valves fully closed and duct burners off are as follows:
- | | |
|--------------------|---------------------------------------|
| Hot Startup (1x1) | Less than two-and-a-half (2.5) hours |
| Warm Startup (1x1) | Less than four-and-a-half (4.5) hours |
| Cold Startup (1x1) | Less than six-and-a-half (6.5) hours |
- A.1.9.4.2 The time limits from combustion turbine flame on to the SCR reaching functional temperature for formaldehyde emission mitigation shall be less than three (3) hours.

A.1.9.5 Plant Operating Shutdown Demonstration Test

Seller shall define and demonstrate 1x1 Plant operating shutdown times and durations prior to Substantial Completion. Demonstration of tests must be done with all control loops in automatic, the unit shall not runback or trip, and all loops shall remain within the operating parameters of the Plant.

A.1.9.6 NERC Compliance Testing

Seller shall engage Buyer approved Seller (as identified in Exhibit [N]) to perform NERC compliance testing to the latest NERC Standards that are in effect at the time of Contract execution. This testing shall include NERC-MOD-025, -026, and -027. Testing documentation in accordance with the NERC standard and test equipment certifications shall be provided to Buyer for review. Testing and completion of final Buyer accepted documents must be completed within 180 days of Substantial Completion.

A.1.9.7 MISO Generation Verification Test Capacity (GVTC)

Seller shall perform a four-hour Net Electrical Output test conducted without cycle isolation prior to Substantial Completion. MISO generation capacity and test method shall be mutually agreed upon between Seller and Buyer.

A.1.9.8 MISO Automatic Generation Control (AGC) Closed Loop Demonstration Test

Seller shall demonstrate ability to follow AGC by conducting a two-hour test with MISO sending the unit dispatched loads prior to Substantial Completion.

END OF SECTION

Section A.2 Project Execution Plan Requirements

A-2.1. Objective / Introduction

The purpose of this document is to provide an overview of the selected execution method to develop, engineer, and construct the combined cycle facility to generate power in compliance with all federal, state, and local requirements. Following execution of the Agreement, the Seller shall execute the Project in accordance with the requirements of this Section A.2.

No modifications to the PEP are permitted without first providing the Buyer a reasonable opportunity to review and comment on any proposed modifications, and the Seller shall give due consideration to any Buyer's comments received and shall not base its subsequent decision to modify or not modify the PEP solely on cost or convenience to the Seller. The Buyer will be reasonable and timely in any modification requests.

This Section A.2 is intended to complement and not conflict with any of the various other parts of the Agreement or its Exhibits, Schedules or Sections; however, to the extent any conflict cannot be reasonably reconciled between the provisions of this Section A.2 and those of the Agreement or its Exhibits, Schedules or Sections besides this Section A.2, those provisions and not the conflicting provision(s) of this Section A.2 shall control and prevail.

The provisions of this "Objective / Introduction" section shall be construed as having equal force as the provisions in the rest of this document and are not mere recitals.

A-2.1.1. At a minimum, the following shall be addressed:

1.0	Health, Safety, and Environmental Plan
2.0	Quality Assurance/Quality Control Plan
	2.1 Quality Policy
	2.2 Quality Program
	2.2.1 Process Control
	2.2.2 Document and Design Control
	2.2.3 Inspection and Testing
	2.2.4 Benchmarking
	2.2.5 Auditing
	2.2.6 Managing Non-conformance
	2.2.7 Training
3.0	Project Site Security Plan
4.0	Project Organization Plan
	4.1 Overall Project Organization

	4.2 Home Office Organization
	4.3 Site Organization
5.0	Engineering Plan 5.1 General 5.2 Permits, Laws and Regulations 5.3 Professional Engineers/Architects Seal Requirements 5.4 Definition of Deliverables 5.5 Numbering Systems for Design Documents and Drawings 5.6 Plant Equipment Numbering 5.7 Drawing Title Blocks 5.8 CAE/CAD Approach 5.9 Constructability Approach 5.10 Value Engineering/Cost Reduction Program 5.11 Process Safety Management/Hazard Review 5.12 Unique Design/Execution Considerations 5.13 Requirements for Record Drawings/ Specifications Requirements 5.14 Definition of Spare Parts Requirements 5.15 Drawing Approval Requirements 5.16 Excluded Items
6.0	Contracting Plan
7.0	Procurement Plan 7.1 Procurement Basis 7.2 Procurement Systems 7.3 List of Items Supplied by Client/Others 7.4 Client Purchase Documents and Terms and Conditions 7.5 Receiving/Warehouse Requirements 7.6 Sales Tax Requirements 7.7 Insurance Requirements 7.8 Tax Exempt Status 7.9 Applicable General Conditions 7.10 Invoicing Services and Payment of Invoicing Responsibility

	7.11 Expediting Services, Including Supplier Document Review Requirements 7.12 Inspection Services 7.13 Approved Project Supplier List
8.0	Construction Plan 8.1 Site Organization 8.2 Mobilization Plan 8.3 Temporary Facilities Requirements 8.4 Evaluations of Special Requirements 8.5 Evaluations of Special Equipment Requirements 8.6 Operations Restriction During Construction 8.7 Pre-Outage Construction Work Permit Requirements 8.8 Summary Analysis of Tie-ins to Existing Facilities 8.9 Support to be Provided by Others 8.10 Definition of Project Completion and Measurement Criteria 8.11 Rigging/Equipment Plans 8.12 Security 8.13 Environmental, Safety and Health 8.14 On Site Material Receiving/Storage
9.0	Document Control Plan
10.0	Project Risk Register
11.0	Schedule Management Plan
12.0	Preliminary Baseline Level I and Level II Project Schedules and WBS
13.0	Performance Measurement Baseline



Project Milestone Schedule
Reference Section 12

To be provided by Seller as a part of the Proposal

SECTION A.4
CONSTRUCTION REQUIREMENTS

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SECTION A.4

CONSTRUCTION REQUIREMENTS

- A.4.1 CONSTRUCTION CONSIDERATIONS
- A.4.1.1 Seller shall provide construction services in accordance with the Seller Project Execution Plan and this Specification.
- A.4.1.2 The Environment Health and Safety Plan ("EH&S Plan") shall incorporate all specific Project Site health and safety requirements and will be an attachment to the construction execution plan. In addition, the Seller must adhere to all established EH&S Plan requirements. Safety plans shall include major events, but not limited to hurricanes and tornadoes. Safety plans shall include support for annual drills.
- A.4.1.3 Construction execution along with environmental site planning participation between Buyer and Seller are essential and will be ongoing throughout Project execution. Upon initiation of the Project, construction execution will be an integral part of overall planning.
- A.4.1.4 A layout drawing of temporary construction facilities/offices, laydown yards, security, and parking, shall be an attachment to the construction execution plan.
- A.4.1.5 Not Used
- A.4.1.6 Prior to start of construction activities, Seller shall have onsite all necessary construction facilities, personnel, signage, personnel protection equipment (PPE), construction reporting tools, etc.
- A.4.1.7 Source of construction water shall be determined by the seller.
- A.4.1.8 Construction Constraints:
The Seller shall design and install a new process discharge for the project. Seller is responsible for obtaining discharge permit for new discharge location.
- A.4.2 ENVIRONMENTAL REQUIREMENTS
- A.4.2.1 The proper management, handling and disposal of any air emissions and effluent discharges, including Project site drainage during construction, shall be the responsibility of the Seller.
- A.4.2.2 Seller shall obtain a new TPDES wastewater discharge permit to support operation of the facility, which shall be based on the projected wastewater flows, outfalls and discharges identified in the Water Balances provided in Section A.16.4.2 of this Specification.
- A.4.2.3 The Seller shall dispose of above ground and underground flushing and testing water offsite. The Seller shall dispose the boiler hydro and chemical clean discharge water offsite.

- A.4.2.4 The Seller shall develop a site-specific SWPPP requiring the design, installation, implementation, and maintenance of effective pollution prevention measures by the Seller. The SWPPP shall be prepared in accordance with sound engineering practices and identify potential sources of pollution that may reasonably be expected to affect the quality of storm water discharges associated with construction activity. The SWPPP shall describe and ensure the implementation of specific best management practices for the project site, which will reduce pollutants in storm water discharges and assure compliance with the terms and conditions of the TPDES
- A.4.2.5 The Seller shall not commence construction activity, prior to receipt of the written notification of approval of permit coverage by the Buyer.
- A.4.3 DEMOLITION
- A.4.3.1 The Seller shall examine the areas and conditions under which demolition or alterations are to take place and notify Buyer in writing of conditions which are detrimental to the proper and timely completion of the Work.
- A.4.3.2 Demolition or alteration procedures and Work are subject to inspections conducted by Buyer. Such inspections shall not relieve Seller of responsibility to provide Work in compliance with the contract and specifications. Buyer reserves the right, at any time before Final Acceptance, to reject Work not complying with the specified requirements.
- A.4.3.3 Seller is responsible for identification and mitigation of any hazard present prior to performing demolition and alteration Work to ensure the safe execution of the Work.
- A.4.3.4 Where concrete is being demolished or Seller is performing any other dust producing activity, the Seller shall use water sprays to keep dust from spreading.
- A.4.3.5 Seller shall not utilize blasting as a means of demolition.
- A.4.3.6 Any underground exploratory work shall be by hydro-excavation. Use of other exploratory means shall require the review and approval by Buyer.
- A.4.4 HAZARDOUS MATERIALS AND HAZARDOUS WASTE
- A.4.4.1 The existing materials to be disturbed in execution of the Work may contain lead, mercury, or various other hazardous materials. These hazardous materials may be a result of original product manufacturing or subsequent factors such as contamination. Seller shall take appropriate precautions to protect its workers, subcontractor employees, Buyer employees, third-party employees, the general public, and the environment including, but not limited to, identifying hazardous materials prior to exposure. Seller shall notify Buyer immediately if previously unidentified hazardous materials are identified.
- A.4.4.2 Seller shall comply with applicable Law, Contract requirements, and Buyer's policy requirements concerning the removal and disposal of all hazardous material/waste.
- A.4.4.3 Removal, transport, and disposal of hazardous materials, including asbestos, are the responsibility of the Seller.
- A.4.4.4 Disturbance of and exposure to asbestos, lead, and all other hazardous materials involves certain health, safety, and environmental risks.

- A.4.4.5 Seller shall abide by all Buyer's hazardous materials and waste requirements and policies.
- A.4.4.6 Asbestos and Lead Awareness:
- A.4.4.7 The disturbance of any kind of asbestos containing material may cause the release of asbestos fibers, which may lead to exposure in excess of allowable exposure limits defined in the Federal Clean Air Act, the Federal Occupational Safety and Health Act, and other applicable Law, or exposure by way of carrier, contamination, or uncontrolled release.
- A.4.4.8 The burning, cutting, flaking, or any other form of disturbance of lead-containing material may cause the release of lead, which may lead to exposure in excess of allowable exposure limits defined in the Federal Clean Air Act, the Federal Occupational Safety and Health Act, and other applicable Law, or exposure by way of carrier, contamination, or uncontrolled release.
- A.4.5 DISPOSAL
- A.4.5.1 Disposal of all waste resulting from the Work shall be per applicable Law.
- A.4.6 TRAFFIC, NOISE, DUST, OVER-SPRAY ABATEMENT AND MITIGATION MEASURES; OTHER RESTRICTIONS DURING CONSTRUCTION
- A.4.6.1 Buyer desires to be a good neighbor to the local residence and local community during the construction activities. As such, Seller shall adhere to the terms of this Specification and the following policies:
- A.4.6.2 It is the responsibility of the Seller to address, in its work plan, the construction noises, dust, over-spray, etc., abatement or mitigation during all phases of the Work, including construction mobilization, erection work and demobilization periods. Additionally, Seller to address, in the work plan, work hours, times for truck delivery, steam and gas blows, heavy hauls, rail siding, etc. Seller may work nightshift and weekends, at the discretion of the Seller, with these off normal work hours addressed in the work plan.
- A.4.6.3 Seller shall repair any pothole, or any other damage caused by the Work as soon as reasonably possible, but before the end of the project.
- A.4.6.4 Seller shall provide any necessary improvements to the site access roads between the public highway and facility to facilitate their work and deliveries.
- A.4.7 PARKING
- A.4.7.1 Seller is responsible for maintaining the Parking Area.
- A.4.7.2 Seller shall minimize traffic disruption and congestion near the Project site and in the surrounding community. On working days, during morning and evening rush hours, Seller shall arrange as needed to have law enforcement on duty to help control traffic.

A.4.8 TEMPORARY FACILITIES

A.4.8.1 Temporary facilities shall be provided by Seller including canopies, awnings, or other roof like features to provide rain coverage at trailer main access doors. The Buyer shall supply and deliver one (1) eight plex trailer and a double wide trailer to site for Owner use during construction. Buyer shall supply power and water per Section A.16.1-DOR Matrix.

A.4.8.2 Seller shall provide temporary portable bathrooms and hand washing stations for all construction personnel. Seller shall service, clean, pump out and dispose as necessary.

A.4.8.3 Seller shall provide holding tanks for sanitary sewage discharge from both Buyer and Seller construction trailers in accordance with local codes. Seller shall service, clean, pump out and dispose as necessary.

A.4.8.4 Seller shall install and supply internet and associated fiber installation to the construction trailer. Seller is responsible for distribution network including switches, phones, and computers cabling and raceway, etc. throughout the site for Seller use. Once construction is complete the fiber cables will be abandoned in place.

A.4.8.5 Seller shall provide space and power connection (cable, conduit, etc.) for six (6) connex for Buyer Equipment storage.

A.4.9 Not Used

A.4.10 NOISE ABATEMENT

A.4.10.1 In addition to OSHA, State, and standard protection precautions required during the Work, protection shall be provided for noise control including but not limited to noise caused by construction traffic through residential areas, especially before 7:00 a.m. and after 7:00 p.m.

A.4.11 TURNOVER WALKDOWNS

A.4.11.1 Seller shall conduct and lead construction to commissioning and commissioning to complete system walkdowns as a presentation of the system for acceptance by the Buyer.

A.4.11.2 Seller shall lead the walkdowns prepared with knowledge of the physically installed system and location of components, associated system drawings, documentation needed to review and verify the commissioning completion of the system, and a list of known deficiencies.

A.4.11.3 Seller shall provide a 24-hour advance notice to the Buyer for any walkdown to occur Tuesday through Thursday. Seller shall provide a 72-hour advance notice to the Buyer for any walkdown to occur Friday through Monday.

A.4.11.4 For equipment, components and materials damaged during the construction process, see requirements for remedy and resolution in Agreement Terms and Conditions.

A.4.12 MASTER DEFICIENCY LIST (PUNCHLIST)

A.4.12.1 During construction turnover to commissioning walkdowns, and commissioning to Buyer walkdowns, Seller and the Buyer shall make note of and document identified outstanding work to be completed such as punchlist items, deficiencies, etc., and will maintain these items on a Master Deficiency List for the system. Seller shall be responsible for maintaining the punchlist.

A.4.12.2 The Seller will define the priority of the deficiencies based on start-up sequence, safe check out, and/or operation of the system. Priority assignments for deficiencies are described as follows:

A.4.12.3 Priority A: Must be completed
prior to acceptance of Mechanical Completion.

A.4.12.4 Priority B: Must be completed
prior to acceptance of Substantial Completion.

A.4.12.5 Priority C: Must be completed
prior to Final Acceptance.

A.4.12.6 Priority D: Other - commercial /
Buyer requested items.

A.4.12.7 Seller shall not remove deficiency list items or change priority assignments of deficiencies without Buyer approval. Buyer will ensure there is sufficient staff to review proposed changes.

A.4.13 CONSTRUCTION TURNOVER (CTO) DOCUMENTATION

A.4.13.1 Seller will scope drawings to define system turnover boundaries and will include Drawing and Engineering Lists.

A.4.13.2 Seller shall document all construction checkout, quality assurance/quality control and testing results.

A.4.13.3 The required format and content of the Construction turnover packages that are to be assembled, completed, and populated by Seller is indicated in the following index:

Bulk Quality Turn Over

Section 1 GENERAL INFORMATION (Each Section)	
A	Turnover Package Transmittal
1.A.1	Transmittal
B	Scoped Drawings
1.B.1	Scoped Drawings (by package)
Section 2 FOUNDATIONS	
A	Installation Reports
2.A.1	Pile / Pier Installation Reports (if self-performed)
2.A.2	Pile / Pier Installation Reports (if subcontracted)



B	Special Inspection Reports (3rd Party)
2.B.1	Special Inspection Reports (if applicable)
C	Material Test Report's
2.C.1	Material Test Reports (Steel or Rebar)
D	Concrete Placement & Batch Tickets
2.D.1	Concrete Placement Form
2.D.2	Batch Ticket Reports
E	Compressive Strength Results
2.E.1	Compressive Test Result Log
2.E.2	Compressive Test Result Form (28 Day results)
F	As-built Information
2.F.1	As-built Information

Section 3 RETAINING WALLS – If Applicable	
A	Installation Reports
3.A.1	Pile / Pier Installation Reports (if self-performed)
3.A.2	Pile / Pier Installation Reports (if subcontracted)
B	Special Inspection Reports (3rd Party)
3.B.1	Special Inspection Reports (if applicable)
C	Material Test Report's
3.C.1	Material Test Reports (Steel or Rebar)
D	Proof Test Reports
3.D.1	Proof Test Reports
E	Concrete Placement & Batch Tickets
3.E.1	Concrete Placement Form
3.E.2	Batch Ticket Reports
F	Compressive Strength Results
3.F.1	Compressive Test Result Log
3.F.2	Compressive Test Result Form (28 Day results)
G	As-built Information
3.G.1	As-built Information

Section 4 CIVIL	
A	Compaction Tracking (3rd Party)
B	Soil Samples (Proctor and Gradation)
C	Asphalt Records
D	Daily Geo Reports (3rd Party)
E	Backfill Testing
F	Daily Blast Reports
G	Deep Dynamic Compaction (DDC) Reports
H	Void Mitigation Reports

Section 5 CONCRETE (by Area / by Foundation)	
A	Placement Checklists
B	Batch Tickets
C	Material Test Reports
D	Special Inspection Reports (if applicable)
E	Compressive Strength Results



F	Concrete Coatings

Section 6 GROUT (by Area / by Major Equipment)

A	Grout Card
B	Compressive Strength Results

Section 7 STRUCTURAL STEEL (by Structure / by Area)

A	Bolt Testing Records
B	Structural Weld Maps
C	Nondestructive Examination Reports (If Applicable)
D	Material Test Report's

Section 8 PIPING (by engineering system)

A	Weld Maps
B	NDE Reports
C	Heat Treatment Reports
D	Material Test Report's

Section 9 PAINTING

A	Daily Inspection Reports
B	Vendor Certification
C	Color Samples
D	Painting Final Acceptance

Section 10 BUILDINGS

A	Pre-Engineered Buildings
B	Masonry Grout Cube Break Results
C	Structural Steel Inspection Records
D	Material Test Report's & Certificates of Compliance
E	Pressure Testing (if applicable)
F	HVAC Testing Records
G	Fire Proofing
H	Fire System Testing Records
I	Exterior Finishes Certifications
J	Special Inspection Reports

Section 11 Misc.

A	ASME Section 1 Final Certifications
B	Substantial Completion Certificates
C	Mechanical Completion Certificates
D	WPS/PQR/Welder Certification
E	Performance Testing Results
F	Conformed to Construction Drawings
G	O&M Manuals

- A.4.14 SYSTEM TURNOVER PACKAGEs (STPs) DOCUMENTATION
- A.4.14.1 Seller shall combine completed CTO documentation organized by system with their STPs for submittal to the Buyer.
- A.4.14.2 Seller shall document all checkouts, start-up testing procedures, testing results, initial operation of systems, and integrated system testing as part of the turnover to Buyer process.
- A.4.14.3 Seller shall provide NERC FAC-008 supporting information documentation per A.16.2.9 – NERC GO-GOP Standards.
- A.4.14.4 Seller shall provide testing documentation for batteries/relays/PTs/CTs testing utilizing NERC nomenclature and parameters.
- A.4.14.5 All documentation shall be reviewed and accepted by Buyer prior to acceptance of the system by Buyer, within the timeframe defined by Section A.1.4.4.5.b.
- A.4.14.6 The required format and content of the STPs that are to be assembled, completed, and populated by Seller prior to substantial completion to Buyer is indicated in the following index:

Section 1 GENERAL INFORMATION	
	Description
A	Turnover Package Transmittal
1.A.1	Transmittal to the Client
B	System Turnover Acceptance Form & Notice of Mechanical Completion Form
1.B.1	System Acceptance Form (Internal)
1.B.2	Mechanical Completion Form (If Required by Contract)
1.B.3	System Custody Transfer Form (To Client)
C	Turnover System Description
1.C.1	Startup System Description (by SU Manager)
D	Scoped, Red-Lined P&IDs
1.D.1	Mechanical P&ID DWG List (Attached and Referenced)
1.D.2	Scoped P&ID's (Seller & Vendor)
E	Scoped, Red-Lined Electrical Drawings
1.E.1	Electrical DWG List (Attached and Referenced)
1.E.2	One Line Diagrams, and Panel Drawings
F	Master System Work List/Punch List
1.F.1	Master Worklist
G	RFI, NCR and ECN Applicable to System
1.G.1	ECN-001
1.G.2	RFI-023

Section 2 PIPING	
	Description
A	Piping Line List
2.A.1	Scoped Pipe Line List
B	Pipe Hydrostatic/Pneumatic/ISLT Test Reports



2.B.1	Hydro Test Record with Highlighted P&ID
2.B.2	Hydro Test Restoration Checklist
C	Flushing and Cleaning Reports/with Highlighted P&IDs
2.C.1	Flush Report with Highlighted P&ID & Flush Procedure
2.C.2	Cleanliness Reports (Oil Samples etc.) (Third Party)
D	Valve List
2.D.1	Scoped Valve List
E	Engineered Hangers and Supports Checklist
2.E.1	Scoped Engineered Hanger/Support List
2.E.2	Pipe Support Checklist (Hot Supports Only)
F	Expansion Joint Alignment Records
2.F.1	Scoped Expansion Joint List
2.F.2	Expansion Joint Alignment Checklist
G	High Pressure Flange Torque Records (>250PSIG Max Op Pressure)
2.G.1	Flange Torque Record (> 250PSIG Max Op Pressure only)

Section 3 MECHANICAL

Description	
A	Mechanical Equipment List
3.A.1	Scoped Mechanical Equipment List
B	Specialties List
3.B.1	Scoped Specialties List
C	Equipment Lubrication Records
3.C.1	Pump Lubrication Record
3.C.2	Motor Lubrication Record
D	Mechanical Equipment Alignment Records
3.D.1	Pump Alignment Record (Direct 008 or Reverse 009)
3.D.2	Pump Alignment Record (Rota-Line Report) (Direct 008 or Reverse 009)
3.D.3	Turbine Alignment Record (OEM Report/Rota-Line Report)
3.D.4	Conveyor Pulley Alignment Record
3.D.5	Fan Tip Clearance and Pitch Angle Record
3.D.6	Sheave Alignment and Belt Tension Record
3.D.7	Pipe Strain Report
E	Rotating Equipment Pre-Op Inspection Records
3.E.1	Rotating Equipment Pre-Op Inspection
3.E.2	Rotating Equipment Datasheet Record
F	Vessel Inspections & Closure Form
3.F.1	Vessel Clean & Close
G	SRV Certifications
3.G.1	Scoped Safety Relief Valve List
3.G.2	SRV Certification of set points

Section 4 ELECTRICAL

Description	
A	Electrical Equipment List
4.A.1	Scoped Electrical Equipment List
B	Motor Checkout Forms



4.B.1	LV Motor Checkout
4.B.2	MV/HV Motor Checkout
4.B.3	DC Motor Checkout
4.B.4	Motor Vibration Record (Typically provided with SU-ME-FM-004)
4.B.5	Synchronous Motor Checkout (Third Party) Specialty Motor
4.B.6	Motor CT Test Record (Third Party)
C	Switchgear Acceptance Record
4.C.1	Switchgear MV Pre-Energization Checkout
4.C.2	Switchgear MV Energization Checkout
4.C.3	Switchgear LV Pre-Energization Checkout
4.C.4	Switchgear LV Energization Checkout
4.C.5	Switchgear CT Test Record (Third Party)
4.C.6	Switchgear PT Test Record (Third Party)
4.C.7	Switchgear High Pot/Insulation Resistance Record (Third Party)
4.C.8	Switchgear Contact Resistance Record (Third Party)
4.C.9	Switchgear Functional Test Record (Third Party)
4.C.10	Switchgear Relay Test Record (Third Party)
4.C.11	Switchgear Breaker Test Record (Third Party)
D	HV & MV Transformer Acceptance Records
4.D.1	GSU/UAT Pre-Energization Checkout
4.D.2	GSU/UAT Energization Checkout
4.D.3	SUS Liquid Pre-Energization Checkout
4.D.4	SUS Dry Transformer Pre-Energization Checkout
4.D.5	SUS Liquid/Dry Energization Checkout
4.D.6	GSU/UAT Current Transformer Test Records (Third Party)
4.D.7	GSU/UAT Potential Transformer Test Records (Third Party)
4.D.8	GSU/UAT Relay Test Record (Third Party)
4.D.9	GSU/UAT Ratio Test on All Taps Test Record (Third Party)
4.D.10	GSU/UAT Winding Resistance & Phase relationship Test Records (Third Party)
4.D.11	GSU/UAT Winding Power Factor Test Record (Third Party)
4.D.12	GSU/UAT Bushing Power Factor Test Record (Third Party)
4.D.13	GSU/UAT Excitation Test Record (Third Party)
4.D.14	GSU/UAT Winding Insulation Resistance (Third Party)
4.D.15	GSU/UAT Core insulation resistance (Third Party)
4.D.16	GSU/UAT Surge Arrestors (Third Party)
4.D.17	GSU/UAT Functional Test for XFMR Instruments (Third Party)
4.D.18	GSU/UAT Oil Test Reports (Third Party) (Pre/Post Energization and Monthly C&M)
4.D.19	SUS CT Test Records (Third Party)
4.D.20	SUS PT Test Records (Third Party)
4.D.21	SUS Relay Test Records (Third Party)
4.D.22	SUS Ratio on all Taps Test Records (Third Party)
4.D.23	SUS Winding Resistance & Phase relationship (SUS) (Third Party)
4.D.24	SUS Winding Power Factor (Third Party)
4.D.25	SUS Excitation (Third Party)
4.D.26	SUS Winding Insulation Resistance (Third Party)
4.D.27	SUS Core insulation resistance (Third Party)



4.D.28	SUS Surge Arrestors (Third Party)
4.D.29	SUS Functional Test for XFMR Instruments (Third Party)
4.D.30	SUS Oil Test Reports (Third Party) (Pre/Post Energization and Monthly C&M)
E	Motor Control Center Acceptance Record
4.E.1	LV MCC Checkout
4.E.2	LV MCC (Megger) Insulation Resistance (Third Party)
4.E.3	LV MCC Contact Resistance (Third Party)
4.E.4	MV MCC CT Test Records (Third Party)
4.E.5	MV MCC PT Test Records (Third Party)
4.E.6	MV MCC High Pot/Insulation Resistance (Third Party)
4.E.7	MV MCC Contact Resistance (Third Party)
4.E.8	MV MCC Functional Test Record (Third Party)
4.E.9	MV MCC Relay test Records (Third Party)
F	Motor Operated Valve Checkout Record
4.F.1	Motor Operated Valve List
4.F.2	MOV Checkout
G	Cable/Circuit List by System
4.G.1	Scoped Cable List
H	Heater Checkout Record
4.H.1	Heater Checkout Records (Large 3 Phase Heaters only)
I	Cable Megger, High Potential, Fiber Optic Acceptance Records
4.I.1	Cable Megger Test Acceptance Record
4.I.2	Cable High Potential Test Acceptance Record
4.I.3	Cable High Potential Test Acceptance Record (Third Party)
4.I.4	Fiber Optic Cable Test Reports
J	Torque Verification Report
4.J.1	Termination Verification Report
4.J.2	Termination Torque Verification Report
K	Generator Circuit Breaker Acceptance Records
4.K.1	GCB Pre-Energization Checkout
4.K.2	GCB Field Vendor Test Records (Third Party)
4.K.3	GCB High Pot/Insulation Resistance (Third Party)
4.K.4	GCB Contact Resistance (Third Party)
4.K.5	GCB Functional Test Record (Third Party)
4.K.6	GCB CT Test Records (Third Party)
4.K.7	GCB Breaker Timing (Third Party)
4.K.8	GCB SF6 Gas Test (Third Party)
4.K.9	GCB Lightning Arresters & Surge Arresters (Third Party)
4.K.10	GCB PT Test Records (Third Party)
L	Isophase and Non-Seg Bus Duct Acceptance Records
4.L.1	Isophase Pre-Energization Checkout
4.L.2	Non-Seg Bus Duct Pre-Energization Checkout
4.L.3	Isophase High Pot Acceptance Report (Third Party)
4.L.4	Isophase Contact Resistance (Third Party)
4.L.5	Non-Seg Bus High Pot Acceptance Report (Third Party)
4.L.6	Non-Seg Contact Resistance (Third Party)



M	Battery Acceptance Records
4.M.1	DC Battery Bank Test Record (Pre-Commissioning and Monthly)
4.M.2	DC Battery Bank Test Record (IEEE 450 Test) (Third Party)
4.M.3	DC Power Panel Checkout
4.M.4	DC/UPS Battery Charger Checkout Record
4.M.5	DC/UPS Battery Charger Vendor Field Checkout Record (Third Party)
N	Generator Acceptance Records
4.N.1	Third Harmonic Under Voltage Reading (27TN)
4.N.2	Static Startup System AC & DC Link Reactor Checkout
4.N.3	Generator Relay Test Record (Third Party)
4.N.4	Insulation Resistance Record Stator (Third Party)
4.N.5	Insulation Resistance Record Rotor (Third Party)
4.N.6	Generator CT Test Record (Third Party)
4.N.7	Generator PT Test Record (Third Party)
4.N.8	Neutral Grounding XFMR Test Record (Third Party)
O	LV Power Panel & XFMR Acceptance Records
4.O.1	Single Phase Power Panel Checkout
4.O.2	3-Phase Power Panel Checkout
4.O.3	Low Voltage XFMR Checkout (120V/208V)

Section 5 INSTRUMENTATION AND CONTROLS

Description	
A	Instrument List
5.A.1	Scoped Instrument List
B	Control Valve Checkout Records
5.B.1	Control Valve Checkout Record
C	Instrument Calibration Records
5.C.1	Analog Calibration Record
5.C.2	Digital Calibration Record
5.C.3	Orifice Plate Checkout
5.C.4	Analog Instrument Calibration Record (When Vendor Supplied)
5.C.5	Digital Instrument Calibration Record (When Vendor Supplied)
D	DCS Data Links & Point Checks Report
5.D.1	DCS Data Links & Point Checks Report

Section 6 VENDOR AND SUB CONTRACTOR FIELD COMMISSIONING REPORTS

Description	
A	Vendor and Sub Contractor Field Reports
6.A.1	Mechanical Equipment Vendor Field Report
6.A.2	Electrical Equipment Vendor Field Report
6.A.3	Instrument Equipment Vendor Field Report

Section 7 CARE & MAINTENANCE

Description	
A	Care & Maintenance Records

7.A.1	Mechanical Equipment Care & Maintenance Records
7.A.2	Electrical Equipment Care & Maintenance Records

A.4.15 CONSTRUCTION STARTUP, TESTING AND CHECKOUT, AND COMMISSIONING TESTS

- A.4.15.1 The Seller shall be responsible for construction testing, checkout, start-up testing, initial operation of systems, integrated system testing, performance testing and system turnover to the Buyer.
- A.4.15.1.1 The Seller shall be responsible for system checkout, verification of design conformance, documenting, cleaning, and flushing, system pressure testing, electrical continuity, and implementation of design setpoints.
- A.4.15.1.2 The testing shall be performed by the Seller in coordination with the suppliers or in accordance with supplier instructions administered by the Seller. Procedures provided to Buyer for review.
- A.4.15.1.3 The Seller shall provide means for the Buyer to access, observe and visually confirm proper operation of all equipment and systems.
- A.4.15.1.4 Buyer shall provide operators to assist with startup and commissioning. A minimum of two will be provided for the duration of the startup schedule (beginning with backfeed).
- A.4.15.2 The Seller shall provide functional testing and initial operation of all components, equipment, and systems.
- A.4.15.2.1 The Seller shall demonstrate the ability of the systems to operate safely and reliably in a coordinated manner throughout the range of normal and transient operating conditions, for which they were designed.
- A.4.15.2.2 The Seller shall provide all tools, instruments, laptop computers with removable media to the Buyer at the completion of the project, tablets, software programs and services required to perform system functional and integrated systems testing. This includes providing the connection to systems to be tested, operation of the test equipment and instrumentation and generating test results as required.
- A.4.15.2.3 The testing equipment shall have calibration certificates documented and readily available for review by the Buyer and shall have been calibrated within the previous 12 months.
- A.4.15.3 The Seller shall provide utilities necessary to execute testing and commissioning, including water, fuels (excluding natural gas), lubricants, chemicals, batteries, and other similar expendable items. The Seller shall provide any equipment or device required for access, such as ladders and platforms.
- A.4.15.4 Not Used

- A.4.15.5 The Seller shall provide and use qualified and experienced operations personnel to operate components, equipment and systems during coordinated equipment and system initial operations through the Buyer's Final Acceptance.
- A.4.15.6 Seller shall identify requirements for fuel gas and provide daily usage to the Buyer through Substantial Completion.
- A.4.16 QUALITY ASSURANCE & QUALITY CONTROL (QA/QC)
- A.4.16.1 Seller shall submit its project specific QA/QC manual for review and acceptance by Buyer. Seller shall ensure that all materials, equipment, products, and Work are manufactured in accordance with the QA/QC program. The Seller shall be responsible for ensuring that it's Subcontractors' respective QA and QC programs meet the specified requirements imposed on the Seller by Buyer. Seller shall resolve any comments to Buyer's satisfaction.
- A.4.16.2 The Seller shall be responsible for ensuring that all welders, welding inspectors, and the nondestructive examination (NDE) personnel are certified in accordance with the applicable code requirements and their certifications shall be made available when requested for review by Buyer.
- A.4.16.3 Seller shall develop an inspection point program. The program shall include the manufacturing, inspection, and test operations that the Seller believes may be of interest to Buyer in demonstrating product quality.
- A.4.16.4 No later than two (2) months prior to beginning of fabrication, or as defined elsewhere under Drawings/Data submittal requirements, the following procedures shall be submitted for review and acceptance as applicable:
- A.4.16.4.1 Welding Procedure Specifications (WPS) and the corresponding Procedure Qualification Records (PQR).
- A.4.16.4.2 Inspection and test procedures developed in accordance with applicable industry standards such as, but not limited to, ASME, ANSI, IEEE, API, HEI, NEMA, and ASTM.
- A.4.16.4.3 Cleaning, painting, storage, packaging, and shipping procedures. Seller shall attach the Safety Data Sheets (SDS) with all painting/coating procedures.
- A.4.16.4.4 Nondestructive examination (NDE) procedures.
- A.4.16.4.5 Other special processes and procedures, such as heat-treating, pipe bending, flushing, etc.
- A.4.16.4.6 Welder certification records and continuity logs shall be made available to Buyer upon request.
- A.4.16.5 Certificates of Completion including, but not limited to, the following OEM equipment: CTG, HRSG and STG. Seller shall provide this documentation to confirm that the installation is fully complete. Seller shall receive this information from the respective Equipment OEM for mutual agreement of complete installation.

- A.4.16.6 Quality documents, such as but not limited to the ones listed below, shall be submitted as required by Buyer for review and acceptance:
 - A.4.16.6.1 Material certifications, including filler metal certifications.
 - A.4.16.6.2 Inspection check sheets and nondestructive examination records.
 - A.4.16.6.3 Test records including construction and installation records.
 - A.4.16.6.4 Manufacturer's data reports (Form-U), material safety data sheets, etc.
 - A.4.16.6.5 Copies of all deviation reports/non-conformance reports and dispositioning records.
 - A.4.16.6.6 Non-Conformance procedure
 - A.4.16.6.7 Certificate of conformance.
- A.4.16.7 Volumetric Testing Reports and the corresponding reader sheets shall be submitted to Buyer for review and acceptance within ten (10) days after completion of testing or made available immediately upon request from Buyer. All phased array ultrasonic testing reports not properly identified will be rejected.
- A.4.16.8 Non-conformances and deviations from purchase documents, approved drawings, procedures, or approved material selection shall be documented in detail within ten (10) days of discovery, submitted to the Buyer for review, acceptance, and resolution. The submittal shall include the supplier's proposed disposition with appropriate technical justification.
- A.4.16.9 Buyer, Buyer's Engineer and Buyer's other authorized representatives shall have full access to Seller's and its Subcontractors' facilities for reviewing conformance to the approved QC program and records, and for witnessing of inspections and tests.
- A.4.17 OPERATION AND MAINTENANCE TRAINING
 - A.4.17.1 Seller shall develop a Project specific site based Training Program which shall include but not be limited to a training plan, training materials, and presentation schedule to train the Buyer's personnel which shall include but not be limited to thirty (30) qualified individuals. The training plan, course objectives, list of training modules, and presentation schedule shall be provided to the Buyer for review, comment, and approval six (6) months prior to the start of the training and the training shall be completed prior to Mechanical Completion. Training that is not able to be completed by start of Commissioning shall be mutually agreed and approved by the Buyer. A Training Program Coordinator shall be assigned to manage and coordinate the overall Training Program.

- A.4.17.2 The objective of the Training Program is to train the Buyer personnel in the successful operation and troubleshooting of each system, auxiliary equipment, and control systems. The Training Program shall provide a basic understanding of each component, its relationship in a system, and the integration of all systems in the Facility. The Training Program shall include modules that cover each system of the Project and shall include but not be limited to the following:
- System Descriptions and Control Narratives
 - Piping and Instrument Diagrams (P&ID) and Electrical One Lines
 - Seller & Subcontractor Operation and Maintenance Manuals
 - System specific Power Point Presentations
 - Student training guides
 - System walkdown checklists and walkdowns in the field
 - A particular component's effect on the overall system during start-up, transient, shutdown conditions
 - The sequence of system start-up and shut down that is required to place the unit in service and remove the unit from service
 - The performance requirements of a particular system to achieve the rated unit power output
 - Control System
- A.4.17.3 The classroom training program shall be followed by continuing on-the-job training during the commissioning phase of the Project as the Buyer's personnel support the initial testing, start-up, commissioning, and initial operations of the various systems.
- A.4.17.4 All Seller and Vendor/Original Equipment Manufacturers presentations, lectures, walk-downs, etc. shall be conducted by personnel having extensive experience in Combined Cycle Combustion Turbine Operation and Maintenance. All trainees shall be provided with individual copies of the training materials i.e., System Descriptions, Control narratives, P&IDs, Electrical One Lines, etc., ten (10) additional copies of the training shall be provided to the Buyer, and electronic copies shall be provided to the Buyer in the format of training session and native format. Seller shall digitally record, upon approval of the Seller and its OEMs, the complete training sessions, with the exception of the HRSG, and provide copies to the Buyer. Seller shall supply copies of the HRSG training manuals to the Buyer and all participants in the training sessions. The training documentation shall be in English. The training modules shall include but not be limited to the sessions below:
- Project Introduction and Introduction to Print Reading – P&ID, Control Drawings, and Electrical Drawings

- Storm Water and Waste Water Treatment – Oily Water Separation
- Fuel Gas Supply System
- Ammonia Storage and Supply
- Ammonia Dilution Fans and SCR
- HRSG (By OEM)
- Electrical Distribution including High Voltage Switchyard, Electrical Switchgear and MCCs, CTG Generator Breaker, Transformers, Batteries, UPS, 125 VDC Distribution Systems, and Emergency Diesel Generator
- CEMS
- Combustion Turbine (By OEM) Operation
- Combustion Turbine (By OEM) Maintenance
- Combustion Turbine (By OEM) Hands-on Control System
- Combustion Turbine (By OEM) Generator
- Combustion Turbine (By OEM) Generator Excitation systems
- Demineralized, Service, Potable Water and Sanitary Waste Systems
- Closed Cooling Water
- Compressed Air System (Instrument and Service Air)
- Condensate
- Condenser Vacuum System
- Feedwater
- Steam Turbine (By OEM) Operation
- Steam Turbine (By OEM) Maintenance
- Steam Turbine (By OEM) Hands-on Control System
- Steam Turbine (By OEM) Generator
- Steam Turbine (By OEM) Generator Excitation systems
- Raw Water System
- Air Cooled Condenser
- H₂/CO₂/N₂ Supply Systems

- Fire Protection and Detection
- Steam Drains and Blowdown Tanks
- Chemical Feed Systems and Steam and Water Sampling
- Steam, including Hot and Cold Reheat, and Steam Bypass Systems
- Auxiliary Steam System
- Heat Balances and Water Balances
- Start-up and Shut-down Curves for all operating modes
- 6.9KV and 480V Hands-on Breaker Racking (Remote & Manual)
- DCS – (By OEM) Hands-on Operation
- DCS – (By OEM) Hands-on Data Acquisition
- DCS – (By OEM) Hands-on Logic Building
- DCS – (By OEM) Hands-on Graphics Building
- DCS – (By OEM) Hands-on Troubleshooting
- DCS – (By OEM) Hands-on AMS Device Manger and ValveLink™
- Integrated Startup and Shutdown
- Fuel Gas Compression Operation (if applicable)

A.4.18 SYSTEM OPERATING PROCEDURES

A.4.18.1 Seller shall develop and provide the Buyer Project specific System Operating Procedures. These System Operating Procedures shall be task-oriented procedures in the Buyer's standard format and the System Operating Procedures shall be provided in PDF and the native file format. The Seller shall provide the System Operating Procedures to the Buyer for review, comment, and approval. The first draft of the System Operating Procedures shall be provided to the Buyer prior to placing the systems into service for commissioning. The Seller shall incorporate changes to the system operating procedures via change control methods to ensure the operating procedures reflect system operations at the completion of the project. The System Operating Procedures include but are not limited to:

- Hot Startup Procedure 1x1
- Warm Startup Procedure 1x1
- Cold Startup Procedure 1x1
- Shutdown Procedure 1x1

- Emergency Shutdown 1x1
- Island Mode Procedure
- Restoration of Grid Connecting from Island
- Ammonia Unloading Procedure
- Chemicals Unloading Procedure
- Air Compressor Operation (Including swapping air comp.)
- Feedwater
- Condensate including Ammonia Feed
- Condenser Vacuum System
- Raw Water System
- Demineralized Water System
- Service Water System
- Aqueous Ammonia/SCR
- HRSG Nitrogen Wet Layup
- HRSG Nitrogen Dry Layup
- Air Cooled Condenser
- Closed Cooling Water
- Combustion Turbine Fire Protection
- Steam and Water Chemistry Specification Sheet for all water and steam systems, i.e., Feedwater, Condensate, Demineralized Water, Steam, Closed Cooling Water, Service Water, Evaporative Cooler, etc.
- 6900V Electrical Switching
- 480V Electrical Switching
- 6900V Racking (Remote & Manual)
- 480V Racking (Remote & Manual)
- Generator Breaker Operation
- Switchyard Breakers Operation
- Combustion Turbine H2 Purge/Fill

- Steam Turbine H2 Purge/Fill
- Combustion Turbine Offline Water Wash
- Combustion Turbine Online Water Wash
- Combustion Turbine Fuel Gas Control Valve Calibration
- Combustion Turbine IGV Calibration
- Combustion Turbine VGV Calibration
- Steam Turbine Valve Calibration
- Fire Protection and Detection Operation/Weekly Testing
- Emergency Diesel Generator Operation/Weekly Testing
- Combustion Turbine Hazardous Gas Detection Calibration
- Loss of Power Procedure
- CEMS Daily Calibration
- CEMS Linearity
- Fuel Gas Purge
- UPS/Essential Bus Operations
- Exciter Local/Manual Operation
- Oil/Water Separator
- Fuel Gas Compression Operation (if applicable)
- Winter Readiness and Winter Event Response Procedure. Develop a guide and procedure to aid in evaluating winter events and recommended actions based on the basis of design and event conditions.

END OF SECTION

SECTION A.5
COMBUSTION TURBINE-GENERATOR (CTG)

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SECTION A.5
COMBUSTION TURBINE-GENERATOR (CTG)

A.5.1 INFORMATION AND SCOPE OF WORK

A.5.1.1 GENERAL

- A.5.1.1.1. The Seller shall provide combustion turbine generators (CTGs) complete with all required auxiliaries.
- A.5.1.1.2. The CTG design and construction shall be based on manufacturer's current heavy-duty industrial/gas turbine model specifically developed and rated for continuous-duty, base-load and cycling power generation services at 60Hz, except where specified otherwise herein. Buyer is relying upon Seller's skill, judgment, and ability to furnish equipment suitable and fit for this service.
- A.5.1.1.3. CTG equipment shall be designed for operation as specified in Section A.1 - Project Requirements.
- A.5.1.1.4. Not Used.
- A.5.1.1.5. Seller shall provide P&IDs and General Arrangements showing Seller's terminal points. Based on this Terminal Point boundary, Seller to provide Equipment/Commodity listing of furnished materials.
- A.5.1.1.6. Seller to provide complete bill of materials. Bill of materials shall include piping material, piping schedule, length of all piping, material specifications, number of valves, type of valves, pressure classification of all valves and fittings, etc.

A.5.1.2 CTG SCOPE OF WORK

- A.5.1.2.1. Seller shall design, furnish, manufacture, shop test, and deliver to the Project site, CTG packages.
- A.5.1.2.1.a. Equipment that requires additional bracing for shipment should have the temporary bracing clearly identified.
- A.5.1.2.2. The Work shall include all necessary and/or usually supplied equipment and appurtenances for the safe, efficient, and convenient operation of all CTG within the scope of this specification whether or not such items are specifically referred to in this specification.
- A.5.1.2.3. CTG will be located outdoors. All equipment supplied by the Seller shall be suitable for outdoor operation or located within the Seller-provided outdoor rated enclosure.
- A.5.1.2.3.a. Not Used.

- A.5.1.2.4. For all CTGs, Seller shall provide auxiliaries and features including, but not limited to, the following:
- A.5.1.2.4.a. Combustion Turbine Package complete with multistage axial compressor, multistage turbine, thermal insulation, and dry low NO_x combustors capable of burning natural gas. Synchronous Generator Package complete with all necessary auxiliaries.
 - A.5.1.2.4.b. Generator static excitation system complete with all accessories, automatic voltage regulation system, and power system stabilizer.
 - A.5.1.2.4.c. Generator neutral grounding equipment.
 - A.5.1.2.4.d. Natural gas fuel and purge systems supplied by the Seller refer to Mechanical Design Criteria Section A.10. Provision for natural gas purge will be provided per Major Equipment supplier's standards.
 - A.5.1.2.4.e. Chromatograph with hydrocarbon dewpoint measurement capability.
 - A.5.1.2.4.f. Lubrication and generator seal oil systems.
 - A.5.1.2.4.g. Fire protection system (detection and suppression).
 - A.5.1.2.4.h. Inlet air system structural support system loads and loading criteria.
 - A.5.1.2.4.i. Inlet air filtration system.
 - A.5.1.2.4.j. Inlet air evaporative cooler and auxiliaries.
 - A.5.1.2.4.k. Not Used.
 - A.5.1.2.4.l. Inlet ductwork with silencer (as required to meet site noise requirements).
 - A.5.1.2.4.m. Inlet air bleed heat system, including interconnecting piping, valves, and supports (as required), which may have filter de-icing functionality.
 - A.5.1.2.4.n. Rotor air coolers, intercoolers, and turbine air coolers as applicable with interconnecting piping, instrumentation, supports, and necessary system components if required by manufacturer's design.
 - A.5.1.2.4.o. Combustion turbine exhaust system with exhaust diffuser duct, thermal insulation, and exhaust manifold.
 - A.5.1.2.4.p. Exhaust system expansion joint connecting turbine exhaust diffuser to heat recovery steam generator inlet duct.
 - A.5.1.2.4.q. On-line and off-line water wash system.
 - A.5.1.2.4.r. Instrument and control system, including automatic start-up/shutdown/emergency stop sequencing.

- A.5.1.2.4.s. Performance monitoring system.
- A.5.1.2.4.t. Equipment enclosures, including but not limited to the following:
- CT Enclosure.
 - CT Aux Package (encloses lube oil, hydraulic oil, etc.).
 - CT Electrical / Control Packages, i.e., PDC.
 - Turning Device Package.
 - Excitation and Static Starter Package.
- A.5.1.2.4.u. HVAC / H&V system for enclosures, as required in Section A.9 – Site Design Data and Section A.15 – Building and Equipment Enclosure.
- A.5.1.2.4.v. Enclosures that are sized for personnel to be inside during regular maintenance shall have interior and exterior lighting. Enclosures that require panel removal for access shall be equipped with interior lighting. Lighting shall be of the LED type as defined in Section A.12 – Electrical Requirements and Design Criteria.
- A.5.1.2.4.w. Thermal and personnel protection insulation with lagging.
- A.5.1.2.4.x. Shop applied priming and finish painting for external surfaces of all equipment and interior surfaces of enclosures.
- A.5.1.2.4.y. Exterior and interior access platforms and stairways; with necessary mounting brackets for attachment, for CTG, generator, inlet filter house and all enclosures, needed for normal maintenance and operation.
- A.5.1.2.4.z. Electrical auxiliary power distribution (480V and below) and control systems, including protective relays. Electrical equipment shall be housed in a PDC type prewired enclosure. The PDC shall house a complete system of electrical equipment. This system shall be factory-prewired to the largest extent possible. The PDC shall house as a minimum MCCs, Batteries, battery chargers, generator and turbine control panels, and protective relay panels.
- A.5.1.2.4.z.1 PDC shall include space accommodations for two (2) wall mounted security panel/box (one in each control package section, near end wall doors) 36 inch H x 30 inch W x 8 inch D and one (1) Floor Mounted LAN Cabinet (front/rear access) 24 inch W x 52 inch D x 84 inch H.
- A.5.1.2.4.aa. Batteries shall be located in battery rooms in the CTG Electrical package. Battery rooms shall contain eye wash and shower combination to comply with codes listed in Section A.1.5. The battery room HVAC will include N+1 redundancy and include hydrogen monitoring.
- A.5.1.2.4.bb. The CT control package shall be prewired to the maximum extent possible. Wiring shall be provided to match wiring diagrams.
- A.5.1.2.4.cc. A complete and redundant generator protection system.

- A.5.1.2.4.dd. AC/DC battery and charger system.
- A.5.1.2.4.ee. Electric motor driven turning gear and clutch.
- A.5.1.2.4.ff. CTG static starting system.
- A.5.1.2.4.gg. Leveling blocks, soleplates, baseplates, thrust blocks, anchor bolts, jacking posts, fixators, embedded plates, anchor bolt and embedded plate erection templates and shims.
- A.5.1.2.4.hh. Lifting beams, lugs and other provisions for off-loading, erection, and maintenance.
- A.5.1.2.4.ii. Special tools required for installation, operation, and maintenance.
- A.5.1.2.4.jj. Spare parts and consumables as required for installation, commissioning and startup, and operation of CTG through the Substantial Completion.
- A.5.1.2.4.kk. The CTG shall be capable of operation in Islanded Mode following the loss of its connection to the grid by tripping its high side breaker while continuing to provide power to the Operating Facility auxiliary system. Refer to Sections A.1 and A.12 demonstration testing requirements and design capabilities for island mode.
- A.5.1.3 SERVICES SCOPE OF WORK
 - A.5.1.3.1. Attend monthly design and scheduling meetings with Buyer.
 - A.5.1.3.2. Training for five (5) days is included in the base scope for Buyer's operating and maintenance personnel.
 - A.5.1.3.3. Design drawings necessary to operate and troubleshoot the Seller-supplied equipment.
 - A.5.1.3.4. "As installed" drawings necessary to operate and troubleshoot the Seller-supplied equipment.
 - A.5.1.3.5. Service manuals for the Seller-supplied equipment.
 - A.5.1.3.6. Transportation of the Seller-supplied equipment.
 - A.5.1.3.7. Participate in balance-of-plant DCS Factory Acceptance Testing (that portion applicable to the TCS interface) – Seller's scope to include one (1) trip with three (3) consecutive days at the DCS test location.
 - A.5.1.3.8. Coordination with the Purchaser to provide compliance with Buyer-selected color scheme.
 - A.5.1.3.9. Provide Seller-recommended protective relay settings.
 - A.5.1.3.10. Provide an intelligent 3D Model (excluding instrumentation and tubing, and components inside of prefabricated electrical package) sufficient to accurately locate Purchaser's piping and electrical connections, foundation support points and all Seller-provided

components external to the CTG to allow Purchaser to ensure and interference-free design. The 3D model submitted shall reflect the submitted Seller's documentation.

A.5.1.3.11. Seller shall provide training for 30 people.

A.5.1.4 OPTIONAL SCOPE OF WORK

A.5.1.4.1. Not Used.

A.5.1.4.2. Not Used.

A.5.1.4.3. Not Used.

A.5.1.5 GENERAL OPERATING REQUIREMENTS

A.5.1.5.1. CTG shall be designed for the operation described in Section A.1 - Project Requirements. The unit shall be capable of startups and shutdowns as well as occasional trips from load and shall be designed suitable in all respects for potential cycling service operation in accordance with Section A.1.2.

A.5.1.5.2. CTG unit(s) shall have a design life of 30 years operation without distress due to cycling loads, provided Buyer carries out maintenance according to supplier's manual and without abnormal operation.

A.5.1.5.3. CTG turning gear system shall have the ability to jog the rotor to allow maintenance and borescope inspections. Seller shall specify all means, including options, for indexing rotor for such events. Seller to provide a local push button pendent to operate the turning gear system.

A.5.1.5.4. The spatial average for near-field noise level shall not exceed 85 dBA outside of any enclosure or auxiliary equipment when measured 3 feet (1 meter) – per ISO 10494 – in the horizontal plane and at an elevation of 5 feet (1.5 meters) from grade. Generator noise level shall not exceed 85 dBA average when measured above the turbine generator deck.

A.5.2 REQUIRED SUBMITTALS

A.5.2.1 REQUIREMENTS

A.5.2.1.1. Seller shall submit documents for review in accordance with the submittal requirements of Section A.1.4 Document Submittal Requirements and Table A.1-1.

A.5.2.2 GENERAL

A.5.2.2.1. Complete list of drawings that shall be submitted following contract award.

A.5.2.2.2. Not Used.

A.5.2.2.3. List and description of modularized skids.

- A.5.2.2.4. List and description of piping and electrical termination points.
- A.5.2.2.5. Storage requirements.
- A.5.2.2.6. Cleaning requirements for all systems.
- A.5.2.2.7. All equipment data sheets.
- A.5.2.2.8. System operating procedures.
- A.5.2.2.9. Expected life of all major components including major combustion components.
- A.5.2.2.10. Identification of the location of service centers capable of turbine and/or generator maintenance and re-build.
- A.5.2.2.11. Instrument manufacturer, name, model number, calibration, and set point data for all instruments and control devices furnished by Seller on Instrument Data sheets in ISA format. Instrument list, valve list, equipment list per Master Drawing and Document List (MDL) requirements in Section A.1- Project Requirements.
- A.5.2.2.12. Motor nameplate data for all motors furnished in the form of nameplate drawing or a completed data form certified to be actual nameplate data.
- A.5.2.2.13. Design data sheets and drawings for natural gas equipment.
- A.5.2.2.14. Detailed project schedule.
- A.5.2.2.15. Detailed spare part list along with unit pricing and typical lead time itemized for the recommended spare parts to be provided for equipment in which the information is readily available; however, typical lead times on the spare parts list are for reference only and cannot be guaranteed as supply fluctuates.
- A.5.2.2.16. Seller shall provide a training program for Buyer's personnel to inspect, maintain, and operate the Equipment.
- A.5.2.2.17. Complete Inspection and Testing Plan (ITP) shall be provided to include all witness and hold points that are applicable to the equipment.
- A.5.2.2.18. Certificates of Completion including checklists to confirm that the installation and commissioning is fully complete.
- A.5.2.2.19. Inspection intervals for combustion and hot gas path components shall be provided.
- A.5.2.3 DRAWINGS
- A.5.2.3.1. Drawings shall include equipment main dimensions, including all auxiliaries furnished therewith.

- A.5.2.3.2. Drawings that show equipment laydown area requirements with component weights and overall dimensions that will be required for erection, disassembly, and maintenance.
- A.5.2.3.3. Drawings shall have dimensions per U.S. customary units with metric dimensions in brackets where appropriate.
- A.5.2.4 PROCEDURES
 - A.5.2.4.1. Seller's turbine lube oil flushing method, procedures, and recommendations.
 - A.5.2.4.2. Procedure for grouting of soleplates, sub-soleplates, etc.
 - A.5.2.4.3. Cleaning, checking, and testing procedures.
- A.5.2.5 EQUIPMENT CONNECTION REACTIONS
 - A.5.2.5.1. All equipment connection reaction shall be supplied, including:
 - A.5.2.5.1.a. Allowable recommended reaction range on each turbine connection. Reactions should be stated as the resultant force and resultant moment for each connection.
 - A.5.2.5.1.b. Loading conditions on which the above reactions are based.
 - A.5.2.5.1.c. Total allowable moments on all casings and bearings from all reactions of the connections.
 - A.5.2.5.1.d. Free expansion direction data of all connections from cold to operating temperature position.
- A.5.2.6 PERFORMANCE INFORMATION
 - A.5.2.6.1. CTG performance calculations including net output, net heat rate, gross output, gross heat rate, exhaust flow, exhaust temperature, exhaust pressure, exhaust gas composition, CTG emissions, exhaust pressure loss, evaporative cooler effectiveness, and rotor air cooler heat duty data.
 - A.5.2.6.2. Expected CTG performance data to be provided for the entire range of expected ambient conditions. Buyer requires CTG performance data from 0% to 100% CT Load at 10% load increment and minimum emission compliant load conditions across all ambient conditions listed in Section A.9 - Site Design Data, including the project performance point. Performance to be provided with and without evaporative cooler in operation (as applicable for the ambient).
- A.5.2.7 PERFORMANCE CURVES
 - A.5.2.7.1. For operating conditions that are different from the Guarantee Design Conditions the Seller shall supply Buyer certified performance curves and correction factors to cover the intended range of conditions. This information should cover the expected range of variation including but not limited to the following: turbine load, compressor inlet

temperature, compressor inlet humidity, atmospheric pressure, exhaust pressure losses, generator frequency, generator power factor, cooling water temperature and effect of variations in fuel properties. Performance parameters indicated should be power output, fuel flow, exhaust temperature, exhaust flow and heat rate (designate higher or lower heating value). Additionally, the following type of performance curves shall be provided:

- A.5.2.7.1.a. Curves showing correction to heat rate versus exhaust pressure in increments of 0.5 inches H₂O from zero to maximum CTG backpressure at specified loads.
- A.5.2.7.1.b. Performance (power output, heat rate, fuel flow, and water flow) with evaporative inlet cooling system in operation.
- A.5.2.7.1.c. Curves showing performance degradation over time based on recommended maintenance practices.
- A.5.2.8 CTG emission information, including NO_x, CO, UHC, VOC, PM, SO_x, H₂SO₄, NO to NO₂ ratio, Formaldehyde (HCHO), and emissions averaging basis shall be provided. Information to be supplied in ppmvd at 15%O₂ and lb/hr.
- A.5.2.9 Generator curves shall be submitted.
 - A.5.2.9.1. Vee-curves, showing generator stator current (armature current) as a function of the field current (excitation current) for power factor ranges 0, through 1 in addition to rated, on both leading (underexcited) and lagging (overexcited) modes, at rated and reduced hydrogen pressures.
 - A.5.2.9.1.a. Capability curve, showing active power as a function of reactive power on both leading (underexcited) and lagging (overexcited) modes. If generator has more than one output rated power, depending on coolant pressure, the Capability curve shall present all generator possible operation limits as function of coolant pressure.
 - A.5.2.9.1.b. Short circuit curves for three-phase, line-to-line (or phase-to-phase), and phase-to-phase-to-ground (or double-line to ground) conditions, including the effect automatic voltage regulator (AVR).
 - A.5.2.9.1.c. Regulation curve with excitation and speed constant.
 - A.5.2.9.1.d. No load and full load saturation curves for the exciters.
 - A.5.2.9.1.e. Exciter load versus exciter voltage curves showing drooping characteristic.
 - A.5.2.9.1.f. Saturation Curve – showing data on the excitation and voltage regulation system characteristics showing generator stator, field, and exciter per unit amperes versus time. Specify which IEEE excitation system model type and constants are representative of the equipment.
 - A.5.2.9.1.g. Block diagram, gains, and time constants of the power system stabilizer, voltage regulator and exciter based on the standard models in IEEE 421.5. Model shall also be provided in PSS/E software.

- A.5.2.9.1.h. Necessary data/parameters, including constants, gains, and time constants, required for the Buyer's development of the standard GGOV1 PSS/E ".dyr" model file.
- A.5.2.9.1.i. Table of generator constants and reactances (both saturated and unsaturated values), including actual tolerance of the synchronous, transient, sub-transient, negative sequence, and zero sequence reactances of the generator. As tested values shall be within $\pm 15\%$ of the design values.
- A.5.2.10 TEST REPORTS
- A.5.2.10.1. Test Reports shall be provided, including:
- A.5.2.10.1.a. End of manufacturing report (EOMR) for the combustion turbine shall include customer documentation, Stator Casings chemical composition and mechanical properties, rotor balance and assembly data. Report is not completed until after unit ships. Unit rotor balance chemical composition and mechanical properties for each wheel and shaft forging report. This documentation shall be available for review at time of balance.
- A.5.2.10.1.b. Generator Factory Tests performed during the manufacture and assembly of the non-packaged power generators shall include all tests prescribed in IEEE Std C50.13, Table 8. Generator testing and quality control procedures shall be per manufacturer's standard and in compliance with IEEE 115. Copies of the applicable test reports for the following process testing shall be provided:
- Resistance of Stator and rotor windings.
 - Dielectric test of stator and rotor windings.
 - Phase sequence.
 - Overspeed to 120% of rated speed.
 - Insulation resistance of stator and rotor windings.
 - Measurement of bearing insulation resistance.
 - Rotor winding shorted turn test at rated speed.
 - Stator core imperfection testing by EL CID, SMCAS, or core-loop testing.
- The following generator assembly tests are to be performed and reported:
- Air gap measurement.
 - Oil flush.
 - Wiring checks.
 - Hydrostatic test of coolers.
 - Air leakage test of generator rotor bore copper (if applicable).
- A.5.2.11 INSTRUCTION (OPERATION AND MAINTENANCE) MANUALS
- A.5.2.11.1. Seller shall furnish Buyer with copies of complete instruction, operating and maintenance manuals for all equipment furnished by Seller, consisting of manufacturers' instruction manuals, leaflets and drawings for maintenance, operation, and erection of the equipment to give Buyer complete information for operation, maintenance, ordering of spare parts and dismantling of equipment in user-friendly digital format. The information shall be separated into logical groups or sections with identifying tabs. Each instruction/operating

book shall have an index listing all leaflets in the same order as they appear in the book. (Individual submittal of various manufacturers' instruction manuals, etc., will not be acceptable).

- A.5.2.11.2. Two (2) hard copies of each manual and CIP compliant electronic copy or other Buyer approved method copy shall be provided.
- A.5.2.11.3. Instruction manuals shall include:
 - A.5.2.11.3.a. Equipment identification by equipment number, Station name, Unit number, and function name.
 - A.5.2.11.3.b. Final reduced drawings of general arrangements and cross sections, guaranteed performance data, design data, test results, and performance curves for all equipment.
 - A.5.2.11.3.c. Complete operation, troubleshooting and maintenance instructions.
 - A.5.2.11.3.d. Parts list shall be complete in every respect. Parts shall be identified by the original manufacturers' complete part numbers as well as by Seller's identification numbers.
- A.5.2.11.4. Instruction manuals shall be thoroughly edited before submittal, to exclude and/or to cross out text, data, illustrations, curves, etc., which do not apply to the specific equipment purchased.
- A.5.2.11.5. Seller shall supply additional information or replace information or entire instruction manuals if field inspection of equipment indicates omissions or inaccuracy of the manuals.
- A.5.2.11.6. It is intended that the instruction manuals shall be submitted complete. Partial shipment with material deliberately missing (i.e., "to follow later") is unacceptable.

A.5.3 GENERAL TECHNICAL REQUIREMENTS

A.5.3.1 GENERAL

- A.5.3.1.1. CTG shall conform to all federal, state, and local codes or regulations having jurisdiction at the Project site and references in Section A.1 - Project Requirements. It shall be the Seller's responsibility to investigate such statutes and determine applicable provisions regarding the equipment they propose to furnish.
- A.5.3.1.2. Electrical equipment shall be in accordance with standards of the National Electrical Code as well as local and state ordinances. The National Electric Code is not applicable to utility owned generating stations. In these cases, IEEE C2, the National Electric Safety Code (NESC) shall apply.
- A.5.3.1.3. Foreign material sourcing shall include allowance for inspection of manufacturing process, sufficient notice, and mutual agreement with Buyer.

A.5.3.2 CLEANLINESS AND SURFACE PREPARATION

- A.5.3.2.1. All manufacturing waste, such as metal chips and filings, welding rods and stubs, waste, rages, debris, and other contaminants shall be removed from the interior of each component. All loose mill scale, rust, oil, grease, chalk, crayon, paint marks and other deleterious material shall be removed from interior and exterior surfaces. At time of shipment, product shall be dry and clean inside and outside.
- A.5.3.2.2. The Seller shall prepare, protect, prime, and paint the CTG to provide the required protection during shipment and installation of the equipment.
- A.5.3.2.3. Structural steel and supports shall be hot dipped galvanized except for Electrical Packages that shall be painted steel.
- A.5.3.3 PAINTING SYSTEMS
- A.5.3.3.1. Seller shall prime and finish paint all equipment including for the exterior of enclosures, inlet and exhaust duct and the inlet filter housing. Seller shall prime and finish painting all internals of enclosures. Field finish paint shall be from same manufacturer as Seller's shop applied prime coats.
- A.5.3.3.2. Seller shall follow Section A.14 - Civil, Struct, Arch Req and Design Criteria for required painting requirements. Paint system shall be applied by Seller at the shop. The compressor inlet bellmouth shall be provided with a protective coating. Seller's standard coating shall be applied in the shop.
- A.5.3.3.3. All exposed steel which may be subjected to temperature of 200° F and higher shall be primed with one coat of inorganic zinc primer to a dry film thickness of 2-4 mils and painted with one coat of silicon acrylic paint to a dry film thickness of 1.5 to 2 mils.
- A.5.3.3.4. The Seller shall furnish touch-up paint for each coat of Seller applied paint. The quantity of touch-up shall allow coverage of 5% of the painted surfaces.
- A.5.3.4 SPARE PARTS FOR STARTUP AND COMMISSIONING
- A.5.3.4.1. The Seller shall provide spare parts required for startup purposes and for application of the Seller's operating and startup reliability guarantees.
- A.5.3.4.2. Spare parts shall be packaged and suitable for long-term storage in excess of 6 months based on the Seller standard preservation and packing requirements.
- A.5.3.4.3. Seller to provide standard provisions for startup and commissioning spares.
- A.5.3.5 Seller shall provide a manufacturer's Shop inspection and test plan to be reviewed and approved by Buyer and in accordance with the requirements identified herein.
- A.5.3.5.1 General
- A.5.3.5.1.a. The Seller or Seller's subcontractors at their shops prior to shipment shall test the CTG and auxiliary equipment furnished under this specification. Factory test and inspections shall demonstrate the quality, accuracy, workmanship, balance, clearances, and similar

characteristics. Seller shall furnish certified reports showing the results of all such tests for Buyer's information. The content and format of these test reports shall be mutually agreed to by the Seller and Buyer during project execution.

- A.5.3.5.1.b. The combustion turbine, generator, exciter, and the auxiliary and accessory equipment shall be factory assembled (to the extent possible) as required to establish critical fits and clearances, alignment, weld connection, mating surfaces and bolt hole alignment, to minimize field adjustments and fitting.
- A.5.3.5.1.c. Factory testing shall include low speed dynamic rotor balancing and high-speed dynamic rotor balancing. Overspeed trip test at 110% shall be performed during commissioning.
- A.5.3.5.1.d. All CTG equipment, including auxiliaries and accessories, but excluding field installed piping, which utilizes a working fluid, control fluid, lubricating fluid or cooling fluid, shall be inspected or leak tested as system, parts of systems, or elements in accordance with Seller's accepted standard practice to ensure their proper operation without leakage, or with such leakage as necessary for lubrication purposes. Such tests shall comply with applicable code requirements.
- A.5.3.5.1.e. Buyer shall be given a minimum of two (2) weeks prior notice of the Seller's intent to conduct any shop testing.
- A.5.3.5.2. Combustion Turbine
 - A.5.3.5.2.a. Factory tests on the turbine shall include 100% rotor inspection by radiograph, ultrasonic methods, or other equivalent tests to verify the integrity of the material being used in the assembled turbine rotor. Rotors can be tested for mechanical integrity in spin pits, heater boxes, or vacuum chambers.
 - A.5.3.5.2.b. After assembly in the factory, a thorough and complete checkout and test of the entire fuel gas flame safety unit shall be required. All limit devices shall be set and tested, all circuitries shall be checked thoroughly, and complete programming checks shall be accomplished. A complete checkout form covering all aspects of burner operations shall be completed and submitted to the Buyer.
- A.5.3.5.3. Generator
 - A.5.3.5.3.a. Special performance tests as described in IEEE Std C50.13 Section 9.1.3, Table 9 shall be made on the generator as a minimum requirement. No load and sudden short-circuit tests at reduced voltage to determine reactance and time constants are excluded from this testing. Any excluded shop test shall have a type test report submitted to Buyer.
 - A.5.3.5.3.b. The excitation system shall be tested in accordance with IEEE 421.1 and 421.2.
 - A.5.3.5.3.c. Thermal cycling test, voltage endurance test, and dissection of production bars shall be performed per IEEE Std 1310 and IEEE Std 1043. Destructive stator bar testing shall be performed for the generator in accordance with Manufacturer's standard procedures.

- A.5.3.5.3.d. Seller shall perform an SMCAS/ELCID test of the stator core interlaminar insulation in accordance with the Seller's procedure/standards. This test shall be performed prior to the flux test.
- A.5.3.5.3.e. Seller shall perform a rated flux (core loop) test of the stator core interlaminar insulation for hot spots by establishing and maintaining 80-100% of rated working flux density for a minimum of 2 hours. Testing will be done in accordance with Seller's procedures.
- A.5.3.5.3.f. A report on SMCAS/ELCID and core loop tests shall be provided to Buyer.
- A.5.3.5.3.g. Hot spots for an unwound core, defined as any area of the core with temperature greater than 5° C above the neighboring core temperature, shall be detected by means of infrared examination. If hot spots are detected, Seller shall provide a disposition for remediating the condition, including repair methods to be used, to the Buyer for review. Unless an alternate disposition is approved by the Buyer, Seller shall repair the core to within specifications eliminate hot spots. If directed by Seller's Engineering, an additional flux test, in accordance with the requirements of this specification, shall be performed if a core repair is made.
- A.5.3.5.4. Control System
 - A.5.3.5.4.a. All circuit boards, power supplies and input/output (I/O) modules shall be subject to "burn-in" at an appropriate normal temperature for a period of time sufficient to reduce premature failures of the components. Burn-in shall be accomplished prior to assembly of the components into the control system.
 - A.5.3.5.4.b. Prior to shipment of the control system hardware from the Seller's facility, the entire turbine control system shall be "staged" for operational hardware testing and demonstration. This testing shall include proper operation of all I/O, redundant control processors, redundant power supplies, operator console(s), redundant communication highways, printer(s), and interfaces (foreign datalinks).
 - A.5.3.5.4.c. Prior to shipment of the control system software from the Seller's facility, the entire control system software package shall be fully tested based on the Seller standard testing procedure to verify proper logic implementation.
 - A.5.3.5.4.d. Buyer shall witness and participate in the control system hardware and software testing. A minimum of 2 weeks prior notice shall be given of the Seller's intent to conduct these activities.
- A.5.3.5.5. Electric Motor Testing
- A.5.3.5.6. Each motor shall be given routine tests in accordance with NEMA MG1 or manufacturer's standard test if NEMA test requirements are satisfied. Rotation, megger, and high potential tests, as minimum shall be included.
- A.5.3.6 Quality assurance requirements shall be in accordance with the requirements identified herein and the manufacturer provided shop inspection and test plan.

- A.5.3.6.1. To ensure quality of materials, all materials used must be new and first run.
- A.5.3.6.2. Quality assurance provisions shall meet the requirements as specified in Section A.1 - Project Requirements.
 - A.5.3.6.2.a. To ensure project quality, the following are mandatory witness points for which the Buyer must be notified (and can attend as desired).
 - A.5.3.6.2.b. Turbine and Compressor Rotor High Speed Balance (to the extent bladed at the factory)
 - A.5.3.6.2.c. Generator Rotor Balance
 - A.5.3.6.2.d. Generator Stator and Field High Potential Test
 - A.5.3.6.2.e. Control System Final Check Out including verification of software and displays at Seller's facility, DCS verification at Buyer's facility, and hardware verification at Seller's facility.
- A.5.3.6.3. Certificates of Completion
 - A.5.3.6.3.a. Certificates of Completion including checklists to confirm that the installation is fully complete shall be provided.
- A.5.3.7 FABRICATION REQUIREMENTS
 - A.5.3.7.1. Welding shall be in accordance with the requirements identified in the Major Equipment Inspection and Test Plan, which meet the intent of the sub-article below.
 - A.5.3.7.1.a. All welds on pressure vessels and piping shall be in accordance with the requirements of ASME B&PV Code, Section VIII and ANSI B31.1. Structural welding shall comply with the latest version of AWS D1.1. Equivalent JIS standards are acceptable.
- A.5.3.8 NAMEPLATES AND NUMBERING
 - A.5.3.8.1. Seller shall provide stainless steel nameplates with unique identification numbers for all Seller-provided equipment, valves, and instrumentation, and they shall be securely fastened in a visible location by means of rivets, welding, or screws.
 - A.5.3.8.2. Seller's unique identifications shall appear both on the nameplate and drawings and shall follow all the requirements as specified in the Mechanical Requirements and Design Criteria.
 - A.5.3.8.3. The requirements shall apply to all of Seller's supplied equipment, including the combustion turbine, generator, generator excitation equipment, inlet air system, fuel system, evaporative cooler, lubrication, seal, and control oil systems, fire detection and suppression equipment, water wash system, all electrical equipment, control panels, all equipment skids, all pumps and heat exchangers, all instrumentation that requires interface wiring connections, all valves, and all instrumentation connected to Facility DCS.

- A.5.3.8.4. All instrumentation and equipment shall have the manufacturer's standard identification nameplate and number plus any relevant information about the component being tagged (i.e., equipment ratings).
- A.5.3.9 VIBRATION
- A.5.3.9.1. Critical speeds for all rotating components should be analyzed and removed from the 60 Hz operating frequency
- A.5.3.9.2. Design of the compressor and turbine sections shall avoid a vibrational response at any conditions within 10% of the operating speed.
- A.5.3.10 PREPARATION FOR SHIPMENT
- A.5.3.10.1. All equipment shall be adequately prepared for shipment, protection during transit, and outdoor storage.
- A.5.3.10.2. The equipment shall be prepared for shipment after shop tests have been completed. Lifting points shall be clearly marked and all openings shall be tightly and effectively closed. Flanges shall be protected by metal covers, screwed openings closed with steel plugs or plywood sealed with rubber gaskets and held in place by four (4) bolts. All combustion turbine and auxiliary component openings, including inlet and exhaust openings, are to have suitable shipping covers.
- A.5.3.10.3. After cleaning, all openings and machined openings shall be provided with the appropriate temporary closures, metal caps, or polyethylene caps and waterproof sealed closed.
- A.5.3.10.4. Before the equipment is shipped, the original shipping stops, bolts, ties, etc., shall be reinstalled in all devices and clearly identified.
- A.5.3.10.5. Electrical and control panels shall be protected against corrosion, weather, and mechanical damage during transit. Temporary structural bracing shall be installed as required to allow for normal field handling, skidding, and hoisting and clearly identified.
- A.5.3.10.6. Seller shall provide internal and external protection from the effects of corrosion for all parts not otherwise coated or painted. Where closure is incomplete, plastic material adequately supported, protected, and sealed shall be used to fabricate an effective barrier.
- A.5.3.10.7. Equipment that is leak tested in the shop by Seller shall be completely drained and blown dry by air prior to shipment when practical. When such drainage requires the removal of plugs, drain valves, or other parts, Seller shall reinsert or reassemble these parts prior to shipment.
- A.5.3.10.8. Motor rotors shall be locked to prevent movement during shipping. Oil lubricated motors shall be drained before shipping.
- A.5.3.11 SERVICES

- A.5.3.11.1. Technical Field Advisory Services: Manufacturer shall provide technical field advisory (TFA) services to support installation, training, start-up, commissioning, and performance testing of the combustion turbine generator. The advisor shall be technically trained and experienced with the equipment offered.
- A.5.3.11.2. Training: Manufacturer shall conduct a full and comprehensive training program to the Buyer's suitably qualified personnel to enable them to fully and efficiently operate the CTG. The courses will include material on inspection, maintenance, troubleshooting, and operation of all equipment furnished with the specification.
- A.5.3.11.3. Performance Testing Services: Refer to Section A.1- Project Requirements for performance testing requirements.
- A.5.3.12 GUARANTEES
Refer to Section A.1- Project Requirements for guarantees.
- A.5.4 COMBUSTION TURBINE AND AUXILIARIES TECHNICAL REQUIREMENTS
- A.5.4.1 GENERAL DESIGN CRITERIA
- A.5.4.1.1. CTG shall be factory assembled to the greatest extent possible.
- A.5.4.1.2. CTG shall be designed to provide the adequate protection and safety for personnel and equipment during startup, operation, and shutdown. Seller shall consider catastrophic failures of the rotating equipment in the design of CTG to mitigate these effects.
- A.5.4.1.3. The automatic speed governor shall prevent the unit from reaching the electronic overspeed trip point in the event of a full load to no load situation.
- A.5.4.1.4. CTG shall be provided with overspeed trip capability. Equipment design shall allow testing of overspeed protective devices without over-speeding the turbine.
- A.5.4.1.5. Not Used.
- A.5.4.1.6. The equipment shall include rotor turning device, with automatic starting feature, to prevent thermal bowing of the rotor shutdown and to allow restart of turbine without excessive vibration. The preferred device would be an electric motor-driven turning gear. A rotor brake or other provision shall be provided to prevent unacceptable windmilling if such is anticipated during shutdown.
- A.5.4.1.7. All rotating equipment shall be capable of withstanding the normal fatiguing stresses from aerodynamically and mechanically induced excitation forces at all operating loads.
- A.5.4.1.8. CTG shall safely withstand transient speeds up to and including the turbine trip speed setting for brief periods at operating temperature, under all load conditions. The equipment shall be capable of subsequent normal operation without need for inspection.

- A.5.4.1.9. Seller shall provide reaming type coupling bolts, based on OEM standards, for the turbine-generator load coupling.
- A.5.4.1.10. Casings, supports, and expansion joints shall prevent injurious distortion caused by temperature, load, or piping stresses. Supports shall maintain proper alignment of connected equipment.
- A.5.4.1.11. Jack screws, lifting lugs, eyebolts, and/or the equivalent on casing and ductwork shall be provided to facilitate alignment during disassembly and re-assembly.
- A.5.4.1.12. All pressure parts shall be suitable for operation at the most severe condition of coincident pressure and temperature expected. Casing joints shall be designed to minimize leakage.
- A.5.4.1.13. Couplings and guards shall be designed to take necessary movements of various casings and shafting of rotation equipment. Seller shall specify alignment for all components connected with these couplings.
- A.5.4.1.14. Couplings and spacers shall be dynamically balanced independent of the rotating assemblies to a tolerance suitable for the maximum continuous speed. The coupling halves, spacers and bolting shall be match marked or numbered.
- A.5.4.1.15. Couplings and guards shall be removable without removal of rotors of interconnected equipment and shall not prevent access to adjacent bearings and seals.
- A.5.4.1.16. Sub-soleplates, if used, shall be factory drilled and tapped for leveling screws to level and support the equipment.
- A.5.4.1.17. Press fit type fittings shall not be utilized in any system.
- A.5.4.2 COMBUSTION TURBINE DESIGN:
 - A.5.4.2.1. General
 - A.5.4.2.1.a. Both compressor and turbine design shall provide easy accessibility to all parts. Openings shall be included in casings and ductwork to allow visual inspection of critical areas without disassembly of the compressor, combustion section and turbine sections. Access shall be by removable covers and/or holes designed for use of borescopes and/or eddy current probes.
 - A.5.4.2.1.b. Seller shall carefully consider and take into account all movements and differential movements due to temperature gradients in all components and structural members during start-up, operation, and shutdown. Seller is fully responsible for all design considerations necessary to prevent buckling, distortion, and misalignment or fatigue failure of components. Seller shall indicate on their drawings all such movements at interfaces with Seller's supports.
 - A.5.4.2.1.c. All compressor and turbine casings shall be designed for ease of inspection and maintenance and shall include suitable provisions for lifting access and alignment.

- A.5.4.2.1.d. Casings shall be split horizontally for removal of internals.
- A.5.4.2.1.e. Seller shall provide borescope inspection ports for internal inspections of critical components in the hot gas path of the turbine and compressor.
- A.5.4.2.1.f. Turbine bearings shall be able to be examined and repaired without removing major components, i.e., inlet duct, and silencer.
- A.5.4.2.2. Compressor and Turbine Blading:
 - A.5.4.2.2.a. The blading and discs of the combustion turbine shall be designed to be free from resonant vibrations and shall withstand thermal transients without distortion or creep.
 - A.5.4.2.2.b. Rotating blades shall be individually removable for replacement. Vane segments shall also be removable.
 - A.5.4.2.2.c. Stationary and rotation blades shall be coated as necessary to minimize erosion and corrosion degradation.
- A.5.4.2.3. Compressor Section
 - A.5.4.2.3.a. The compressor shall be a multistage axial-type and shall be directly coupled to the turbine section. Modulating inlet air guide vanes shall be provided.
 - A.5.4.2.3.b. Variable inlet vanes will modulate airflow to enhance starting, to prevent compressor surge and stall, and to maintain high exhaust temperature during part load operation. The design shall provide control at low temperature conditions to limit high mass flow into the compressor.
 - A.5.4.2.3.c. Provisions shall be made for bleeding off air from the compressor when necessary to prevent compressor surge or stall.
 - A.5.4.2.3.d. Seller to provide a permanently installed water wash system including interconnect piping and spray nozzles located at the compressor bellmouth.
 - A.5.4.2.3.e. Bell-mouth shall be coated with Seller's standard coating. The bell-mouth shall be calibrated for flow calculations and have connections to allow a manometer to be connected for flow measurement.
 - A.5.4.2.3.f. Not Used.
- A.5.4.2.4. Combustion Systems
 - A.5.4.2.4.a. The combustion system shall be designed to maximize combustion efficiency, combustion stability, and equipment life while using the site-specific natural gas fuel. Control of NOx emissions shall be through dry low NOx combustors.
 - A.5.4.2.4.b. Combustion system shall allow for continuous operation of the unit from base load condition to the Seller defined minimum stable operating load.

- A.5.4.2.4.c. Combustion turbines with multi-burner design shall have provisions to ensure accurate fuel distribution to all fuel nozzles. These provisions shall minimize blade path temperature differences and unnecessary impulsing of turbine blading. Flow dividers or other metering provisions shall be located for ready accessibility and not be located behind or beneath other components that would hinder access. Flow dividers/manifolds shall have suitable instrumentation to monitor level fuel pressures during CTG operation.
- A.5.4.2.4.d. Combustion liners or baskets and transition pieces shall be individually removable. Combustion liners or baskets and transitions while installed shall be accessible without removal to perform the manufacturers' combustion inspection criteria. All combustion liners or baskets shall be interconnected with cross-flame or cross-fire tubes.
- A.5.4.2.4.e. As a part of Seller's standard design, the flame detection shall be performed by software monitoring of trend of blade path temperature in CTG control systems.
- A.5.4.2.4.f. Multiple igniters shall be provided for starting the units and shall be self-retracting after the unit is operating.
- A.5.4.2.5. Turbine Section
 - A.5.4.2.5.a. Turbine blading shall be designed to minimize loads due to tangential, axial, and torsional modes of vibration under all anticipated operating conditions.
 - A.5.4.2.5.b. Turbine blades and nozzles shall be coated as necessary to prevent degradation from erosion, corrosion, or deposits. Components to be coated and coatings to be used shall be submitted to Buyer for review.
- A.5.4.3 INLET AIR SYSTEM
 - A.5.4.3.1. General
 - A.5.4.3.1.a. The inlet air system shall consist of a three-stage filter assembly including vertical weather louvers, coalescing pre-filters, high efficiency filters, EPA final filters, silencer ductwork, expansion joints, instrumentation, controls, lighting, support steel), platforms, ladders, and access stairs.
 - A.5.4.3.1.b. Filter house to include a stair tower in lieu of ladders for normal maintenance and operations.
 - A.5.4.3.1.c. There shall be provisions for emergency egress from Inlet Filter House during maintenance in the event of a fire.
 - A.5.4.3.1.d. All ladders shall have anti-slip rungs. Rung covers, anti-slip tape and/or paints/coatings shall not be acceptable.
 - A.5.4.3.1.e. A complete high-pressure inlet bleed heat system with all associated piping shall be provided.

- A.5.4.3.1.f. The base of the lowest air inlet of the filter enclosure shall be elevated a minimum of 8 ft above grade and shall be accessible by Seller's stairway.
- A.5.4.3.1.g. Not Used.
- A.5.4.3.1.h. Dual plexiglass or equivalent polycarbonate windows shall be located outside the inlet duct and/or transition duct. One window for viewing and one window for the flashlight.
- A.5.4.3.1.i. Enclosure and ductwork shall be sufficiently rigid to avoid vibration problems and compressor surges. Fasteners, if necessary, inside the clear air path a minimum and be tack secure welded to prevent loosening and be ingested by compressor. Tack weld maps shall be provided identifying each such fastener in the clean air side shall be provided in the quality documentation and signed off by the shop quality inspector.
- A.5.4.3.1.j. Interior lighting and convenience outlets shall be provided upstream of final filtration stage in the dirty air side. The lighting shall be of the LED type and shall provide a minimum of 200 lux illumination at 4 feet from the fixture.
- A.5.4.3.1.k. Inlet silencing shall be provided as required to meet site noise requirements.
- A.5.4.3.1.l. Inlet air system structural support steel shall be hot dipped galvanized in accordance with structural design criteria, Section A.14.
- A.5.4.3.1.m. Seller shall provide one (1) 1-ton or larger hoist, with jib and associated support steel, at the top of the air inlet filter house.
- A.5.4.3.1.n. Seller shall provide one (1) 5-ton or larger hoist, with associated monorail, for CTG lube oil skid maintenance.
- A.5.4.3.1.o. Seller shall provide the following cranes, with associated monorails, below the inlet filter house:
- A.5.4.3.1.o.1 Two (2) 5-ton or larger hoists for generator gas cooler maintenance.
- A.5.4.3.1.o.2 One (1) 6-ton or larger hoist for generator maintenance
- A.5.4.3.1.o.3 One (1) 5-ton or larger hoist for generator bearing maintenance.
- A.5.4.3.2. Filter System
- A.5.4.3.2.a. The filter system shall include the following:
- A.5.4.3.2.b. Three-stage inlet filtration system housed within a bolted structure in shop fabricated modules that will be assembled using gasket bolted joint. Suitable gasket stops shall be provided in the mating flanges to prevent gasket over compression. Gaskets shall be neoprene-blend, ½ inch thick and shall be compressed to 50% of its original thickness.
- A.5.4.3.2.c. Suitable weather rain hoods shall be designed for a maximum updraft velocity of 650 FPM (3.3 m/s) including site conditions as defined in Section A.9. Vertical weather

louvers comprising of marine grade aluminum vanes shall be provided with a fractional droplet removal efficiency of 100% at a limit drop size of 25 microns. Suitable drains shall be provided to facilitate removal of collected water to the drain pit.

- A.5.4.3.2.d. Bird screen made out of stainless steel 304 wire gage shall be provided in the weather hoods. Bird screen shall be made out of wire diameter 3 mm (0.12 inch), 30 mm x 30 mm (1.25 inch x 1.25 inch) mesh center to center spacing.
- A.5.4.3.2.e. All dirty air side of modules shall be provided with minimum 1 inch drainage hole every 5-7 feet to prevent standing water during outages. The clean air side shall be provided with couplings shop installed in the floor and provided with piping to a common customer drain interface.
- A.5.4.3.2.f. Stairways, ladders, and platforms shall follow requirements contained in Section A.14 – Civil Structural Architectural Requirements and Design Criteria.
- A.5.4.3.2.g. Exterior LED lighting and convenience outlets upstream of final filtration stage.
- A.5.4.3.2.h. Differential pressure transmitter with a built-in digital indicator for each stage of the inlet filter.
- A.5.4.3.3. Filters
 - A.5.4.3.3.a. The inlet filter system shall consist of a three-stage filtration system. A coalescing type pre-filter, high efficiency filters, and EPA final filters shall be utilized.
 - A.5.4.3.3.b. Evaporative Cooler
 - A.5.4.3.3.c. Evaporative cooler shall include all water dispersion media, moisture separator, casing, drain piping, feed piping, valves, pumps, catch basin, instrumentation, and controls for a fully functional system.
 - A.5.4.3.3.d. Evaporative cooler modules shall be constructed of painted carbon steel except for the wetted surfaces, which require stainless steel to be used.
 - A.5.4.3.3.e. The evaporative cooler shall be sized for at least 85% design efficiency at the Summer Design conditions specified in the Construction Operating Requirements.
 - A.5.4.3.3.f. Average air velocity through the evaporative media shall not exceed 650 feet/min. Maximum velocity across any portion of media shall not exceed 900 feet/min.
 - A.5.4.3.3.g. A moisture separator (or drift eliminator) shall be provided after the evaporative media. The drift eliminator shall remove a minimum of 90% of all droplets 50 microns or larger in diameter.

- A.5.4.3.3.h. An automatic dump and make-up system shall be provided to monitor and maintain evaporative cooler recirculating water quality in accordance with manufacturer's requirements. Evaporative cooler shall have fully redundant recirculation pumps, Pumps shall be made of a corrosion resistant material with SS304 internals.
- A.5.4.3.3.i. The quality of supply water to the evaporative cooler shall be maintained in accordance with combustion turbine manufacturer requirements or industry standards.
- A.5.4.3.4. Inlet Ductwork
- A.5.4.3.4.a. Ductwork downstream of the filter shall be a 3-coat paint carbon steel interior and a 3-coat paint carbon steel exterior for exposed surfaces, and a 1-coat primer for surfaces under cladding.
- A.5.4.3.4.b. Duct supports shall be designed to remove all loads from the combustion turbine flanges. The ducts shall be supported to allow lateral as well as axial growth due to temperature changes. The ducting and support shall be designed to remain stationary when sections near the combustion turbine are removed for unit maintenance. Ducts shall be sufficiently rigid to avoid vibration.
- A.5.4.3.4.c. Manways shall be provided to allow final cleaning and inspection of the entire duct systems. Manway covers will have all fasteners located exterior to the ductwork to prevent the fasteners or other objects falling into the ductwork. All manways shall be sealed with dual compression seals.
- A.5.4.4 EXHAUST SYSTEM
- A.5.4.4.1. The combustion turbine package shall be furnished with a complete exhaust system including the exhaust diffuser plenum duct, supports and thermal insulation.
- A.5.4.4.2. The exhaust plenum duct shall direct the exhaust gases into the HRSG.
- A.5.4.4.3. The turbine exhaust system shall consist of an exhaust plenum duct terminating with a flange. The flange will mate up with the flange of an expansion joint that will connect the exhaust plenum to HRSG inlet. All exhaust plenum duct growth due to thermal expansion shall be accommodated in the expansion joint such that allowable loading on the combustion turbine exhaust flange is not exceeded.
- A.5.4.4.4. The exhaust plenum duct shall be designed to prevent separation of joints, loosening of turning vanes and braces and fracture of bolts due to thermal forces, operating forces, and vibration.
- A.5.4.4.5. The exhaust system shall be designed for the maximum expected temperature plus the Seller's normal design margin. The exhaust duct shall be provided with liners of stainless-steel material. Exhaust system outside skin temperature shall not exceed 140° F for personnel protection during any operating condition at summer design ambient conditions with 3 mph wind speed for outdoor piping.

- A.5.4.4.6. Hot end bearing tunnel temperature shall remain below 200° F when operating at base load with summer design conditions.
- A.5.4.4.7. Mechanical design of the exhaust area should allow for a static pressure of at least 20 inches water column at maximum full load turbine exhaust temperature.
- A.5.4.4.8. Exhaust system should include necessary instrument ports for use in testing and tuning of CTG.
- A.5.4.5 FUEL GAS SYSTEM
- A.5.4.5.1. The fuel gas system shall be designed to meet all requirements and recommendations based on codes and standards Section A.1.5.
- A.5.4.5.2. The natural gas system shall be designed to operate on a range of natural gas compositions. Natural gas analysis is provided in Section A.1 – Project Requirements.
- A.5.4.5.3. Seller shall provide their standard fuel gas conditioning system. The Seller shall provide all heating equipment necessary to meet the fuel gas quality requirements for the equipment.
- A.5.4.5.4. Seller shall provide a fuel gas performance heater. External marshalling cabinet shall be provided for the dew point heaters for ease of field wiring.
- A.5.4.5.5. Fuel gas shall be heated to maximize combustion turbine performance. The fuel gas piping and equipment shall be insulated downstream of the fuel gas performance heater.
- A.5.4.5.6. Seller shall provide two (2) gas calorie meters.
- A.5.4.5.6.a. Seller shall provide all remaining system components required for a complete system for firing natural gas per CTG including but not limited to fuel metering / measurement, gas inlet filter (5 micron), duplex absolute separator filter, stop (shutoff) valve, control valves, interconnecting piping from gas module to combustion turbine base, ring manifold to burners, fuel gas condensate liquid drains tank, and all required instrumentation.
- A.5.4.5.6.b. Fuel gas isolation and automatic vent valves shall be provided; however, system is not required to meet NFPA 85 purge credit requirements.
- A.5.4.5.6.c. Stop valves shall be provided on the natural gas piping at the combustion turbine base for fire protection isolation. Interlocks shall be provided to alarm and trip the combustion turbine on actuation of these stop valves. Stop valves shall close on loss of power.
- A.5.4.5.6.d. Two means for stopping fuel flow shall be provided. They shall respond to normal or emergency shutdown control signals. A fast-acting stop/shutoff valve shall be provided as one means.
- A.5.4.5.6.e. Seller shall provide a fuel control station to regulate and control the supply of natural gas to the plant. The flow regulating station shall include flow regulating valves, vent valves,

normal and emergency gas shutoff valves, manual shutoff valves, and necessary controls for flow regulation.

- A.5.4.5.6.f. Seller shall provide a calibrated flow element for measurement of fuel gas flow. This flow meter shall be used for EPA emissions reporting calculations and CTG control. The flow meter must meet the requirements of 40 CFR 60 and 40 CFR 75. Flow meters shall be pressure and temperature compensated. The meter shall include a calibrated flow section and a remote transmitter. Seller shall obtain Buyer's approval for type of flow meter used (e.g., orifice, vortex, nozzle, Coriolis).
- A.5.4.5.6.g. All Seller supplied interconnecting fuel gas piping and valves, downstream of the last stage filter, shall be per Section A.10.30.20.
- A.5.4.5.6.h. Fuel gas system shall be designed to allow for borescope inspection of fuel gas system based on Seller standard supply.
- A.5.4.5.6.i. For fuel gas system drain lines that interface with fuel gas drains tanks, the Seller shall provide appropriate instrumentation for operator monitoring. The instruments shall be redundant and available to prevent operation of drain lines in a prolonged open position. In particular, the system design shall protect against prolonged open position of drain valves that may lead to high-pressure exhaust of fuel gas and potential for fuel gas condensate discharge. The proposed design shall be subject to Buyer review and approval.
- A.5.4.6 GENERAL OIL SYSTEM REQUIREMENTS
 - A.5.4.6.1. General
 - A.5.4.6.1.a. The following requirements apply to the lubrication oil and generator seal oil systems.
 - A.5.4.6.2. Oil Piping
 - A.5.4.6.2.a. Lube oil piping, valves, and fittings from the reservoir to the filters shall be, at a minimum, carbon steel and shall change to Type 304 stainless steel after the filters. Drain piping from the bearings to the reservoir shall be, at minimum, carbon steel.
 - A.5.4.6.2.b. Seal oil piping, tubing, valves, and fittings shall be carbon steel between the reservoir and the filters and then after the filters it shall change to Type 304 stainless steel. The return piping and fittings shall be carbon steel. Control oil piping, tubing, valves, and fitting shall be ASTM A312 Type 304 Stainless Steel.
 - A.5.4.6.2.c. Lube oil piping shall be shielded, guarded, or routed in such a way so that any potential leakage shall not spray onto hot surfaces. The supply oil piping which is close to the hot parts may be guarded by running within the return oil pipe.
 - A.5.4.6.2.d. Lube or seal oil piping which is pressurized to 50 psig or above with flanges outside the guard piping shall use flange guards. Guard pipe and flange guards are not required if a listed fire-retardant fluid is used or if piping is not routed close to the hot parts.

- A.5.4.6.2.e. Seller to supply all interconnecting piping.
- A.5.4.6.3. Instrumentation
 - A.5.4.6.3.a. Indicating pressure transmitters shall be provided on main bearing lube oil supply header.
 - A.5.4.6.3.b. For further requirements, refer to Section A.5.4.11.
- A.5.4.7 LUBRICATION OIL SYSTEM
 - A.5.4.7.1. General
 - A.5.4.7.1.a. Seller shall provide a complete lube oil system including oil storage, pumps, filters, pressure regulation, cooling, heating, piping, fill and vent valves, and instrumentation and controls.
 - A.5.4.7.1.b. Lube oil accumulators, if required to sustain pressure or flow to prescribed limits during transients, shall be supplied and shall be designed and stamped to the requirements of ASME Boiler and Pressure Vessel Code Section VIII, Division I.
 - A.5.4.7.2. Oil Reservoir
 - A.5.4.7.2.a. Oil reservoirs shall be sized in accordance with the industry standards to provide a normal operating volume of at least 5 times the flow per minute to the bearings and other services. Consideration shall be given for adequate dwell time to separate entrained air and water and to permit safe coast down of the unit on loss of AC power.
 - A.5.4.7.2.b. The oil reservoir shall be stainless steel. If the Seller's standard design utilizes laminated coatings on any components, then the following requirements shall apply:
 - A.5.4.7.2.b.1 Seller shall submit an inspection test plan that details specific lube oil tank and bearing pedestal/housing coating procedure and inspection.
 - A.5.4.7.2.b.2 Seller shall submit detailed documentation showing the results of the coating inspections and integrity tests that were performed during fabrication.
 - A.5.4.7.2.c. Seller shall provide differential pressure instrumentation across the lube oil filters.
 - A.5.4.7.2.d. Seller to supply lube oil system including external purification equipment, if required.
 - A.5.4.7.2.e. Accessories shall include a manhole and connections with block valves for oil makeup and for contaminated oil drains. A sample connection shall be provided for obtaining grab samples for laboratory testing. Oil reservoirs shall have a visual oil level indicator, low-level switch, and top-mounted relief and access doors. Low-level shall be annunciated in unit's control system. All reservoir instrumentation shall be accessible without opening access doors.
 - A.5.4.7.2.f. Seller shall furnish electrical immersion heaters with thermostatic control. Heater shall be capable of maintaining the optimal oil temperature at minimum specified winter design

ambient temperature conditions. The heaters shall be placed below the low oil level. Heaters shall be placed in wells to allow heater removal without draining the reservoir. Heaters shall be automatically de-energized upon low oil level in the reservoir.

- A.5.4.7.2.g. Lube Oil Pumps
- A.5.4.7.2.h. Two full-capacity AC motor driven pumps shall be supplied with one partial capacity emergency DC motor driven pump.
- A.5.4.7.2.i. Not Used.
- A.5.4.7.2.j. If a jacking or lift oil pump is required for the bearing design, two 100% pumps shall be provided. The pumps shall be furnished with suitable interlocks to prevent rolling of the turbine without acceptable pressure.
- A.5.4.7.2.k. Each pump shall have a suction strainer to protect the pump.
- A.5.4.7.2.l. All control equipment necessary for operation of DC equipment on loss of Auxiliary AC power shall be provided.
- A.5.4.7.3. Lube Oil Coolers
 - A.5.4.7.3.a. Seller shall provide two (2) 100 percent capacity water-cooled lube oil coolers with oil temperature regulators or control valves.
 - A.5.4.7.3.b. The heat exchanger shall be plate and frame type.
 - A.5.4.7.3.c. Heat exchanger shall be accessible for cleaning without draining oil from the reservoir.
 - A.5.4.7.3.d. The heat exchanger shall drain gravity to the oil reservoir.
 - A.5.4.7.3.e. The lube oil system shall be capable of switching between oil coolers with unit on line.
 - A.5.4.7.3.f. Coolers shall be provided with an inlet thermocouple at oil reservoir and thermocouples, pressure test connections, and vent and drain connections.
 - A.5.4.7.3.g. Thermal design of each cooler shall include a 10% margin and shall be based on providing the required oil temperature under maximum ambient and loading conditions.
- A.5.4.7.4. Lube Oil Filters
 - A.5.4.7.4.a. Two (2) 100% capacity, duplex type, multi-element oil filters with continuous flow transfer valves shall be provided.

- A.5.4.7.4.b. Both filters shall be accessible for maintenance. High-pressure drop across the filter in use shall alarm on the unit's control system and be visually indicated at the filter.
Replacement of oil filter cartridges shall not require draining of the oil reservoir.
- A.5.4.7.5. Vapor Extractors
- A.5.4.7.5.a. Seller shall provide two (2) 100% oil vapor extractors with one (1) independent mist eliminator. Extractors shall purge bearing housings and reservoir of oil vapors. Oil shall be separated and returned to the lube oil reservoir.

Seller to supply piping isolation between the vapor extractors to allow maintenance during operation. Refer to mechanical design criteria, Section A.10 for equipment isolation requirements.
- A.5.4.7.5.b. Coalescent type mist eliminators shall be provided. Electrostatic type mist eliminators are not acceptable.
- A.5.4.8. GENERATOR SEAL OIL SYSTEM
- A.5.4.8.1. General
- A.5.4.8.1.a. A complete generator seal oil system shall be provided for the purpose of lubricating seals and preventing pressurized gas from escaping from the generator. The system design shall ensure that any oil returned to the lube oil system reservoir (if applicable) shall be free of hydrogen.
- A.5.4.8.1.b. Seller shall provide a complete seal oil system including pumps, filters, pressure regulation, piping, fill and vent valves, instrumentation and controls, and any other equipment required to provide manufacturer's standard automatic system, which may be integrated into the lubrication oil system.
- A.5.4.8.1.c. Even in the case of shaft seal failure, any oil returned to the lubricating oil reservoir (if applicable) shall be free of hydrogen.
- A.5.4.8.1.d. Seal oil pressure shall be controlled so that pressure is always greater than the compressed gas pressure, even in upset conditions.
- A.5.4.8.2. Seal Oil Pumps
- A.5.4.8.2.a. Two full-capacity AC motor driven pumps shall be supplied with one partial capacity emergency DC motor driven pump.
- A.5.4.8.2.b. Not Used.
- A.5.4.8.2.c. All control equipment necessary for operation of DC equipment on loss of Auxiliary AC power shall be provided.
- A.5.4.8.3. Seal Oil Filter

- A.5.4.8.3.a. One (1) 100% seal oil filter shall be provided, as required by manufacturer's standard.
- A.5.4.9 Not Used.
- A.5.4.10 COOLING SYSTEM
- A.5.4.10.1. The Closed Cooling Water (CCW) will supply coolant to the lube oil coolers, atomizing air cooler (if applicable), generator gas coolers, and any other water-cooled equipment provided by Seller.
- A.5.4.10.2. The quality of water for the closed cooling water system will be maintained in accordance with equipment manufacturer requirements or industry standards, including corrosion inhibitors and anti-freeze strength.
- A.5.4.10.3. Refer to the Mechanical Requirements and Design Criteria for CCW system design criteria.
- A.5.4.11 BEARINGS
- A.5.4.11.1. Seller's standard bearing design shall be used.
- A.5.4.11.2. On both the active and inactive side of the thrust bearings, bearing temperature shall be measured using at least one dual element type-E thermocouple. In cases where direct temperature measurement of the bearing metal temperature is not feasible, bearing lube oil drain lines shall be monitored.
- A.5.4.11.3. Tilt pad journal bearings temperature shall be measured using at least one dual element type-E thermocouple.
- A.5.4.11.4. A single element thermocouple shall be utilized to measure oil drain temperatures at each bearing location and site glasses shall be provided for each drain.
- A.5.4.11.5. All journal shaft bearings shall be provided with vibration monitors. Active thrust bearing shall be monitored using a proximitors. At least two non-removable thermocouples per bearing shall be provided for control system monitoring and alarm. It shall be possible to change wiring from failed thermocouples to non-failed thermocouples without thermocouple or bearing removal.
- A.5.4.11.6. Lube oil reservoir vapor pressures shall be measured and indicated locally and on unit control system.
- A.5.4.11.7. Non-painted surfaces in the bearing housing that are in contact with lubricating oil shall be flushed with a rust prevention fluid. Painted surfaces shall have mill scale and other material removed by cleaning.
- A.5.4.12 WATER WASH SYSTEM
- A.5.4.12.1. One (1) water wash system shall be provided.

- A.5.4.12.2. CTG unit shall be provided with an on-line and off-line compressor water washing system suitable for use with detergents.
- A.5.4.12.3. At a minimum, the system shall be skid-mounted and consist of the following: water tank (capable of use with detergent); one (100%) booster pump with AC driven motor, valves, piping, nozzles, and piping specialties; instrumentation and controls; and water injection manifold piping and effluent drains on the combustion turbine. All interconnecting piping and accessories shall be provided by Seller.
- A.5.4.12.4. The system design shall not allow water or detergents to enter lube or control oil systems. All driven equipment shall be electrically operated. A NEMA 4x control panel including pump status lamps, contactors, control relays, control switch, and heater switch with status lamp shall be provided.
- A.5.4.12.5. Water/detergent tank shall be stainless steel or HDPE. Piping, valves, etc., shall be stainless steel. All hardware shall be corrosion-resistant.
- A.5.4.12.6. The system shall be sized for one complete off-line wash and rinse cycle of one CTG.
- A.5.4.12.7. Drains from the water wash system shall be routed to a separate storage tank for off-site disposal.
- A.5.4.12.8. Compressor design shall be suitable for both online and offline washing, using detergents. The Seller shall provide a list of approved detergents.
- A.5.4.13 FIRE PROTECTION AND DETECTION SYSTEM
- A.5.4.13.1. Seller shall provide a complete fire protection system for each supplied combustion turbine equipment. Separate detection and discharge zones shall be provided for combustion turbine enclosure, including combustion turbine bearings as well as fuel gas unit, auxiliary enclosure, including lubricating oil skid and turning gear enclosure.
- A.5.4.13.2. CO₂ fire protection system design requirements.
- A.5.4.13.2.a. The fire protection system shall be a low-pressure CO₂ system.
- A.5.4.13.2.b. The system shall be designed in accordance with NFPA 12 and CTG OEM requirements. In cases where requirements differ, the more stringent shall apply.
- A.5.4.13.2.c. Fill and vapor return lines shall be stainless steel.
- A.5.4.13.2.d. CO₂ system tank shall be oriented to facilitate filling from the road.
- A.5.4.13.2.e. CO₂ system shall be sized for two (2) discharges into the largest hazard area.
- A.5.4.13.2.f. Low pressure CO₂ system shall be designed to maintain the CO₂ at a nominal pressure of 300 psi (2068 kPa) corresponding to a temperature of approximately 0° F (-18° C) as required by NFPA 12-2022 4.6.6. The CO₂ tank shall be well insulated, able to self-regulate the pressure in case of power loss.

- A.5.4.13.2.g. CO₂ shall be refilled from a third party and needs not to be controlled at site.
- A.5.4.13.3. The CO₂ bulk storage vessel(s) shall be designed, fabricated, inspected, and stamped to the requirements of the ASME Boiler and Pressure Vessel Code Section VIII, Division I.
- A.5.4.13.4. The CO₂ system shall be skid mounted and complete.
- A.5.4.13.5. The CO₂ system shall be FM approved and capable of providing protection for the entire enclosure.
- A.5.4.13.6. CO₂ system safety features shall include, at a minimum.
 - A.5.4.13.6.a. Pre-discharge pneumatically driven (CO₂ vapor from tank) sirens at system activation and pneumatic time delay (set to 60 seconds) to allow for personnel evacuation prior to discharge.
 - A.5.4.13.6.b. System lockout achieved through physical lockout valve closing.
 - A.5.4.13.6.c. Electric service disconnect switch interrupts releasing circuit allowing for testing without actuation of fire suppression system.
 - A.5.4.13.6.d. Odorizer (wintergreen) to indicate presence of discharging CO₂ and any discharged CO₂ lingering trapped in low spots.
 - A.5.4.13.6.e. System lockout indicators at each door.
- A.5.4.13.7. Not Used.
- A.5.4.13.8. Not Used.
- A.5.4.13.9. Upon detection of a fire, compartment ventilation shall stop immediately.
- A.5.4.13.10. Fire condition shall be detected by heat detectors.
- A.5.4.13.11. The system shall include provisions for locating failed heat detectors. Each detector shall report to the local fire alarm control panel separately.
- A.5.4.13.12. The system shall be capable of extinguishing any fire without causing damage to any turbine components as a result of excessive cooling of the turbine casing.
- A.5.4.13.13. The zone of a detected fire should be clearly identified via annunciation to the local fire alarm control panel.
- A.5.4.13.14. A fire detection system shall be supplied for the electrical and control packages and battery compartment as per CTG OEM standard area smoke detection design which shall, at a minimum, consists of smoke detection and manual extinguishers.
- A.5.4.13.15. Handheld fire CO₂ extinguishers shall be provided for the control package.

- A.5.4.13.16. Refer to the requirements of the Fire Protection Design Criteria in Section A.11 for additional fire protection and detection system requirements.
- A.5.4.14. STARTING SYSTEM
- A.5.4.14.1. One (1) static starter per CTG shall be provided.
- A.5.4.14.2. Complete CTG electrical starting system, including low speed AC or DC motor-driven turning gear assembly, motor starting system, load-commutating inverter (LCI) power conversion equipment / static frequency converter (SFC), isolation transformer, required control and isolation equipment, data link reactors, and all controls and indication interfaces, shall be supplied as required.
- A.5.4.14.3. The starting system shall be rated to supply 110% of the required starting and acceleration load during shutdown condition to self-sustaining speed.
- A.5.4.14.4. If required for maintenance or cleaning, the start system shall be capable of running CTG continuously at the unfired condition.
- A.5.4.14.5. All starting equipment shall be capable of continuous operation at or near cranking speed to allow rapid cool down of the machine for maintenance following shutdown. It shall be interlocked with the lubrication system to provide bearing lubrication for turbine rotation during standby, pre-start and cool-down periods (if required) or for any period with normal bearing lubrication. Spin cooling shall be limited to the extent possible.
- A.5.4.14.6. The starting system shall be capable of accelerating the combustion turbine to a level where the starting system may be secured, allowing the combustion turbine to accelerate normally without undue thermal stress.
- A.5.4.14.7. If a start is terminated any time prior to the normal securing of the starting system, the combustion turbine must be capable of attempting at least two (2) restarts without a component cooling waiting period.
- A.5.4.14.8. If there is a time limitation on the number of successive starts due to a duty cycle constraint on the equipment, the control circuit shall go into an alarm condition, once the limitation has been reached.
- A.5.4.14.9. In the cool down mode, the system must be capable of continuous operation for at least 3 hours and capable of two (2) start attempts after the cool down period has ended without waiting for components to cool.
- A.5.4.15. TURNING GEAR
- A.5.4.15.1. A turning gear system, complete with housing and safety guards, shall be supplied for use during rotor cooldown.
- A.5.4.15.2. Turning gear shall be capable of operation in case of AC power failure.

- A.5.4.15.3. Turning gear shall maintain the rotor in a condition that allows for starting at any time after the shutdown period.
- A.5.4.15.4. The turning gear device shall be suitable for indexing the rotor when performing borescope examinations and other maintenance/inspection activities.
- A.5.4.15.5. Turning gear shall be provided with pneumatically operated turning equipment.
- A.5.4.15.6. Turning gear operation shall be fully automatic. The turning gear shall automatically engage upon rotor stoppage and disengage upon rolling turbine during startup. The turning gear shall be capable of maintaining shaft rotation at all times during shutdown periods with provisions for manual operation in the event of power loss assuming power to the emergency lube oil pump is available.
- A.5.4.16 ENCLOSURES
- A.5.4.16.1. Enclosures shall be in accordance with manufacturer's standard.
- A.5.4.16.2. Equipment enclosures shall be provided as needed to meet environmental and noise requirements as specified in Section A.9 - Site Design Data. Enclosures shall be provided for the combustion turbine, generator, electrical equipment, and mechanical auxiliary equipment, as required.
- A.5.4.16.3. Seller shall provide external and lighting for operation and maintenance. External lighting shall meet the requirements as specified in Section A.12 - Electrical Requirements and Design Criteria. External lighting at door entrances shall be provided. All lighting shall be of the LED type.
- A.5.4.16.4. Self-contained emergency backup lighting equipment provided in control and accessory areas in case of AC power outage.
- A.5.4.17 PIPING
- A.5.4.17.1. Seller shall provide standard tubing, piping, hangers, valves, fittings, and all accessories required for CTG. To the greatest extent possible, piping and auxiliaries should be factory assembled.
- A.5.4.17.2. All instrument air fittings, tubing, and piping shall be constructed of seamless stainless steel.
- A.5.4.17.3. All valves, fittings, pipe, and other materials shall be verified as clean inside and out before erection. The inside of all pipes and fittings shall be free of rust, scale or dirt when erected. All piping shall be thoroughly inspected before being placed in operation to ensure that the inside of all parts of the system are free from foreign matter.
- A.5.4.17.4. A preservative coating compatible with system oil shall be applied to all oil system piping to prevent corrosion and rusting of the piping.

- A.5.4.17.5. For oil piping, at locations near bearing caps, oil piping shall be flanged to allow for field oil flushing.
- A.5.4.17.6. Welded connections should be minimized to reduce field work.
- A.5.4.17.7. All piping supports shall be hot dip galvanized.
- A.5.4.18 HVAC
 - A.5.4.18.1. General
 - A.5.4.18.1.a. Refer to Section A.9 Site Requirements and Design Criteria for general HVAC design criteria and conditions.
 - A.5.4.18.2. Heaters
 - A.5.4.18.2.a. Seller shall provide heaters to maintain start-up temperatures and humidity protection during shutdown and standby periods. All compartments and enclosures require heating. The heating systems shall be designed to maintain system design basis temperatures and humidity protection down to the winter design temperature. Systems will also be sized to prevent enclosure temperatures from falling below the freezing point for the site Record Low temperature.
 - A.5.4.18.2.b. All heaters shall be thermostatically controlled.
 - A.5.4.18.3. Ventilation
 - A.5.4.18.3.a. Seller shall provide redundant exhaust fans to create a negative pressure within the turbine compartment.
 - A.5.4.18.3.b. Ventilation design shall ensure that temperatures exceeding internal components' application limits are not exceeded in any of the supplied enclosures.
 - A.5.4.18.3.c. All ventilation shall exhaust outside of CTG enclosures.
 - A.5.4.18.3.d. Ventilation for CT enclosure shall be equipped with fuel gas leak detection system.
 - A.5.4.18.4. Air Conditioning
 - A.5.4.18.4.a. Seller shall provide air conditioning units with N+1 redundancy for the control compartment which will maintain the interior environment suitable for sustained and stable operation of electrical and control equipment at the Project site extreme temperature. Battery room shall have at least one (1) air conditioning unit.
- A.5.4.19 INSULATION AND LAGGING
 - A.5.4.19.1. General

- A.5.4.19.1.a. Insulation shall be used where required by OSHA for personnel safety. Personnel protection shall be sized to maintain a surface temperature of 140° F or below, at Project site summer design conditions with 3 mph wind speed for outdoor piping. Insulation and related products shall be asbestos free.
- A.5.4.19.1.b. Insulation shall be blanket type and be designed to be easily removed and re-applied. Insulation system to be designed to be removed and reapplied a minimum of 1 time/year for the life of the equipment.

A.5.5 GENERATOR AND APPURTENANCES TECHNICAL REQUIREMENTS

A.5.5.1 GENERAL

- A.5.5.1.1. The generator and its appurtenances shall conform in all respect to the Institute of Electrical and Electronics Engineers (IEEE) Standard for Cylindrical-Rotor 50 Hz and 60 Hz Synchronous Generators Rated 10 MVA and Above – IEEE Std C50.13 – and API Standard 616 (Chapter 8) or equivalent modern guide with their latest revisions and additions, plus all Governing Codes, Standards and Regulations details in Section A.1.5.
- A.5.5.1.2. The generator shall be of the cylindrical rotor type, air, hydrogen, or water cooled. The generator shall be designed to develop the capacities specified under the operating conditions chapter.
- A.5.5.1.3. The generator shall be asbestos free.
- A.5.5.1.4. The rotors shall be installed in the generator and shipped to site, whenever logistic permit.

A.5.5.2 GENERATOR RATING

- A.5.5.2.1. The rating of the generator shall be such that when operating at the rated power factor and the cooling method the generator shall be capable of carrying continuously the maximum output of the driving turbine without exceeding the guaranteed temperature rise. The synchronous generator and its excitation system shall be matched to the maximum combustion turbine capability. The generator nor its excitation system nor its accessories shall limit Facility output.
- A.5.5.2.2. The generator shall be capable of operating in parallel with the grid with constant or fluctuating load and with leading or lagging power factor.
- A.5.5.2.3. Generator shall comply with NERC PRC-24-2.
 - A.5.5.2.3.a. Generator shall be protected by a two-level V/Hz relaying scheme as indicated below:
 - A.5.5.2.3.b. Level 1 pickup for alarm at 106% volts/hertz level instantaneously.
 - A.5.5.2.3.c. Level 2 to be set to a pickup for trip at 118% volts/hertz with a 2 second delay.
 - A.5.5.2.3.d. The V/Hz limiter in the AVR set at 105% volts/hertz level.

- A.5.5.2.3.e. The protection in the AVR set to operate at 110% volts/hertz level.
- A.5.5.2.4. The generator shall comply with all requirements in IEEE Std C50.13.
- A.5.5.2.5. The generator shall have the following additional characteristics:
- | | | |
|--------------|---|---|
| A.5.5.2.5.a. | Cooling method | [by Seller] |
| A.5.5.2.5.b. | Rating | [by Seller] |
| A.5.5.2.5.c. | Power factor: | 0.85 |
| A.5.5.2.5.d. | Voltage: | [by Seller] |
| A.5.5.2.5.e. | Number of phases: | 3 (wye connected) |
| A.5.5.2.5.f. | Frequency: | 60 Hz |
| A.5.5.2.5.g. | Speed: | 3600 r/min |
| A.5.5.2.5.h. | Short Circuit Ratio: | Not less than 0.50
at rated H ₂ pressure at maximum cooling water temperature
or at rated power if air-cooled method is selected |
| A.5.5.2.5.i. | The generator shall be capable of withstanding the effects negative phase-sequence current as specified in IEEE Std C50.13 without any resulting damage. | |
| A.5.5.2.5.j. | The generator shall be capable of withstanding the thermal effects of unbalanced faults at the generator terminals in accordance with IEEE Std C50.13 without any resulting damage. | |
| A.5.5.2.5.k. | Generator shall withstand any short circuits at the terminals for a minimum of 10 seconds or generator short time thermal capability, when operating at its rated kVA and power factor, and also 5% over-voltage per the IEEE Std C50.13. | |
| A.5.5.2.5.l. | Generator shall withstand a 3-phase, line-to-line (or phase-to-phase), phase-to-phase-to-ground (or double-line to ground), and phase-to-ground faults to the entire machine. | |
| A.5.5.2.5.m. | The generator shall also be capable of withstanding a 3-phase short circuit capability of not less than 10 seconds. | |
| A.5.5.2.5.n. | BIL level shall be minimum 150 kV. | |
| A.5.5.2.5.o. | Not Used. | |
| A.5.5.2.5.p. | The Generator deviation factor for the open circuit terminal voltage wave of the generator shall not exceed 0.1 (10%) from a pure sine wave. | |
| A.5.5.2.5.q. | Excitation system response ratio: | 2.0 or greater |

A.5.5.2.5.r.	Nominal excitation voltage:	Manufacturer's optimum
A.5.5.2.5.s.	Stator winding connection:	Copper
A.5.5.2.5.t.	Stator winding connection:	Star
A.5.5.2.5.u.	Number of leads brought out:	6
A.5.5.2.5.v.	Field winding conductors:	Copper
A.5.5.2.5.w.	For hydrogen cooled generators, rated gas pressure:	Manufacturer's standard
A.5.5.2.5.x.	Hydrogen coolers, maximum inlet cooling water temperature Conditions (refer to Section A.9 - Site Design Data)	Summer Design
A.5.5.2.5.y.	The generator windings and end-turns shall be braced for peaking duty requiring frequent startups and shutdowns (refer to Section A.1 - Project Requirements for approximate number of startup and shutdown cycles per year).	
A.5.5.2.5.z.	The generator shall be designed to withstand, without mechanical damage, any type of short current at its terminals for times not exceeding short-time thermal requirements, when operating at rated KVA and power factor and +5% overvoltage provided the maximum phase current is limited by external means to a three-phase fault value.	
A.5.5.2.5.aa.	The generator shall be designed to operate at rated frequency and at frequencies in accordance with IEEE C50.13 of the latest issue. Generator shall be able to carry the rated stator current and the rated field current as per IEEE C50.13	
A.5.5.2.5.bb.	In case of motoring operation, a reverse power protection relay shall be used to send out an alarm and trip the unit after proper time delay.	
A.5.5.2.5.cc.	If hydrogen cooled, the generator shall be constructed such that at normal hydrogen pressure, the average temperature rise of each of the various parts of the machine above the average temperature of the cooling medium does not exceed the value specified in the latest standards for the type and size generator furnished, i.e., IEEE Std C50.13.	
A.5.5.2.5.dd.	Generator leads shall be brought out in three (3) line side and three (3) neutral side bushings.	
A.5.5.2.5.ee.	Bushings shall be capable of being replaced without removing the generator rotor.	
A.5.5.2.5.ff.	Generator lead box shall be modular to provide maximum shop assembly in consideration of transportation associated restrictions as applicable.	
A.5.5.3	Generator control terminal boxes shall include maximum preassembly and rewiring in consideration of transportation associated restrictions as applicable. Electrical Characteristics	

- A.5.5.3.1. Generator shall be thermally capable of continuous operation within the confines of its reactive capability curve over the ranges of voltage, frequency, and reduced gas pressure operation for hydrogen-cooled generators and base peak capabilities as IEEE Std. C50.13.
- A.5.5.3.2. The exciter shall have sufficient capacity to operate within its current rating with the generator operating at its maximum capability.
- A.5.5.3.3. For closed cooling cycles, the generator housing shall be completely enclosed and arranged for cooling by hydrogen. The slip ring housing can be open ventilation with air cooling. Suitable fans furnished as an integral part of the generator rotor and a closed ventilating system shall be provided to ensure necessary cooling under all specified operating conditions with a conservative factor of safety. Pressure and temperature devices shall determine the availability of the cooling system.
- A.5.5.3.4. For hydrogen cooled cycles, the terminal bushing assembly shall be designed for operation without leakage under the specified maximum hydrogen pressure.
- A.5.5.3.5. For hydrogen cooled cycles, the generator stator housing shall be so designed that pockets of hydrogen gas will not be formed in any location inside the housing during the purging operations.
- A.5.5.3.6. If brushless exciters are used, they shall be completely enclosed and air-cooled with ventilating systems as required.
- A.5.5.3.7. Design of generator shall be such that stator and/or rotor may be removed and replaced with a minimum of difficulty.
- A.5.5.3.8. Insulating materials used shall be of the best quality available and be properly applied to give a high factor of safety.
- A.5.5.3.9. The insulation shall be Class F; however, the machine shall be designed for a Class B maximum temperature rise.
- A.5.5.3.10. Bearings of the generator shall be electrically insulated to minimize shaft currents. Insulated bearing and seals shall be capable of being megger tested without generator disassembly. Automatic shaft ground detecting monitoring equipment shall be provided.
- A.5.5.4 STATOR
- A.5.5.4.1. All stator parts, whether gas-cooled or air-cooled, shall be tested to ensure unrestricted passage of the coolant.

H₂ gas-cooled system for stator includes H₂ cooler which is supplied by closed cooling water system.
- A.5.5.4.2. Generator stator winding shall be insulated with an approved type of insulation designed and selected with a view to permanence and flexibility under all expected conditions, and such that the whole may form a compact and solid construction free from all internal air spaces.

- A.5.5.4.3. Phase and neutral terminals shall be marked consecutively in the order of their phase sequences.
- A.5.5.4.4. Heaters shall be provided with the stator to avoid condensation moisture during stand-by periods.
- A.5.5.4.5. Not Used.
- A.5.5.4.6. A minimum of four single element 100-ohm platinum RTDs per phase shall be provided for the stator windings. Leads shall be brought out to a junction box.
- A.5.5.4.7. Drains and liquid detectors and shall be provided at the low points.
- A.5.5.4.8. Hydrogen within the generators shall have provisions for surface type coolers. These shall be located in the stator enclosure with accessibility for cleaning and repairing the coolers. Connection to the temperature detecting device shall be a 1 inch NPT connection.
- A.5.5.4.9. CO₂ shall be used as a purging medium. The H₂/CO₂ supply and purge systems shall provide for the evacuation and safe charging of the hydrogen from the generator.
- A.5.5.4.10. Gas pressure in the machine shall be maintained by a controls system at the required level. Supervisory instrumentation shall be provided which will continuously indicate the temperature, purity of gas, and presence of liquid.
- A.5.5.4.11. H₂ and CO₂ storage, if required, shall be provided by Seller. Piping and connection between the storage and Seller's control stations shall be by Seller.
- A.5.5.4.12. The control cabinet for Hydrogen, in the event a generator with hydrogen gas cooling is quoted, shall be suitable for an outdoor environment with the applicable hazardous area classification.
- A.5.5.4.13. Alarms shall have dry C contacts to interface with the Facility DCS. The H₂ cabinet shall provide trouble indication.
- A.5.5.5 ROTOR
 - A.5.5.5.1. Castings shall not be used for any part of the rotor, unless approved by Buyer.
 - A.5.5.5.2. Generator rotor winding shall be insulated with mica or other suitable material specially chosen to ensure against deterioration by temperature, vibration, or other causes due to constant running under all working conditions.
 - A.5.5.5.3. Generator rotor shall have two retaining rings, made of 18 Mn – 18 Cr forged material.
 - A.5.5.5.4. Collector rings shall be provided with an insulating barrier.

- A.5.5.5.5. Collector ring brushes shall be of such number, design, location and spacing that they can be removed one at a time, maintained or replaced while the generator is running under full load current.
- A.5.5.5.6. Brushes shall be mounted in such a way as to prevent uneven wear of the collector rings.
- A.5.5.5.7. Permanently mounted generator flux probes shall be provided for each turbine generator as noted below shall be provided on all associated devices to detect any turn-to-turn shorts in the rotor.
- One (1) – Generator flux probe
 - One (1) – Casing gland (gas-tight terminal connection))
 - One (1) – Signal wire (inside of generator only).
- A.5.5.5.8. The field windings shall be designed for direct cooling by the cooling medium.
- A.5.5.5.9. Rotor vibration shall meet the requirements of ISO 20816 Zone A/B.
- A.5.5.5.10. Excitation System:
- A.5.5.5.11. General
- A.5.5.5.11.a. A static excitation system shall be supplied and shall include a line fed excitation transformer.
- A.5.5.5.11.b. Excitation transformer shall be dry type, cast resin suitable for outdoor use.
- A.5.5.5.11.c. Transformer shall be sized with sufficient capacity based on ceiling voltage at the rated generator conditions.
- A.5.5.5.11.d. The exciter shall be of the fast-response type. The response ratio shall be 2.0 or greater at generator rated load conditions. At least one spare bridge must be provided (n+1) so that the loss of a bridge has no impact on full load operation.
- A.5.5.5.11.e. Transformer BIL rating shall comply with the requirements of IEEE Std C57. Overload protection for the excitation transformer shall be provided.
- A.5.5.5.11.f. The system shall be rated to provide generator voltage regulation from 95% to 105% of the rated voltage at any operating load.
- A.5.5.5.11.g. An exciter field breaker or contactor shall be provided.
- A.5.5.5.11.h. The entire exciter shall be totally enclosed in a NEMA 3R/IP 54 enclosure with inspection windows and shall be arranged with air cooling (no water) to maintain a proper ambient temperature. Appropriate enclosure lights and receptacles shall be provided. Light switches shall be mounted on the outside of the housing at entry points.
- A.5.5.5.11.i. If field flashing is used, a fused field flashing circuit shall be provided.

- A.5.5.5.11.j. The generator field temperature shall be monitored and displayed.
- A.5.5.5.12. Voltage Regulating Equipment
- A.5.5.5.12.a. A continuously acting solid state, redundant channel, automatic voltage regulator shall be provided complete with required relays, contactors, switches, and auxiliary devices. The regulator shall contain an adjustable reactive-current compensation feature to provide adjustment of the reactive load when the generator is operated in parallel with similar units. The circuitry shall be designed to permit a smooth transfer from automatic to manual regulation and vice versa, by means of a transfer switch and a field tracking circuit. The voltage regulator shall have two separate independent controllers for manual and automatic operation.
- A.5.5.5.12.b. The voltage regulator shall contain a power system stabilizer including an over excitation limiter and a minimum excitation limiter circuit, which shall be set to coordinate with the generator reactive capability curve characteristics.
- A.5.5.5.12.c. A generator terminal voltage protection scheme, with a volts-per-hertz regulator and a volts-per-hertz protection system shall be provided for use during normal operation plus startup and shutdown of the turbine-generator to prevent over-excitation of the generator and all transformers connected to the generator terminals. Backup protection shall be provided during manual control and voltage regulator control while the turbine-generator is in service to protect the close coupled transformers during periods of sudden load shedding. Rotor earth fault protection shall be provided.
- A.5.5.5.12.d. V/Hz pickup settings shall be as follows: shall allow continuous operation at 105%, Refer to Section A.5.5.2.3 for additional settings.
- A.5.5.5.12.e. A means of local and remote voltage adjustment shall be provided.
- A.5.5.5.12.f. Rotor temperature indicator as well as field current and field voltage transducers shall be provided.
- A.5.5.5.13. Cooling System: The generator shall be a totally enclosed hydrogen-cooled generator, air-cooled generator or water-cooled generator stator. If air-cooled cooling method is selected, the generator shall be totally enclosed water-to-air (TEWAC). If open ventilated, high-efficiency filters shall be considered/included in case of dusty sites.
- A.5.5.5.13.a. Closed Cycle Hydrogen Cooled Generator: Hydrogen-cooled generators shall utilize a closed-loop hydrogen circuit within the generator and a hydrogen-to-water heat exchanger. A leak test, per Seller's subcontractor's standard, shall be conducted. A hydrogen flow meter with totalizing shall be provided.
- A.5.5.5.14. Surge Arrestors and Potential Transformers shall be provided. Surge arrestors shall be station type and shall contain no PCBs by Seller.

- A.5.5.5.14.a. A surge and potential transformer cabinet shall be furnished. The cabinet shall house surge capacitors, surge arresters, potential transformers, disconnect links, copper bus, and all other materials and accessories in a NEMA 4 enclosure.
- A.5.5.5.14.b. Two (2) sets of three (3) single phase potential transformers shall be provided with each set feeding primary and back up relaying per CTG Seller's subcontractor's one line diagrams. A voltage balance relay shall be provided to detect and inhibit trips in the case of PT fuse failure. Potential transformer secondary circuits shall be three phase, four wire, 120 volts AC. Two (2) auxiliary potential transformers shall be provided to isolate the line and the machine PTs from the synchronizing circuits.
- A.5.5.5.14.c. Surge Protection: Lightning arresters and surge capacitors shall be furnished by the Seller. Lightning arresters shall be station type. Surge capacitors shall not contain PCBs.
- A.5.5.5.15. Generator Neutral Grounding shall be provided.
- A.5.5.5.15.a. A suitable means of grounding the generator shall be provided. This equipment shall provide a high resistance generator grounding system which will limit the generator neutral current.
- A.5.5.5.15.b. A high resistance grounding system (NGR) for the generator shall be provided. The grounding system shall provide 100% generator ground fault protection.
- A.5.5.5.16. Metering and Protection
- A.5.5.5.16.a. Transducers shall be provided for the following quantities (except watt-hours) to display in the Facility DCS. Unless specifically noted otherwise, transducers shall have an accuracy of 0.5% or better and shall have an output range of 4-20 mA.
- A.5.5.5.16.b. As a minimum, transducers shall be provided for the following parameters to be displayed in the Facility DCS:
- Generator frequency.
 - Generator voltage, phase-to-phase (3 phases with a voltmeter switch).
 - Generator current (3 phases with an ammeter switch).
 - Generator field voltage.
 - Generator field current.
 - Generator gross watts.
 - Generator gross VARS.
 - Generator gross watt-hours (with a pulse output suitable for tele-metering).
 - Power factor (Showing both leading and lagging) transducer minimum accuracy of 3.0%.
- A.5.5.5.16.c. The following metered data shall be available via the Seller's hardwire interface for remote operation:
- a. Voltage.

- b. Current.
- c. Kilowatts (generator terminals).
- d. Kilovars.
- e. Generator gross watt-hours (with a pulse output suitable for tele-metering).

A.5.5.5.16.d. Generator Protective Relaying

A.5.5.5.16.d.1 Primary and backup relays shall be provided. Primary shall be SEL-300G and backup shall be an alternative model SEL relay. These shall provide all controls, logics, and provide protection of the turbine-generators and auxiliaries against potential damaging conditions. These relays shall also be capable of automatic tripping and alarming.

A.5.5.5.16.d.2 Buyer shall be consulted to determine protection preferences (out of step, voltage-controlled overcurrent).

A.5.5.5.16.d.3 The following generator protective relays and protection schemes shall be provided:

- Phase fault protection, generator differential.
- Impedance back up 21P.
- Ground fault protection during normal operation and for ground faults close to the neutral.
- Short reach loss of field with time delay and long reach loss of field.
- Pole slipping protection.
- Reverse power
- Generator no load over excitation (for offline protection).
- Negative sequence.
- Dual volts per Hertz with stepped activation.
- Voltage balance.
- Generator motoring protection.
- Automatic synchronizing.
- Exciter and generator field ground fault protection.
- Over excitation protection.
- Transfer trip from switchyard or substation.
- Stator over temperature protection.
- Inadvertent energization.
- Under / over frequency.
- Under / over voltage.
- Generator breaker failure protection.
- Lockout relay for generator breaker trip.

A.5.5.5.16.d.4 Generator shall be capable of continuous operation in the “No-Trip” zone of NERC PRC-024 without limitation by protective relaying.

- A.5.5.5.16.d.5 Generator and excitation transformer relay settings shall meet requirements of NERC PRC-019, -024, -025 -026, and -027.
- A.5.5.5.17. Current transformers used for generator protection shall be relaying accuracy suitably sized for the burden.
- A.5.5.5.18. Eighteen (18) bushing-type current transformers (CTs) shall be furnished for use with relaying and metering. Three (3) per each line side bushing and three (3) per each neutral side bushing shall be provided.
- A.5.5.5.19. CT relaying accuracy shall be C400 and metering accuracy shall be 0.3B1.8.
- A.5.5.5.20. All generator lockout relays shall be located in the Generator Control Relay Panel (GCRP), which shall be located in the CT Control Package. As a minimum, two (2) generator and one (1) breaker failure lockout relays shall be furnished, each with a minimum 14 NO and 14 NC contacts. All other generator protective relays shall be equipped with test switches.
- A.5.5.5.21. The turbine-generator shall have appropriate synchro check relay and auto synchronizer to allow automatic synchronizing with the utility power grid.
- A.5.5.6 MOTOR CONTROL CENTER(S)
- A.5.5.6.1. Section A.12 – Electrical Requirements and Design Criteria is not applicable to OEM-supplied CTG auxiliaries' motors; these motors will conform to OEM standard requirements. Motor Control Center(s) (MCC) shall be per CTG Seller's subcontractor's one line diagrams. Minimum 10% of spare and 10% of space of MCC buckets shall be provided in each MCC.
- A.5.5.6.2. Seller shall provide a complete low voltage power distribution system. Two AC 480V MCCs, each with NEMA 1 with Gasket design for the combustion turbine unit. These MCCs shall provide both power and control for the 480V loads associated with the combustion turbine unit, except for the loads larger than 250 HP, common loads (SFC etc.), and SFC and excitation package utility loads which shall be fed from power distribution equipment for BOP equipment. All redundant loads shall be split between these two MCCs (one normal MCC and one essential MCC), and the essential MCC shall be fed by essential switch gear that has emergency AC backup power source.
- A.5.5.6.3. MCCs shall be of the arc resistant type 2A accessibility with retractable bus stab. Seller to provide remote racking equipment as a special tool provision.
- A.5.5.6.4. MCC incoming cables shall be adequately sized, 600V having construction as specified in Section A.12 – Electrical Requirements and Design Criteria.
- A.5.5.6.5. Seller shall provide DC motor starters for all DC motors supplied including DC emergency oil pumps and for DC seal oil pumps with NEMA 1 gasket design for indoor applications.
- A.5.5.6.6. IP54/NEMA 3R shall be considered for outdoors.

A.5.5.7 BATTERIES

- A.5.5.7.1. The battery cells shall be low antimony type with pasted plate grids in transparent plastic jars. Redundant charger system sized as required for the DC motors, DC control logic circuits, and power supply for the process control system power.
- A.5.5.7.2. Batteries shall be located in their own compartment isolated from other equipment. The battery compartment shall be negatively vented to prevent the accumulation of noxious or explosive gases. Two (2) 100% battery compartment ventilation fans with air flow switches shall be supplied and monitored by the TCP to ensure accumulation of explosive gases is not permitted.
- A.5.5.7.3. Location of the battery compartment shall allow direct access for service to all cells.
- A.5.5.7.4. Batteries shall be sized to maintain all DC motors, circuits, and control systems for a minimum duration as required for safe shutdown of the GTG and related equipment and in no case for less than 120 minutes. SFC DC loads and other common DC loads shall be powered by Balance of Plant DC system.
- A.5.5.8 A separate and dedicated DC power pack system, only for 220 VDC actuators and valves, should be provided by Seller, and the battery type can be VRLA.

A.5.5.9 GROUNDING

- A.5.5.9.1. Refer to Section A.12 - Electrical Requirements and Design Criteria for specific grounding requirements.
- A.5.5.9.2. Seller shall provide suitable copper ground grid connection pads on skid for connection to Facility grounding systems. Two diagonally opposite ground pads shall be furnished on the generator. All equipment shall be grounded by copper conductor permanently bonded to skid and bolted to equipment.
- A.5.5.9.3. A copper ground bus extending the full length of the panel shall be provided. The ground bus shall be bolted to the panel structure and effectively ground the entire structure. The ground bus shall be grounded to the skid or the Facility ground grid at both ends.
- A.5.5.9.4. Each circuit requiring grounding shall be individually and directly connected to the copper ground bus and fastened with a drilled and tapped connection. Each ground point shall be readily accessible for removal, testing, and replacement.
- A.5.5.9.5. The cases of all instruments, relays, and switching devices shall be grounded.

A.5.5.10 PANELS

- A.5.5.10.1. Panels shall be assembled per CTG Seller's subcontractor's standard.

A.5.5.11 TERMINAL BLOCKS AND WIRING

- A.5.5.11.1. Terminal blocks and wiring shall be CTG Seller's subcontractor's standard.

A.5.5.11.2. All terminal blocks and points shall be labeled as indicated on the electrical drawings.

A.5.5.12 MISCELLANEOUS REQUIREMENTS

A.5.5.12.1. All auxiliary switches, control switches and alarm switches shall be heavy-duty type suitable for 125 VDC operation and with inductive rating of at least 0.5 ampere at 250 VDC. Pressure switch contacts shall have a minimum continuous rating of 1 ampere at 120 VAC and an interrupting rating of 0.4 ampere inductive at 120 VDC. Level switches contacts shall have a minimum continuous rating of 1 ampere at 120 VAC and an interrupting rating of 0.3 ampere inductive at 120 VDC. Limit switch contacts shall have a minimum continuous rating of 1 ampere at 120 VAC and an interrupting rating of 0.4 ampere inductive at 120 VDC.

A.5.5.12.2. All solenoid valves shall be suitable for continuous operation and shall have coils with Class "H" insulation. Solenoids shall have NEMA 4 enclosures.

A.5.5.12.3. All junction boxes on the turbine-generator or mounted on equipment furnished separate from the turbine generator and not located in a hazardous area shall have hinged doors and shall be enclosed in NEMA 4 junction boxes, minimum. NEMA 4X junction boxes are preferred. NEMA 4 Boxes can be painted per OEM standard.

A.5.5.12.4. Power source conditioning is the responsibility of the Seller to protect against transient voltages.

A.5.5.12.5. Radio Frequency Interference

A.5.5.12.5.a. The control system shall be designed to operate in a power plant environment and shall exhibit immunity to stray magnetic fields.

A.5.5.12.5.b. The control system shall be immune to radio frequency interference generated by radio transceivers.

A.5.5.12.5.c. Operation of radio frequency generating equipment within 5 feet of combustion turbine equipment, with cabinet doors closed, shall not adversely affect combustion turbine operation.

A.5.6 INSTRUMENTATION AND CONTROL

A.5.6.1 CONTROL SYSTEM-GENERAL

A.5.6.1.1. Seller shall furnish and install all instrumentation and control devices required for safe and efficient operation of CTG. All instrumentation and control devices shall meet the process instrument and installation requirements as specified in the I&C Requirements and Design Criteria, refer to Section A.13.

A.5.6.1.2. Seller shall provide CTG with a complete and functional control system located adjacent to CTG to operate all the equipment from a local HMI with 24-inch minimum dual display monitors. Control from a remote central control room shall also be possible via a data link to the Facility Distributed Control System (DCS) and one (1) remote Seller's

HMI with 24-inch minimum dual display monitors and a printer common for CTG and STG. The local CTG control system shall be connected via CTG unit Seller's subcontractor's standard redundant network. A proven redundant, fiber optic datalink utilizing OPC over Ethernet shall connect the Facility DCS with CTG control system network.

- A.5.6.1.3. Seller's control system shall utilize distributed redundant microprocessor-based hardware.
- A.5.6.1.4. CTG control system shall be used as a source of control, data acquisition, performance calculations and monitoring, alarming, historical storage and retrieval, sequence of events recording (SOE), logging, and operator information. The time tagged information of all SOE points associated with CTG shall be communicated to the Facility DCS for inclusion in the SOE report for the facility. As such reliability, availability, and maintainability of this system is imperative. As a minimum, no single point failure shall cause control system malfunction. All processors, power supplies, communication interfaces, data highways shall be redundant with automatic failover.
- A.5.6.1.5. A data base shall be developed from all I/O points and shall consist of, but not be limited to, I/O I.D. - English service description, set point, alarming priorities, etc., for the system provided for controlling CTG - per unit. The Seller shall provide the system database files in Excel or Access format.
- A.5.6.1.6. Reliability is a requirement of the highest order. The system shall be designed to minimize unwarranted shutdowns from faults in the control system (nuisance trips). All key operating parameters of the combustion turbine and generator shall be monitored. Sufficient sensors and channels shall be provided such that a single component failure neither causes nor inhibits a trip. To minimize nuisance trips, the system shall employ such techniques as redundancy for critical items such as sensors; modular power supplies (n+2) arrangements or 100% redundant power supplies; two out of three voting (fault tolerant design) for shutdown actions (except for vibration sensors, bleed valve limit switches, combustion pressure fluctuation sensors due to limitation of installation location, and/or applicability during start-up period only); pre-alarm warning before shutdown; time delay before shutdown; self-checking circuitry with diagnostic test points, etc. It should be possible to change out failed equipment with the system on-line with no interruption of service.
- A.5.6.1.7. Seller shall provide all required hardware and software necessary to perform routine maintenance and configuration changes on the control system during both on-line and off-line modes of operation. This shall include any special tools. A special tool is defined as equipment or software not commonly found in a power plant. Seller shall provide a USB drive or other Buyer approved method and two hard copies of CTG control system configuration as-shipped drawings within one week of shipment of the system.
- A.5.6.1.8. CTG performance monitoring and calculations shall include, as a minimum, gross power, power factor, ambient dry bulb temperature, compressor inlet dry bulb temperature, barometric pressure, relative humidity, combustor shell pressure, turbine exhaust temperature, index differential pressure at CTG compressor inlet, inlet guide valve angle, fuel flow rate, fuel temperature, fuel heating value from gas chromatograph, operating

heat rate, expected power, expected heat rate, and compressor air flow. Performance monitoring data shall be trended and archived within each CTG's control system. Reports shall be supplied showing on-line performing information and past data.

- A.5.6.1.9. The data acquisition system shall be Seller's standard package. The data acquisition system shall consist of a dual redundant computer package that shall record historical trends and provide alarm/event logs in addition to performance monitoring and calculations.
- A.5.6.1.10. The historical storage and retrieval system within each CTG's control system shall include a minimum storage of critical parameters for a minimum of 2 years' worth of data in user friendly format, for all monitored instrumentation at 1-second save rate, including performance monitoring data. Historian shall have capability to transfer older data to digital storage media so that a complete Facility data history is maintained for the life of the Facility.
- A.5.6.1.11. Each CTG's control system shall include a redundant OPC communication link to Facility DCS.
- A.5.6.1.12. Not Used.
- A.5.6.1.13. Emergency stop switches shall have a means to prevent accidental operation such as clear plastic / Lexan covers or push button guards.
- A.5.6.2 CONTROL SYSTEM - FUNCTIONAL REQUIREMENTS
- A.5.6.2.1. The functional requirements, description of operation, and control requirements included herein are not intended to limit the operation, functions, and safeguard to those either mentioned or implied. Seller shall make any additional suggestions or recommendations that will improve the proposed operational procedures or method of control. All the system engineering and hardware needed to constitute a fully integrated, complete, and operable startup, shutdown and on-line control and monitoring system shall be supplied by the Seller whether or not specifically detailed.
- A.5.6.2.2. Each CTG's control system shall be designed for complete automatic startup, synchronizing, loading, protective shutdown, and manually initiated shutdown.
- A.5.6.2.3. In the case of a sudden loss of load while a CTG is operating with maximum power output, the speed governing system shall be capable of controlling the speed at a value that is less than the setting of the emergency over speed governor.
- A.5.6.2.4. CTG shall be equipped with an exhaust temperature controller to limit power output (fuel input) commensurate with maximum allowable exhaust temperature and shall effectively override all other devices asking for increased power output.
- A.5.6.2.5. NFPA 85 HRSG purge and CT to HRSG interlock requirements must be satisfied by each CTG's control system.

- A.5.6.2.6. The load control subsystem shall include provisions for manipulating each CTG's power output as a function of load demand. The unit shall include kW, KVAR, and power factor controllers. The droop control shall be in service while the CTG is in local control. Unit is to be controlled locally or remotely. Remote control of unit kW setpoint will be through a 4-20 mA signal from the Facility DCS.
- A.5.6.2.7. The control system shall include protection functions independent of the control and monitoring functions. Provision shall also be included for hard-wired overspeed protection independent of control system with on-line testing of EOST modules, such as overspeed protection, while the CTG is online.
- A.5.6.2.8. All CTG control screens shall be replicated in the Facility DCS for each CTG. During the engineering stage, Seller shall provide graphics to be displayed in the DCS for Buyer's review.
- A.5.6.2.9. Seller's equipment shall also include provisions for interfacing through hardwired facilitate controlling and redundant data highway for monitoring each CTG from Facility DCS. During the engineering stage, Seller shall provide a list of signal interface with the DCS (hardware and software I/O list).
- A.5.6.2.10. Seller's schedule shall include the duration required for engineering and testing the interface with DCS system.
- A.5.6.2.11. CTG shall be designed to operate in Island Mode after disconnection from the power grid.
- A.5.6.3 CONTROL SYSTEM - HUMAN-MACHINE INTERFACE
- A.5.6.3.1. Virtual HMI shall be applied to operator console, engineering workstation, historical storage and retrieval system, and OPC server.
- A.5.6.3.2. Two (2) independent Host Server machines shall be provided in the control room. CTG's local operator console with engineering workstation (Thin Client) shall have two full-function, 24-inch minimum color LCD dual display monitors with keyboard and the associated electronics.
- A.5.6.3.3. The remote operator console (Thin Client) for each CTG shall also have a full-function, 24-inch minimum color LCD dual display monitors with keyboard and the associated electronics shall be remotely located.
- A.5.6.3.4. Through the LCD/keyboard interface, the system shall provide all the necessary information and capabilities to enable the operator to conveniently and effectively control and monitor CTG operation.
- A.5.6.3.5. Seller shall furnish an engineering workstation (Thin Client) with 24-inch dual display monitor. Engineering workstation shall be located in the control room / building. The Thin Client shall be used for historical storage and retrieval system and OPC server.

- A.5.6.3.6. An additional Thin Client with 24-inch display monitor shall be provided for historical and retrieval system and OPC server.
- A.5.6.3.7. Software assurance for Thin Client's licenses shall be a 2 year license provided at the time of substantial completion. After that point, the Buyer is responsible for renewal unless extended coverage is included in the LTSA agreement. A printer shall be provided for the operator station and the engineering workstation in the control room.
- A.5.6.3.8. Control System – I/O Partitioning and System Redundancy
 - A.5.6.3.8.a. I/O shall be partitioned so that redundant field instruments/equipment shall be partitioned and assigned to different I/O cards.
 - A.5.6.3.8.b. System Redundancy: The system shall include redundant equipment for each real time operational subsystem up to (excluding) the I/O card's level. Transfer to the backup shall be automatic and bumpless and shall not create any disturbance to the system. Provisions shall be made in the cabinets to allow manual transfer to the backup control system and vice versa. Controller redundancy shall be provided in a one-to-one fashion; no more than one microprocessor shall be backed up by the redundant processor. A processor failure shall be alarmed on the operator's console.
- A.5.6.3.9. Data Communication Subsystem
 - A.5.6.3.9.a. The data communication subsystem shall link the control and monitoring subsystem, input/output processing subsystem, and system peripherals through redundant high-speed data communication link systems so as to provide reliable and efficient communication between CTG control system components. Failure of any component which interfaces with the data communication subsystem shall not cause the failure of the data communication subsystem or any other system or component. The transfer between main and backup data communication subsystems shall be bumpless. Alarm signals (messages) shall be initiated when transferring from main to backup and vice versa. Alarm messages shall be sent on failure of any part of the system.
 - A.5.6.3.9.b. Each functional processor and its backup shall be programmed to execute the assigned tasks with no communication overhead. Security of communication shall be ensured by use of a proven highway protocol and system-wide diagnostics that are designed to detect faults and initiate recovery actions transparent to the operator.
- A.5.6.3.10. Control System - Programming/Configuring (Software)
 - A.5.6.3.10.a. Seller shall furnish a complete configured system, debugged, tested, and operational. Seller shall perform all Work required for programming/configuring the control system, using his standard software and all special configurations required to implement and meet all the functional requirements of this Technical Specification.

A.5.6.4 VIBRATION MONITORING SYSTEM

A.5.6.4.1. The Seller shall furnish a Bently Nevada 3500 monitoring system to provide continuous measurement and monitoring of various turbine-generator supervisory parameters. Additional serial port shall be allocated for Buyer to install Alta communication card.

A.5.6.4.2. Parameters Monitored

A.5.6.4.2.a. As a minimum, the following parameters shall be monitored as outlined below. The intent is to provide alarm and trip monitoring, diagnostic and predictive maintenance information for the combustion turbine-generator.

- Turbine Inlet End Vibration X Relative
- Turbine Inlet End Vibration Y Relative
- Turbine Exhaust End Vibration X Relative
- Turbine Exhaust End Vibration Y Relative
- Generator Turbine End Vibration X Relative
- Generator Turbine End Vibration Y Relative
- Generator Collector End Vibration X Relative
- Generator Collector End Vibration Y Relative
- Collector Bearing X Vibration Relative
- Collector Bearing Y Vibration Relative
- Speed Indication
- Angular displacement (phase angle) between vibration high spots and a fixed reference on the rotor
- Relative axial position of the rotor thrust collar shall be monitored as required in Section A.5.4.11

A.5.6.4.2.b. CTG supervisory system values and alarms will communicate with the CTG control system via hardwired connections. Trips shall be hard wired between each CTG's supervisory system and control system. Vibration values and alarms are to be included in OPC communication link between CTG control system and the Facility DCS for monitoring.

A.5.6.5 PERFORMANCE TESTING INSTRUMENTATION

A.5.6.5.1. Seller shall furnish all instruments and test ports required for performance testing of each CTG and the complete Facility.

A.5.6.6 LOCAL INSTRUMENT PANELS

A.5.6.6.1. Seller shall furnish local instrument stanchions or open racks for indoor and outdoor use. Instrument stanchions or open racks shall be steel and self-standing type.

- A.5.6.6.2. Indicating instruments mounted on local boards shall be mounted on the front of the boards to provide easy access to read these instruments. Other instruments (switches, transmitters, etc.) mounted on the local instrument stanchions or open racks shall be easily accessible for servicing. Test valves, drain valves, and valve manifolds for transmitters shall be furnished and installed for easy access to these valves and manifolds for servicing the instruments.
- A.5.6.6.3. Terminal blocks shall be used for electrical wiring between the inside and outside panel. Bulkhead fittings shall be used for piping and tubing between the inside and outside of the panels.
- A.5.6.6.4. Time Synchronization
- A.5.6.6.4.a. External time synchronization for the plant control systems shall be from a satellite clock signal. The satellite clock signal shall be connected to all microprocessor-based equipment, which generates alarms for use in the DCS. Synchronization is required in order that a true sequence of events can be determined after an event. Each CTG's internal system clock shall keep all CTG subsystems synchronized.
- A.5.6.6.4.b. Seller shall provide an interface to a satellite clock for purposes of time synchronization of CTG. CTG shall be capable of supporting time synchronization via IRIG-B. Seller shall provide a time server, which shall be synchronized with the satellite clock by IRIG-B. The time server shall provide network time protocol and pulse per second outputs for time synchronization of CTG control systems.
- A.5.6.6.4.c. Seller to supply linking generator relays to the time server.
- A.5.6.6.5. NERC/CIP compliance requirement and Cyber-Security (refer to Section A.16.2.5 for further details).
- A.5.6.6.5.a. CTG control system shall follow NERC CIP-005, 006, 007, 009 and 013 to Seller's standard security policy based on NERC standard. If new requirements come up due to change in the NERC standard, impact shall be assessed and discussed between Buyer and Seller to solve the issues.
- A.5.6.6.5.b. Buyer ingress card swipe is required on physical areas that contain cyber assets that can affect megawatts within 15 minutes of the time they are comprised. Seller to provide space allocation. Examples include CT Control Package, etc.
- A.5.6.6.5.c. No interactive remote access is allowed into a plant's control systems. Any process data that flows out of the plant will go through Buyer's data diode protection system, Seller standard equipment may be utilized after detailed review and approval from Buyers in lieu of Buyer's data diode protection system.
- A.5.6.7 INSTRUMENTATION - GENERAL
- A.5.6.7.1. All instrumentation and control devices shall be suitable for the environment where they will be located.

- A.5.6.7.2. Profibus and foundation fieldbus shall not be installed on instruments and valves.
- A.5.6.7.3. Pressure indicators on pump headers shall be provided with snubbers and shall be glycerol filled.
- A.5.6.7.4. Instrument enclosures, if used, shall be provided with a low temperature alarm to notify the Facility operator when a heater fails or heat trace circuit trips. The alarm can be wired into the heat trace panel alarm circuit.
- A.5.6.7.5. In general, where Facility generation is directly reduced upon input failure, two independent measurement inputs shall be provided for process control and for process alarm. Redundant measurements shall have separate tap points for each measurement.
- A.5.6.7.6. Instrument tags shall be stainless steel and either screwed into instrument or attached to instrument by a stainless-steel wire.
- A.5.6.7.7. All instrument tagging shall agree with the approved project tagging procedure and shall be read in English units.
- A.5.6.7.8. Instrument tubing (304 stainless steel) shall not be welded and shall be 1/2 inch minimum in size. Generator may utilize smaller tubing per Major Equipment standard design.
- A.5.6.7.9. Instrument tubing (304 stainless steel) shall be installed in a neat workmanlike manner, properly slopped, and shall not show any signs of crumpling, too short of bend radius, or flattening.
- A.5.6.7.10. Instruments located on the packaged equipment systems shall be furnished, mounted, and installed by Seller.
- A.5.6.7.11. Pressure gauges shall be minimum 4-1/2 inch local mounted, 3-1/2 inch board mounted, and 1-1/2 inch to 2-1/2 inches mounted on air operated control valves.
- A.5.6.7.12. Dual element temperature probes shall be furnished as a minimum.
- A.5.6.7.13. All differential pressure instrumentation shall be supplied with five valve manifolds. Two valve manifolds shall be supplied for all pressure instruments.

END OF SECTION

SECTION A.6
HEAT RECOVERY STEAM GENERATOR (HRSG)

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SECTION A.6

HEAT RECOVERY STEAM GENERATOR (HRSG)

A.6.1 INFORMATION AND SCOPE OF WORK

A.6.1.1 GENERAL

A.6.1.1.1 The Facility will utilize heat recovery steam generators (HRSGs) to recover waste heat from the combustion turbine generators (CTGs) to generate steam, to produce electric power in the steam turbine(s). The Facility will be configured to optimize the number and configuration of CTGs, HRSGs, and steam turbine-generators (STGs). The HRSG(s) shall be designed for operation as shown in Section A.1 - Project Requirements.

A.6.1.1.2 The Seller shall provide each HRSG complete with all required auxiliaries. Hot dipped galvanized outdoor structural steel (excludes main module structural steel) and supports should be fully pre-assembled to the maximum extent possible to allow for shipment to the site. Baseplates for columns shall be shop welded.

A.6.1.1.3 Each HRSG design and construction shall be based on the manufacturer's standard design model, except where specified otherwise herein. Buyer is relying upon Seller's skill, judgment, and ability to furnish equipment suitable and fit for this service.

A.6.1.1.4 HRSGs shall be designed for operation as specified in Section A.1 - Project Requirements.

A.6.1.1.5 Not Used.

A.6.1.1.6 Seller shall provide piping and instrumentation diagrams (P&IDs) and piping isometric drawings (large and small bore) showing all terminal points. Based on this terminal point boundary, Seller shall provide equipment/commodity listing of all furnished materials.

A.6.1.1.7 Seller to provide complete bill of materials. Bill of materials shall include piping material, piping schedule, length of all piping, material specifications, number of valves, type of valves, pressure classification of all valves and fittings, etc.

A.6.1.1.8 Internal sections of the HRSG stacks shall be unprimed and unpainted.

A.6.1.2 HRSG SCOPE OF WORK

A.6.1.2.1 Seller shall design, furnish, manufacture, shop test, and deliver to the Project site:

A.6.1.2.1.a Base scope for delivery shall consist of equipment transportation to the site. The heavy haul from that point of delivery to the power block shall be performed by Seller.

- A.6.1.2.2 All accessories and appurtenances as hereinafter specified include, but are not limited to, the following:
- A.6.1.2.2.a Inlet gas transition duct from each CTG's exhaust to the associated HRSGs. Each CTG's exhaust plenum growth due to thermal expansion shall be accommodated.
 - A.6.1.2.2.b High Pressure (HP) superheater, evaporator, steam drum, and economizer.
 - A.6.1.2.2.c Reheaters and superheaters.
 - A.6.1.2.2.d Intermediate Pressure (IP) superheater, evaporator, steam drum, and economizer.
 - A.6.1.2.2.e Low Pressure (LP) superheater, evaporator, steam drum, and LP economizer.
 - A.6.1.2.2.f Flow accelerated corrosion (FAC) analysis.
 - A.6.1.2.2.g Extraction of water from the IP feedwater system (location to be optimized to achieve fuel gas temperatures required by each CTG for each CTG's fuel gas performance heater).
 - A.6.1.2.2.h Design confirmation of each CTG's outlet expansion joint details with each CTG's exhaust interface.
 - A.6.1.2.2.i Atmospheric blowdown tank with steam quenching capability (including instrumentation and control valves), vent stack, and vent silencer.
 - A.6.1.2.2.j Feedwater control valves.
 - A.6.1.2.2.k Exhaust stack (with silencer if required to meet noise guarantee) complete with emission monitoring ports, access platforms, and ladders.
 - A.6.1.2.2.l Stack damper with electric-motor drive.
 - A.6.1.2.2.m Exhaust stack lighting to meet the Federal Aviation Administration (FAA) regulations. All lighting shall be LED type.
 - A.6.1.2.2.n Superheater and reheater interstage desuperheaters with associated spray control and stop valves to meet the requirement of ASME B31.1.
 - A.6.1.2.2.o Acoustic enclosures, barrier walls, and silencers as required to meet the noise guarantee in the Site Requirements and Design Criteria.
 - A.6.1.2.2.p Dual-function catalyst and selective catalytic reduction (SCR) system designed for removal efficiency needed to achieve emission limits imposed by the air permit and performance guarantees.
 - A.6.1.2.2.q Ammonia control, vaporization, dilution, and injection systems.
 - A.6.1.2.2.r Not Used.

- A.6.1.2.2.s Cranes and hoists as defined herein.
- A.6.1.2.2.t Test ports as defined herein.
- A.6.1.2.2.u Access doors as defined herein.
- A.6.1.2.2.v Gas tight casing, except for weep holes where required, with thermal insulation.
- A.6.1.2.2.w Not Used.
- A.6.1.2.2.x All ASME Section I piping and boundary valves for transition to ASME/ANSI B31.1 piping.
- A.6.1.2.2.y Instrument trim and trim piping.
- A.6.1.2.2.z Shop priming of all items suitable for all extremes of environment.
- A.6.1.2.2.aa Hot dipped galvanized access walkways, platforms, handrail, and stairways for access to each HRSG and steam drums, stack outlet test ports, and all valves in accordance with the Civil/ Structural, Architectural Requirements and Design Criteria.
- A.6.1.2.2.bb Slide bearing assemblies for all non-anchor supports.
- A.6.1.2.2.cc One set of all special tools.
- A.6.1.2.2.dd Shop testing, including functional testing of equipment specified.
- A.6.1.2.2.ee Nitrogen connections on the water/steam side of the steam drums and piping for long term layup of the equipment.
- A.6.1.2.2.ff Steam and water sampling connections.
- A.6.1.2.2.gg Chemical feed connections per manufacturer's standard.
- A.6.1.2.3 Seller shall provide a flow model. The purpose of the CFD model is to determine the exhaust gas flow distribution through the oxidation catalyst spool piece, ammonia injection grid (AIG), and dual-function catalyst.
- A.6.1.2.4 Not Used.
- A.6.1.2.5 Seller shall provide documentation and data to Buyer, including but not limited to, the following:
 - A.6.1.2.5.a QA/QC Program.
 - A.6.1.2.5.b QA/QC maintenance procedures.
 - A.6.1.2.5.c All drawings, including as-built drawings; these drawings shall include, in addition to the drawings listed in the Project Requirements, the following:

- A.6.1.2.5.c.1 Piping and Instrument Diagrams. See Section A.10.31.11.
- A.6.1.2.5.c.2 Piping line, specials lists, and valve lists provided in Excel and PDF formats.
- A.6.1.2.5.c.3 System descriptions.
- A.6.1.2.5.c.4 General arrangement drawings of plan and two side elevations of each HRSG and its major equipment.
- A.6.1.2.5.c.5 Drawings of major components and subassemblies. All Seller's subcontractors' drawings received by Seller, including module dimensional drawings, shall be provided to Buyer.
- A.6.1.2.5.c.6 Welding procedures, including construction code definition for field welding.
- A.6.1.2.5.c.7 Erection drawings and procedures.
- A.6.1.2.5.c.8 Certificates of Completion, including checklists to confirm that the installation is fully complete.
- A.6.1.2.5.c.9 Commissioning procedures.
- A.6.1.2.5.c.10 Control systems description and logic diagrams associated with each HRSG system.
- A.6.1.2.5.c.11 Instrument list and I/O list provided in Excel and PDF formats.
- A.6.1.2.5.c.12 Electrical control schematic and wiring diagrams for all major equipment.
- A.6.1.2.5.c.13 Insulation anchors, liners, and insulation details for each HRSG.
- A.6.1.2.5.c.14 Structural steel arrangement drawings.
- A.6.1.2.5.c.15 Ductwork arrangement including insulation and supports.
- A.6.1.2.5.c.16 Interface details between each CTG and the associated HRSG's exhaust duct.
- A.6.1.2.5.c.17 Expansion joints.
- A.6.1.2.5.c.18 Piping arrangement drawings, including overall dimensions, material specifications, wall thickness, and spool piece information.
- A.6.1.2.5.c.19 Module arrangement drawings.
- A.6.1.2.5.c.20 Ladders, platforms, and access doors.
- A.6.1.2.5.c.21 Arrangement drawing for the SCR system section showing the catalyst module arrangement and structural support.
- A.6.1.2.5.c.22 Arrangement drawings with dimensions of the AIG.
- A.6.1.2.5.c.23 Arrangement drawings of test port locations and dimensions.

- A.6.1.2.5.c.24 Safety valve drawings.
- A.6.1.2.5.c.25 Instrument installation details, instrumentation location drawings, and instrument datasheets.
- A.6.1.2.5.c.26 Operation and maintenance manuals (draft and final).
- A.6.1.2.5.c.27 Steam drum sizing basis, including calculations, assumptions, capacity, and level setpoints.
- A.6.1.2.5.c.28 Seller shall provide spare parts as follows:
- Installation, startup, testing, and commissioning spares through Substantial Completion.
 - Priced listing of recommended operational spares to support one (1) year of operation.
 - Spare dual-function catalyst replacement coupons.
 - Spare alloy tubing, requiring alloy mil certs (2 sticks 20-foot length each). Buyer to indicate requested alloy (e.g., T11, T22, or T91) and geometry (e.g., diameter / wall thickness) prior to Seller's purchase of HRSG tubing.
- A.6.1.2.6 HRSG Performance Curves and Data
- A.6.1.2.6.a The following performance correction curves (or software program) shall be provided:
- A.6.1.2.6.a.1 HP steam outlet pressure and temperature correction curve.
- A.6.1.2.6.a.2 HP steam outlet flow correction curve.
- A.6.1.2.6.a.3 Hot reheat steam outlet pressure/temperature correction curve.
- A.6.1.2.6.a.4 Hot reheat steam outlet flow correction curve.
- A.6.1.2.6.a.5 Cold reheat steam inlet pressure and temperature correction curve.
- A.6.1.2.6.a.6 Cold reheat steam inlet flow correction curve.
- A.6.1.2.6.a.7 IP steam outlet pressure and temperature correction curve.
- A.6.1.2.6.a.8 IP steam outlet flow correction curve.
- A.6.1.2.6.a.9 LP steam outlet pressure and temperature correction curve.
- A.6.1.2.6.a.10 LP steam outlet flow correction curve.
- A.6.1.2.6.a.11 HP steam desuperheater flow correction curve (interstage and final/exit stage).

- A.6.1.2.6.a.12 Hot reheat steam desuperheater flow correction curve (interstage and final/exit stage).
- A.6.1.2.6.b Steam mass flow, pressure, and temperature steady state data for the HP, IP, and the LP sections and spray water over the specified ambient temperature and normal operating CTG load ranges.
- A.6.1.2.6.c Gas flow, temperature, and pressure data for the following sections over the specified ambient temperature and normal operating CTG load ranges:
 - A.6.1.2.6.c.1 Inlet to each HRSG.
 - A.6.1.2.6.c.2 Inlet to the Oxidation Catalyst Spool.
 - A.6.1.2.6.c.3 Inlet to the AIG.
 - A.6.1.2.6.c.4 Inlet to the Dual-Function Catalyst.
 - A.6.1.2.6.c.5 Inlet to the HP Section.
 - A.6.1.2.6.c.6 Outlet of the HP Section.
 - A.6.1.2.6.c.7 Inlet of the IP Section.
 - A.6.1.2.6.c.8 Outlet of the IP Section.
 - A.6.1.2.6.c.9 Inlet of the LP Section.
 - A.6.1.2.6.c.10 Outlet of the LP Section.
 - A.6.1.2.6.c.11 Inlet of the Economizer Sections.
 - A.6.1.2.6.c.12 Outlet of each HRSG.
- A.6.1.2.6.d For operating conditions that are different from Guaranteed Design Conditions, Seller shall supply Buyer-certified PC compatible software or performance curves and correction factors to cover the intended range of Project site conditions and combustion turbine load conditions, including but not limited to, combustion turbine exhaust energy output and temperature, atmospheric pressure, and the effects of variations in fuel properties.
- A.6.1.3 OPTIONAL SCOPE OF WORK
 - A.6.1.3.1 Not Used.
- A.6.1.4 EMISSIONS PERFORMANCE CURVES
 - A.6.1.4.1 Stack emission values for each HRSG's performance cases shall also be provided. Each HRSG's performance cases shall include the maximum and minimum ambient temperatures and selected intermediate ambient temperatures with each CTG at 100%

load and at the minimum emissions compliance load (MECL). Curves as follow shall be submitted:

- A.6.1.4.1.a NO_x Reduction (%) vs. Temperature (°F).
- A.6.1.4.1.b NO_x Reduction (%) vs. Flue Gas Flow Rate (acfm or lb/hr).
- A.6.1.4.1.c Not Used.
- A.6.1.4.1.d Not Used.
- A.6.1.4.1.e CO Reduction (%) vs. Temperature (°F).
- A.6.1.4.1.f CO Reduction (%) vs. Flue Gas Flow Rate (acfm or lb/hr).
- A.6.1.4.1.g Not Used.
- A.6.1.4.1.h VOC Reduction (%) vs. Temperature (°F).
- A.6.1.4.1.i VOC Reduction (%) vs. Flue Gas Flow Rate (acfm or lb/hr).
- A.6.1.4.1.j Not Used.
- A.6.1.4.1.k Pressure drop across dual-function catalyst system, including ammonia grid, static mixers, and catalyst layer versus flow rate. Curve shall take into consideration the effects of particulate accumulation and other potential deposits on the catalyst.
- A.6.1.4.1.l Not Used.
- A.6.1.4.1.m Not Used.
- A.6.1.4.1.n SO₂ to SO₃ oxidation with respect to temperature for the dual-function catalyst.
- A.6.1.4.1.o Not Used.
- A.6.1.4.1.p Formaldehyde Reduction (%) vs. Temperature (°F).

A.6.2 HRSG DESIGN CRITERIA AND OPERATING CONDITIONS

A.6.2.1 HRSG MINIMUM DESIGN REQUIREMENTS

Equipment Identification Heat Recovery Steam Generator
Gas Flow Horizontal
Circulation Type Natural
Pressure Levels 3
Configuration Reheat
Operation Mode ☐ Constant Pressure ☒ Sliding Pressure ☒ Hybrid
Stack Damper with operator Yes
Duct Burners Yes
Support Top

Steam Bypass System Yes

A.6.2.2 OTHER HRSG REQUIREMENTS

A.6.2.2.1 A FAC analysis shall be conducted by Seller to identify high velocity and two-phase flow areas and provide low chrome alloys, minimum Grade 11, in these areas to avoid two-phase FAC. In flashing or cavitation areas, Grade 22 minimum material shall be used. In general, low alloy (1 ¼ Cr ½ Mo) materials should be used in the economizer tube bends at the inlet and outlet headers, in the LP drum internal components, and in the LP evaporator tubes, especially in and near bends near headers. Seller shall refer to HRSG Cycle Chemistry Guidelines (EPRI Report 1010438 dated March 2006) when performing the analysis.

A.6.2.2.2 Each HRSG shall be furnished with a complete and operable emissions control system to control CO, VOC, and NO_x emissions generated by the combustion turbine(s) between all loads from MECL to 100% load. HRSG stack emissions shall meet the Emissions Performance Guarantees as defined in Section A.1- Project Requirements. Seller shall be responsible for design and equipment SCR reactor and dual-function catalyst in full accordance with Project Requirements. Operating and maintenance procedures established for this equipment should also be developed in full accordance with all applicable Laws.

A.6.2.2.2.a The CO/VOC catalyst and SCR system shall be considered an integral part of each HRSG. Design, fabrication, inspection, and testing of this equipment shall be in accordance with the requirements of this specification.

A.6.2.2.3 A 25° F margin shall be provided between the design tube metal temperature and the highest predicted tube metal temperature.

A.6.2.2.4 During hot restarts of each STG, a steam bypass to the associated turbine exhaust steam heat rejection system shall be supplied to provide system warm-up capabilities to meet the STG roll permissive.

A.6.2.2.5 Shop hydrostatic testing of all HRSG drums shall be included in Seller scope of work.

A.6.2.2.6 Any temporary shipping supports of each HRSG shall be optimized for quick and easy removal in the field (during erection).

A.6.3 GUARANTEES

A.6.3.1 PERFORMANCE GUARANTEES

A.6.3.2 REFER TO SECTION A.1 - PROJECT REQUIREMENTS FOR PERFORMANCE GUARANTEES.

A.6.4 HRSG DESIGN REQUIREMENTS

A.6.4.1 GENERAL DESIGN REQUIREMENTS

- A.6.4.1.1 Each HRSG unit, including piping and appurtenances integral therewith, shall be designed, fabricated, inspected, certified, and stamped in accordance with the applicable requirements of the ASME Boiler and Pressure Vessel Code (Code) and shall comply with all applicable Laws. The manufacturer of each HRSG unit shall provide proper Code certification that all Work performed by them or Seller responsible to them complies with all requirements of the Code, including design, construction, materials, and workmanship.
- A.6.4.1.2 Electrical equipment shall be in accordance with the National Electrical Code (NFPA 70) as well as local and state ordinances.
- A.6.4.1.3 HRSG(s) shall be designed in accordance with NFPA 850 and NFPA 85.
- A.6.4.1.4 Each HRSG unit shall have a design life of 30 years of operation without distress due to cycling loads.
- A.6.4.1.5 OSHA1910 Federal Standards, General Industry Safety Orders, codes, regulations and the Civil/ Structural, Architectural Requirements, Section A.14 and Design Criteria, Section A.9 shall apply for platforms, ladders, handrails, etc.
- A.6.4.1.6 Each HRSG and its appurtenances, including stacks, ductwork, piping, platforms, and stairs, shall be designed for the site design data as specified in the Site Requirements and Design Criteria.
- A.6.4.1.7 Each HRSG's outlet stack shall be designed in accordance with the Site Requirements and Design Criteria and ASME STS-1, Steel Stacks.
- A.6.4.1.8 Access platforms, stairs, ladders, and railings shall conform to OSHA; local code requirements; and the Civil/Structural, Architectural Requirements and Design Criteria. Platforms and galleries shall be grating and shall be designed for dead load, applicable utility supports plus minimum design live load of 100 lb/ft².
- A.6.4.1.9 Each HRSG's steel structure, platforms, stairs, and associated components shall be designed in accordance with AISC 360, Specification for Structural Steel Buildings, and AISC 341, Seismic Provisions for Structural Steel Buildings.
- A.6.4.1.10 Seller shall provide the material certification documentation for all materials used in pressure parts of each HRSG.
- A.6.4.1.11 Each HRSG's outer casing shall be carbon steel. Insulation shall be installed internally and covered with carbon steel and stainless steel lining. Support columns shall be shop-welded to the outer casing.
- A.6.4.1.12 Lower tube headers in different services shall be physically separated; divider plates shall not be used in this application.
- A.6.4.1.13 Requirements provided in Section A.10 - Mechanical Requirements and Design Criteria for numbering and labeling shall apply to the Seller's supply of the HRSG, electrical and control panels, electric motors, pumps, heat exchangers, instrumentation requiring

interface connections with wiring by Seller, instrumentation wired directly into the Facility DCS, and valves. OEM IDs/tags must include unit and system designations.

A.6.4.2 PIPING

A.6.4.2.1 Piping materials, fabrication, and erection shall be in accordance with ANSI B31.1 “Power Piping” except as noted otherwise herein. All piping shall be seamless except as noted in Section A.10.30.3.

A.6.4.2.2 Aqueous ammonia piping shall be stainless steel.

A.6.4.2.3 Vaporized ammonia piping shall be stainless steel.

A.6.4.2.4 Equipment, piping, and instrumentation shall be provided with freeze protection (heat tracing and insulation), in compliance with the Mechanical Requirements and Design Criteria.

A.6.4.2.5 All components subject to freezing shall be freeze protected with electric heat tracing cable. Drum end enclosures shall be provided to enclose one end of each drum. Design and layout spacing of piping and instrumentation shall provide sufficient space to accommodate insulation and lagging of adjacent components. It shall not be presumed that multiple components, such as piping or instruments, can be grouped together to share insulation.

A.6.4.2.6 Identify piping, valves, tanks, system etc., which require freeze protection and required temperature to be maintained above ambient. P&IDs shall indicate the above requirements including recommended temperatures to be maintained. Any components requiring freeze protection shall be clearly indicated as such on the respective drawings (including Seller and Seller’s subcontractor drawings and engineering lists), with adequate detail for procurement, construction and erection of heat tracing and insulation materials.

A.6.4.2.7 Positive material identification per ASME code requirements shall be maintained and submitted, as requested by Buyer, for all alloy pipe. Seller shall keep the alloy pipe material identification and records for P91 field and shop welds on file for three (3) years or submit it to Buyer, including NDE requirement to provide testing points for hardness post heat treat in four (4) quadrants with points specifically on base metal, heat affected zones, weld metal.

A.6.4.2.8 Access Facilities

A.6.4.2.8.a Each HRSG shall have a minimum of five (5) feet of clearance underneath the bottom casing to allow drain piping to be sloped and provide maintenance access.

A.6.4.2.8.b Special attention shall be given to the spacing and arrangement of tubes and to providing doors, handholes, and such other facilities necessary for access to headers and for inspection and maintenance purposes. In lieu of handholes in the headers, sufficient boroscope access shall be provided. The minimum space of the cavity in the direction of gas flow shall be a minimum of 24-inches between heat transfer sections.

- A.6.4.2.8.c Seller shall provide hinged or davit arm access and inspection doors for both sides of all parts of the HRSG(s) and upstream and downstream of each heating transfer section, ductwork, flues, and other equipment. The minimum size of the doors shall be 18 inches wide by 24 inches high. Doors shall be designed for tightness and easy operation. Where necessary, doors shall be provided with latches to hold doors open for inspection, access, or cleaning. Doors shall be provided with linings for thermal insulation, where necessary. Doors shall be designed to anchor and hold the linings in place. Doors shall be insulated with a gasketed seal to the casing. A stanchion or other suitable device shall be provided for attachment to the Buyer's "sky-climber" for inspection of all heat transfer surfaces. Caged ladders, platforms and guard rails shall be provided for easy, safe access to all door located more than 10 feet above grade.
- A.6.4.2.8.d Wherever practical, valves and instruments shall be located such that they can be operated and easily accessed from grade. Platform access with stairs or ladders shall be provided to all test ports and metering points that are not readily accessible from grade. Where valves and instruments normally requiring operator access must be located in elevated locations, access platforms, handrails, ladders, and gauges shall be provided.
- A.6.4.2.8.e Minimum clearance over walkways platforms, and exit routes shall be 7 feet, 6 inches (90 inches) measured from the surface to the bottom of any overhead obstruction. All working surfaces shall comply with OSHA standards. Vertical clearance above any stair tread to any overhead obstruction shall be at least 6 feet, 8 inches, as measured from the leading edge of the tread. Spiral stairs must meet the vertical clearance requirements in paragraph (d)(3) of OSHA Standard 1910.25
- A.6.5 HRSG OPERATING PARAMETERS
- A.6.5.1 GENERAL OPERATING PARAMETERS
- A.6.5.1.1 Each HRSG shall be suitable for operation at all loads from startup to the rated steam generating capacity. The turndown ratio and rate of load change of each HRSG shall be compatible with each combustion turbine. Each HRSG shall be designed for cycling operation and baseload operation. Each HRSG shall be subject to numerous thermal transients during their lifetime. Seller shall take into account the damaging aspects of these thermal transients in the design of the HRSG(s). The HRSG(s) shall be designed for the number of starts as defined in A.1.2.3.5.a. Refer to the Construction Requirements for additional details regarding operating parameter requirements.
- A.6.5.2 EXPANSION JOINTS
- A.6.5.2.1 Seller shall provide expansion joints as required for the design of the ductwork, each HRSG, and stack.
- A.6.5.2.2 Expansion joints shall be suitable for use at temperature 200° F above flue gas temperature.
- A.6.5.2.3 Metallic expansion joints shall be designed for a service of 10 years of operation without distress due to cycling loads. Metallic bellows shall be used for all piping penetrations in the roof and floor panels. Fabric expansion joints may be used for piping penetrations in

the roof and floor panels when movements exceed the capabilities of commercially available metallic expansion joints. The expansion joint between each CTG's outlet duct and the associated HRSG's inlet duct and the expansion joint between each HRSG's exit and the associated breech duct shall be a heavy duty, fabric type joint.

A.6.5.3 DUCTWORK

A.6.5.3.1 General Ductwork Design Requirements

- A.6.5.3.1.a Duct design shall be such that the velocity of gas or air will not be excessive. Abrupt turns shall be avoided except where required to meet each HRSG and catalyst Seller's subcontractor's requirements; distribution devices shall be provided. Internal design pressure of the ducts shall be not less than 25-inch water gauge, and no visible distortion of the ducts under this pressure exceeding the deflection allowed by the AISC code used for the duct design will be permitted.
- A.6.5.3.1.b Each HRSG shall include the exhaust duct from the associated combustion turbine exhaust to the HRSG inlet (excluding expansion joint). The inlet transition ductwork shall not exceed a 51° degree angle of inclination for single slope designs, for the initial slope on compound angle designs. Seller shall advise Buyer otherwise if this design differs from their standard offering.
- A.6.5.3.1.c The stainless steel covering system shall consist of suitable insulation for HRSG design (ceramic fiber insulation is not acceptable) and an interior stainless steel liner. Insulation shall be retained to prevent packing. The liner shall be retained in such a manner as to prevent detrimental movement perpendicular to the duct and to allow axial thermal expansion and contraction. Provisions at overlaps shall be provided to prevent the liner from buckling or being lifted by gas flow velocities in the duct. Insulation thickness shall be selected to maintain an average external casing temperature of no more than 140° F during summer design ambient conditions with still air (3 mph wind speed). Insulation and liner on horizontal and semi-horizontal surfaces shall be designed to accommodate a concentrated load of 250-pound personnel walking load without damage to insulation and liner.
- A.6.5.3.1.d Insulation material shall be of proven design by Seller. Seller shall ensure that insulation material is suited for the application being specified for this scope of supply.
- A.6.5.3.1.e Ducts shall be of gas-tight welded construction, properly stiffened and reinforced to prevent buckling and vibration. Construction shall be welded steel plate with full penetration welds. Partial penetration welds are acceptable as long as the weld strength is not less than the base material strength. Ductwork plate shall be a minimum of 0.25-inch (6 mm) thickness A36 carbon steel. All ductwork is to be reinforced with external structural steel stiffeners. Stiffeners shall be welded to the ducts with full seal welds to prevent corrosion in the area between duct and stiffener. Access doors shall be provided to permit entry into the ductwork. Doors shall be lined with insulation and shall be pressure tight.

A.6.5.4 HRSG OUTLET STACK

- A.6.5.4.1 The exhaust stack shall be a self-supporting carbon steel stack, with emission testing ports, damper, platforms, caged ladder, personnel protection, access doors, drain connections, and a stack silencer (if required to meet noise requirement).
- A.6.5.4.2 The stack exit velocity shall be within the range identified in the Emissions Requirements. Stack design temperature shall encompass all expected normal operating and upset conditions. Stack shall be made of ASTM A36 carbon steel with a corrosion allowance of 1/16-inch on the plate material incorporated in the stack design.
- A.6.5.4.3 Stack shall include a 2-foot by 2-foot access door at the base of the stack above the false bottom and a 2-foot by 2-foot access door below the false bottom. Drain piping for the stack shall include a water seal external to the stack and all piping shall be 2-inch Sch. 80 stainless steel minimum.
- A.6.5.4.4 Insulation thickness/lagging shall be selected based on personnel protection requirements at base of stack, at ladders, at platform elevations, and all locations where personnel may access.
- A.6.5.4.5 Stack design shall include provisions for a painter's trolley for stack damper maintenance and a lifting arm to facilitate lifting of CEMs test probes and temporary emissions testing equipment up to the platform elevation.
- A.6.5.4.6 Stack shall include proper openings for sampling flue gas per the US EPA specifications. A 5-foot support beam shall be provided above the port locations to support test equipment. The stack shall also include the proper CEMS ports for measuring compliance with the air permit.
- A.6.5.4.7 Stack design shall include a platform located at the sample port and CEMS port level, with proper ladder access to provide safe access to platform while carrying equipment.
- A.6.5.4.8 Each HRSG stack shall be equipped with a stack beacon lighting system in accordance with FAA Advisory Circular 70/7460-1K, "Obstruction Marking and Lighting." Lighting shall be LED type.

A.6.5.5 STACK DAMPER

- A.6.5.5.1 HRSG design shall include an automatic, motorized, corrosion resistant stack damper to minimize draft cooling during shutdown.
- A.6.5.5.2 Each stack damper shall be a multi-blade louver type, actuated by a single AC motor-operator located external to the gas stream.
- A.6.5.5.3 The motor operator shall be furnished with shaft mounted limit switches. A mechanical linkage type local position indicator or observation window shall be provided to confirm damper position.

- A.6.5.5.4 The damper linkage and one of the damper blades shall be configured to automatically open, should the CTGs be started before the damper reaches the fully open position.
- A.6.5.6 CASING, INSULATION, AND LINER
- A.6.5.6.1 Each HRSG's inlet duct and boiler walls shall be of a "cold frame" type of construction, with an exterior gastight carbon steel casing, internal insulation, and a steel floating liner. The outlet duct shall be designed for external insulation and lagging.
- A.6.5.6.2 All duct and casing shall be designed to provide suitable drainage. Horizontal surfaces shall be provided with a means to remove rainwater other than evaporation to ensure runoff of rainwater. Stiffeners shall be designed in such a manner as not to impede rainwater runoff.
- A.6.5.6.3 Exterior casing shall be welded steel plate to provide a gastight construction. Casing shall be welded with full penetration welds properly stiffened and reinforced to prevent buckling and detrimental vibration, designed to withstand a pressure equal to maximum turbine exhaust static pressure. Partial penetration welds are acceptable as long as the weld strength is not less than the base material strength. Stiffeners shall be shop-welded to the casing with continuous welds to prevent corrosion in the area between duct and stiffener. Exterior casing plate shall be a minimum of 0.25-inch thickness ASTM A36 carbon steel.
- A.6.5.6.4 The outer casing shall have access doors and provisions for test connections. Access doors shall be provided to permit entry into each section of the ductwork. Doors shall be lined with insulation and shall be pressure tight. Emission test ports in the inlet duct (minimum four (4) per side) shall be 4-inch minimum diameter. Performance and emission test ports shall be adequate for performance testing according to ASME PTC 4.4 and for emission testing per EPA Reference Method 40 CFR Part 60.
- A.6.5.6.5 Internal gas path liner shall be stainless steel in accordance with the table below.

Max. Gas Temperature °F	Material
Below 750	Carbon Steel
750-1200	SA240 S40910
1201-1400	SA240 S30409
1401-1600	SA240 S30909

- A.6.5.6.6 Transition ductwork internal gas path liner shall be a 12-gauge (3 mm) minimum thickness for floor, sides, and roof. Each HRSG's liner shall be 12-gauge (3 mm) minimum thickness for floor panels and minimum of 16-gauge (1.5 mm) thickness for sidewalls and roof. Liner seams shall overlap in the direction of gas flow to prevent lifting and exhaust gas permeation into the insulation. Liner shall be connected by 3/8 inch minimum diameter studs to the exterior casing and insulation with a welded nut or retention clip to the stud, which will allow free expansion of the liners. Stud spacing for internal gas temperatures over 700° F shall not exceed 12 inches (or manufacturer's standard); 18-inch spacing (or manufacturer's standard) may be used in the cooler zones. The stud material shall be equal to or greater than the liner material and shall be

connected to the duct or HRSG's casing by welding. Stainless steel washers or batten channels on both sides of the liner will be placed under the nut or retention clip to seal the gap between the liner and the stud.

A.6.5.7 TUBE BANKS

A.6.5.7.1 All heat transfer sections shall be of modular design.

A.6.5.7.2 Each section shall be vertically oriented and capable of fully self-draining and venting.

A.6.5.7.3 Lower headers shall be furnished with 2-inch minimum drain pipe connections.

A.6.5.7.4 Tubes shall be arranged with a rectangular or triangular pitch to maximize heat transfer. If triangular pitch is used, ensure diagonal lanes are maintained to allow efficient cleaning.

A.6.5.7.5 Each HRSG's tubing heat exchange surface that is finned shall have fins no higher than $\frac{3}{4}$ inch and shall have a fin spacing no more than eight (8) fins per inch of tube length. The tube fin thickness shall be a minimum of 0.031 inch (0.8 mm). Fins shall be attached to the tubes using a continuous high frequency electrical resistance welding technique.

A.6.5.7.6 Tube banks adjacent to the SCR system and CO catalyst spool piece shall be a sufficient distance from the reactors such that cleaning the tubes will not negatively impact the surface of the catalysts.

A.6.5.7.7 Material/Welds

A.6.5.7.7.a All headers, tubing, and connecting pipe subject to steam/water temperatures from 212° F to 460° F that are in liquid service or liquid/steam two-phase service shall be P11/T11.

A.6.5.7.7.b The basis of the low temperature economizer (LTE) design will be for 0.25 gr/100 SCF total sulfur. Short term higher sulfur content (up to 5 gr/100 SCF total sulfur) will result in increased corrosion in the LTE.

A.6.5.7.8 LP economizers and/or condensate heaters prior to the stack shall be made of a carbon steel material. A recirculation system shall be provided to raise the inlet condensate temperature to 140° F to prevent condensation from forming on the first tube rows of the economizer and also to prevent the exhaust gas temperature from falling below acid dew point. The economizer temperature shall be controlled using an external heat exchanger arrangement instead of a recirculation pump system.

A.6.5.7.9 Full penetration welds shall be used to join the HP superheater and reheater tubes to headers. Other tube to header welds shall be stick through, which is considered a full-strength weld by the ASME Code. Tube to header joints shall be designed for cyclic service.

A.6.5.8 EVAPORATORS

A.6.5.8.1 The evaporator section shall be a natural circulation design without the need for assisted circulation devices at any load. The IP and LP evaporator systems shall be designed with

a minimum circulation ratio of 8 to 1. The HP evaporator system shall be designed with a minimum circulation ratio of 4 to 1. The entire evaporator section, including the steam drum, shall be designed to generate dry saturated steam. At least one drain with double block valves shall be provided on the evaporator section headers. The evaporator shall be designed fully drainable and of all welded construction. An intermittent blowdown system shall be provided and be capable of reducing steam drum swell during startup.

A.6.5.8.2 The LP Evaporator header shall be constructed of P11 alloy material.

A.6.5.9 SUPERHEATERS/REHEATERS

A.6.5.9.1 Superheater/reheater design and location shall prevent wide fluctuations in steam temperature over the entire load range of the HRSG(s) and to ensure proper cooling of tube metal and distribution of steam over the tube and header elements during startup, shutdown, and operation at all loads. Superheater and reheaters shall include the proper coil pressure drops and header sizing to ensure that the tube to tube steam flow maldistribution shall not exceed 10%.

A.6.5.9.2 Superheater/reheater design shall be protected by a code overpressure device of not less than 115% of the calculated maximum required relieving flow.

A.6.5.9.3 Superheaters/reheaters shall be fully drainable. Drains shall be designed to allow remote operation during cold starts, hot starts, and shutdown operation. Headers and interconnecting piping shall be routed to prevent low points and piping shall be sloped where required to drain all condensate during startups. All low points shall include a drain of sufficient size to remove condensate and prevent pooling in the lower header and tubes.

A.6.5.9.4 Superheaters shall be of all welded construction with tube to header attachments per applicable ASME requirements using full penetration welds. Superheater outlet nozzles shall be located on top of the HRSG(s) and shall be butt-weld end located a minimum of 3 feet (1 meter) exterior to the casing. Outlet headers shall have a convenient access, such as a plug or nozzle that can be used for boroscope inspection, provided to allow internal inspection for fatigue cracks during maintenance outages.

A.6.5.9.5 A motor operated vent valve shall be provided to allow purging of the superheaters of gases and non-condensables during startups. The vent line shall be connected to an exhaust silencer.

A.6.5.9.6 Each superheater main steam outlet shall have a stop valve. The valve shall be a parallel disc gate valve of the outside-screw-and-yoke rising-stem type so as to indicate from a distance by position of its stem whether it is closed or open, and the wheel may be carried either on the yoke or attached to the stem. The valve shall be motor operated to allow bottling up the HRSG(s) during shutdowns. The valve shall meet the requirements of MSS SP-61. The valve body shall have a drain connection on the upstream side connected to the boiler drain system and a bypass valve around per MSS SP-45.

A.6.5.9.7 Not Used.

- A.6.5.9.8 The 100% bypass system shall be primarily used for starting up and tripping the STG(s) but shall be capable of continuously operating. For startup, the bypass system will be modulated and the HRSG startup vents will be opened to atmosphere, if necessary.
- A.6.5.9.9 Start-up vent valves shall be designed as follows: HP and IP/RH based upon 30% of flow (MCR [maximum continuous rate]) at 30% pressure and LP for 100% flow at 100% pressure.
- A.6.5.10 DESUPERHEATERS
- A.6.5.10.1 The HP superheaters and reheater shall have interstage and final (exit) stage desuperheaters for temperature control. Desuperheaters utilizing spray water shall be supplied from the feedwater pump discharge.
- A.6.5.10.2 Superheater exit temperature shall be maintained throughout the load range of the steam generator. The desuperheater location within the superheat surface shall be designed so that overspray is not required to maintain superheater exit temperature. The steam temperature downstream of the desuperheater shall maintain at least 18°F superheat at all times under all steady-state combustion turbine loads.
- A.6.5.10.3 Seller shall provide complete design details for location of the final (exit) stage desuperheaters.
- A.6.5.10.4 Seller shall furnish interstage and final (exit) stage desuperheaters with spray water control valves, shutoff valves (ball valve), flow elements, check valves, and strainer. Pipe downstream of the desuperheaters shall include a thermal sleeve in lieu of a 0.060-inch corrosion/erosion allowance. Pipe downstream of the desuperheaters shall be straight for at least 15 pipe diameters, or per desuperheater manufacturer's requirements.
- A.6.5.10.5 Seller shall provide all controls and instrumentation details necessary to fully control and monitor all of the desuperheaters. This includes control logic that is to be implemented for the overall project.
- A.6.5.11 ECONOMIZERS
- A.6.5.11.1 All economizers shall be designed for the entire operating range of the combustion turbine(s) and HRSG(s).
- A.6.5.11.2 The inlet to the first stage of each economizer shall be a single pipe connection provided with a check valve and motor operated stop valve.
- A.6.5.11.3 Economizers that have the feedwater control valve located between the economizer exit and the steam drum inlet shall be provided with relief valves per code.
- A.6.5.11.4 LP Economizer (condensate heater): The exhaust gas temperature leaving the economizer prior to the stack shall be above the 160° F (minimum) temperature (to be determined based on the site-specific fuel) when operating on natural gas to avoid acid dew point corrosion. The Seller shall determine the minimum temperature based on the worst-case sulfur content of the site-specific natural gas fuel.

- A.6.5.11.5 LP economizers and/or condensate heaters prior to the stack shall be made of a carbon steel material or as required per Section A.6.5.7.7.a. A recirculation system shall be provided to raise the inlet condensate temperature to 140°F to prevent condensation from forming on the first tube rows of the economizer and also to prevent the exhaust gas temperature from falling below the acid dew point. The economizer temperature shall be controlled using an external heat exchanger arrangement instead of a recirculation pump system.
- A.6.5.11.6 Steam Drums
- A.6.5.11.6.a Steam drums shall contain the following minimum connections (all redundant components, including instruments, shall have dedicated drum connection):
- A.6.5.11.6.b Feedwater Inlet/Outlet.
- A.6.5.11.6.c Downcomer Connections.
- A.6.5.11.6.d Riser Connections.
- A.6.5.11.6.e Steam Outlet.
- A.6.5.11.6.f Drum Vent.
- A.6.5.11.6.g Safety Valves.
- A.6.5.11.6.h Continuous Blowdown (HP and IP).
- A.6.5.11.6.i Intermittent blowdown
- A.6.5.11.6.j Chemical Feed Inlet, if manufacturer's standard.
- A.6.5.11.6.k Nitrogen.
- A.6.5.11.6.l Pressure Gauge.
- A.6.5.11.6.m Pressure Transmitters (3 Sets/Drum).
- A.6.5.11.6.n Level Gauges (2 Sets/Drum).
- A.6.5.11.6.o Level Transmitters (3 Sets/Drum).
- A.6.5.11.6.p Feedwater pump connection for suction (LP Drum only).
- A.6.5.11.6.q Drums shall include a 1/16-inch corrosion allowance.
- A.6.5.11.6.r Drums shall include two elliptical manholes per steam drum (one on each end) having a minimum size of 14 inches (356 mm) x 18 inches (457 mm). The manhole cover shall be of the pressure seal design in that the internal pressure holds the cover firmly in position. The manhole shall be hinged to open inwards and shall be capable of being disconnected from the hinges and removed through the manhole.

- A.6.5.11.6.s The steam drums shall have shop installed steam separators of sufficient size and capacity to limit moisture carryover to the superheater for the full range of operation conditions. Carryover shall be per the recommendations of the American Boiler Manufacturers Association (ABMA).
- A.6.5.11.6.t All steam drum downcomers shall have vortex breakers.
- A.6.5.11.6.u Not Used.
- A.6.5.12 STEAM DRUM SIZING
- A.6.5.12.1 Steam drums shall be sized on the most stringent of the following criteria, whichever is greater. The storage volume shall be from the NWL to the low-low alarm level.
- A.6.5.12.1.a For an LP drum providing flow to a boiler feed pump, a minimum of five (5) minute storage at unfired design conditions. Low level water alarm shall be placed to provide a minimum retention time of two (2) minutes between the low alarm and low-low water level trip.
- A.6.5.12.1.b IP drum per Seller 's standard. Minimum four (4) minute storage at unfired design conditions. Low level water alarm shall provide a minimum retention time for the IP drum of one (1) minute between the low alarm and low-low water level trip.
- A.6.5.12.1.c HP drum per Seller's standard. Minimum two (2) minute storage at unfired design conditions. Low level water alarm shall provide a minimum retention time for the HP drum of one (1) minute between the low alarm and low-low water level trip.
- A.6.5.12.2 Steam drums shall be sized and designed to accommodate cycling, both up and down on load repeatedly throughout the load range, without a drum level trip.
- A.6.5.13 BOILER DRAINS
- A.6.5.13.1 General Boiler Drain Requirements
- A.6.5.13.1.a Seller shall provide a system of drain internal and external piping to allow all steam and water passages to be completely drainable and to drain condensate during startup and shutdown of the HRSG(s). Drain piping shall be routed to the east side of the HRSG(s). Piping shall not be discharged to grade. Boiler drains shall be given a service classification of "operational," "startup," or "maintenance."
- A.6.5.13.1.b Expansion bends or loops shall be provided where required for thermal expansion.
- A.6.5.13.2 Operational Drains
- A.6.5.13.2.a Operational drains are defined as any drain that is required to be used during the startup, operation, shutdown, or hot restarts of the HRSG(s), and may include superheater drains, continuous blowdown, and intermittent blowdown. The valves associated with operational drains shall be metal seated ball valves with motor (open/close operation only) for remote control. Intermittent blowdown valves shall have position transmitters and motor operators with jogging capability.

- A.6.5.13.2.b Drain lines shall be grouped together in common pressure service, HP, IP, and LP. Drain lines from multiple tube rows shall be routed out from underneath the HRSG(s) where a block valve shall be located for each tube row header. If the tube row consists of multiple modules of the same pressure service, the drain piping may be connected before the first block valve. Discharge of the first block valves shall then be headered together with a common second block valve for the same pressure service.
- A.6.5.13.2.c Seller shall provide the continuous blowdown line with a control valve such that the online water sampling system of the drum water may provide a control signal to the control valve adjusting the amount of continuous blowdown.
- A.6.5.13.3 Maintenance Drains
- A.6.5.13.3.a Maintenance drains are defined as any drain that is not required to be used during operation and is only intended for use with the HRSG(s) depressurized in a safe condition for maintenance functions. These drains may include economizer drains and casing drains. Valves associated with maintenance drains may be manually operated.
- A.6.5.13.4 Startup Drains (applies to warm or cold startup):
- A.6.5.13.4.a Seller shall provide startup drains with remote operated actuators and all Section I valves.
- A.6.5.14 BOILER TRIM VALVES AND PIPING
- A.6.5.14.1 Trim Valves
- A.6.5.14.1.a Seller shall furnish with the boiler, but shall not be limited to, the boiler trim, valves, and other appurtenances in accordance with ASME B&PV Code Section I and ASME/ANSI B31.1.
- A.6.5.14.1.b All manually, pneumatically, and motor operated valves required for complete operation of the HRSG(s) and as applicable per codes shall be furnished. Downstream drain valves on the HP, IP, and LP superheaters and reheaters shall be capable of remote operation.
- A.6.5.14.1.c All valves requiring operation during startup and shutdown of the HRSG(s) shall be motor operated, except where specified. Where two valves in series are required, the second valve shall also be motor operated, except where specified.
- A.6.5.14.1.d Piping root valves shall be provided for instrument connections. Double root valves are required on systems designed for 900 psig or greater.
- A.6.5.14.1.e Safety valves shall be provided for the HRSG(s) to meet the requirements of ASME code. HP steam, superheated steam, and hot reheat steam safety valves shall have welded inlets and flanged outlets. All other HRSG safety valves may have flanged inlet and outlets. Safety valves shall be provided with all necessary equipment for gagging the valves for hydrostatic tests.
- A.6.5.14.1.f Material sourcing shall be provided per Section A.1 – Project Requirements.

A.6.5.15 PIPE AND FITTINGS

A.6.5.15.1 Seller shall provide all “boiler proper” and “boiler external piping” within ASME Section I code boundaries.

A.6.5.16 SILENCERS

A.6.5.16.1 Each safety valve and start up vent shall be provided with its own separate silencer. Silencers shall be designed to reduce the noise level to a maximum of 110 dBA at nearest operating platform from silencer or a maximum level required to meet the Noise Guarantee whichever is more stringent. Silencers shall be designed to resist corrosion. Vents shall be routed a minimum of 15 feet above platforms or walkways (not including stack platforms).

A.6.5.17 DUCT BURNER

A.6.5.17.1 The duct burner system shall be of a low nitrogen oxide (NO_x) design.

A.6.5.17.2 The duct burner system shall be designed to be able to operate on 95% of GT load when GT is in operation. The duct burner minimum turndown ratio shall be 10:1 with gas fuel with all burner elements operating.

A.6.5.17.3 The burner system shall include burner elements, solid state igniters, flame scanners, duct burner frame, sensors, fuel skid, burner controls, Burner Management System (BMS), Flame Safety System, two (2) x 100% capacity scanner cooling air blowers, view ports for each burner with cooling air, piping from duct burner fuel skid to duct burner elements, and all other equipment and devices required for a complete firing system.

A.6.5.17.4 Fuel combustion shall have no flame impingement on liners, tubes, supports, or baffles over the entire operating range.

A.6.5.18 BURNER MANAGEMENT SYSTEM

A.6.5.18.1 The Duct Burner System shall be provided with a BMS which shall permit manual and automatic start or shutdown from either the Facility DCS or local control panel and support both staged and unstaged operation. All logic and programming for the BMS shall be provided by the burner system manufacturer. Failure of any burner element shall not prevent the other elements from running.

A.6.5.18.2 The fuel flow demand signal shall come from the Facility DCS.

A.6.5.18.3 Fuel gas for the duct burners shall be from a take-off on the Project fuel gas supply header.

A.6.5.18.4 The BMS shall be programmable logic controller (PLC) based, independent from the Facility DCS. The PLC shall be configured in accordance with NFPA 85 as applicable to HRSGs, and capable of purge credits.

- A.6.5.18.5 The BMS PLC shall have redundant communication links to/from the Facility DCS. All alarm and monitoring points available in the local PLC shall be available in the DCS. Monitoring shall be done from the control room.
- A.6.5.18.6 Remote Start/Stop functions shall be available through the Facility DCS system.
- A.6.6 SELECTIVE CATALYTIC REDUCTION (SCR) SYSTEM
- A.6.6.1 SCR GENERAL
- A.6.6.1.1 Each HRSG shall be furnished with a complete SCR system to control concentrations of NO_x generated by the associated combustion turbine at all loads between MECL and 100% load. The SCR shall be a complete system requiring only the supply of 29 wt% aqueous ammonia and electrical power. All ancillary equipment, including supports, access doors, loading doors, controls, valves, integral piping, atomizing air, and all other appurtenances needed for complete maintenance and operation of the system, shall be provided by Seller.
- A.6.6.1.2 The SCR system will utilize a dual-function catalyst to reduce NO_x, CO, and VOCs in accordance with the Emissions Guarantees.
- A.6.6.1.3 SCR and ammonia system shall be sized for the addition of 50% more catalyst volume in the future.
- A.6.6.1.4 The design of the SCR system shall include consideration of sliding pressure operation of the associated HRSG, with optimization of the location of catalyst modules with respect to temperature and required performance.
- A.6.6.1.5 Emission Performance Guarantees defined in the Guarantee section shall be met concurrently for all combustion turbine(s) exhaust conditions and all Project site ambient conditions while the combustion turbine(s) is operated at or above MECL. The SCR system shall be guaranteed as designed to provide the emission reductions specified without requiring rejuvenation, maintenance, addition, or replacement for five (5) calendar years after initial operation or up to 40,000 actual hours of operation.
- A.6.6.1.6 Seller shall be responsible for design and equipment supply for the SCR reactor and dual-function catalyst in full accordance with all applicable regulations and requirements. Operating and maintenance procedures established for this equipment shall also be developed in full accordance with all applicable regulations and requirements. All devices and components shall be UL listed for ammonia service where applicable to aqueous ammonia.
- A.6.6.1.7 The outer casing shall have provisions for test connections before and after the SCR system to determine the performance of the dual-function catalyst.
- A.6.6.1.8 Dual-function catalyst loading doors shall be included for easy replacement of the catalyst materials.

- A.6.6.1.9 The SCR Seller's subcontractor shall provide detailed operating and maintenance instruction for the equipment. This shall include:
 - A.6.6.1.9.a Performance monitoring, to include differential pressure measurement across the catalyst.
 - A.6.6.1.9.b Recommended system control schemes, both for the SCR itself and for auxiliary equipment items/skids.
 - A.6.6.1.9.c Diagnostic and repair procedures.
 - A.6.6.1.9.d Performance correction curves.
 - A.6.6.1.9.e Provisions for controlling NO_x while maintaining or servicing SCR equipment.
 - A.6.6.1.9.f Operating restrictions (temperatures, gas composition, etc.).
 - A.6.6.1.9.g Dual-function catalyst design basis.
 - A.6.6.1.9.h Performance data – Molar ammonia vs. NO_x, effect of ammonia injection on emissions (SO₃, ammonium salts, etc.).
 - A.6.6.1.9.i Preventive and scheduled maintenance requirements.
 - A.6.6.1.9.j Recommended maintenance practices.
 - A.6.6.1.9.k Recommended catalyst coupon testing plan.
 - A.6.6.1.9.l Recommended shutdown procedure and vaporized ammonia piping purge recommendations.
 - A.6.6.1.9.m Limitations of SCR performance with respect to NO/NO₂ ratio.
- A.6.6.1.10 The SCR manufacturer's service or maintenance programs as well as their scopes, limitations, and costs are required. The manufacturer shall provide, in detail, the guarantees and warranties, as well as restrictions and limitations, on equipment performance and life.
- A.6.6.2 SCR ARRANGEMENT
 - A.6.6.2.1 Access shall be provided for AIG maintenance, removal of catalyst coupons, to allow cleaning of the catalyst, from front and back, during periodic maintenance intervals. The internal structure of the HRSG's casing and location of the AIG shall allow complete access to the catalyst front and rear face without removal of internal structures.
 - A.6.6.2.1.a Access doors shall be located on both upstream and downstream sides of the catalyst. Doors shall be pressure tight with tool free closure (e.g., safety latch, lock bar, etc.). Seller shall provide all necessary stairs, platforms, and guardrails to allow access to the access doors.

- A.6.6.2.2 Catalyst shall be located with adequate space between tube banks such that cleaning of the tube banks does not adversely affect the catalyst, due to moisture or other reason.
- A.6.6.2.3 The reactor system shall be designed and equipped for easy operation and maintenance. All pressure parts downstream of the catalyst must be easily accessible for visual inspection and cleaning during the HRSG's 30-year life.
- A.6.6.2.4 The location of the ammonia injection grid, flow correction devices, and the catalyst modules shall be based on the results of the flow model study and/or as recommended by the catalyst manufacturer based on the minimum and maximum operating temperature of the supplied catalyst.
- A.6.6.2.5 Provide all gas distribution devices that are recommended as a result of the model study. The gas velocity, temperature, and concentration distribution at the reactor inlet and/or outlet shall be designed such that the stack emissions shall be met. Flow correction devices throughout the HRSG(s) shall be made of appropriate materials for the design life and conditions present throughout the HRSG(s).
- A.6.6.3 AMMONIA METERING, VAPORIZING, AND DILUTION
- A.6.6.3.1 Skid mounted ammonia dilution equipment shall be provided with the SCR system. Recirculated flue gas shall be used as the dilution medium. Gas shall be introduced by a centrifugal blower and measured by an annubar type flow element.
- A.6.6.3.2 The ammonia injection equipment shall include two 100% dilution gas or air fans, dilution air heaters, gaseous ammonia mass flowmeter (with remote readout capabilities), flow control valve, instruments, and all other required accessories.
- A.6.6.3.3 Diluted ammonia piping shall be provided as a single 100% train, unless otherwise required by Seller.
- A.6.6.3.4 Ammonia vaporization and dilution equipment, including the gas recirculation or dilution air system, shall be constructed of suitable materials for the mixing temperatures and composition present.
- A.6.6.3.5 The ammonia shall be vaporized, diluted, and mixed with conveying gas prior to injection into the flue gas stream. The resultant gas and ammonia mixture shall typically contain between 2 and 5% ammonia by volume for all load conditions and in no case shall contain greater than 7% ammonia by volume. The concentration shall be monitored, and the system shall be shut down if the ammonia concentration is greater than 12%.
- A.6.6.4 AMMONIA/GAS MIXING AND INJECTION GRID
- A.6.6.4.1 The ammonia injection grid shall be located upstream of the SCR reactor chamber in a zone where gas or surface temperatures do not exceed 800° F, or as required by the catalyst supplier if lower. The injection grid shall be designed and arranged to ensure uniform mixing (as described herein) of the ammonia and the exhaust gas stream at all load ranges between MECL and 100% CT load.

- A.6.6.4.2 Skid mounted dilution equipment shall be provided with each SCR system. Aqueous ammonia will be provided at the inlet to Seller's ammonia control skid and shall be vaporized and diluted prior to injection. Exhaust gas or air shall be used as the dilution medium. Air shall be introduced by a centrifugal blower and measured by a pitot tube measuring device. The ammonia injection equipment shall include two 100% dilution air fans, flow control valve, piping, heaters, instruments, and all other required accessories associated with the dilution air fans. The ammonia flow control, vaporizing, and injection manifold shall include one 100% system per HRSG. The HRSG's ammonia dilution (SCR) fan bearings shall be provided with temperature monitoring and proximity probes which shall be connected to the Facility DCS for monitoring.
- A.6.6.4.3 The ammonia system shall be designed to accommodate the maximum injection rate based on the cases provided in the data pages with appropriate margin. The maximum usage rate shall be calculated assuming the use of separate oxidation catalyst in the future located upstream of the dual-function catalyst. Maximum design shall be based on NO/NO₂ ratio (provided in guarantee section) at full load.
- A.6.6.4.4 The ammonia injection grid shall be designed with multiple injection branches. The ammonia injection system shall be designed with a number of independently adjustable ammonia injection zones, which shall be adjustable from the exterior of the duct and arranged to ensure uniform mixing of the ammonia and the exhaust gas stream. Valves shall be a butterfly type.
- A.6.6.4.5 Each branch of the ammonia injection grid shall be designed to provide ammonia from a single header manifold on only one side of the HRSG(s) that does not interfere with the flue gas duct or cause congestion. Each injection zone shall include flow orifices, injection nozzles, and independent flow rate adjusting valves necessary to allow maximum tuning flexibility. Valved connections for a Magnehelic type differential pressure measurement instrument shall be provided on each branch of the injection grid. Valved connections shall be accessible from manlift or Seller supplied platforms. Magnehelic type differential pressure measurement instruments shall be provided with the ammonia injection grid.
- A.6.6.5 SCR REACTOR AND CATALYST
- A.6.6.5.1 The reactor shall be large enough to accommodate a catalyst with 50% larger volume than that required to meet the NO_x limits outlined in the Performance Requirement section.
- A.6.6.5.2 The reactor shall be equipped with test ports at the inlet and outlet of the reactor. The test ports shall be arranged to allow testing of at least a 6 by 6 matrix of points or in a 3 foot by 3 foot grid. Test port diameters shall not be less than 4 inch inside diameter.
- A.6.6.5.3 The design velocity through the SCR reactor shall be limited to 20 fps based on maximum flow through the reactor.
- A.6.6.5.4 The SCR reactor shall be equipped with dual-function catalyst, designed to reduce NO_x, CO, and VOC emissions and limit ammonia slip.

- A.6.6.5.5 The catalyst shall be the regular packed parallel flow type and shall be designed to be within the overall HRSGs exhaust gas pressure loss specified by Seller. The catalyst composition shall be appropriate to meet the Emissions Requirements and other requirements as specified and for the intended range of operation throughout the life of the catalyst.
- A.6.6.5.6 The catalyst modules shall be constructed as modules that can be placed one above the other across the SCR reactor. The catalyst modules shall be capable of supporting all other subsequent catalyst modules required to be stacked directly on the lower modules.
- A.6.6.5.7 Appropriate seals shall be provided with the catalyst to prevent any flue gas bypass through catalyst elements or around the catalyst modules.
- A.6.6.5.8 To monitor catalyst life and performance, a minimum of ten (10) test coupons shall be provided and installed in each catalyst bed as recommended by the catalyst manufacturer. Each catalyst coupon shall be labeled with a serial number. All catalyst coupons shall be from the same lot as the installed catalyst. These samples will be tested to evaluate catalyst activity and physical properties as the catalyst ages.
- A.6.6.5.8.a The catalytic element sampling coupons or elements shall be readily accessible without disturbing other equipment and by use of common tools. Identify the catalyst Seller's subcontractor's particulars for used element disposal. This shall include identification of hazardous waste, composition, concentration, need for special handling or storage, personnel precautions, need for special tools or provisions, means of transportation, and disposal destination. The dual-function catalyst used element disposal shall be in accordance with all applicable regulations. Provisions shall be made for tube cleaning downstream of the SCR system due to tube fouling which may occur.
- A.6.6.5.8.b At a minimum, one (1) replacement coupon shall be provided by Seller for each removable element/cassette.
- A.6.6.5.9 Catalyst shall be shipped in weatherproof packaging of the catalyst modules.
- A.6.6.5.10 Specimens of the catalyst to be used shall be tested, prior to fabrication, to determine specific surface area, activity, and SO₂ to SO₃ conversion rates to satisfy the Emissions Performance Guarantees listed in this specification.
- A.6.6.5.11 Any Special tools or necessary equipment to transport the catalyst modules from the lifted location to the final reactor positions shall be included.
- A.6.6.6 CONTROL REQUIREMENTS
- A.6.6.6.1 The SCR system shall be controlled through the Facility DCS. Logic shall be available for both manual and automatic control of all major SCR systems. Seller shall provide an isolation and a manual bypass for the ammonia flow control valve.
- A.6.6.6.2 All alarms will be transmitted to the Facility DCS for annunciation in the control room.

- A.6.6.6.3 The process control system logic shall utilize a triple loop control scheme which uses exhaust gas flow, inlet NO_x emission level, and stack outlet NO_x emission level.
- A.6.6.6.4 Seller shall supply calculations, equations, and curves for use in control of the SCR. Seller shall provide NO_x analyzers and flowmeters as needed for ammonia injection rate determination.
- A.6.6.6.5 All primary control and instrumentation required by the ammonia injection control system shall be included in the scope. Primary instruments shall be provided for monitoring, alarming, and verification of performance to ensure reliability of the SCR system and associated equipment.
- A.6.6.6.6 Local instrumentation shall be furnished where required for maintenance and periodic inspection. As a minimum, provide local instrumentation and test taps at all locations where a pressure or temperature process tap has been made.
- A.6.6.6.7 Appropriate signals from the control system shall also be transmitted to the CEMS for reporting to the federal and state regulatory agencies.
- A.6.6.6.8 Ammonia Area Monitors
- A.6.6.6.8.a Seller shall supply an area ambient monitoring system for continuous ammonia vapor monitoring at the ammonia vaporization skid location and/or ammonia injection location. Each ammonia monitor shall be capable of monitoring ambient ammonia levels in the 1 to 100 ppm range with a minimum $\pm 5\%$ accuracy and $\pm 2\%$ repeatability of reading.
- A.6.6.7 SCR OPERATING REQUIREMENTS
- A.6.6.7.1 The SCR system and catalyst shall be suitable for thermal cycling between the maximum system operating temperature and the minimum outdoor temperature and the specified Facility cycles without injurious effect on the structure, catalyst, or other system components. The design of the SCR system, including the catalyst, shall not restrict operation of the HRSG(s) due to limitations on rate of thermal change. The design shall include, but not be limited to, the following operating parameters:
- A.6.6.7.1.a Starting of flue gas source into a cold system.
- A.6.6.7.1.b Starting of flue gas source into a hot system.
- A.6.6.8 SCR MATERIALS
- A.6.6.8.1 Copper or copper alloys shall not be used for any components in the SCR system.
- A.6.6.8.2 The dual-function catalyst shall be the regular packed parallel flow type and shall be designed to be within the overall HRSG(s) exhaust gas pressure loss specified by Seller. The catalyst shall be either homogeneous extruded material or the catalyst shall be supported on a metallic, fiberglass, or ceramic monolithic base material. The bonding procedure used and the design of the catalyst's cells shall be such that delamination of the catalyst from the support material or permanent deformation of the support material shall

not occur due to stresses induced by the design seismic, pressure, wind, and thermal conditions or combinations thereof.

- A.6.6.8.3 All piping, instrumentation, and equipment (including the vaporizer) in the ammonia system from the exit of the storage tank forward shall be stainless steel.
- A.6.6.8.4 The SCR system casing shall be designed and constructed in accordance with the requirements of this HRSG specification. The casing shall be designed such that the dimensions match, as closely as possible, the cross-sectional area of adjacent HRSG sections. The casing shall be furnished with the same insulation and lagging system as the upstream portion of the HRSG(s). The catalyst casing shall include all required internal supports for catalyst loading, thermal stress, and earthquake loading.
- A.6.6.8.5 The SCR shall be the same as the HRSG(s) pressure part sections.
- A.6.6.9 PERFORMANCE GUARANTEE REQUIREMENTS
- A.6.6.9.1 The following system performance parameters shall be guaranteed when firing natural gas:
- A.6.6.9.1.a Not Used.
- A.6.6.9.1.b NO_x emissions.
- A.6.6.9.1.c Ammonia slip emissions.
- A.6.6.9.1.d Catalyst life.
- A.6.6.9.1.e Not Used.
- A.6.6.9.1.f Ammonia injection and consumption rate.
- A.6.6.9.2 All guarantees shall be achieved simultaneously. Design values for fuel quality, steam generator minimum and maximum operating limits and associated operating parameters, and any other required parameters will be as defined elsewhere in this specification.
- A.6.7 FLOW MODEL TEST
- A.6.7.1 OBJECTIVES
- A.6.7.1.1 The computational fluid dynamics (CFD) flow model test shall be used to determine optimum location and arrangement of flow straightening/gas distribution devices to ensure satisfactory performance of heat transfer surfaces and emissions control equipment. The CFD model shall use the combustion turbine(s) swirl angles and gas path configuration or manufacturer's CFD model as the flow input.
- A.6.7.1.2 The flow model shall also be used to determine optimum location and operation of the ammonia injection system. The model results shall prove adequate performance of the distribution of the ammonia injection systems.

- A.6.7.1.3 Determine the optimum arrangement of the heat transfer surfaces, CO catalyst spool, SCR reactor, AIG, associated ductwork, and the shape and location of gas distribution devices necessary to obtain uniform gas flow conditions through the load range and to minimize pressure losses.
- A.6.7.1.4 Establish the locations for gas test ports for performance testing of the SCR system and future CO catalyst.
- A.6.7.1.5 The Seller shall be responsible for determining all gas flow vaning, straightening, or distribution devices required by the HRSG(s) and SCR(s) systems and future CO catalyst(s). The required devices shall be based on the model tests described herein. These devices shall become an integral part of the HRSG(s) design.
- A.6.7.1.6 Seller shall perform system pressure drop tests at the specified design flow conditions to optimize design in meeting the pressure drop Performance Guarantee. Seller shall use the flow model to optimize the pressure drop in the total system, including ammonia grid and reactor and future CO catalyst to be shown on the general arrangement drawings.
- A.6.7.1.7 Seller shall perform any other tests or determinations not specifically listed herein which are normally performed or required for proper operation of the HRSG(s), SCR(s) systems, and future CO catalyst(s) or to achieve the test flow model study objectives listed herein.
- A.6.7.2 AT A MINIMUM, THE FOLLOWING SYSTEMS SHALL BE INCLUDED IN THE MODEL:
- A.6.7.2.1 CT outlet swirl angle.
- A.6.7.2.2 CO catalyst spool (with and without CO catalyst installed).
- A.6.7.2.3 Ammonia injection.
- A.6.7.2.4 SCR reactor.
- A.6.7.2.5 Stack.
- A.6.7.3 AT A MINIMUM, THE RESULTS OF THE FLOW MODELS SHALL PROVE THAT THE FOLLOWING DISTRIBUTION REQUIREMENTS HAVE BEEN MET:
- A.6.7.3.1 The maximum deviation from the flow-weighted mean of the ammonia concentration downstream of the catalyst shall not vary more than $\pm 50\%$.
- A.6.7.3.2 Under all operating conditions, variation in temperature across the duct cross-sectional area at the catalyst face inlet shall not vary by more than $\pm 20^{\circ}\text{F}$ from the arithmetic average temperature. These design requirements shall be met at a minimum; if dual-function catalyst requirements are more stringent, those shall be met.
- A.6.7.3.3 NH_3 to NO_x ratio: The NH_3/NO_x ratio shall not exceed 5% in 90% of the cross-sectional area and 10% in the remaining 10% of the cross-sectional at the catalyst face. These design requirements shall be met at a minimum; if dual-function catalyst requirements are more stringent, those shall be met.

- A.6.7.3.4 Dual-Function Catalyst Inlet Gas Velocity Distribution: The velocity of the flue gas in 90% of the cross-section of the HRSG(s) upstream of the ammonia injection grid shall not vary more than $\pm 10\%$ from the arithmetic mean value of the velocity at the test conditions. For the remaining 10% of the cross-section, the velocity of the flue gas shall not vary more than $\pm 25\%$ from the arithmetic mean value of the velocity at the test conditions. These design requirements shall be met at a minimum; if dual-function catalyst requirements are more stringent, those shall be met.
- A.6.7.4 FLOW OBSTRUCTIONS, NO MATTER HOW MINOR, WHICH SELLER ELECTS NOT TO MODEL SHALL NOT BE USED AS A BASIS FOR CLAIMS OF POOR DISTRIBUTION IN THE FULL-SIZE SYSTEM AND SHALL NOT BE USED AS A BASIS FOR NOT MEETING PERFORMANCE GUARANTEES.
- A.6.7.5 THE MODEL SHALL BE RETAINED BY THE SELLER UNTIL THE FINAL PERFORMANCE TEST HAS DEMONSTRATED THAT THE SCR SYSTEM HAS MET THE PERFORMANCE GUARANTEES.
- A.6.7.6 SELLER SHALL PROVIDE A FINAL REPORT INCLUDING THE FOLLOWING ITEMS AS A MINIMUM:
- A.6.7.6.1 Methodology, procedures, and conclusions of the flow model test stating how the objectives were achieved in the model and how these same results can be achieved in the full-scale design.
- A.6.7.6.2 Development of flow model inputs, physics parameters, boundary conditions, etc.
- A.6.7.6.3 Effect of various arrangements of flow correction devices on gas distribution and pressure loss.
- A.6.7.6.4 Recommendations on the location and configuration of the flow correction devices and ammonia injection grid.
- A.6.7.6.5 Drawings with location of turning vanes, perforated plates, AIG, and sample port locations corresponding to each run reported.
- A.6.7.6.6 Tables summarizing the flue gas flow velocity and velocity distribution, pressure and pressure profile, ammonia distribution, and temperature and temperature distribution throughout the model.
- A.6.8 HRSG INSTRUMENTATION
- A.6.8.1 SELLER SHALL PROVIDE INSTRUMENTATION, INCLUDING BUT NOT NECESSARILY LIMITED TO, THE FOLLOWING:
- A.6.8.1.1 Electronic transmitters.
- A.6.8.1.2 Pressure switches and transmitters to align with Section A.6.8.2.4.
- A.6.8.1.3 Differential pressure switches and transmitters to align with Section A.6.8.2.4.
- A.6.8.1.4 Pressure gauges.

- A.6.8.1.5 Differential pressure gauges.
- A.6.8.1.6 Flow measuring orifices.
- A.6.8.1.7 Flow measuring nozzles, venturies, and low loss tubes.
- A.6.8.1.8 Thermocouples, RTDs, and thermowells.
- A.6.8.1.9 Temperature switches and transmitters to align with Section A.6.8.2.4.
- A.6.8.1.10 Temperature gauges.
- A.6.8.1.11 Liquid level transmitters.
- A.6.8.1.12 Liquid level switches.
- A.6.8.1.13 Level gauges.
- A.6.8.1.14 Control valves.
- A.6.8.1.15 Boroscope inspection ports on evaporator.
- A.6.8.2 GENERAL INSTRUMENTATION REQUIREMENTS
 - A.6.8.2.1 All instruments used for control shall be provided as redundant pairs. All instruments used as sensing elements for tripping and drum level control shall be triple redundant.
 - A.6.8.2.2 Each feedwater and HP, IP, CRH, and LP steam line shall have a minimum of one pressure transmitter, one dual-element temperature probe, and one flow transmitter.
 - A.6.8.2.3 Seller's instrument and device accuracy sensitivity and error limits shall conform to the ASME PTC 19 requirements and/or the Technical Specification requirements, whichever are more stringent.
 - A.6.8.2.4 Process transmitters (pressure, temperature, level, differential pressure, flow, etc.) shall be supplied in lieu of switches. Seller to obtain Buyer's approval before using process switches. In general, process switches will only be accepted in applications where necessary to meet Code requirements. (This requirement does not apply to valve limit switches). Superheater drains will use temperature elements, except at first pass where level switches are used due to minimum superheat.
 - A.6.8.2.5 Motor operated valves requiring an intermediate operating position (not fully open, not fully closed) shall have position transmitters. The transmitters shall transmit linear 4 to 20 mA signals to the DCS.
 - A.6.8.2.6 All attemperator valve stations shall include a manual shutoff valve, check valve, automatic spray water block valve, flow element, spray water control valve, and attemperator (ring or insertion style depending on water flow requirement). The remote operated block valves shall be air operated ball valves (one per HRSG).

- A.6.8.2.7 The attemperator spray water control valves and automatic block valves shall conform with the requirements of ASME/ANSI Standard TDP-1-2013.
- A.6.8.3 ECONOMIZER INSTRUMENTATION
- A.6.8.3.1 Seller shall provide one temperature element/thermowell and one test well at the inlet and exit of each economizer tube bank module.
- A.6.8.3.2 Redundant measurements shall have separate tap points for each measurement.
- A.6.8.3.3 Pressure indicators on pump headers shall be provided with snubbers and shall be glycerol filled.
- A.6.8.3.4 Instrument enclosure, if used, shall be provided with a low temperature alarm to notify the operator when a heater fails or a heat trace circuit trips. The alarm can be wired into the heat trace panel alarm circuit.
- A.6.8.3.5 All instrument tagging shall agree with the approved project tagging procedure and shall be read in English units.
- A.6.8.3.6 Instruments located on the packaged equipment systems shall be furnished and mounted/installed by Seller.
- A.6.8.3.7 Pressure gauges shall be 4-1/2 inch minimum local mounted, 3-1/2 inch board mounted, and 1-1/2 inch to 2-1/2 inch mounted on air operated dampers and control valves.
- A.6.8.3.8 Instrument tags shall be stainless steel, either screwed into instrument or attached to instrument by stainless steel wire.
- A.6.8.3.9 Instrument tubing shall not be welded and shall be 1/2 inch minimum size.
- A.6.8.3.10 All instrumentation and control devices shall be suitable for the environment where they will be located.
- A.6.8.3.11 Instrument tubing shall be installed in a neat workmanlike manner, properly sloped, and shall not show any sign of crumpling, too short on bend radius, or flattening. Minimum bending radius for tubing sensing lines shall be three times the tubing diameter.
- A.6.8.3.12 Profibus and foundation fieldbus shall not be installed on instruments and valves.
- A.6.8.3.13 Emergency stop switches shall have a means to prevent accidental operation, such as clear plastic/Lexan covers or push-button guards.
- A.6.8.4 STEAM DRUM INSTRUMENTATION
- A.6.8.4.1 Each HP, IP, and LP drum shall have as a minimum three analog level transmitters, three analog pressure transmitters, three dual-element temperature probes, local site gauges, and one independent remote drum level indicator system (with twelve conductivity probes in compliance with Section I of the ASME Boiler Code as a minimum), with no

less than four independent alarm switches and remote indicating display which will be mounted in the control room.

A.6.8.4.2 HP drum level control shall be upstream of the HP economizer.

A.6.8.4.3 One pressure gauge shall be independently connected to each steam drum.

A.6.8.4.4 Double root valves shall be provided for drum pressure and level transmitters.

A.6.8.4.5 Two (2) inner wall and two (2) mid-wall thermocouples on each drum shall be provided.

A.6.8.4.6 IP and LP drum level control shall be downstream of the IP and LP economizer and upstream of the IP and LP drum.

A.6.8.5 SUPERHEATER INSTRUMENTATION

A.6.8.5.1 A test well shall be provided for troubleshooting and testing at the inlet and exit of each superheater tube bank module. A test well is not required at the superheater inlet from the steam drum.

A.6.8.5.2 At each superheater outlet there shall be at least one (1) temperature element and thermowell.

A.6.8.5.3 At least one temperature element and thermowell shall be provided at each primary superheater outlet upstream of the desuperheater spray nozzle to aid in spray valve leakage detection.

A.6.8.5.4 Not Used.

A.6.8.6 REHEATER INSTRUMENTATION

A.6.8.6.1 A test well shall be provided for troubleshooting and testing at the inlet and exit of each reheater tube bank module.

A.6.8.6.2 At each reheater outlet there shall be at least one (1) temperature element and thermowell.

A.6.8.6.3 At least one temperature element and thermowell shall be provided in each reheater upstream of the desuperheater spray nozzle to aid in spray valve leakage detection when the reheater utilizes water spray attenuation.

A.6.8.7 GAS PATH INSTRUMENTATION

A.6.8.7.1 Three temperature elements will be provided at module inlets and outlets, and three temperature elements will be provided to measure the temperature entering the SCR and CO catalysts. These points shall be available in the Facility DCS.

A.6.8.7.2 All transmitters shall be Rosemount Model 3051 series and provided with HART protocol. All thermocouples shall be furnished with thermowells and shall be Type E

except where gas temperature exceeds 1501° F for which Type K thermocouples shall be furnished.

A.6.8.7.3 Instruments requiring periodic maintenance shall be accessible from platforms. If any instrument is not accessible from platforms, a secondary platform shall be provided.

A.6.8.8 MOTOR AND MISCELLANEOUS ELECTRICAL REQUIREMENTS

A.6.8.8.1 For Electrical requirements, refer to Section A.12 - Electrical Requirements and Design Criteria.

A.6.8.8.2 All electrical equipment and devices furnished for separate mounting shall be checked and tested in the factory before shipment.

A.6.8.8.3 Whenever two or more pieces of electrical equipment are mounted in an enclosure or on a shipping section, they (except power and motor leads) shall be factory wired to one common termination box mounted on the equipment. Power and motor leads shall be terminated in separate equipment termination or motor conduit boxes for incoming power cables.

A.6.8.8.4 Connections between shipping sections shall be arranged to require a minimum of field wiring. Terminal blocks shall be provided on one side of a shipping break, and coiled wires, properly tagged, shall be provided on the other side to facilitate these connections.

A.6.8.8.5 All assemblies shall be furnished completely wired. With the exception of control and ac power buses, all other alarm and control wiring for extension to remote equipment or for interconnection between compartments shall terminate at terminate blocks.

A.6.8.8.6 All electrical enclosures shall comply with the following:

A.6.8.8.6.a Not Used.

A.6.8.8.6.b Enclosures shall be suitable for the environment and provide the degree of protection of the enclosed electrical equipment according to NEMA Standard 250.

A.6.8.8.6.c NEMA Type 4X.

A.6.8.8.6.d Minimum box depth shall be 6 inches.

A.6.8.8.6.e All external hardware shall be stainless steel.

A.6.8.8.6.f Adjacent enclosures, cabinets, etc. shall be installed to maximize their accessibility and minimize walkway interference.

A.6.8.8.6.g The door of the enclosure, when it is opened, shall not block access to adjacent enclosures.

A.6.8.8.6.h Side by side enclosure arrangement shall incorporate door hinges on opposite sides to facilitate access (as if the arrangement is a center opening double door cabinet).

- A.6.8.8.6.i Metal enclosures shall be fabricated of not less than 14-gauge material; where necessary, for rigidity, heavier plate or stiffening members shall be used.
- A.6.8.8.6.j Barriers shall be provided to separate different voltages.
- A.6.8.8.6.k Door gaskets shall be solid neoprene.
- A.6.8.8.6.l Terminal boxes and control enclosures shall be provided with 10-gauge aluminum backing plate on which to mount terminal blocks and devices.
- A.6.8.8.6.m Backing plates shall be bonded to the box.
- A.6.8.8.6.n Not more than two (2) conductors shall be terminated at any one termination point; minimum 20% spare terminals shall be provided.
- A.6.8.8.6.o A 1/4 inch x 1 inch ground bus shall be furnished running the full length of each control panel. Each end of this bus shall have a Burndy Type YA (2 AWG to 1/0 AWG) terminal lug for ground cable.
- A.6.8.8.6.p Indicating devices shall be mounted on the front of the control panel. Relays, etc., shall be mounted inside the panel. All equipment shall be wired to conveniently located terminal blocks arranged for cables entering from below.
- A.6.8.8.6.q All spare relay contacts shall be wired out to terminal blocks.
- A.6.8.8.6.r Push buttons and selector switches shall be heavy-duty, NEMA Type 4X.
- A.6.8.8.6.s Seller shall furnish integral starters for all motor-operated valves (MOV), damper drives, and local starters for all other motors less than 1/2 hp.
- A.6.8.8.6.t Nonmetallic components and devices, such as terminal blocks, wireways, wire troughs, wire cleats, cable ties, etc., shall be manufactured from “nonburning” materials as defined by ASTM D635.

A.6.9 PLATFORMS AND STAIRS

- A.6.9.1 AS A MINIMUM, A STAIRWAY SHALL BE PROVIDED TO THE FOLLOWING PLATFORMS:
 - A.6.9.1.1 Main operating platform (360° at steam drum level).
 - A.6.9.1.2 Safety valves and drums.
 - A.6.9.1.3 Stack sampling and monitoring ports (360°) via ladder access from the steam drum level platform.
 - A.6.9.1.4 All isolation and block valves on superheater outlets.
 - A.6.9.1.5 All desuperheater valves.

A.6.9.1.6 All drum valves and instrumentation (ladder access from the operating platform to items on top of the drums).

A.6.9.1.7 Stack damper platform.

A.6.9.1.8 A staircase shall be provided on one side of each HRSG to access the upper platform. Intermediate landings shall be provided as required to minimize access with ladders. A ladder system shall be provided on the opposite side of each HRSG as a secondary means of egress.

A.6.10 CRANES AND HOISTS

A.6.10.1 Not Used.

A.6.10.2 Seller shall provide a 1-ton capacity (minimum) stack-mounted jib crane with hoist for each HRSG.

A.6.10.3 All lifting devices and monorails shall be clearly stenciled with rated lifting capacity. All lifting devices shall be capable of reaching grade elevation.

A.6.11 CLEANING

A.6.11.1 Seller shall hand clean loose material from steam drums. Each steam drum interior shall be blast cleaned with steel or other non-silica-bearing grit and coated with a water soluble or other corrosion preventive material before shipment, consistent with Seller standard approach.

A.6.11.2 Surfactant flush (cold water de-grease) or high pH boilout (alkaline chemical clean) of the HRSG(s) shall be performed during the commissioning phase of the project. Clean flanged connections shall be supplied for each pressure level of the HRSG(s).

A.6.12 TRAINING

A.6.12.1 Manufacturer shall assist Seller in the training of Buyer's operating personnel.

A.6.12.2 On-site HRSG training modules shall start in classroom and incorporate system walkdowns.

A.6.12.3 Course material shall include manufacturer's recommended procedure for regular startups, operation, and shutdown of the equipment, including emergency conditions, and shall include maintenance training for all control systems.

A.6.12.4 Course material shall be provided for each student's use and retention and lessons shall consist of lesson objectives, system descriptions, proper system startup, operation, and shutdown.

A.6.12.5 Course material shall include a spare parts list and reordering information.



END OF SECTION

SECTION A.7
STEAM TURBINE – GENERATOR (STG)

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SECTION A.7
STEAM TURBINE – GENERATOR (STG)

A.7.1 GENERAL REQUIREMENTS

A.7.1.1 STEAM TURBINE GENERATOR (STG) GENERAL REQUIREMENTS

- A.7.1.1.1 The STG(s) shall consist of tandem-compound, condensing unit(s) with reheat, and a three-phase, 3,600 rpm, 60 Hz synchronous generator with line-fed static excitation.
- A.7.1.1.2 Seller shall define the steam conditions to the STG(s) in heat and mass balance diagrams included with the proposal.
- A.7.1.1.3 Seller may propose their standard condensing turbine exhaust configuration including one or two-flow, axial or downward.
- A.7.1.1.4 Seller shall provide interface list and DOR for approval by Buyer.
- A.7.1.1.5 Not Used
- A.7.1.1.6 Not Used
- A.7.1.1.7 The STG unit(s) may be located indoors or outdoors with an HP/IP enclosure and designed for the environmental design data provided in the Site Design Criteria, Section A.9, and shall operate in conjunction with the CTG/HRSG train(s). The STG(s) shall be sized based on the maximum output of the associated CTG/HRSG train(s).
- A.7.1.1.8 The STG unit(s) shall be designed to operate with steam supplied from the combined cycle HRSG(s) and shall be subjected to the operating cycle, modes and operating conditions set forth in Section A.1 - Project Requirements and shall be designed for such conditions.
- A.7.1.1.9 The STG(s) shall be designed to allow continuous operation over the load range corresponding to the full emissions compliant, steady-state load range of one or all of the combustion turbines. The electrical output of the STG(s) shall be controllable from the Minimum Emissions Compliant Load (MECL) of a single CTG/HRSG through the STG(s) Turbine Maximum Continuous Rating (TMCR) and suitable for continuous operation across the load range.
- A.7.1.1.10 The STG(s) shall be capable of operating continuously in either fixed pressure or sliding pressure modes.
- A.7.1.1.11 Reliability, availability, and maintainability are of the utmost importance in the design of the turbine generator. The STG unit(s) shall be capable of 30 years of operation without distress, provided Buyer carries out maintenance according to Manufacturer's manual and without abnormal operation.
- A.7.1.1.12 The minimum major inspection interval shall be based on an interval of 10 years, 1,200 starts, or 48,000 operating hours, whichever is reached first.
- A.7.1.1.13 All STG mechanical, structural, and electrical components and systems shall be designed in accordance with the site design data provided in Section A.9 - Site Requirements and Design Criteria and codes and standards set forth in Section A.1- Project Requirements.

- A.7.1.1.14 The STG(s) shall be designed to operate, start up, and shut down in conjunction with a 100% steam bypass system, and shall provide the equipment necessary to protect the STG(s) during bypass operation, provided by Seller.
- A.7.1.1.15 The STG(s) shall be provided with an automatic, temperature-controlled exhaust hood spray system that shall control exhaust steam temperature to within the limits required to protect the STG equipment including exhaust expansion joints.
- A.7.1.1.16 The STG(s) shall be designed to operate in a no-load condition for a duration that allows all required pre-synchronization generator tests, and at speeds as high as the STG overspeed trip speed for short durations while staying within vibration limits established by the manufacturer.
- A.7.1.1.17 The STG(s) shall be designed to withstand a motoring condition, in its normal direction of rotation, over the full range of Steam Turbine operating pressures for one minute without damage, in compliance with the ST ALARM/TRIP set points set by the Original Equipment Manufacturer (OEM).
- A.7.1.1.18 Seller shall provide necessary equipment as required for automation of the turbine generator unit(s). This shall include those items of equipment, as recommended by the manufacturer, which shall allow complete turbine startup, operation, load change, and shutdown by the turbine control system (TCS) and complete control functions interface via redundant data link to the Facility control system.
- A.7.1.1.19 The equipment shall normally be monitored from the site's central control room and a Facility control system and shall be designed to permit such monitoring.
- A.7.1.1.20 The STG(s) shall be provided with a fault tolerant, electronic overspeed trip protection system. The system shall use triple redundant speed sensing circuits as a minimum. The TCS shall be provided with on line testing capability for Emergency Overspeed Test (EOST) modules. The TCS shall also be provided with an actual overspeed test. This test, however, must be performed with the generator off line.
- A.7.2 SCOPE OF WORK
- A.7.2.1 PROVIDED BY SELLER
- A.7.2.1.1 The Seller shall impose on each sub-Seller the applicable requirements of this specification and shall be directly responsible that the manufacturers and Seller's subcontractors are aware of these requirements, and that items and services meet the specified requirements.
- A.7.2.1.2 Seller's scope of supply shall include, but not be limited to, the following items:
- A.7.2.1.2.a. Steam turbine.
- A.7.2.1.2.b. Generator.
- A.7.2.1.2.c. Manufacturer's standard enclosures:
- A.7.2.1.2.c.1 HIP Steam Turbine enclosure and enclosure between LP Steam Turbine and Generator.
- A.7.2.1.2.c.2 Steam Turbine/Generator Excitation Equipment Enclosure.
- A.7.2.1.2.d. Excitation system, including:

- A.7.2.1.2.d.1 Voltage regulators.
- A.7.2.1.2.d.2 Excitation Transformer, including HV and LV terminal enclosures and cable supports.
- A.7.2.1.2.d.3 Solid state electronics.
- A.7.2.1.2.d.4 Current transformers.
- A.7.2.1.2.d.5 Instrumentation.
- A.7.2.1.2.d.6 Controls and protections.
- A.7.2.1.2.d.7 Ground fault protection and detection.
- A.7.2.1.2.d.8 Power system stabilizer.
- A.7.2.1.2.d.9 Thyristor rectifier.
- A.7.2.1.2.d.10 Field circuit breaker.
- A.7.2.1.2.d.11 Weatherproof, conditioned enclosure for thyristor rectifier and field circuit breaker.
- A.7.2.1.2.e. Turbine and generator grounding system.
- A.7.2.1.2.f. Foundation soleplates, fixators with grout forms, and shims.
- A.7.2.1.2.g. Main steam stop and control valves including supports and steam blow kits where applicable.
- A.7.2.1.2.h. Reheat steam stop and control valves, including supports and steam blow kits where applicable.
- A.7.2.1.2.i. HP exhaust (cold reheat steam) air-assisted non-return valve.
- A.7.2.1.2.j. LP steam stop and control valves, as applicable, including supports and steam blow kits where applicable.
- A.7.2.1.2.k. TCS, including control logic, turbine protection, data storage (may be common with CTG control system), human machine interface (HMI) (may be common with CTG control system), and sequence of event (SOE) system. The time tagged information of critical SOE points associated with STGs shall be communicated to the Facility DCS via OPC communication link for inclusion in the SOE report for the facility.
- A.7.2.1.2.k.1 The DCS and TCS timestamps for critical SOE signals including indications for Trips, Alarms, and Events shall match for tracking purposes.
- A.7.2.1.2.l. Common operator workstations and engineering workstations may be provided for CTG(s) and STG(s) (refer to CTG Spec, A.5). Two (2) operator workstations (Thin Clients) with dual 24" monitors shall be provided. The operator workstations shall be located in the control room. One engineering workstation (Thin Client) with dual 24" monitors shall be provided and also located in the control room.
- A.7.2.1.2.m. IP to LP steam crossover piping (if required by Seller's design).
- A.7.2.1.2.n. Overall plant performance shall be tested in accordance with ASME PTC 46. However, all test connections required to test the steam turbine in accordance with ASME PTC 6.2 shall also be provided.

- A.7.2.1.2.o. Exhaust casing relief diaphragms.
- A.7.2.1.2.p. Bolted turbine and generator shaft couplings.
- A.7.2.1.2.q. Turning gear (including jacking oil pump system if required).
- A.7.2.1.2.r. Lube oil system, including main pumps, emergency bearing oil pump (EBOP), oil conditioning skid, valves, filters, exhausters, strainers, heat exchangers, reservoir, instrumentation, and controls.
- A.7.2.1.2.s. Generator seal oil system, including main pumps, emergency pump, valves, filters, traps, instrumentation, and controls and any other equipment required to provide manufacturer's standard automatic unit.
- A.7.2.1.2.t. Electro-hydraulic control (EHC) system, including but not limited to, pumps, filters, valves, accumulators, coolers, vessels, enclosure, piping, and supports.
- A.7.2.1.2.u. Gland seal steam system, including valves, traps, exhausters, heat exchangers, instrumentation, and controls.
- A.7.2.1.2.v. LP steam turbine exhaust hood spray system, including valves, internal piping, instrumentation, and controls. Hood spray valves shall be installed in STG piping.
- A.7.2.1.2.w. If Seller proposes a hydrogen cooled generator, they shall also provide a carbon dioxide and hydrogen gas control system, including hydrogen measuring, hydrogen purity indicator, drain pots, valves, instrumentation, controls, pipe, and hangers within the terminal point location (inlet of gas valve station) if required by Seller's proposed design.
- A.7.2.1.2.x. If Seller proposes a hydrogen cooled generator, a hydrogen dryer shall be included.
- A.7.2.1.2.y. Insulation and lagging for HP and IP turbine casings (as necessary to meet noise emissions and thermal requirements), main steam stop and control valves, reheat stop and control valves and piping between the stop and control valves and the steam turbine.
- A.7.2.1.2.z. The Seller shall provide piping, hangers, and supports for all piping that connects manufacturer-provided equipment and systems, including lube oil, seal oil, EHC, generator cooling, hydrogen/CO₂ gas (if required), and gland steam.
- A.7.2.1.2.aa. Rigging devices.
- A.7.2.1.2.bb. Specialty tools.
- A.7.2.1.2.cc. Spare parts for startup and commissioning.
- A.7.2.1.2.dd. Separate spare part list for long term operation and maintenance.
- A.7.2.1.2.ee. The ability to perform valve calibration using the logic monitoring function of the Operator Station shall be provided. This shall include the ability to directly input simulated valve position commands.
- A.7.2.1.2.ff. Automated steam turbine startup mode selection software in the TCS.
- A.7.2.1.2.gg. Steam turbine and generator supervisory instrumentation system, including system and vibration monitoring.

- A.7.2.1.2.hh. Steam turbine auxiliary instrumentation wired to manufacturer's terminal enclosure and/or control panel.
- A.7.2.1.2.ii. Generator control panel, including multi-transducers and synchronizing relays.
- A.7.2.1.2.jj. Voltage transformer (VT) / surge arrestor (SA) enclosure.
- A.7.2.1.2.kk. Generator terminals, including neutral shorting bar.
- A.7.2.1.2.ll. Generator terminal enclosure.
- A.7.2.1.2.mm. Neutral grounding resistor.
- A.7.2.1.2.nn. Generator protection relay panel.
- A.7.2.1.2.oo. DC motor starters for emergency seal oil pump (ESOP) motor, (if required), and EBOP motor with NEMA 1 gasket design for indoor applications, and IP54/NEMA 3R outdoor applications.
- A.7.2.1.2.pp. Acoustic/weather enclosures shall include interior lighting and ventilation in accordance with requirements in Section A.1, Project Requirements. All lighting shall be LED type.
- A.7.2.1.2.qq. On-site storage for 6 months per manufacturer's standard recommendations.
- A.7.2.1.2.rr. On-site steam turbine operations and maintenance training, including OEM's standard STG general training and advanced controls maintenance training, consisting of five (5) business days for each course section.
- A.7.2.1.2.ss. Warranty.
- A.7.2.1.2.tt. All interconnecting piping and tubing, including hangers/supports, between the STG(s) and auxiliary support skids and other equipment/components.
- A.7.2.1.2.uu. If Hydrogen and CO₂ gas are required by Seller's proposed design, bulk gas storage systems and piping external to manufacturer's terminal points shall also be provided. Piping that connects between manufacturer-provided equipment may be provided by the manufacturer as determined by the Seller.
- A.7.2.1.2.vv. 100% Steam turbine steam bypass system.
- A.7.2.1.2.ww. Exhaust connection expansion joints.
- A.7.2.1.2.xx. Condensate piping to the exhaust hood spray system and steam seal attemperating system.
- A.7.2.1.2.yy. Safety relief valves located in the main and reheat steam lines.
- A.7.2.1.2.zz. Drain piping.
- A.7.2.1.2.aaa. Vacuum breaker valves and piping.
- A.7.2.1.2.bbb. Steam TCS has an inlet steam pressure control function utilizing sliding pressure control mode.
- A.7.2.1.2.ccc. Auxiliary steam supply to the steam seal regulator.
- A.7.2.1.2.ddd. Water supply and return piping for all coolers.
- A.7.2.1.2.eee. Lube oil.

- A.7.2.1.2.fff. Exhaust piping from vapor extractor.
- A.7.2.1.2.ggg. Redundant power supply to the TCS.
- A.7.2.1.2.hhh. EHC system cooling water piping.
- A.7.2.1.2.iii. Hydrogen system cooling water piping if required by Seller's proposed design.
- A.7.2.1.2.jjj. Hydrogen and CO₂ supply piping and vent piping if required by Seller's proposed design.
- A.7.2.1.2.kkk. Auxiliary electric power for the TCS.
- A.7.2.1.2.lll. Steam Turbine Bypass System.
- A.7.2.1.2.mmm. Control room alarms integrated in the Facility DCS.
- A.7.2.1.2.nnn. Mounting and wiring of any loose instruments.
- A.7.2.1.2.ooo. Connection from generator neutral to manufacturer-supplied neutral grounding equipment.
- A.7.2.1.2.ppp. Static excitation system interconnecting wiring and installation.
- A.7.2.1.2.qqq. Wiring and mounting of static excitation system remote indicators and control switches.
- A.7.2.1.2.rrr. Auxiliary power supplied to equipment, including 120V UPS system auxiliary power and 125 VDC auxiliary power.
- A.7.2.1.2.sss. Grounding.
- A.7.2.1.2.ttt. Motor control equipment for manufacturer-provided pumps, excluding DC starters.
- A.7.2.1.2.uuu. 480V Motor control center motor starters.
- A.7.3 SUBMITTALS
- A.7.3.1 GENERAL REQUIREMENTS
- A.7.3.1.1 Submit documents for review in accordance with the submittal requirements of Section A.1.4, Document Submittal Requirements, and Table A.1-1.
- A.7.3.1.2 Submittals shall include the following:
- A.7.3.2 GENERAL
- A.7.3.2.1 An experience list of operating installations with equipment of similar service and steam conditions.
- A.7.3.2.2 STG maintenance schedule.
- A.7.3.2.3 List of operational enhancement options and descriptions.
- A.7.3.3 DRAWINGS
- A.7.3.3.1 Drawings showing equipment lay-down area requirement with component weights and overall dimensions required for erection, disassembly, and maintenance of the turbine generator.
- A.7.3.3.2 Drawings showing details of the TCS and other controls furnished.
- A.7.3.3.3 P&IDs

- A.7.3.3.4 Drawings shall include equipment main dimensions, including all auxiliaries furnished therewith.
- A.7.3.3.5 Drawings shall have dimensions per U.S. customary units with metric dimensions in brackets where appropriate.
- A.7.3.4 PROCEDURES
- A.7.3.4.1 Full set of startup procedures which account for steam bypass system, including startup curves for ambient, cold, warm, and hot starts, and criteria for determination of ambient, cold, warm, or hot startup condition.
- A.7.3.4.2 Formulas for determination of operating hours for use in determining inspection/
- A.7.3.4.3 overhaul intervals, with descriptions of inspections and minor/major overhauls, including scope and duration for each.
- A.7.3.4.4 Description of operational limitations of the STG control valves with respect to operational control during startup and part-load operation to control HRSG floor pressure requirements, including the upper and lower limits of sliding pressure operation.
- A.7.3.4.5 Description and identification of the maximum expected HP turbine exhaust temperature and the operating condition where it is expected to occur (i.e., startup, other).
- A.7.3.4.6 Curves showing maximum allowable steam turbine exhaust pressure with alarm and trip limits over the full range of exhaust flows.
- A.7.3.4.7 Description of STG minimum continuous operating load, including criteria for determining minimum load, and maximum load ramp rate from minimum load.
- A.7.3.4.8 The Seller shall provide a detailed description of the construction, reliability, moisture erosion resistance, and experience for the last two LP stage blades.
- A.7.3.4.9 The Seller shall provide a statement describing the minimum expected STG blade life and the criteria required to achieve the desired blade life.
- A.7.3.4.10 The Seller shall provide a detailed description of the method of rolling the turbine with bypass in operation.
- A.7.3.4.11 General description of generator and exciter, including cooling system, bearings, couplings, insulation of alternator armature and field winding, end turn supports and terminal lead supports, armature coil construction, including provision for guarding against corona, terminals for stator, field, and exciter, and design of field collector rings and brushes.
- A.7.3.4.12 Complete description of the cooling system equipment, including sealing glands, coolers, pumps, dryers, purifiers, filling and purging equipment, instruments, and control devices as required.
- A.7.3.4.13 Complete description of voltage regulating equipment.
- A.7.3.4.14 Manufacturer's turbine oil flushing method, procedures, and recommendations.
- A.7.3.4.15 Main stop and control valve closure times.

- A.7.3.4.16 The Seller shall provide a single, comprehensive document identifying minimum preventative maintenance requirements for components in manufacturer's scope of supply, including buy-out items.
- A.7.3.5 ADVISORY SERVICES
- A.7.3.5.1 Not Used
- A.7.3.6 STEAM TURBINE THERMAL KIT
- A.7.3.6.1 Steam turbine heat balance diagrams.
- A.7.3.6.2 Turbine exhaust loss curve.
- A.7.3.6.3 Steam turbine degradation curves.
- A.7.3.6.4 Curves showing corrections to load for variations in HP steam flow for all guarantee heat balance cases. Curves showing corrections to load for variations in HP steam temperature for all guarantee heat balance cases.
- A.7.3.6.5 Curves showing corrections to load for variations in HP turbine flow capacity for all guarantee heat balance cases.
- A.7.3.6.6 Curves showing corrections to load for variations in reheat system pressure drop for all guarantee heat balance cases.
- A.7.3.6.7 Curves showing corrections to load for variations in reheat steam flow for all guarantee heat balance cases.
- A.7.3.6.8 Curves showing corrections to load for variations in LP admission steam flow for all guarantee heat balance cases.
- A.7.3.6.9 Curves showing corrections to load for variations in steam turbine exhaust pressure for all guarantee heat balance cases.
- A.7.3.6.10 Curves showing the turbine generator mechanical and electrical losses over a range of power factors.
- A.7.3.6.11 Curves showing corrections to load for variations in generator hydrogen pressure if applicable.
- A.7.3.6.12 Steam and water quality requirements per the STG manufacturer.
- A.7.3.6.13 Thermal kit requirements.
- A.7.3.7 GENERATOR CURVES
- A.7.3.7.1 Vee-curves, showing generator stator current (armature current) as a function of the field current (excitation current) for power factor ranges 0, through 1 in addition to rated, on both leading (underexcited) and lagging (overexcited) modes, at rated and reduced hydrogen pressures.
- A.7.3.7.2 Capability curve, showing active power as a function of reactive power on both leading (underexcited) and lagging (overexcited) modes. If generator has more than one output rated power, depending on coolant pressure, the Capability curve shall present all generator possible operation limits as function of coolant pressure.

- A.7.3.7.3 Short circuit curves for three-phase, line-to-line (or phase-to-phase), and phase-to-phase-to-ground (or double-line to ground) conditions, including the effect Automatic Voltage Regulator (AVR).
- A.7.3.7.4 Regulation curve with excitation and speed constant.
- A.7.3.7.5 No load and full load saturation curves for the exciters.
- A.7.3.7.6 Exciter load versus exciter voltage curves showing drooping characteristic.
- A.7.3.7.7 Saturation Curve – showing data on the excitation and voltage regulation system characteristics showing generator stator, field, and exciter per unit amperes vs. time. Specify which IEEE excitation system model type and constants are representative of the Equipment.
- A.7.3.7.8 Block diagram, gains, and time constants of the power system stabilizer, voltage regulator and exciter based on the standard models in IEEE 421.5. Model shall also be provided in PSS/E software.
- A.7.3.7.9 Necessary data/parameters, including constants, gains, and time constants, required for the Buyer's development of the standard GGOV1 PSS/E ".dvr" model file.
- A.7.3.7.10 Table of generator time constants and reactances (both saturated and unsaturated values), including actual tolerance of the synchronous, transient, sub-transient, negative sequence, and zero sequence reactances of the generator. As tested values shall be within $\pm 15\%$ of the design values.
- A.7.3.8 TEST REPORTS
 - A.7.3.8.1 Reports of all tests performed on steam turbine and generator equipment.
- A.7.3.9 MOTOR NAMEPLATE DATA
 - A.7.3.9.1 Motor nameplate data for all motors furnished in the form of nameplate drawing or a completed data form certified to be actual nameplate data.
- A.7.3.10 INSTRUCTION BOOKS
 - A.7.3.10.1 Seller shall furnish the Buyer with a complete instruction/operating book for all equipment furnished, consisting of manufacturers' instruction books, leaflets and drawings for maintenance and operation of the equipment and to give Buyer complete information for ordering of spare parts and dismantling of equipment. The information shall be separated into logical groups or sections. The instruction/operating book shall have an index listing all leaflets, in the same order as they appear in the book. (Individual submittal of various manufacturers' instruction books, etc., will not be acceptable.) Instruction books shall be provided in the form of two (2) hard copies and USB drive or other Buyer approved format.
 - A.7.3.10.2 Instruction books shall include:
 - A.7.3.10.2.a. Equipment identification by equipment numbers, station name, unit number and function name.
 - A.7.3.10.2.b. Final reduced drawings of general arrangements and cross sections, warranted performance data, design data, test results, and performance curves for all equipment.

- A.7.3.10.2.c. Complete operation, startup, shutdown, troubleshooting and maintenance instructions.
- A.7.3.10.2.d. Part lists shall be complete in every respect. Parts shall be identified by the original manufacturer's complete part number as well as by Seller's identification number.
- A.7.3.10.2.e. Lubricants list.
- A.7.3.10.2.f. Instruction books shall be thoroughly edited before submittal to exclude and/or to cross out text, data, illustrations, curves, etc., that do not apply to the specific equipment purchased.
- A.7.3.10.2.g. Seller shall supply additional information or replace information or entire instruction books if field inspection of equipment indicates omissions or inaccuracy of the books.
- A.7.3.11 MATERIAL SPECIFICATIONS
 - A.7.3.11.1 Seller shall provide material specifications (material information on chemical composition and mechanical properties) for the following main components:
 - A.7.3.11.1.a. Rotors.
 - A.7.3.11.1.b. Inner and outer casings, exhaust hood.
 - A.7.3.11.1.c. Rotating and stationary blades.
 - A.7.3.11.1.d. Main valve casings (Main Steam, Hot Reheat, LP Admission).
- A.7.3.12 SPARE PARTS
 - A.7.3.12.1 List of recommended operational spare parts for equipment, which shall include prices quoted by the manufacturer.
- A.7.3.13 COATINGS
 - A.7.3.13.1 All manufacturer-supplied coatings shall be in accordance with the requirements set forth in Section A.14. Coating details, including description of the manufacturer and product trade name for prime and finish coating systems, shall be submitted to Buyer for review/approval.
- A.7.3.14 INSTRUMENT NUMBERS AND DATA SHEETS
 - A.7.3.14.1 Seller shall furnish detailed specification, calibration, and setpoint data for all instruments and control devices furnished as part of this Specification, including devices furnished factory mounted on the equipment and devices furnished loose for mounting by the manufacturer.
 - A.7.3.14.2 The data furnished by Seller shall be included in the Buyer's Facility Instrument Index and Data Book and, therefore, shall be furnished in the format that is compatible with book format as follows:
 - A.7.3.14.3 Instrument numbers shall be assigned per Section A.10, Mechanical Requirements, and Design Criteria. Seller shall use the assigned number on all tags and in all references to the instrument on drawings, correspondence, manuals, reports, etc.

- A.7.3.14.4 Seller shall furnish the instrument specification, calibration, setpoint, and tagging data on his instrument data sheets. The instrument data sheets in ISA format shall be provided for all instruments furnished by the Seller.
- A.7.3.15 **QUALITY ASSURANCE PROGRAM**
- A.7.3.15.1 Manufacturer's quality assurance program documentation in accordance with Section A.4, Construction Requirements.
- A.7.3.15.2 Proposed shop inspection and testing program that identifies detailed items of inspection and testing according to the manufacturer's QA system. Buyer will review the proposed test plan and identify items requiring Buyer's witness.
- A.7.3.16 **CERTIFICATES OF COMPLETION**
- A.7.3.16.1 Certificates of Completion including checklists to confirm that the installation and commissioning is fully complete.
- A.7.4 **MECHANICAL REQUIREMENTS**
- A.7.4.1 **TURBINE GENERAL**
- A.7.4.1.1 STG and auxiliary equipment noise levels shall meet the requirements specified in the Site Design Criteria, Section A.9.
- A.7.4.1.2 The STG(s) and all components shall be of proven design with a minimum of 5 years of in-service history. Prototype design and components shall not be used. If offering alternative design with less proven components, Seller shall provide a detailed list of such components for review by Buyer.
- A.7.4.1.3 All parts and components supplied under this specification shall be designed for resistance to stress corrosion, cracking, fatigue, and creep over the design life, and shall consider the operational cycles defined in this specification.
- A.7.4.1.4 All materials shall be of industry-proven composition and successfully used in utility grade STG service at the specified design conditions and shall comply with applicable codes and standards. Material shall be selected for a minimum 30-year life. All components requiring cooling shall be designed with corrosion resistant materials wetted with cooling medium. Compatibility of materials with cooling medium is the responsibility of the Seller.
- A.7.4.1.5 The STG(s) shall be fitted throughout with renewable wearing parts.
- A.7.4.1.6 **Normal and Off Frequency Operation**
- A.7.4.1.6.a. Manufacturer shall supply operating restraints for both voltage and frequency. This information shall be provided in a step type chart which plots the combined variations over time.
- A.7.4.1.6.b. During system disturbances and abnormal conditions, the STG design shall permit safe undamaged extended operation with necessary restriction for operating load and time at off-frequency conditions (greater than 57 Hz or less than 63 Hz).
- A.7.4.1.6.c. STG(s) shall be designed for normal frequency of 58.8 to 61.2 Hz for continuous operation.

- A.7.4.1.6.d. STG(s) shall be designed such that it complies with PRC-024 and does not impinge on the frequency no trip zone.
- A.7.4.1.7 A worst-case, over-speed analysis shall be performed by the STG manufacturer. The manufacturer shall identify the basis for failure criteria.
- A.7.4.1.8 All casing welds shall be 100% examined by ultrasonic methods or by radiography. High pressure turbine casing shall be ultrasonic method or magnetic particle method. LP exhaust casing welds may be examined by magnetic particle or liquid penetrant methods. All welds shall be subject to magnetic particle/liquid penetrant examination. P91 hardness testing shall be performed for all shop and field welds.
- A.7.4.1.9 Borescope inspection ports for off-line inspection shall be provided for the last stages of each HP, IP, and LP turbine sections not accessible by a manhole.
- A.7.4.1.10 The Seller shall provide turbine atmospheric relief diaphragms and emergency relief trip function required to protect the complete STG unit from over pressure operation.
- A.7.4.2 STOP VALVES, INTERCEPT VALVES, AND CONTROL VALVES
 - A.7.4.2.1 Valve design shall provide the capability of on line partial stroke testing. Seller shall identify the maximum load at which this testing may be performed.
- A.7.4.3 TURBINE STEAM PIPING
 - A.7.4.3.1 The Seller shall provide three (3) HP inlet and three (3) reheat inlet steam pressure taps for load reference purposes.
 - A.7.4.3.2 The Seller shall provide 1-inch minimum turbine performance test connections with shutoff valves as required for acceptance tests in accordance with ASME PTC-6.2.
 - A.7.4.3.3 The Seller shall provide all pipe and fittings, including all required valves and accessories for the following systems:
 - A.7.4.3.3.a. Piping between inlet stop valves and HP turbine casing.
 - A.7.4.3.3.b. Piping between reheat stop valves and IP turbine casing.
 - A.7.4.3.3.c. Crossover piping between IP outlet and LP inlet turbine casings.
 - A.7.4.3.4 Piping which contains steam, or fluids with flash points higher than lube oil, and is within 25 feet of lube oil piping shall be insulated.
- A.7.4.4 ROTOR
 - A.7.4.4.1 Each STG rotor and its associated coupling shall be designed such that removal of any one rotor from its cylinder is possible without disturbing other rotors or cylinder covers.
 - A.7.4.4.2 Each rotor shall be machined from a one-piece solid steel forging integral with the shaft ends. Forging material shall be tested in compliance with rigid specifications. Rotors shall use boreless forgings, and shall be heat stress relieved.
 - A.7.4.4.3 Vibration shall be measured at the rotors. The manufacturer shall perform shop and field balancing and test procedures to limit vibration to 3.0 mil peak-to-peak on the rotors during final field operational runs, per ISO 20816-2 Zone A/B boundary.

- A.7.4.4.4 Turbine rotors shall be balanced to within 3 mil peak-to-peak at 3600 RPM in compliance with ISO 20816-2. Additionally, the rotor shall be tested for mechanical soundness and setting of buckets at 115% of operating speed in a dynamic spin pit with full vacuum. The rotor shall be tested at critical speed, running speed and 15% overspeed. No weight resolutions shall be made without a final run of the rotor to speed in which these vibration criteria are maintained and recorded. A heat stability test of the High and Intermediate Pressure (HIP) steam turbine rotor forging shall be provided in accordance with ASTM A472 while generator rotor will comply with manufacturer standards.
- A.7.4.4.5 A rotor 15% overspeed test shall be performed while fully bladed.
- A.7.4.4.6 The LP rotor shall be designed such that the turbine generator rotor system does not respond to torsional excitation occurring at forcing frequencies of 60 Hz or 120 Hz in either steady state or transient operation.
- A.7.4.4.7 The natural frequencies of the rotor system with blading shall be out of the range of $120 \text{ Hz} \pm 3 \text{ Hz}$.
- A.7.4.4.8 Rotor dynamic balancing without removal of the casings after installation on site shall be performed. This shall include turbine-end, generator-end, and mid-span access balance ports for all rotors. Coupling shall be provided with provisions for installing balance weights. The use of coupling bolts for installing balancing weights is not acceptable.
- A.7.4.4.9 The critical speeds of the rotating element of the assembled turbine generator(s) shall be sufficiently removed from the rated speed to avoid any adverse effect on the operation of the unit. The critical speed should avoid the rated speed by at least +15% and -10%, with the critical speed evaluation of the STG(s) based on Q-factor method which is internationally-recognized, and similar to ISO 21940. If critical speeds fall within the exclusion range stated above, Seller shall confirm that the rotor has sufficient damping and is capable of low sensitivity and smooth operation by Q-factor method. Documentation of critical speed determination and any associated damping analysis shall be provided to Buyer for review. Seller to confirm and adjust rotor vibration at site to ensure it is within design limits in operation.
- A.7.4.4.10 The influence of the foundation on all critical speeds shall be taken into account by the manufacturer.
- A.7.4.4.11 Damage due to circulating electrical currents in the turbine generator rotor shaft and bearings shall be prevented.
- A.7.4.5 BLADING
- A.7.4.5.1 All rotating blading shall use a well proven design and shall be made from bar block or forged material. The last stage(s) of low-pressure blades shall be designed for protection against erosion by wet steam.
- A.7.4.5.2 Steam turbine last stage blades shall be steel material. Use of titanium last stage blades will require Buyer approval acceptable.
- A.7.4.5.3 Where axial sealing is used, it shall be simple and shall not prevent or limit rapid starts and rapid load changes. Blade root fixing dimensional accuracy shall be such that interchangeability with spare blading is assured.

- A.7.4.5.4 Moisture in the steam at any turbine stage shall be limited based on good engineering practice, in order to ensure long turbine life. Seller shall list and describe all water removal features for the later stages of the LP turbine. A water removal nozzle shall be applied to the appropriate stage to protect blades from erosion if required based on steam moisture content.
- A.7.4.5.5 The STG blade life shall be equal to the design life of the Facility.
- A.7.4.6 BEARINGS
- A.7.4.6.1 All steam turbine and generator bearings shall be readily accessible and capable of removal and replacement without removing the rotors or turbine casings.
- A.7.4.6.2 Design shall provide for a visual indication of the oil flow from each bearing. Mixing of oil from different bearings is not permitted before the points where temperature measuring and the visual flow devices are installed.
- A.7.4.6.3 Journal bearing shall be horizontally split, capable of vertical and lateral adjustment without removal of the rotors.
- A.7.4.6.4 Thrust bearings shall be tilting-pad type.
- A.7.4.6.5 All bearings shall be machined to accept vibration probes. Field machining will not be permitted for installation.
- A.7.4.6.6 Bearing housings shall be designed for water-resistance, dust-resistance, and oil-leakage resistance.
- A.7.4.7 EXHAUST HOOD SPRAYS
- A.7.4.7.1 The Seller shall provide exhaust hood cooling sprays complete with all required control valves and initiating devices (i.e., temperature elements) for completely automatic operation. An alarm shall be provided to indicate exhaust hood high temperature.
- A.7.4.7.2 The exhaust hood spray system shall be fed from a source of condensate provided by the Seller.
- A.7.4.8 EXHAUST OUTLET
- A.7.4.8.1 The LP exhaust outlet of the STG(s) shall be arranged for welding/bolting to the condenser steam inlet duct(s).
- A.7.4.9 LUBE OIL SYSTEM
- A.7.4.9.1 A complete lubrication system including storage, main AC-driven oil pumps, DC EBOP, strainers, filters, pressure regulation, cooling, heating, reservoir, dual vapor extractors, mist eliminator, circulating pipe to and from the turbine and generator, instrumentation and controls, and all accessories necessary to supply the bearing oil requirements of the STG unit shall be furnished.
- A.7.4.9.2 The temperature control valve for the lube oil coolers shall be supplied by Seller with control implemented in the Facility DCS. The manufacturer shall provide the temperature control algorithm for the valve and valve specifications.

- A.7.4.9.3 The lubricating system main reservoir, pumps, heaters, coolers, and filters shall be packaged on a skid-mounted unit.
- A.7.4.9.4 The lube oil system shall be designed to provide a minimum of 10°F margin between the lube oil temperature leaving the bearings and the high temperature alarm setpoint for all ambient conditions.
- A.7.4.9.5 The lubricating and seal oil systems shall be designed to minimize the possibility of fire due to leakage of vapors or fluids as the result of physical damage or piping failures.
- A.7.4.9.6 The oil conditioning skid shall be per STG manufacturer recommendations for a minimum number of turnovers per 24-hour period. The skid shall include filtration, water separator coalescing filter, and pumps.
- A.7.4.10 OIL RESERVOIR
- A.7.4.10.1 The oil reservoir shall be sized to provide a minimum retention time of five (5) minutes, and 8 times/hour maximum circulation rate. The system shall be designed to provide adequate dwell time to separate entrained air and water and to permit safe coast down of the STG unit on loss of AC power.
- A.7.4.10.2 The oil reservoir shall be sized to hold full flow-back of all oil on shutdown.
- A.7.4.10.3 The oil reservoir shall be stainless steel with oil-resistant epoxy coating on the inside and outside. Accessories shall include a manhole and connections with block valves for oil makeup and for contaminated oil drains. Connections on the reservoir shall be provided to allow connection of a lube oil conditioner. The oil reservoir shall have a visual oil level indicator, thermocouple in wells near the heaters, a level transmitter and top-mounted relief and access doors. High-and low-levels shall be annunciated in the STG control system.
- A.7.4.10.4 Electrical immersion heaters with thermostatic control shall be furnished. Heaters shall be capable of maintaining the optimal oil temperature at minimum specified winter design ambient temperature conditions.
- A.7.4.10.5 Provisions shall be made for connection to an external turbine oil storage tank provided by others. The connection shall be a full ported gate valve.
- A.7.4.10.6 The oil reservoir shall include a pump-out connection to be used during commissioning. The connection shall be positioned in the lube oil tank to provide for removal of all the reservoir contents.
- A.7.4.11 OIL PIPING
- A.7.4.11.1 Lube oil piping, which interconnects manufacturer-supplied equipment and/or skids shall be supplied by the manufacturer as determined by the Seller.
- A.7.4.11.2 Oil, vapor, gas, and other auxiliary piping systems shall use welded joints to the maximum extent practical. The piping shall be adequately supported and braced to minimize the effects of vibration. Screwed or mechanical joints on these systems shall be minimized and used only where essential to the equipment.

- A.7.4.11.3 The supply oil piping from the duplex oil filter outlet to each bearing housing shall be ASTM A312 Type 304 stainless steel. Other piping shall be carbon steel (ASTM A106 Gr B).
- A.7.4.11.4 Hydraulic oil piping, tubing, valves, and fittings shall be ASTM A312 Type 304 stainless steel.
- A.7.4.11.5 Seal oil piping downstream of the filter to generator bearing shall be ASTM A312 Type 304 stainless steel, other piping shall be carbon steel (ASTM A106 Gr B).
- A.7.4.11.6 Lube oil piping shall be shielded, guarded, or routed in such a way so that any potential leakage shall not spray onto hot surfaces. The supply oil piping which is close to the hot parts may be guarded by running within the return oil pipe.
- A.7.4.11.7 Lube or seal oil piping which is pressurized to 50 psig or above with flanges outside the guard piping shall use flange guards. Guard pipe and flange guards are not required if a listed fire-retardant fluid is used or if piping is not routed close to the hot parts.
- A.7.4.11.8 Compression type couplings shall not be used.
- A.7.4.12 OIL PUMPS
- A.7.4.12.1 Two full capacity AC motor driven lube oil pumps and one partial capacity DC motor driven lube oil pump, including redundant auto-start pressure switches and motor starter, of sufficient capacity for shutting down the STG unit, shall be furnished.
- A.7.4.12.2 The auxiliary or redundant pump shall start automatically upon initial loss of normal lube oil pressure. The DC auxiliary pump shall start automatically upon loss of normal lube oil pressure after AC driven auxiliary or redundant pump fails to bring lube oil pressure back to normal. The redundant AC or the DC pump shall be capable of being started anytime to verify readiness.
- A.7.4.12.3 Each lube and seal oil pump shall have a suction strainer to protect the pump.
- A.7.4.12.4 All control equipment necessary for operation of DC equipment including the DC starter on loss of auxiliary AC power shall be provided.
- A.7.4.12.5 Cabling for redundant lube oil pumps shall be separated so that a single event does not render both pumps inoperable. Separation may be accomplished by the use of either physical separation of at least 10 horizontal feet between cable runs, or through the use of separate cables for the DC driven pump routed within dedicated conduit.
- A.7.4.13 LUBE OIL COOLERS
- A.7.4.13.1 Two (2) 100% water cooled lube oil coolers shall be provided. Cooling water shall be supplied by the cooling water system.
- A.7.4.13.2 The oil coolers shall be designed for not less than 110 % of the actual heat duty at the maximum rated capability of the turbine generator unit at the specified water rate and maximum cooling water temperature with a 0.001 ft²-F-hr/Btu fouling factor.
- A.7.4.13.3 Coolers shall be provided with inlet thermocouple at oil reservoir and outlet thermocouple on the headers (one (1) dual-element thermocouple (remote indication at HMI), pressure test connections, vent and drain connections.

- A.7.4.13.4 The lube oil system shall be capable of switching between oil coolers with the STG on line. Each lube oil cooler shall be removable for maintenance with the STG in operation. Coolers shall be arranged such that any fluid leaks shall not cause equipment damage or fires.
- A.7.4.14 LUBE OIL FILTERS
- A.7.4.14.1 A duplex, multi-element filter with a continuous flow transfer valve shall be provided. The two (2) 100% nominal, ten-micron or smaller filters with a manually controlled continuous flow transfer valve shall be furnished to filter contaminants out of the lubricating oil.
- A.7.4.14.2 Connections shall be provided for an auxiliary lube oil conditioner.
- A.7.4.15 VAPOR EXTRACTORS
- A.7.4.15.1 Two (2) 100% AC motor driven oil vapor extractors and one (1) mist eliminator shall be provided. Extractors shall purge bearing housings and reservoir of oil vapors.
- A.7.4.15.2 Coalescent type mist eliminators shall be provided. Electrostatic type mist eliminators are not acceptable. Oil shall be separated and returned to the lube oil reservoir.
- A.7.4.16 INSTRUMENTATION
- A.7.4.16.1 One (1) dual element Type-E ungrounded thermocouple for monitoring and alarm shall be provided to measure steam turbine and generator bearing metal temperatures.
- A.7.4.16.2 Bearing header and vapor extraction vacuum pressures shall be measured and indicated locally and on the STG control system.
- A.7.4.16.3 Sight glasses shall be included to allow confirmation of lube oil flow from each bearing.
- A.7.4.17 GENERATOR SEAL OIL SYSTEM (IF REQUIRED)
- A.7.4.17.1 The Seller shall provide a complete hydrogen seal oil system to lubricate the seals and prevent hydrogen from escaping from the generator under all conditions of operation. The seal oil system shall be designed for detrainning all hydrogen from oil returning to the lube oil reservoir, as applicable, and for preventing hydrogen from escaping into the reservoir in the event of a shaft seal failure.
- A.7.4.17.2 The system shall be single-sided or double-sided depending on the manufacturer's standard design and shall ensure sufficient redundancy. The system shall include at least 1 x 100% capacity AC motor-driven pump along with a backup DC motor-driven ESOP with automatic starting devices and motor starter, and all piping and valves required to interconnect the seal oil equipment skid to the generator. DC seal oil pumps shall be capable of being tested on line without tripping of the STG.
- A.7.4.17.3 The hydrogen seal oil system shall include supply system, hydrogen alarms with annunciation, gas temperature indicator, gas purity analyzer including indicator and accessories piped and wired to terminal blocks, hydrogen gas pressure transmitter and purity indicator, connections for hydrogen and CO₂ at the inlet of the gas valve station, and air purge.

- A.7.4.17.4 The seal oil system shall be capable of maintaining the oil pressure above the hydrogen pressure to ensure a tight seal during hydrogen pressure changes.
- A.7.4.17.5 The seal oil equipment shall be skid mounted and shall include an enclosure designed for the environmental conditions provided in Section A.9, Site Design Criteria.
- A.7.4.17.6 The Seller shall provide all piping, valves, and controls for connecting the turbine lube oil system to the hydrogen seal oil system, as applicable to the manufacturer's design.
- A.7.4.18 GENERATOR GAS SYSTEM (IF REQUIRED)
- A.7.4.18.1 The Seller shall supply a complete hydrogen gas system including valves and gauges.
- A.7.4.18.2 The generator hydrogen gas system design shall ensure the safe charging and evacuation of hydrogen from the generator. CO₂ shall be used as a purge gas. Controls shall be provided to maintain the required gas pressure. Supervisory instrumentation shall be provided to continuously indicate pressure, temperature and gas purity, and the presence of liquid.
- A.7.4.18.3 Finned type hydrogen coolers shall be provided. The coolers shall be installed in the stator enclosure and shall be accessible from above the generator room floor level for cleaning and tube repair.
- A.7.4.18.4 Hydrogen lines and equipment shall be routed and designed in such a manner as to avoid pockets of explosive mixtures containing hydrogen and air.
- A.7.4.18.5 Buyer to provide all gases prior to substantial completion.
- A.7.4.19 ELECTRO-HYDRAULIC CONTROL (EHC) SYSTEM
- A.7.4.19.1 Hydraulic fluid system shall be furnished as follows:
- A.7.4.19.2 The turbine EHC fluid system shall use a fire resistant, ASTM fluid.
- A.7.4.19.3 A stainless steel EHC reservoir shall be provided which shall have access doors, float type indicating oil gauge and level transmitter for high- and low-level alarm. The high- and low-level alarm shall be monitored with the transmitter signal in the TCS.
- A.7.4.19.4 The system shall be designed so that a momentary loss (< 5 seconds) of power to both fluid supply pumps shall not trip the STG. Each pump shall be sized to supply the fluid requirements of the turbine fully loaded. Failure of the operating pump or a condition of low hydraulic pressure shall start the standby pump.
- A.7.4.19.5 The EHC system shall be served by two (2) 100% AC motor-driven, positive displacement pumps with suction strainers.
- A.7.4.19.6 The EHC skid shall include one (1) hydraulic fluid cooler with stainless steel tubes.
- A.7.4.19.7 EHC system shall include two (2) full-size inline filters. Inline filter shall be metallic. Filter shall have differential pressure instrumentation.
- A.7.4.19.8 Type 304 stainless steel, welded piping from reservoir to and from turbine and to hydraulic actuators shall be provided.
- A.7.4.19.9 Dual Chromel constantan (Type E) thermocouple (one (1) dual-element thermocouple (remote indication at HMI) on EHC reservoir for fluid temperature.

- A.7.4.19.10 Triple redundant indicating pressure transmitters for indication and protective interlocks of hydraulic pressure.
- A.7.4.19.11 The EHC system shall include nitrogen charged bladder-type fluid accumulators located on pumping unit near valve actuators to avoid over-pressurization of components without tripping the steam turbine.
- A.7.4.19.12 The EHC reservoir shall include oil heating function.
- A.7.4.19.13 Seller shall provide a bypass provision for field flushing of hydraulic lines.
- A.7.4.20 GLAND STEAM SEALING SYSTEM
- A.7.4.20.1 The Seller shall provide a complete steam seal system that provides conditioned steam to the steam turbine's steam seal system and from the turbine to the gland steam exhausters.
- A.7.4.20.2 The gland steam sealing system shall be automatic and shall comply with ASME standard TDP-1-Prevention of Water Damage to Steam Turbines. Gland steam for start-up is to be drawn from the turbine bypass steam system.
- A.7.4.20.3 The diaphragm and shaft glands shall be spring supported. It shall be designed to prevent damage should contact occur during transient conditions and shall be able to withstand shaft bending due to uneven temperature distribution.
- A.7.4.20.4 Shaft end gland seals shall be designed such that the individual packing holders can be independently aligned both transversely and vertically in relation to the packing casing.
- A.7.4.20.5 The automatic gland steam system shall be comprised of:
- A.7.4.20.6 Steam seal glands in accordance with manufacturer's standard design.
- A.7.4.20.7 Automatic steam seal regulator for regulating seal steam supply for turbine seals. Steam seal pressure and temperature to be controlled to the manufacturer-required value from the sources stated above. Steam seal header pressure shall be controlled by the DCS system.
- A.7.4.20.8 Automatically operated shutoff and bypass valves.
- A.7.4.20.9 One (1) full flow shell and tube type gland steam seal condenser with stainless steel type 304 tubes, and two 100% AC motor-driven air exhausters, discharge and check valves, loop seal vents, drains and alarms.
- A.7.4.20.10 All instrumentation sensors, switches, and other devices for connection to the Facility DCS system.
- A.7.4.20.11 Gland steam unloading valve shall be furnished by Seller.
- A.7.4.20.12 The gland steam condenser shall be designed for the shutoff pressure of the condensate pumps and shall be designed to accommodate the full condensate pump flow (bypass arrangements within the channel are considered acceptable). Gland steam condensers shall be in compliance with HEI standards and shall be ASME code stamped.
- A.7.4.20.13 Expansion joints provided in steam seal piping shall be of stainless steel metal bellows type.

A.7.4.21 STEAM TURBINE BYPASS SYSTEM

A.7.4.21.1 The 100% steam turbine bypass system, supplied by the Seller, shall be designed to provide the ability of operating the HRSGs independently of the steam turbine. HP steam will cascade to cold reheat via the HP bypass valve station, through the HRSG's reheater and then be routed to the condenser via the HRH bypass valve station. LP steam will bypass the steam turbine and be routed to the condenser via the LP bypass valve station. The bypass system must be designed to operate at 100% of TMCR load. Upon steam turbine trip, either or both duct-firing in the HRSG, (if used), or inlet cooling at the CTG will also be tripped, reducing steam flows to the condenser during bypass operation.

A.7.4.22 TURNING GEAR

A.7.4.22.1 The Seller shall provide a turning gear which shall be of the automatic engagement type and shall be capable of starting the STG(s) from a standstill and driving it continuously at required speed, with normal bearing oil pressure. The turning gear shall automatically disengage when rotor speed surpasses shaft speed produced by the turning gear.

A.7.4.22.2 The turning gear shall be automatically engaged once the turbine is shut down and zero speed is reached. The turning gear shall be automatically disengaged at startup when rolling out. Manual operator engagement/disengagement and turning of the STG(s) shall also be possible.

A.7.4.22.3 Normal control of the turning gear shall be from the TCS with supervisory control from the Facility DCS operator console in the main control room. The turning gear system shall have the ability to jog the rotor to allow maintenance and borescope inspections. Seller shall specify all means, including options, for indexing rotor for such events. Seller to provide a local push button pendent to operate the turning gear system.

A.7.4.22.4 Turning gear shall be furnished complete with AC electric motor drive, and auxiliary switches to indicate in and out positions of gear mechanisms.

A.7.4.22.5 A suitable protective pressure device shall be provided to prevent the starting of the turbine generator by the turning gear until the proper oil pressure has been established in the turbine generator bearings.

A.7.4.22.6 Turning gear design shall be such that should the turbine be started while the turning gear is in operation, the gear shall immediately be thrown out of engagement without shock and shall not reengage.

A.7.4.22.7 An alarm device shall be furnished with the turning gear equipment to indicate failure of lube oil supply when the turning gear is in operation, and the protective equipment shall be connected so that if the oil pressure drops to an unsafe value, the turning gear shall be stopped automatically.

A.7.4.22.8 Turning gear shall automatically engage at zero shaft speed if proper oil pressure is established.

A.7.4.22.9 Turning gear shall include one (1) turbine tuning local operation box mounted on the turbine frame containing one "Turning Gear Engage" lever and one "Jog" pushbutton for turning the gear motor. The "Jog" pushbutton station shall permit the operator to rotate the turbine and stop it in any desired position.

- A.7.4.22.10 Turning gear system shall include a handle or other means for manual turning of the turbine and generator rotors by the operator.
- A.7.4.23 STEAM STRAINERS
- A.7.4.23.1 Steam strainers shall be of the removable type, either furnished integral with the throttle stop valves or as a separate unit for installation in the steam line ahead of the throttle stop valves. Strainers shall be provided with suitable lugs or eyebolts to facilitate removal of flange and strainer internals.
- A.7.4.24 TURBINE DRAINS
- A.7.4.24.1 Drain outlets shall be provided in sufficient number to completely drain and warm the furnished equipment. Turbine drains shall be provided at all locations where condensate may accumulate within the turbine casings and within steam lines situated after the turbine stop valves. Valves in drains from steam piping, turbine valve seats, and turbine shell shall be automatically operated metal seated globe valves.
- A.7.4.24.2 Manufacturer's and Seller's piping shall meet the requirements of ASME B31.1. The drain systems shall meet the requirements of ASME Standard TDP-1, Prevention of Water Induction Recommendations.
- A.7.4.25 ENCLOSURE FOR HP/IP TURBINE AND ENCLOSURE BETWEEN LP TURBINE AND GENERATOR
- A.7.4.25.1 The enclosure shall include the Contactor's recommended access clearance for maintenance and inspection around the full perimeter.
- A.7.4.25.2 The enclosure's walls and roof shall be painted metal siding and acoustically lined as necessary to achieve noise limits per Section A.9, Site Requirements and Design Criteria. Coating system and siding color shall be in accordance with Section A.14, Civil/Structural/Architectural Requirements and Design Criteria.
- A.7.4.25.3 The enclosure roof sections shall be self-supporting and removable to allow for maintenance activities.
- A.7.4.25.4 Structural steel members shall be hot-dipped galvanized.
- A.7.4.25.5 A combination of single and double doorways shall be provided for enclosure access. Doors shall be located at both ends of the enclosure and arranged to suit regular inspection and routine maintenance activities.
- A.7.4.25.6 A gutter system, including downspouts, along the full length of both sides of the enclosure shall be provided.
- A.7.4.25.7 Flashing and/or gaskets, as applicable, for penetrations, wall corners, roof sections and wall sections shall be provided.
- A.7.4.25.8 The Seller shall provide internal lighting and power receptacles for operation and maintenance. Lighting shall meet OSHA requirements for maintenance functions. External lighting at door entrances shall be provided. All lighting shall be LED type.
- A.7.4.25.9 Ventilation fans, inlet louvers and ventilation ducts suitable to facilitate venting heat and flammable gases, shall be provided to maintain safety conditions and an inside

temperature between ambient and 107°F with equipment operating at full load. Equipment and materials located in limited access areas shall be designed to withstand minimum and maximum anticipated air temperatures.

- A.7.4.25.10 The manufacturer shall prefabricate the enclosure to the maximum extent feasible in order to minimize site labor requirements.
- A.7.4.26 INSULATION AND LAGGING
- A.7.4.26.1 All high-temperature parts of the steam turbine shall be fully insulated with suitable materials. This shall include where the upper and lower sections of the high-pressure and intermediate-pressure, casing flanges, steam chests, and all other integral parts of the equipment requiring insulation, such as throttle or stop valves and strainers, piping connections between throttle or stop valves and steam chest, reheat stop valves, reheat intercept valves and reheat piping between intercept valves and the turbine, cross over or cross under pipes, gland steam condenser, etc. In general, all exposed surfaces that have operating temperatures of 140°F and above shall be considered hot surfaces and shall be properly insulated.
- A.7.4.26.2 Insulation shall be used where required by OSHA for personnel safety. Personnel protection shall be sized to maintain the insulation or lagging surface temperature at 140°F or below, at project site summer design conditions with still air inside of the enclosure.
- A.7.4.26.3 All materials shall be free of asbestos and free of man-made vitreous fiber (MMVF). Seller shall identify and provide basis for any applications where this requirement cannot be satisfied.
- A.7.4.26.4 Insulation shall have appropriate lagging. Seller standard removable type insulation shall be used where access is needed for valves, pipe connections, bolted joints, instrumentation, etc.
- A.7.4.26.5 Acoustical insulation shall be utilized where thermal insulation is not sufficient to meet the sound level requirements set forth in Section A.9, Site Requirements and Design Criteria.
- A.7.4.26.6 The manufacturer's insulation design shall minimize the differential temperature gradients between the upper and lower casings to allow for rapid re-start.
- A.7.4.26.7 Removable skirt lagging for the generator shall be provided as necessary for acoustical treatment.
- A.7.4.26.8 Insulation studs, holding clips, or similar fixation devices shall be provided for attachment of insulation wire to hold insulation securely in place.
- A.7.4.27 GUARDS
- A.7.4.27.1 Safety guards for all exposed revolving shafts and shaft couplings and for other exposed moving parts of the complete turbine generator unit shall be provided.
- A.7.4.28 STEAM VALVES
- A.7.4.28.1 Stop valves shall have backseat capability.

- A.7.4.28.2 Control and stop valve stems and bushings shall be designed with appropriate materials to allow 32,000 hours of operation before valves will require disassembly to remove scale.
- A.7.4.29 HAZARDOUS MATERIALS
- A.7.4.29.1 The Seller shall provide Safety Data Sheets covering all hazardous materials furnished under this specification. The Seller shall provide either copies of the applicable Safety Data Sheets or documents certifying that no Safety Data Sheets are required under federal, state, or local law, regulation, statute, or ordinance in effect at the jobsite.
- A.7.4.30 SPECIFICALLY PROHIBITED MATERIALS
- A.7.4.30.1 The following materials are prohibited for the project:
- A.7.4.30.2 Asbestos, including gaskets, packing, and other materials.
- A.7.4.30.3 MMVF (Fiber reinforced plastic (FRP) and epoxy impregnated glass roving used for generator electrical insulation is acceptable).
- A.7.4.30.4 Mercury.
- A.7.4.30.5 Lead-Based Paint.
- A.7.4.30.6 PCBs.
- A.7.4.30.7 Lead products (other than bearing babbitt) – Seller to justify any uses and notify Buyer.
- A.7.4.30.8 Ceramic fibers.
- A.7.4.31 WELDING
- A.7.4.31.1 Fabrication or repair welding of STG accessory piping or pressure/vacuum vessels shall be in accordance with the requirements of ASME Section VIII, and welding procedures and welder performance tests shall be according to ASME Section IX, JIS/JWES and manufacturer's standard.
- A.7.4.31.2 Fabrication or repair welding of the STG unit proper and manufacturer-supplied auxiliary skids and equipment shall be in accordance with manufacturer's written standards and procedures. Welders shall also be qualified for conformance to ASME Code Section IX, JIS or JWES and manufacturer's standards, as applicable.
- A.7.4.31.3 All completed welds shall be subject to nondestructive examination conducted in accordance with ASME Section V and the acceptance criteria of the appropriate Appendix of Section VIII of the ASME Boiler and Pressure Vessel Code, or with JIS/JWES or manufacturer's standards, as applicable.
- A.7.4.31.4 ASTM nondestructive examination procedures and acceptance criteria shall apply to all ASTM grade material furnished but not covered by ASME Section V applications. JIS or manufacturer's standards may be applied for manufacturer-supplied equipment, as applicable.
- A.7.4.31.5 The governing welding code for any equipment attached to primary equipment shall be dictated by the code associated with the primary equipment.

A.7.4.32 PREPARATION FOR SHIPMENT

- A.7.4.32.1 All external ferrous metal surfaces, except for machined surfaces, shall be cleaned to remove mill scale and other foreign material. External non-corrosion-resistant metallic surfaces shall be primed in accordance with manufacturer's standard requirements and coating system.
- A.7.4.32.2 Coating systems shall be suitable for the environment in which the STG(s) and auxiliary systems will be installed. Shop prime paint must be compatible with both service and finish painting. In applying the paint, care shall be taken so that nameplates, instrument faces, rotation arrows, etc., are not obscured or otherwise marred.
- A.7.4.32.3 All external machined surfaces shall be coated with cup grease or a grease-based preservative.
- A.7.4.32.4 Piping supports shall be either galvanized or shop-painted.
- A.7.4.32.5 Finish color requirements shall be per Section A.14, Civil/Structural/Architecture Requirements and Design Criteria.
- A.7.4.32.6 Oil from oil lubricated motors shall be drained from bearings prior to shipment and rotors shall be blocked to prevent movement during shipment.
- A.7.4.32.7 All openings shall be immediately closed after cleaning.
- A.7.4.32.8 Flange faces shall be protected with full diameter sheet metal blanks or plywood with rubber gaskets for sealing and held in place by at least four bolts.
- A.7.4.32.9 Openings prepared for field welding shall be closed using pressed metallic caps and sealed using waterproof tape.
- A.7.4.32.10 Vapor phase corrosion inhibitor (VpCI) to be applied to equipment as suits.

A.7.4.33 SPECIAL TOOLS

- A.7.4.33.1 Any special tools required for the proper maintenance of the turbines shall be provided by the Seller.

A.7.4.34 NAMEPLATES AND NUMBERING

- A.7.4.34.1 The Seller shall provide stainless steel nameplates with unique identification numbers for all Seller-provided equipment, valves, and instrumentation, and they shall be securely fastened in a visible location by means of rivets, welding, or screws.
- A.7.4.34.2 Requirements provided in Section A.10, Mechanical Requirements and Design Criteria, for numbering and labeling shall apply to the Seller's supply of the steam turbine, generator, exciter, electrical and control panels, HMI stations, equipment skids, electric motors, pumps, heat exchangers, instrumentation requiring interface connections with wiring by others, instrumentation wired directly into the Facility DCS, and valves.
- A.7.4.34.3 All equipment and instrumentation not included in the above list shall have the manufacturer's standard identification nameplate and number.

- A.7.4.34.4 In addition to the requirements above, pump specific information to be listed in the nameplate is: model number, service, starting limitation (i.e., time between starts) as applicable, flow rate, TDH, and RPM.
- A.7.4.34.5 Seller shall refer to Buyer's standard unit numbering of 1C.
- A.7.4.35 ADVISORY SERVICES
- A.7.4.35.1 The manufacturer shall provide technical field advisory (TFA) services to support installation, training, start-up, commissioning, performance testing, and operation of the equipment provided. The advisor(s) shall be technically trained and experienced with the equipment provided, and fluent in the English language.
- A.7.4.35.2 The manufacturer shall conduct a full and comprehensive training program to the Buyer's personnel to enable them to fully and efficiently operate and maintain the STG. The courses shall include material on inspection, maintenance, troubleshooting, and operation of all equipment furnished with the specification.
- A.7.4.36 SPARE PARTS
- A.7.4.36.1 The Seller shall provide a list of recommended operational spare parts for equipment, which shall include prices quoted by the manufacturer. This list will allow spare parts to be purchased directly from the manufacturer at the prices listed. Any spare items requiring special set-up or tooling (i.e., non-stocked or equipment specific items) shall be included. The Seller's recommended operational spare parts list shall include the following information, as a minimum:
- A.7.4.36.1.a. Spare part name, description, and part or catalog number.
- A.7.4.36.1.b. Recommended quantity for two years of service.
- A.7.4.36.1.c. Expected shelf life.
- A.7.4.36.1.d. Pricing valid for 24 months from time of last delivery of major spare parts by manufacturer, plus delivery price to the jobsite.
- A.7.4.36.1.e. Manufacturing lead time.
- A.7.4.37 Shop inspection and testing shall be in accordance with the requirements identified in the major equipment inspection and test plan, which meet the intent of the sub-articles below:
- A.7.4.37.1 The Seller shall submit a proposed shop inspection and testing program that identifies detailed items of inspection and testing according to the manufacturer's QA system. Buyer will review the proposed test plan and identify items requiring Buyer's witness.
- A.7.4.37.2 The Seller shall assure, through testing, that the equipment provided is in accordance with equipment specifications and will perform as specified.
- A.7.4.37.3 The results of all chemical and physical testing of the turbine and generator rotors, such as ultrasonic, magnetic, etc., shall be available to Buyer for review prior to shipment of turbine generator.
- A.7.4.37.4 STG unit individual sections shall be factory assembled to establish proper fit, alignment, critical clearances, weld connections, mating surfaces, and dimensional accuracy.

- A.7.4.37.5 The manufacturer shall perform operational tests of factory assembled systems or system components including, but not limited to, hydraulic control system governor assembly, valve servo mechanisms, turning gear assembly, and oil pumping systems, to establish proper function. Mechanical completion tests shall include all tests as are reasonably necessary, customary, or required by prudent power industry engineering practices.
- A.7.4.37.6 The STG equipment, including auxiliaries and accessories, (excluding field installed piping) which utilize fluids under pressure shall be factory inspected or leak tested as systems, parts of systems, or as elements in accordance with the manufacturer's accepted standard practice to ensure proper operation.
- A.7.4.37.7 The manufacturer's factory testing of components shall include, but not be limited to, the following:
- A.7.4.37.7.a. Rotors dynamic balancing.
 - A.7.4.37.7.b. Turbine rotor test at 115% of rated speed under full vacuum.
 - A.7.4.37.7.c. Generator rotor overspeed testing at 120% of rated speed for 2 minutes. The overspeed test shall not cause any permanent deformities, or other impact that will affect normal operation. The field winding shall be able to meet the requirements of the voltage withstanding test.
 - A.7.4.37.7.d. Participate in balance-of-plant DCS Factory Acceptance Testing (that portion applicable to the TCS interface) – Seller's scope to include one (1) trip with three (3) consecutive days at the DCS test location.
 - A.7.4.37.7.d.1 Software verification of graphic displays and functionality, simulations of startups, shutdowns, STG subsystems, alarms, and trips at manufacturer's facility.
 - A.7.4.37.7.d.2 Hardware verification against design documents, test hardware I/O functionality, test hardware failure actions (redundant processor checks, for example), and final inspection at the manufacturer's facility.
 - A.7.4.37.7.d.3 Test of the graphics and alarms for the STG(s) to the Facility DCS data link at the Facility DCS FAT. Seller shall provide a laptop simulator and connect it to the Facility DCS for checkout during the Facility DCS FAT.
- A.7.4.38 HYDROSTATIC TESTING
- A.7.4.38.1 The turbine main steam stop valves and reheat stop or reheat stop/intercept valves shall be mechanically suitable to isolate the turbine ends of the main steam and reheat piping for hydrostatic testing at a pressure of 1.5 times the system design pressure per ASME B31.1 with hydrostatic test devices installed. Hydrostatic test water temperature and valve body temperature will be near ambient temperature during these tests.
- A.7.4.39 GENERATOR TESTING
- A.7.4.39.1 Generator Factory Tests performed during the manufacture and assembly of the non-packaged power generators shall include all tests prescribed in IEEE Std C50.13, Table 8. Generator testing and quality control procedures shall be per Seller's subcontractor's standard and in compliance with IEEE 115. Copies of the applicable test reports for the

following process testing shall be provided. For applicable tests, a type test report will be submitted in lieu of a factory performed test report:

- Resistance of stator and rotor windings.
- Dielectric test of stator and rotor windings.
- Phase sequence.
- Overspeed to 120% of rated speed.
- Insulation resistance of stator and rotor windings.
- Measurement of bearing insulation resistance.
- Rotor winding shorted turn test at rated speed
- Stator core imperfection testing by EL CID, SMCAS, or core-loop testing

The following generator assembly tests are to be performed and reported:

- Air gap measurement.
- Oil flush.
- Wiring checks.
- Hydrostatic test of cooler.
- Air leakage test of generator rotor bore copper (if applicable).

- A.7.4.39.2 Special performance tests as described in IEEE Std C50.13, Section 9.1.3, Table 9, shall be made on the generator as a minimum requirement. Sudden short-circuit tests at reduced voltage to determine reactance and time constants is excluded from this testing. Type test reports shall be submitted for Customer reference.
- A.7.4.39.3 The excitation system shall be tested in accordance with IEEE 421.1 and 421.2.
- A.7.4.39.4 Thermal cycling test, voltage endurance test and dissection of production bars shall be performed per IEEE Std 1310 and IEEE Std 1043. Destructive stator bar testing shall be performed for the generator in accordance with Manufacturer's standard procedures.
- A.7.4.39.5 Seller shall perform an SMCAS/ELCID test of the stator core interlaminar insulation in accordance with the Seller's procedure/standards. This test shall be performed prior to the flux test.
- A.7.4.39.6 Seller shall perform a rated flux (core loop) test of the stator core interlaminar insulation for hot spots by establishing and maintaining 80-100% of rated working flux density for a minimum of 2 hours. Testing will be done in accordance with Seller's procedures.
- A.7.4.39.7 A report on SMCAS/ELCID and core loop tests shall be provided to Buyer.
- A.7.4.39.8 Hot spots for an unwound core are, defined as any area of the core with temperature greater than 5°C above the neighboring core temperature, shall be detected by means of infrared examination. If hot spots are detected, Seller shall provide a disposition for remediating the condition, including repair methods to be used, to the Buyer for review. Unless an alternate disposition is approved by the Buyer, Seller shall repair the core to within specifications eliminate hot spots. If directed by Seller's Engineering, an additional flux test, in accordance with the requirements of this specification, shall be performed if a core repair is made.

A.7.5 INSTRUMENTATION AND CONTROLS

The TCS and the turbine supervisory instrumentation (TSI) shall be included for proper operation and protection of the STG. All instrumentation and control devices shall meet the process instrument and installation requirements as specified in the I&C Requirements and Design Criteria, refer to Section A.13.

A.7.5.1 TURBINE CONTROL SYSTEM FUNCTIONAL REQUIREMENTS

A.7.5.1.1 The TCS shall be a redundant microprocessor-based control complete with the operator HMIs, printer, and field-mounted instrumentation and control devices. The control system shall have sufficient redundancy so that a single failure shall not result in the failure of the control system or unavailability of the turbine generator.

A.7.5.1.2 The TCS shall have the following functions, as a minimum:

A.7.5.1.2.a. The TCS shall have automatic turbine start-up logic. The startup of the turbine from turning gear to nominal speed under cold/warm/hot startup conditions, synchronizing the generator on to the transmission system and loading up the turbine shall be fully automatic with limited operator intervention. Provisions shall be made for the operator in the main control room to take control for manual operation of the turbine startup. The STG shall be capable of automatic unloading from 100% to 20% load.

A.7.5.1.2.b. The TCS shall monitor the main steam conditions, status of the turbine auxiliaries and thermal stresses, and shall provide all data necessary for turbine performance calculations.

A.7.5.1.2.c. The control and instrumentation systems shall incorporate a thermal stress evaluator package complete with all necessary hardware and software. The output of the stress evaluation calculation shall be used to automatically limit and hold the loading rates of the steam turbine. Thermal stress shall be limited during startup through use of HP inlet metal temperature to optimize startup times (cold/warm/hot) startup mode selection. The operator shall have override capability over these limits and rates. A rotor stress calculation function with load limiter for use after startup shall be provided.

A.7.5.1.2.d. The TCS shall be capable of shutting down the turbine generator and its auxiliaries in a safe and controlled manner from any load.

A.7.5.1.2.e. The TCS shall have the capability of automatically controlling the turbine speed to prevent the STG from reaching overspeed tripping point in the event of an instantaneous change in load from full load to no load.

A.7.5.1.2.f. Electronic overspeed protection system shall be provided. Speed sensors and electronics shall be triple redundant.

A.7.5.1.2.g. Valve positioning units (including valve position feedback) for:

- Main stop valves, including stop valve lift limit.
- Control valves with protection against excessive rate of initial pressure decay.
- Intercept and induction valves.

A.7.5.1.2.h. Testing circuits for turbine steam valves capable of fully stroking the control valve from the control room with the STG offline. All control, stop, and intercept valves shall be

capable of being tested and calibrated. Appropriate interlocks shall prevent opening stop valves for testing or during calibration when motive steam pressure may be present.

- A.7.5.1.2.i. Emergency trip devices, including:
- Overspeed trip with provisions for testing on line.
 - Vacuum trip, with provisions for remote reset.
- A.7.5.1.3 The TCS shall provide the operator "on demand" with all the information necessary for supervision of the automatic startup procedure and with all the information and step-by-step instructions necessary for normal startup. The information shall include, but not be limited to, the following:
- Values of all relevant process variables.
 - Status of all relevant equipment.
 - Abnormal conditions.
 - Present step (e.g., soaking at 2000 rpm).
 - Next step (e.g., synchronization).
 - Operator instructions (e.g., increase speed); an on line instruction manual is not required.
 - VAR and voltage regulator control.
- A.7.5.1.3.a. The TCS shall take into account the turbine bypass system.
- A.7.5.1.3.b. The TCS shall communicate with the Facility DCS with a redundant fiber optic datalink, using OPC over ethernet.
- A.7.5.1.3.c. Provision for hardwired trips of the steam turbine, one trip hardwired for an operator initial push button and indication in the main control room and one hardwired contact indicating that no turbine is operating.
- A.7.5.1.4 A complete and functional control system with an operator console (Thin Client, common with CTG) consisting of 24" minimum dual display monitors and keyboard to be located in the Facility's main control room shall be provided.
- A.7.5.1.5 An engineering console (Thin Client, may be common with CTG) with 24" dual monitors shall be provided with networked printer (may be common with CTG) to assist and support the engineering/programming functions of the TCS.
- A.7.5.1.6 Control logic drawings and written control system descriptions for complete control of the steam turbine and auxiliaries shall be provided. Actual instrument/equipment numbers shall be incorporated into control logic drawings.
- A.7.5.1.7 All key operating parameters of the steam turbine and generator shall be monitored according to the manufacturer's turbine protection diagram. Sufficient sensors and channels shall be provided such that a single component failure neither causes nor inhibits a trip, except for vibration and trip signals emanating from the Bently Nevada Model 3500 system. Redundant probe inputs are not required. To minimize nuisance

trips, the system shall employ such techniques as redundancy for critical items such as sensors and power supplies (n+2 modular arrangement or 100% redundant); two out of three voting for shutdown actions; pre-alarm warning before shutdown; time delay before shutdown; self-checking circuitry with diagnostic test points, etc.

- A.7.5.1.8 The TCS cabinet(s) shall be freestanding enclosures that shall be located in a building in the turbine area.
- A.7.5.1.9 An STG control cabinet shall be provided and utilized to interface with all control system I/O points with field wiring.
- A.7.5.1.10 The Facility shall be furnished with a remote-control console using a microprocessor-based Facility DCS. This console shall serve as the primary control interface used by Facility personnel and shall be located in the main control room. The Facility DCS shall access the TCS via a completely compatible and redundant OPC communication interface that allows two-way communication of analog and digital information between the two systems. The communication interface hardware and software shall be included in the TCS scope of supply. The manufacturer shall furnish to the Seller, complete information (software and hardware details) on the communications interface. All required hardware and software necessary to perform routine maintenance and configuration changes on the control system shall be provided. This shall include any special tools.
- A.7.5.1.11 The TCS shall provide data to perform full performance monitoring of the turbine. The TCS shall provide vibration monitoring, generator capability, rotor stress monitoring, temperature/pressure ramps, and trending of both current and historical data.
- A.7.5.1.12 All STG TCS screens shall be replicated in the Facility DCS.
- A.7.5.1.13 Not Used
- A.7.5.1.14 Emergency stop switches shall have a means to prevent accidental operation, such as clear plastic/Lexan covers or push button guards.
- A.7.5.2 TURBINE SUPERVISORY INSTRUMENTATION
- A.7.5.2.1 A complete TSI system, including locally mounted supervisory instruments, shall be provided as required for the safe startup, operation, and shutdown of the turbine generator.
- A.7.5.2.2 The TSI shall include, but not be limited to, the following features:
- A.7.5.2.2.a. Three (3) non-contact proximity probes installed near the thrust collar to measure thrust position.
- A.7.5.2.2.b. TSI sensors shall be provided in the following configuration:
- HP differential expansion: Single or dual non-contact probe.
 - LP differential expansion: Single or dual non-contact probes.
 - Keyphaser: Single non-contact probe.
 - Zero speed sensor (for turning gear operation): Single noncontact probe.

- Eccentricity: Single non-contact probe.
- Bearing shaft vibration: Two (2) probes per bearing at x-y position.
- Thrust bearing monitors.

A.7.5.2.2.c. One (1) set of three (3) speed sensors shall be provided for governor control and backup overspeed protection. A separate set of three (3) speed sensors shall be provided for primary overspeed.

A.7.5.2.2.d. Eccentricity – one (1) proximity probe on one end of the steam turbine and generator continuously measuring peak-to-peak and direct eccentricity (rotor and stator bow) at rotational speeds down to 1.5 rpm shall be furnished.

A.7.5.2.2.e. Temperature measurements of turbine metal, STG bearings, and generator stator.

A.7.5.2.2.e.1 One (1) dual element thermocouple per bearing for measurement of bearing metal temperature.

A.7.5.2.2.e.2 Twelve (12) single element RTD's for the measurement of temperature between coils in slot.

A.7.5.2.2.f. Temperature measurement (RTD's) of generator hot gas and cold gas, inlet and outlet, and AC exciter air cooler.

A.7.5.2.2.g. The STG supervisory system shall be a stand-alone Bently Nevada 3500. The system shall provide alarm and trip contact output signals connected to the TCS via hardwired connections.

A.7.5.3 INSTRUMENTS

A.7.5.3.1 All instrumentation used for turbine protection shall be triple-redundant using 2 out of 3 logic except for shaft vibration sensors.

A.7.5.3.2 In general, where Facility generation is directly reduced upon input failure, two independent measurement inputs shall be provided for process control and for process alarm.

A.7.5.3.3 Redundant pressure switches shall be provided for the emergency oil pumps (EBOP and ESOP).

A.7.5.3.4 Pressure indicators on pump headers shall be provided with snubbers and shall be glycerol filled.

A.7.5.3.5 Instrument enclosures, if used, shall be provided with a low temperature alarm to notify the operator when a heater fails or a heat trace circuit trips. The alarm can be wired into the heat trace panel alarm circuit.

A.7.5.3.6 Instrument tags shall be stainless steel, either screwed into instrument or attached to instrument by stainless steel wire.

A.7.5.3.7 Instrument tubing (304 stainless steel) shall not be welded and shall be 1/2 inch minimum size. Generator may utilize smaller tubing per Major Equipment standard design.

A.7.5.3.8 All instrumentation and control devices shall be suitable for the environment where they will be located.

- A.7.5.3.9 Instrument tubing (304 stainless steel) shall be installed in a neat workmanlike manner, properly sloped, and shall not show any sign of crumpling, over-bending, or flattening.
- A.7.5.3.10 Profibus and foundation fieldbus shall not be installed on instruments and valves.
- A.7.5.3.11 Instruments located on the packaged equipment systems shall be furnished, mounted, and installed by Seller.
- A.7.5.3.12 Pressure gauges shall be 4-1/2 inch local mounted, 3-1/2-inch board mounted and 1-1/2 inch to 2-1/2 inch mounted on air operated control valves.
- A.7.5.4 INSTRUMENT DATA
- A.7.5.4.1 Individual and unique tag numbers for each instrument shall be provided. A cross-referenced database between manufacturer's standard and the Seller's instrument numbering system, if different, shall be furnished. All instruments shall have a tag number attached to it.
- A.7.5.4.2 An "Instrument List" with descriptive information for all instruments shall be provided.
- A.7.5.4.3 Instrument data sheets in ISA format shall be provided for all instruments furnished for the STG.
- A.7.6 GENERATOR AND APPURTENANCES
- A.7.6.1 GENERAL
- A.7.6.1.1 The generator and its appurtenances shall conform in all respects to the Institute of Electrical and Electronics Engineers (IEEE) Standard for Cylindrical-Rotor 50 Hz and 60 Hz Synchronous Generators Rated 10 MVA and Above – IEEE Std C50.13 – and API Standard 616 (Chapter 8) or equivalent modern guide with its latest revision and additions plus all Governing Codes, Standards and Regulations details in A.1.5.
- A.7.6.1.2 The generator shall be of the cylindrical rotor type, air, hydrogen or water cooled. The generator shall be designed to develop the capacities specified under the operating conditions described. Cooling water design conditions are given in Section A.10, Mechanical Requirements and Design Criteria.
- A.7.6.1.3 Generator shall be asbestos free.
- A.7.6.1.4 Rotor shall be installed in the generator and shipped to site, whenever logistics permits.
- A.7.6.2 GENERATOR RATING
- A.7.6.2.1 The generator shall comply with all requirements of IEEE Std C50.13.
- A.7.6.2.2 The generator shall operate continuously at TMCR, during normal operating conditions and remain in operation during system disturbance. The generator nor its excitation system nor its accessories shall limit Facility output. The following shall be the minimum requirements for operation modes and withstanding capability of the generator:
- A.7.6.2.2.a. The generator shall be capable of continuously supplying its active power output at the rated output within the System Frequency range of 59.7 to 60.3 Hz. If there is a

decrease of power in the frequency range of 59.7 to 57.6 Hz, it shall not be more than the required proportionate value of the System Frequency decay.

- A.7.6.2.2.b. Within a voltage variation range of 95% to 105% from nominal, the generator shall be capable of supplying its Active Power and Reactive Power outputs.
- A.7.6.2.2.c. STG design shall comply with PRC-024 and not impinge on the frequency no trip zone.
- A.7.6.2.3 Not Used
- A.7.6.2.4 Generator shall be protected by a two-level V/Hz relaying scheme as indicated below:
 - A.7.6.2.4.a. Level 1 pickup for alarm at 106% Volts/Hertz level instantaneously.
 - A.7.6.2.4.b. Level 2 to be set to a pickup for trip at 118% Volts/Hertz with a 2 second delay.
 - A.7.6.2.4.c. The V/Hz limiter in the AVR set at 105% Volts/Hertz level.
 - A.7.6.2.4.d. The protection in the AVR set to operate at 110% Volts/Hertz level.
- A.7.6.2.5 Generator overcurrent shall be in accordance with IEEE C50.13.
- A.7.6.2.6 The generator shall remain in synchronism if the system frequency momentarily rises to 62.4 Hz or falls to 57.6 Hz.
- A.7.6.2.7 The generator shall withstand a continuous negative sequence unbalanced current as specified in IEEE Std C50.13 without any resulting damage.
- A.7.6.2.8 The generator shall withstand the unbalance loading during clearance by the backup protection of a close-up phase-to-phase fault on the grid without tripping.
- A.7.6.2.9 The rating of the generator shall be such that when operating at the rated power factor and the cooling method, the generator shall be capable of continuously carrying the maximum output as provided in the heat balance diagram of the driving turbine without exceeding the guaranteed temperature rise. Neither the generator nor its excitation system nor its accessories shall limit Facility output. The generator shall have the following additional characteristics:
 - A.7.6.2.9.a. Cooling method..... by Seller
 - A.7.6.2.9.b. Rating..... by Seller
 - A.7.6.2.9.c. Power factor..... 0.85
 - A.7.6.2.9.d. Voltage..... by Seller
 - A.7.6.2.9.e. Number of phases 3-phase
 - A.7.6.2.9.f. Frequency..... 60 Hz
 - A.7.6.2.9.g. Speed..... 3600 r/min
 - A.7.6.2.9.h. Short Circuit Ratio:..... Not less than 0.50 at rated H₂ pressure at maximum cooling water temperature, or at rated power if air-cooled method is selected

A.7.6.2.9.i.	Negative sequence capability I_2^2t	Continuous I_2 capability ≥ 0.10 p.u. and $I_2^2t \geq 30s$ (or better, per manufacturer's latest standard series)
A.7.6.2.9.j.	3-phase short circuit capability	Not less than 10 seconds
A.7.6.2.9.k.	Unbalance fault withstand.....	Per IEEE C50.13
A.7.6.2.9.l.	Minimum BIL	150 kV
A.7.6.2.9.m.	Excitation system response ratio.....	2.0 or greater
A.7.6.2.9.n.	Nominal excitation voltage	Manufacturer's optimum
A.7.6.2.9.o.	Stator winding connection	Star
A.7.6.2.9.p.	Number of leads brought out	6
A.7.6.2.9.q.	Field winding conductors.....	Copper
A.7.6.2.9.r.	For hydrogen or pressurized air cooled generators, rated gas pressure	Manufacturer's standard
A.7.6.2.9.s.	Stator winding insulation.....	Class F with Class B rise
A.7.6.2.10	The generator windings and end-turns shall be braced for peaking duty requiring frequent startups and shutdowns (see Section 1A, Project Requirements, for approximate number of startup and shutdown cycles per year).	
A.7.6.2.11	The STG shall be capable of operating in parallel with other electrical generating units connected to the transmission system, on inductive or non-inductive loads, constant or fluctuating, with leading or lagging currents, within the specified capacity of the generator.	
A.7.6.2.12	The generator shall operate at all loads and endure sudden changes of load between zero and nameplate capacity of the generator without damage. The sudden opening of the external circuit shall not result in damage to the generator.	
A.7.6.2.13	The waveform of the generated voltage measured from line-to-line on open circuit at rated voltage and speed shall have a deviation factor of not more than 10% from a pure sine wave.	
A.7.6.2.14	Generator and Excitation System shall be designed to comply with PRC-024 Attachment 1 – “Off Nominal Frequency Capability Curve” and PRC -024 Attachment- 2 – “Voltage Ride-through Time Duration Curve” without invoking PRC-024-2, Section B Paragraph R3.	
A.7.6.2.15	Generator shall be capable of operating continuously at maximum rated kVA output at any power factor between the rated power factor lagging or leading and unity and at any voltage between 5% below and 5% above rated volts. The generator shall be capable of operating at the maximum rating of the selected frame size, over the range of rated power factor.	
A.7.6.2.16	Generator shall be braced to withstand the fault current, which will result from any type of short circuit at the terminals for times not exceeding short time thermal requirements,	

when operating at rated kVA and power factor and +5% over voltage. The duration of the short circuit shall not cause injurious heating nor mechanical damage.

- A.7.6.2.17 The exciter shall have sufficient capacity to operate within its current rating with the generator operating at its maximum capability.
- A.7.6.2.18 Cooling System: The generator shall be of closed cycle hydrogen cooled generator, air-cooled generator or water-cooled generator stator. If air-cooled cooling method is selected, the generator shall be totally enclosed water-to-air (TEWAC) per IEC 60034-6, IC8A1W7. If open ventilated, high-efficiency filters shall be considered/included in case of dusty sites.
- A.7.6.2.19 For closed cooling cycles, the generator housing shall be completely enclosed and arranged for cooling by hydrogen or air. The slip ring housing can be open ventilation with air cooling. Suitable fans furnished as an integral part of the generator rotor and a closed ventilating system shall be provided to ensure necessary cooling under all specified operating conditions with a conservative factor of safety. Pressure and temperature devices shall determine the availability of the cooling system.
- A.7.6.2.20 For hydrogen or pressurized air cooled cycles, the generator stator housing shall have a minimum number of gas tight joints to minimize the leakage of hydrogen or air and shall be designed strong enough to contain within the housing the destructive effect of an internal explosion of the gas contents.
- A.7.6.2.21 For hydrogen or pressurized air cooled cycles, the terminal bushing assembly shall be designed for operation without leakage under the specified maximum pressure.
- A.7.6.2.22 For hydrogen cooled cycles, the stator housing shall be so designed that pockets of hydrogen gas will not be formed in any location inside the housing during the purging operations.
- A.7.6.3 STATOR
- A.7.6.3.1 All stator parts shall be tested to ensure unrestricted passage of hydrogen gas or air.
- A.7.6.3.2 Generator stator winding shall be insulated with an approved type of insulation designed and selected with a view to permanence and flexibility under all expected conditions, and such that the whole may form a compact and solid construction free from all internal air spaces.
- A.7.6.3.3 Phase and neutral terminals shall be marked consecutively in the order of their phase sequences.
- A.7.6.3.4 Heaters shall be provided within the stator to avoid condensation moisture during stand-by periods.
- A.7.6.3.5 Not Used
- A.7.6.3.6 A minimum of four single element 100-ohm platinum RTD's per phase shall be provided for the stator windings. Leads shall be brought out to a junction box.
- A.7.6.3.7 Stator mounting and core construction shall be designed to reduce the effects of vibration.

- A.7.6.3.8 Stator core shall be made of high permeability low-loss silicon punching. Stator core and iron heating shall be minimized.
- A.7.6.3.9 The stator core and windings shall be mounted in such a manner that double frequency magnetic vibrations will be held to a minimum (not to exceed 4 mils).
- A.7.6.3.10 The stator enclosure shall be equipped with at least four openings with removable covers permitting visual inspection of the interior.
- A.7.6.3.11 End windings and connections shall be adequately spaced and braced with nonmagnetic supports to prevent any appreciable coil movement or any damage to the windings or other parts during terminal short circuits as specified.
- A.7.6.3.12 The section of the coils in the slots, and for a suitable distance beyond the ends of the slots, shall be properly wrapped or treated to prevent corona.
- A.7.6.3.13 Manufacturer shall incorporate into the design suitable features to prevent the generation of copper particles in the generator.
- A.7.6.3.14 Liquid detectors and drains shall be provided at the low point(s) in accordance with manufacturer's standard design.
- A.7.6.3.15 A 1-inch NPT connection shall be provided in the stator cold gas discharge for Seller's temperature detecting device.
- A.7.6.3.16 The Seller will supply all hydrogen and carbon dioxide storage as required and will provide piping and connections between storage and the manufacturer's control stations.
- A.7.6.3.17 If Seller provides a hydrogen cooled generator, they shall also include a hydrogen control cubicle to provide an indication of trouble in any part of the hydrogen control system. Each alarm point shall have a dry form "C" contact suitable for interfacing with the Facility DCS. The hydrogen control cubicle shall be suitable for an outdoor environment and the appropriate hazardous area classification.
- A.7.6.3.18 The main terminals shall be arranged for isolated phase bus duct connection. Suitable studs shall be provided to which the flanges for the bus duct can be connected.
- A.7.6.4 ROTOR
- A.7.6.4.1 The generator rotor shall be capable of withstanding, without mechanical damage, an overspeed of 20% for two minutes, in accordance with IEEE Std C50.13.
- A.7.6.4.2 Field winding shall be hard drawn silver bearing copper and not subject to permanent distortion during operation.
- A.7.6.4.3 Generator rotor winding shall be insulated with mica or other suitable material specially chosen to ensure against deterioration by temperature, vibration, or other causes due to constant running under all working conditions.
- A.7.6.4.4 The field winding insulation shall be provided with liberal creepage distance. The completed winding shall be fully baked and seasoned before balancing.
- A.7.6.4.5 Shaft currents shall be minimized. Insulation shall be furnished for the collector end journal bearing (laminated type), shaft seals, oil and water piping, or other suitable means provided to ensure that no damage will result from shaft currents. Terminals

shall be provided for checking the integrity of this insulation. A copper braid or carbon brush shaft grounding assembly shall be furnished.

- A.7.6.4.6 Generator rotor shall have two retaining rings made of 18 Mn – 18 Cr forged steel.
- A.7.6.4.7 Collector rings shall be provided with an insulating barrier.
- A.7.6.4.8 Collector ring brushes shall be of such number, design, location, and spacing that they can be removed one at a time for maintenance or replacement while the generator is running under full load current.
- A.7.6.4.9 Brushes shall be mounted in such a way as to prevent uneven wear of the collector rings.
- A.7.6.4.10 Field collector rings and brushes shall have ample size and area to operate without injurious sparking or heating under any condition of operation for which the generator is designed, and shall be sized and arranged to permit one brush to be removed during operation without overloading the others.
- A.7.6.4.11 The field windings shall be designed for direct cooling by the cooling medium (air or hydrogen).
- A.7.6.4.12 Design shall allow for high voltage bushing replacement without removing the generator rotor.
- A.7.6.4.13 Generator bearings shall be pressure lubricated from the turbine oil system.
- A.7.6.4.14 At least one generator bearing shall be insulated.
- A.7.6.4.15 Space heaters shall be provided for the generator collector housing. Location and maximum surface temperatures of the heaters shall be such that no damage can be caused to the insulation or other equipment. Heaters shall be rated 480V or 208/120V. All space heaters shall be wired-out to a separate Seller-supplied enclosure.
- A.7.6.5 EXCITATION SYSTEM
 - A.7.6.5.1 General
 - A.7.6.5.1.a. A static excitation system shall be supplied and shall include a line fed excitation transformer.
 - A.7.6.5.1.b. Excitation transformer shall be dry type, cast resin suitable for outdoor use.
 - A.7.6.5.1.c. Transformer shall be sized with sufficient capacity based on ceiling voltage at the rated generator conditions.
 - A.7.6.5.1.d. The exciter shall be of the fast-response type. The response ratio shall be 2.0 or greater at generator rated load conditions. At least one spare bridge must be provided (n+1) so that the loss of a bridge has no impact on full load operation. On the Power System Stabilizer (PSS), coordinate Over Excitation Limiter (OEL) and Minimum Excitation Limiter (MEL) or Under Excitation Limiter (UEL) with Generator reactive capability curve. A digital AVR shall be supplied – per IEEE 421.5.
 - A.7.6.5.1.e. Transformer BIL rating shall comply with the requirements of IEEE C57. Overload protection for the excitation transformer shall be provided.

- A.7.6.5.1.f. The system shall be rated to provide generator voltage regulation from 95% to 105% of the rated voltage at any operating load.
- A.7.6.5.1.g. An exciter field breaker shall be provided.
- A.7.6.5.1.h. The entire exciter shall be totally enclosed in a NEMA 3R/IP 54 enclosure with inspection windows and shall be arranged with air cooling (no water) to maintain a proper ambient temperature. Appropriate enclosure lights and receptacles shall be provided. Light switches shall be mounted on the outside of the housing at entry points. Light fixtures shall be LED type.
- A.7.6.5.1.i. A fused field flashing circuit shall be provided. Field flashing power shall be from the Facility DC system.
- A.7.6.5.1.j. High and low voltage limiter in accordance with NERC requirements shall be furnished.
- A.7.6.5.1.k. The generator field temperature shall be monitored and displayed.
- A.7.6.5.1.l. Rated thyristor and excitation transformer secondary voltage shall be greater than or equal to 108% of the rated generator field voltage.
- A.7.6.5.1.m. Rated thyristor and excitation transformer secondary current shall be greater than or equal to 106% of the rated generator field current.
- A.7.6.5.1.n. The static excitation system shall be a high initial response Potential Source-Rectifier exciter with a minimum response ratio of 2.0. The system shall be rated to provide continuous current to the synchronous machine field, with the field at its maximum temperature, while the generator is delivering maximum MW output at rated power factor and 105% rated terminal voltage.
- A.7.6.5.1.o. The system shall permit continuous, stable operation of the generators under automatic voltage control, or while any automatic limiter is functioning for normal load conditions. The system shall be capable of producing positive and negative output voltages in response to control signals from the regulator.
- A.7.6.5.1.p. The excitation system shall be designed of adequate rating to furnish the required excitation at guaranteed normal and transient conditions. The voltage response ratio of the excitation system shall be not less than 0.5 when tested in the field by suddenly reducing the voltage sensed by the voltage regulator from 100 percent to 80 percent, with the excitation system providing excitation to the generator while it is operating at rated kVA, voltage, frequency and power factor, and its field at normal temperature, and with the excitation system components and voltage regulation settling at values which give acceptable stability as recommended in IEEE STD 421A. All regulators shall be automatic, continuously acting without dead band.
- A.7.6.5.1.q. The excitation system shall be capable of regulating the generator voltage from 95 to 105 percent of the rated voltage of the generator at any load level up to the generator nameplate rating. The excitation system terms used are in accordance with IEEE 421.1.
- A.7.6.5.1.r. The excitation system shall have the ability to control the field voltage of the generator so that transient changes in regulated voltages are effectively suppressed and sustained oscillations in regulated voltages are not produced by the excitation system.

- A.7.6.5.1.s. The excitation system shall be controlled from the operator station along with manufacturer supplied industrial PC location to be determined by Seller.
- A.7.6.5.1.t. The rectifiers in the power conversion units shall be protected from damage due to transients on the AC and DC lines. The continuous rating of the rectifier shall be at least equal to 106% the excitation amperes required by the synchronous generator when the machine is operating at rated voltage at rated power factor and at rated kVA with one conversion/bridge or redundant hot backup out of service.
- A.7.6.5.1.u. Thyristor rectifier is capable of operating at rated excitation current with one rectifier element out of service.
- A.7.6.5.1.v. Sufficient redundancy of rectifier bridges and fuses shall be provided to allow operation of the generator at maximum ratings without exceeding the designed temperature rise of the exciter and the generator field with one rectifier fuse assembly out of service.
- A.7.6.5.1.w. The thyristors shall be of the silicon type. The initial capacity of the thyristors shall have an allowance to cover any loss in capacity due to aging.
- A.7.6.5.1.x. Thyristor rectifier cubicle enclosure shall be rated IP41 or NEMA 3R in accordance with manufacturer's standard.
- A.7.6.5.1.y. The excitation system shall include the necessary equipment for discharging the generator field for normal and emergency shutdown of the generator. This equipment shall include an adequately rated high-speed discharge contactor or static switch, discharge resistor network and voltage suppressors connected in shunt with the main field.
- A.7.6.5.1.z. The communications from the Facility DCS to the excitation system shall be truly redundant. As a minimum, the digital voltage regulator shall be equipped with an ethernet port for communication. A graphical function software tool shall be provided on USB drive or other Buyer approved device for programming capability of the AVR software. The program shall be capable of performing on line interrogation, setting adjustments, diagnostics, and tests. The software program shall consist of functional block library with logic functions, programmable for customization of I/O. The software shall be Windows based, menu-driven and user-friendly.
- A.7.6.6 AUTOMATIC VOLTAGE REGULATOR
 - A.7.6.6.1 General
 - A.7.6.6.1.a. The voltage regulator shall be of the continuously acting type, micro-processor based, consisting of static components, responsive to the voltages of all three phases and of type that does not require the mechanical acceleration of parts to perform the regulating function. A continuously acting type of voltage regulator is defined as one which initiates a corrective action for a sustained infinitesimal change in the controlled variable.
 - A.7.6.6.1.b. The Automatic Voltage Regulator (AVR) shall be redundant with bumpless fast transfer capability.

- A.7.6.6.1.c. The solid-state circuitry shall be conservatively designed to be as reliable as practical so that failure of any control element will not cause dangerous or uncontrollable mis-operation of the system.
- A.7.6.6.1.d. The voltage regulating system shall, under steady-state operation, furnish control power to the thyristors from the control power sources listed within this section.
- A.7.6.6.1.e. The voltage regulator shall automatically gate the controlled rectifiers.
- A.7.6.6.1.f. Maintain the average three-phase generator voltage within $\pm 0.5\%$, without hunting, when operating under steady load conditions for any load within the operating range of the generator.
- A.7.6.6.1.g. After the initial generator voltage maximum is reached following any load rejection up to 115% of rated load, the voltage regulator shall restore the generator terminal voltage to a value not more than 5% above or below the voltage being held before load rejection. The regulator shall maintain the voltage within these limits throughout the period of generator overspeed.
- A.7.6.6.1.h. After elements of the voltage regulator have stabilized in temperature, slow changes in ambient temperature shall not cause changes in generator terminal voltage of more than 0.5%.
- A.7.6.6.1.i. Under steady-state conditions, with the generator open-circuited, the regulator shall not permit the terminal voltage to vary more than 2.5% for variations from 95% to 110% in generator frequency. Below 95% of rated frequency, the terminal voltage may respond to the volts-per-hertz limiter as specified.
- A.7.6.6.1.j. Provide an adjustable on line and offline over excitation limiter (OEL), which shall automatically limit the excitation of the generator to a safe value, with the excitation under the control of the automatic regulator. The limiter shall assume control in a smooth and stable fashion.
- A.7.6.6.1.k. Provide an adjustable under excitation limiter (UEL) to prevent loss of generator synchronism due to under-excitation. The limiter circuitry shall use input from the generators potential and current transformers and automatically establish a lower limit for excitation. The circuitry shall assume control in a smooth and stable fashion.
- A.7.6.6.1.l. The excitation system shall have a volts/hertz limiter to prevent generator armature and power transformer saturation. The limiter circuitry will automatically adjust the regulator output to prevent operation at an undesirable volts/hertz level.
- A.7.6.6.1.m. Provide automatic tracking so that manual regulator will automatically track the output of the automatic regulator to allow a bumpless transfer between auto and manual control, without requiring adjustment by the operator.
- A.7.6.6.1.n. Selectable terminal voltage, reactive power, and power factor control modes shall be available as part of the AVR.
- A.7.6.6.1.o. PT loss protection shall initiate an automatic transfer to backup AVR.
- A.7.6.6.1.p. The voltage regulator auto and manual control shall be microprocessor based, fully digital.

- A.7.6.6.1.q. Analog components in the voltage regulator are not acceptable. This regulator shall include the required power devices.
- A.7.6.6.1.r. The regulator provided for control of the generator field voltage shall have provision for remote control. The system shall contain a means for not exceeding the maximum excitation limit, a volts-per-Hertz limiter and runback to provide generator step-up transformer over-excitation protection under automatic control.
- A.7.6.6.1.s. The ac regulator provided for automatic control of the generator terminal voltage shall have reactive current compensation, under-excited reactive limit, maximum excitation limit and under-frequency limit. The voltage adjuster shall be solid state or motor driven for remote control and provided with limit switches as required for position indication.
- A.7.6.6.1.t. Design shall include a Power System Stabilizer.
- A.7.6.6.1.u. Enclosures shall be rated for the conditions required by manufacturer-supplied excitation system enclosure design.
- A.7.6.6.1.v. The excitation system manual regulator, used for testing only, shall regulate the field generator current to within +/-1% of the set point selected by the operator. It shall operate independently from the terminal voltage regulator.
- A.7.6.6.1.w. The interface signals between excitation systems and TCS are via hardwire. The TCS shall provide the necessary excitation signals to the DCS via completely redundant communications link.
- A.7.6.6.1.x. All information within the excitation system shall be made available to the Facility DCS via the communication link.
- A.7.6.6.1.y. All alarms and diagnostic messages from the exciter shall be presented to the operator in clear, easily understandable text messages.
- A.7.6.6.1.z. The ability to modify and maintain excitation control parameters shall be done via the manufacturer supplied interface.
- A.7.6.7 SURGE AND POTENTIAL TRANSFORMERS CABINET
- A.7.6.7.1 A surge and potential transformer cabinet shall be furnished. The cabinet shall house surge capacitors, surge arresters, potential transformers, disconnect links, copper bus, and all other materials and accessories in a NEMA 4 enclosure.
- A.7.6.7.2 Two (2) sets of three (3) single phase potential transformers are required. Each potential transformer shall have a split secondary with primary relaying connected to the “x” winding and the backup relaying connected to the “y” winding. One set shall be dedicated to metering, synchronizing, and voltage regulating functions. The second set shall be dedicated to protection functions. A voltage balance relay shall be provided to detect and inhibit trips in the case of PT fuse failure. Potential transformer secondary circuits shall be three phase, four wire, 120 volts AC. Two (2) auxiliary potential transformers shall be provided to isolate the line and the machine PTs from the synchronizing circuits.
- A.7.6.7.3 Surge Protection: Lightning arresters and surge capacitors shall be furnished by the Seller. Lightning arresters shall be station type. Surge capacitors shall not contain PCBs.

- A.7.6.7.4 Generator Neutral Grounding shall be provided. “Detuned” grounding shall be considered, per discussions on IEEE Std 142.
- A.7.6.7.4.a. A suitable means of grounding the generator shall be provided. This equipment shall provide a high resistance generator grounding system which will limit the generator neutral current.
- A.7.6.7.4.b. A high resistance grounding system (NGR) for the generator shall be provided. The grounding system shall be designed to provide 100% generator ground fault protection.
- A.7.6.8 FACILITY DCS INFORMATION DISPLAY AND RELAYING
- A.7.6.8.1 Panel mounted generator meter shall include a Revenue Class Electro Industries Nexus 1250 (w/minimum 4 meg internal memory) or AMETEK Power Instruments JEMStar series High Accuracy Revenue Meter. Manufacturer is to provide Factory Calibration reports.
- A.7.6.8.2 Transducers shall be provided for the following quantities (except watt-hours) to display in the Facility DCS. Unless specifically noted otherwise, transducers shall have an accuracy of 0.5% or better and shall have an output range of 4-20 mA.
- A.7.6.8.3 At a minimum, transducers shall be provided for the following parameters to be displayed in the Facility DCS:
 - A.7.6.8.3.a. Generator Frequency.
 - A.7.6.8.3.b. Generator Voltage, phase-to-phase (3 phases with a voltmeter switch).
 - A.7.6.8.3.c. Generator Current (3 phases with an ammeter switch).
 - A.7.6.8.3.d. Generator Field Voltage.
 - A.7.6.8.3.e. Generator Field Current.
 - A.7.6.8.3.f. Generator Gross Watts.
 - A.7.6.8.3.g. Generator Gross VARS.
 - A.7.6.8.3.h. Generator Gross Watt-hours (with a pulse output suitable for tele-metering).
 - A.7.6.8.3.i. Power Factor (showing both leading and lagging) transducer minimum accuracy of 3.0%.
- A.7.6.8.4 The following metered data shall be available via the Seller’s hardwire interface for remote operation:
 - A.7.6.8.4.a. Voltage.
 - A.7.6.8.4.b. Current.
 - A.7.6.8.4.c. Kilowatts (generator terminals).
 - A.7.6.8.4.d. Kilovars.
 - A.7.6.8.4.e. Generator gross watt-hours.
- A.7.6.8.5 Generator Protective Relaying.
 - A.7.6.8.5.a. Primary and backup relays shall be provided. Primary shall be SEL-300G and backup shall be an alternative model SEL relay. These shall provide all controls, logics, and

provide protection of the turbine generators and auxiliaries against potential damaging conditions. These relays shall also be capable of automatic tripping and alarming. All relays shall be cybersecurity-hardened per NERC CIP-013. A cybersecurity event logging shall be included.

- A.7.6.8.5.b. Buyer shall be consulted to determine protection preferences (out of step, voltage controlled overcurrent).
- A.7.6.8.5.c. The following generator protective relays and protection schemes shall be provided:
- Phase fault protection, generator differential.
 - Impedance back up 21P.
 - Ground fault protection during normal operation and for ground faults close to the neutral.
 - Short reach loss of field with time delay and long reach loss of field.
 - Pole slipping protection.
 - Reverse power.
 - Generator no-load over excitation (for off-line protection).
 - Negative sequence.
 - Dual volts per Hertz with stepped activation.
 - Voltage balance.
 - Generator motoring protection.
 - Automatic synchronizing.
 - Exciter and generator field ground fault protection.
 - Over excitation protection.
 - Transfer trip from switchyard or substation.
 - Stator over temperature protection.
 - Inadvertent energization.
 - Under / over frequency.
 - Under / over voltage.
 - Generator breaker failure protection.
 - Lockout relay for generator breaker trip.
- A.7.6.8.5.d. Generator shall be capable of continuous operation in the “No-Trip” zone of NERC PRC-024 without limitation by protective relaying.
- A.7.6.8.5.e. Generator and excitation transformer relay settings shall meet requirements of NERC PRC-019, -024, -025 -026, and -027.
- A.7.6.8.6 The generator stator temperature relay shall be used for alarm only.
- A.7.6.8.7 Generator lockout relays shall be provided. As a minimum, two (2) generator and one (1) breaker failure lockout relays shall be furnished, each with a minimum of 14 NO and 14 NC contacts. Relays shall be located on the generator control cabinet and equipped with test switches.

- A.7.6.8.8 The turbine generator shall have appropriate synchro check relay and auto synchronizer to allow synchronizing with the grid.
- A.7.6.8.9 Current transformers used for generator protection shall be relaying accuracy suitably sized for the burden.
- A.7.6.8.10 Eighteen (18) bushing-type current transformers (CTs) shall be furnished for use with relaying and metering. Three (3) per each line side bushing and three (3) per each neutral side bushing shall be provided.
- A.7.6.8.11 CT relaying accuracy shall be C400 and metering accuracy shall be 0.3B1.8.
- A.7.6.9 MOTORS
- A.7.6.9.1 For specific motor requirements, see Section A.12, Electrical Requirements and Design Criteria.
- A.7.6.10 GROUNDING
- A.7.6.10.1 For grounding requirements, see Section A.12, Electrical Requirements and Design Criteria.
- A.7.6.10.2 Seller shall provide suitable copper ground grid connection pads on skid for connection to Facility grounding systems. Two diagonally opposite ground pads shall be furnished on the generator. All equipment shall be grounded by copper conductor permanently bonded to skid and bolted to equipment.
- A.7.6.10.3 A copper ground bus extending the full length of the panel shall be provided. The ground bus shall be bolted to the panel structure and effectively ground the entire structure. The ground bus shall be grounded to the skid or the Facility ground grid at both ends.
- A.7.6.10.4 Each circuit requiring grounding shall be individually and directly connected to the copper ground bus and fastened with a drilled and tapped connection. Each ground point shall be readily accessible for removal, testing, and replacement.
- A.7.6.10.5 The cases of all instruments, relays, and switching devices shall be grounded.
- A.7.6.11 PANELS
- A.7.6.11.1 For panel requirements, see Section A.12, Electrical Requirements and Design Criteria.
- A.7.6.12 TERMINAL BLOCKS AND WIRING
- A.7.6.12.1 For terminal block and wiring requirements, see Section A.12 Electrical Requirements and Design Criteria.
- A.7.6.13 MISCELLANEOUS REQUIREMENTS
- A.7.6.13.1 All auxiliary switches, control switches and alarm switches shall be heavy-duty type suitable for 125 VDC operation and with inductive rating of at least 0.5 ampere at 250 VDC. Pressure switch contacts shall have a minimum continuous rating of 1 ampere at 120 VAC and an interrupting rating of 0.4 ampere inductive at 120 VDC. Level switches contacts shall have a minimum continuous rating of 1 ampere at 120 VAC and an interrupting rating of 0.3 ampere inductive at 120 VDC. Limit switch contacts shall have

- a minimum continuous rating of 1 ampere at 120 VAC and an interrupting rating of 0.4 ampere inductive at 120 VDC.
- A.7.6.13.2 Not Used
- A.7.6.13.3 All solenoid valves shall be suitable for continuous operation and shall have coils with Class “H” insulation. Solenoids shall have NEMA 4 enclosures.
- A.7.6.13.4 All junction boxes on the turbine generator or mounted on equipment furnished separate from the turbine generator and not located in a hazardous area shall have hinged doors and shall be enclosed in NEMA 4 boxes. NEMA 4 Boxes can be painted per OEM standard.
- A.7.6.13.5 Power source conditioning to protect against transient voltages is the responsibility of the Seller.
- A.7.6.13.6 All manufacturer supplied equipment and control systems shall be shop wired and tested to the fullest extent possible prior to shipment.
- A.7.6.13.7 Wiring integral to manufacturer supplied control cabinets, electric drives, and equipment skids shall be provided. For skid mounted assemblies, all instrumentation and control wiring connections by the Seller to manufacturer's equipment shall be external to the equipment on numbered terminal strips in junction boxes or electrical panels. For components provided loose (valves, instruments, etc.) that will be installed in piping, Seller will terminate field cables at the devices themselves.
- A.7.6.13.8 All Seller supplied wiring shall be clearly identified on manufacturer’s drawings using dashed lines or notes.
- A.7.6.13.9 Thermocouples and RTDs on the turbine and generator shall be wired out by Seller to manufacturer-supplied junction boxes mounted at the turbine and generator. Manufacturer supplied thermocouple wiring shall be terminated on thermocouple terminal blocks of the appropriate type.
- A.7.6.13.10 If AC power is unavailable or the AC motor driven pumps fail, the emergency DC motor driven pumps (EBOP or ESOP) shall start automatically.
- A.7.6.13.11 DC Motor Starters for the EBOP & ESOP shall be mounted in Seller’s electrical room.
- A.7.6.13.12 AC lubricating oil pumps shall be started and stopped by the Facility DCS. Instrumentation required to sense, display, and start the backup lube oil pump shall be provided by the Seller and mounted in the Seller's instrumentation panel. Provisions shall be provided within the TCS to test the auto-start provisions of each pump.
- A.7.6.13.13 Radio Frequency Interference:
- A.7.6.13.13.a. The control system shall be designed to operate in a power plant environment and shall exhibit immunity to stray magnetic fields.
- A.7.6.13.13.b. The control system shall be immune to radio frequency interference generated by radio transceivers.

- A.7.6.13.13.c. Operation of radio frequency generating equipment within 5 feet of combustion turbine equipment, with cabinet doors closed, shall not adversely affect combustion turbine operation.
- A.7.6.13.14 All associated control devices such as local/remote selector switches, indicators, and alarms shall be provided on the Generator Control and Protection Relay Panel. The malfunction alarm contacts for all equipment and systems shall be wired to the terminal blocks for remote alarm use.

END OF SECTION



SECTION A.8

GENERATOR STEP-UP TRANSFORMER (GSU)

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SECTION A.8

GENERATOR STEP-UP TRANSFORMER (GSU)

A.8.1. EXTENT

- A.8.1.1 Seller shall design, manufacture, furnish, shop assemble, inspect, test, paint, prepare for shipping, preserve during shipment and storage at site, and deliver two (2) transformers, complete with all accessories as hereinafter specified. The Work shall include all necessary and/or usually supplied equipment and appurtenances for the safe, efficient, and convenient operation of the transformers within the scope of this specification whether or not such items are specifically referred to in this Specification.
- A.8.1.2 The transformers shall be three-phase, 2-winding, 60 Hz, outdoor, step-up, oil-immersed type, cooling class ONAN/ONAF/ONAF. Refer to tables A.8.3.3.1 and A.8.3.4.1 for transformer ratings. Transformer High Voltage ratings are nominal, actual grid voltages may be slightly different and will be provided during detailed engineering. Transformer low voltage ratings are nominal, to be compatible with generator manufacturer's standard voltage. The transformers' LV windings shall be connected in delta. The transformers' High Voltage winding shall be connected in wye. The High Voltage winding star point shall be solidly grounded. All windings shall be copper.
- A.8.1.3 The average winding temperature rise above ambient temperature shall not exceed 65°C at rated load when tested in accordance with IEEE Std C57.12.90 using the combination of connections and taps that give the highest average winding temperature rise.
- A.8.1.4 The maximum (hottest spot) winding temperature rise above ambient temperature shall not exceed 70 °C at rated load for any combination of connections and taps that give the highest maximum (hottest spot) winding temperature rise. This requirement is more stringent than the standard allowed maximum (hottest spot) winding temperature rise of 80 °C in IEEE Std. C57.12.00. The maximum (hottest-spot) winding temperature rise above ambient shall be determined by one of the conditions described in IEEE Std. C57.12.00.
- A.8.1.5 Seller shall review the isolated phase bus duct drawings and ensure there are no problems with potential overheating at the transformer tank and isolated phase bus interface. Low voltage bushings' ratings shall include the bus duct temperatures.
- A.8.1.6 Transformers of the same type and rating and purchased on the same order or contract shall have like parts that are interchangeable both electrically and mechanically with one another. Like parts, when interchanged, shall perform their function equally well in every respect.
- A.8.1.7 The transformers will be used to provide power to a high-voltage electrical transmission system from the output of Facility generators. During Facility start-up and shutdown, the transformers will also be used to back feed. The transformers shall be designed for suitable operation with normal life in the service conditions and shall be rated as specified below.

- A.8.1.8 There will be a circuit breaker between the generator step-up (GSU) transformer and the combustion turbine generator. There is not a circuit breaker between the GSU transformer and the steam turbine generator.
- A.8.1.9 The Seller shall provide the magnetization or core saturation characteristic of the transformers. This magnetizing characteristic shall be suitable for input to the simulation studies using an electromagnetics transient software program. The characteristic shall be a Voltage (p.u.) vs. Current (p.u.) or flux (weber) vs. Current (Amps).
- A.8.1.10 Geomagnetically Induced Current (GIC) Capability:
- A.8.1.10.1 Seller shall present information regarding the capability of the transformers to withstand GIC. Information shall include estimated flux, time constants and resulting temperatures at critical locations in the magnetic circuit and structural components at dc current levels of 10, 25, 50 and 100 A DC for a five-minute duration in the wye-connected windings. Seller shall also present information on past experience and testing of similar designs. Seller shall also indicate the core leg type – 3 or 5 leg core for GIC evaluations.
- A.8.1.11 Transformer tanks, cores and coils, tap changers, radiators, heat exchangers, control equipment, bushings, lightning arresters, and all accessory equipment shall be adequately anchored, braced, and packed to prevent damage from vibration, shock, or dampness that might reasonably be encountered in transportation, handling and storage outdoors.
- A.8.1.12 The transformer manufacturer shall place confined space “Warning Signs” in conspicuous locations on the transformer tanks and covers.
- A.8.1.13 Design Review Meeting:
- A.8.1.13.1 A design review meeting is required for all prototype transformers within the scope of this Specification. The Seller's designer(s) shall meet with the Buyer's Engineer to review the basic design of the transformers. This design review shall be held after the basic design has been established, but before manufacturing begins. The primary intent of the design review is to allow the Buyer's Engineer to gain an understanding of design practices applied to transformers being supplied to the Buyer by the Seller, and to ensure transformer design meets all applicable industry and specification standards and requirements. All information obtained in the design review will be held in strict confidence. It is not intended that the design review would cause modifications to the design. However, should it be discovered that the Seller has not complied with the specified requirements in the contract; the Seller must make those changes necessary to comply with all contract specifications. The Seller's representative shall notify the Buyer's Engineer of a reasonable date for a design review meeting at least two weeks in advance for Seller's in the continental U.S. and four weeks for others. Pre-design contract reviews are encouraged in order to clarify requirements for both parties. At the Buyer's Engineer discretion, the Seller shall, in lieu of a design review meeting, provide a written submittal of the required information subject to the Buyer's Engineer review and comment. Further requirements covered within this Specification or the Ordering Specification may be discussed at the design review, and the Seller shall be prepared with details of how they will meet or exceed such requirements. The Seller shall prepare a written report summarizing the details covered at the meeting and submit them to the

Buyer's Engineer for review within four (4) weeks of the date of design review.
Tabulations of all data shall be included.

A.8.2. PROJECT DOCUMENTS AND DRAWINGS

A.8.2.1 The work specified in this Section shall be in accordance with project documents and drawings included in the following Section:

A.8.2.2 Section A.16.4.7 - Single Line Diagram

A.8.3. TECHNICAL DATA

A.8.3.1 Values shall be the output of Seller's calculation. The values shown on the Conceptual Single Line Diagram are for bid purposes only.

A.8.3.2 The capability rating of each transformer shall be calculated based on the project heat balances. The capability rating of each transformer shall exceed the full output of its respective turbine-generator plus 10 percent, throughout the range of operating ambient temperatures and power factors.

A.8.3.3 The CTG-1A transformer shall have the following ratings:

Table A.8.3.3.1 – CTG-1A Transformer Ratings

		HIGH-VOLTAGE H-WINDING	LOW VOLTAGE X-WINDING
a	Nameplate Rating at 65°C Rise:		
a.1	Power Ratings w/ Cooling Class (ONAN/ONAF/ONAF)(MVA)	360 / 480 / 600	
b	Nominal System Voltage (line-to-line)(kV)	[Insert Value]	23.5
c	Rated winding voltage (line-to-neutral).....(kV)	[Insert Value]	N/A
d	Transformer connections (wye or delta)....(kV)	wye	delta
e	Impedance (ONAN)	[Insert Value]% ± 7.5%	
f	Tap changer - taps to be manually changed when transformer is not excited (DETC):		
f.1	Above nominal rated voltage at full MVA capacity (Number of taps and percent volts each tap)	2 @ 2-1/2%	N/A
f.2	Below nominal rated voltage at full MVA capacity (Number of taps and percent volts each tap)	2 @ 2-1/2%	N/A
g	System neutral	Solidly grounded	
h	Basic lightning impulse insulation level (BIL) (kV)	[Insert Value]	150
i	Neutral basic lightning impulse insulation level (BIL)..... (kV)	150	

A.8.3.4 The STG-1C transformer shall have the following ratings:

Table A.8.3.4.1 – STG-1C Transformer Ratings

		HIGH-VOLTAGE H-WINDING	LOW VOLTAGE X-WINDING
a	Nameplate Rating at 65°C Rise:		
a.1	Power Ratings w/ Cooling Class (ONAN/ONAF/ONAF)(MVA)	252 / 336 / 420	
b	Nominal System Voltage (line-to-line)(kV)	[Insert Value]	21
c	Rated winding voltage (line-to-neutral).....(kV)	[Insert Value]	N/A
d	Transformer connections (wye or delta)....(kV)	wye	delta
e	Impedance (ONAN)	[Insert Value]% ± 7.5%	
f	Tap changer - taps to be manually changed when transformer is not excited (DETC):		
f.1	Above nominal rated voltage at full MVA capacity (Number of taps and percent volts each tap)	2 @ 2-1/2%	N/A
f.2	Below nominal rated voltage at full MVA capacity (Number of taps and percent volts each tap)	2 @ 2-1/2%	N/A
g	System neutral	Solidly grounded	
h	Basic lightning impulse insulation level (BIL) (kV)	[Insert Value]	150
i	Neutral basic lightning impulse insulation level (BIL) (kV)	150	

A.8.3.5 The GSU transformers (GSUT) shall have the following ratings:

A.8.3.5.1 Angular Displacement: The transformer shall have an ANSI standard phase relationship. The angular displacement between high-voltage and low-voltage phase voltages shall be 30° with the high-voltage leading the low-voltage.

A.8.3.5.2 The GSU Transformers shall be capable of withstanding, without damage, the mechanical and thermal stresses caused by through faults in accordance with Clause 7 of the IEEE Standard C57.12.00. For the purpose of establishing the GSUT through fault current for which the transformer has to be braced, the system short circuit strength per Clause 7.1.5.3 of the IEEE C57.12.00 Standard shall be used.

A.8.3.5.3 The transformers shall be designed and manufactured such that all ancillary equipment (e.g., bushings, tap changers, leads, etc.) are thermally coordinated with the transformer core and coil assembly and cooling system. Any ancillary equipment shall not restrict the transformer loading to levels below those permitted by the insulated conductor and other metallic part hot spots.

A.8.4. REFERENCE DOCUMENTS

A.8.4.1 Standards, specifications, manuals, codes and other publications of nationally recognized organizations and associations are referenced herein. Methods, equipment, and materials specified herein shall comply with the specified and applicable portions of the referenced documents indicated in Section A.1.5, in addition to federal, state, or local codes having jurisdiction. References to these documents are to the latest issue date of each document, unless otherwise indicated, together with applicable additions, addenda, amendments, supplements, thereto, in effect as of the date indicated in Section A.1.5.

A.8.4.1.1 ANSI C2 – The National Electrical Safety Code.

A.8.4.1.2 ASME Y14.100 – Engineering Drawing Practices.

A.8.4.1.3 ASTM D1275 – Standard Test Method for Corrosive Sulfur in Electrical Insulating Oils.

A.8.4.1.4 ASTM D2300 – Standard Test Method for Gassing of Electrical Insulating Liquids Under Electrical Stress and Ionization.

A.8.4.1.5 ASTM D3612 – Standard Test Method for Analysis of Gases Dissolved in Electrical Insulating Oil by Gas Chromatography.

A.8.4.1.6 ASTM D3487 – Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus.

A.8.4.1.7 Doble TOPS – Doble Transformer Oil Purchase Specification.

A.8.4.1.8 IEEE C37.04 – Rating Structure for AC High Voltage Circuit Breakers.

A.8.4.1.9 IEEE C57.12.00 – IEEE Standard General Requirements for Liquid-Immersed Distribution, Power and Regulating Transformers.

A.8.4.1.10 IEEE C57.12.10 – IEEE Standard Requirements for Liquid-Immersed Power Transformers.

A.8.4.1.11 IEEE C57.12.70 – Standard Terminal Markings and Connections for Distribution and Power Transformers.

A.8.4.1.12 IEEE C57.12.80 – Standard Terminology for Power and Distribution Transformers.

A.8.4.1.13 IEEE C57.12.90 – IEEE Standard Test Code for Liquid-Immersed Distribution, Power and Regulating Transformers.

A.8.4.1.14 IEEE C57.13 – IEEE Standard Requirements for Instrument Transformer.

- A.8.4.1.15 IEEE C57.19.00 – IEEE Standard General Requirements and Test Procedures for Outdoor Apparatus Bushings.
- A.8.4.1.16 IEEE C57.19.01 – IEEE Standard Performance Characteristics and Dimensions for Outdoor Apparatus Bushings.
- A.8.4.1.17 IEEE C57.91 – Guide for Loading Mineral Oil-Immersed Transformers.
- A.8.4.1.18 IEEE C57.98 – Guide for Transformer Impulse Tests.
- A.8.4.1.19 IEEE C57.109 – IEEE Guide for Liquid-Immersed Transformer Through-Fault Current Duration.
- A.8.4.1.20 IEEE C57.113 – IEEE Guide for Partial Discharge Measurement in Liquid-Filled Power Transformers and Shunt Reactors.
- A.8.4.1.21 IEEE C57.116 – IEEE Guide for Transformers Directly Connected to Generators.
- A.8.4.1.22 IEEE C57.148 – IEEE Standard for Control Cabinet for Power Transformers.
- A.8.4.1.23 IEEE C62.11 – IEEE Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits.
- A.8.4.1.24 IEEE C62.22 – Guide for the Application of Metal-Oxide Surge Arresters for Alternating-Current Systems.
- A.8.4.1.25 IEEE C63.2 – Electromagnetic Noise and Field Strength Instrumentation.
- A.8.4.1.26 IEEE C57.32 – Neutral Grounding Devices.
- A.8.4.1.27 NEMA LA1 – Surge Arresters.
- A.8.4.1.28 NEMA 107 – Methods of Measurement of Radio Influence Voltage (RIV) of High Voltage Apparatus.
- A.8.4.1.29 NEMA C84.1 – Electrical Power Systems and Equipment – Voltage Ratings (60 Hertz).
- A.8.4.1.30 NEMA TR1 – Transformer Regulators and Reactors.
- A.8.4.1.31 NFPA 70 – National Electrical Code
- A.8.5. SUBMITTALS
- A.8.5.1 Submit the following documents for review in accordance with the submittal requirements of Section A.1.4 Document Deliverables and Submittal Requirements:
 - A.8.5.1.1 General:
 - A.8.5.1.1.a General specifications covering the type and design of all principal components of the equipment.
 - A.8.5.1.1.b General Arrangement (GA) drawings consisting of a composite outline layout of all equipment, including auxiliary equipment and anchor bolt or expansion anchor locations.

These drawings show all basic dimensions, clearances, tolerances, and required clearances for access, equipment removal, and maintenance including door swings, etc. Total weight and weight of heaviest piece for lifting during maintenance shall be listed.

- A.8.5.1.1.c Equipment cross-section drawing including identification of parts, termination points and interfaces.
- A.8.5.1.1.d Drawings showing the electrical, instrumentation and controls interface points.
- A.8.5.1.1.e Inspection and testing procedures shall be submitted for review.
- A.8.5.1.1.f Performance Curves:
 - A.8.5.1.1.f.1 For operating conditions that are different from site rated conditions, the Seller shall supply the Buyer with certified performance curves and correction factors to cover the intended range of site conditions, and system load conditions, including but not limited to output, temperature, atmospheric pressure, and the effects of variations in site properties. The following performance curves shall be provided but not limited to the following:
 - A.8.5.1.1.f.2 Transformer capability vs. ambient temperature.
 - A.8.5.1.1.f.3 Transformer overload capability vs. time.
 - A.8.5.1.1.f.4 Transformer volts/hertz vs. time curve.
 - A.8.5.1.1.f.5 Transformer magnetization or core saturation characteristic suitable for simulation studies with a transient program. These characteristics shall be Voltage (p.u.) vs. Current (p.u.) or Flux (weber) vs. Current (amperes).
 - A.8.5.1.1.f.6 Current transformer excitation curves.
 - A.8.5.1.1.f.7 Current transformers ratio correction curves.
 - A.8.5.1.1.g Equipment lay-down and pull space area requirements with component weights and overall dimensions that will be required.
 - A.8.5.1.1.h Outline dimension drawings and elevations of all electrical equipment. In all cases, drawings shall show mounting details, base details, bolt down provisions and locations of cable entrances. Nameplates information for all devices shall also be shown.
- A.8.5.2 Structural:
 - A.8.5.2.1 Structural loading drawings indicating the vertical and lateral loads transmitted to the foundation.
- A.8.5.3 Electrical:
 - A.8.5.3.1 Physical Drawings:
 - A.8.5.3.1.a Outline dimension drawings and elevations of the transformer. Drawings shall show locations of cable entrances. Nameplate information for all devices shall also be shown.

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- A.8.5.3.1.b Internal control panel component arrangement drawings including terminal block size, location, spacing and types.
- A.8.5.3.1.c Physical location drawings showing the location of all equipment supplied by Seller which requires an interconnecting cable or wire connection.
- A.8.5.3.1.d Detailed information concerning the plug connector cables.
- A.8.5.3.1.e Provide drawings for power supply system and control power distribution of all AC and DC feeds complete with protective devices and their ratings and equipment numbers.
- A.8.5.3.2 Schematic Diagrams:
- A.8.5.3.2.a Electrical schematic (elementary) drawings, showing all individual components and interlocks and functionality, shall be supplied. The schematics shall be complete and show inputs required from and outputs available to the Buyer and shall include equipment numbers. The use of a symbol to denote an assembly of electrical item (black boxes) is not acceptable for relay control circuits unless the schematic for that assembly is submitted. All device identifications and wire numbers shall be consistent with the associated wiring drawings. Include manufacturer set points for temperature, pressure, hot spot temperature for alarming and trip set points.
- A.8.5.3.3 Wiring Diagrams:
- A.8.5.3.3.a Complete point to point wiring diagrams shall be provided for all equipment, panels, cubicles, etc. Diagrams shall show actual shop wiring, wire by wire. Wiring drawings shall include other pertinent information such as fuse ratings, and circuit breaker ratings shown by the device. Space shall be provided on the wiring diagram for the addition of wire and cable designations for the external wiring at the terminal blocks.
- A.8.5.3.3.b Cross references shall be provided between wiring diagrams and corresponding schematic diagrams.
- A.8.5.3.4 Electrical Bill of Material:
- A.8.5.3.4.a Bill of material for all electrical equipment and components showing manufacturer, catalog numbers, ratings, quantities, equipment reference, etc.
- A.8.5.4 Erection:
- A.8.5.4.1 Seller shall provide information package to be included in the equipment erection bid packages, including the following:
- A.8.5.4.1.a A detailed scope of work involved in the complete erection of this equipment, including all accessories.
- A.8.5.4.1.b Drawings, Procedures and Data:
- A.8.5.4.1.b.1 A comprehensive outline as to the extent of field fabrication required, including all temporary falsework, scaffolding, blocking, shoring, hanging, heating, wiring, disassembling, reassembling, welding, preheating, stress relieving, cleaning, checking,
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inspection, insulation and lagging, painting, testing, etc., required to be done by the Seller.

A.8.5.4.1.b.2 Erection sequence schedule.

A.8.5.4.1.b.3 Electrical outline and wiring diagrams required for erection.

A.8.5.4.1.b.4 Weights of the equipment and all components.

A.8.5.4.1.b.5 A detailed breakdown or bills of material listing all components of the transformer. This list shall show, by piece number, the total of any delivery group, its required delivery date and the shipping destination and receiving date at the project site.

A.8.5.4.1.b.6 Shipping drawings showing degree of assembly and center of gravity of the equipment.

A.8.5.4.1.b.7 All other pertinent data or information required by the Engineer to prepare the erection specifications.

A.8.5.4.2 Seller's erection information shall be formatted and coordinated to identify and cross-reference shipping piece numbers with the erection drawing numbers, bills of material listings and the instructions.

A.8.6. GENERAL QUALITY CONTROL AND QUALITY ASSURANCE PROVISIONS

A.8.6.1 Refer to Section A.4.16 for Quality Assurance and Quality Control (QA/QC).

A.8.7. DELIVERY, HANDLING AND STORAGE

A.8.7.1 The transformer shall be shipped less oil.

A.8.7.2 The transformer shall be shipped under approximately 3 psid of dry air to maintain positive pressure during shipment under normal atmospheric conditions. Nitrogen shall not be used for shipment. The dry air shall conform to the applicable requirements below:

A.8.7.2.1 Dry air shall be manufactured and tested in accordance with the requirements of the latest Compressed Gas Association (CGA) Specification G-7.1, "Commodity Specification for Air," and Specification G-7, "Compressed Air for Human Respirators".

A.8.7.2.2 The minimum acceptable grade of dry air shall comply with Grade D, Type I (Gaseous) as defined in the latest CGA Specification G-7.1. Grade D is the minimum grade for routine use in self-contained or supplied-air protective breathing equipment and for general respiratory use.

A.8.7.2.3 The dry air shall have a dew point of minus 60°F or lower.

A.8.7.3 The rail car or transport used to ship the transformer shall be equipped with a cushioning device, if available, to reduce the effect of rough handling and shock impact (jolts and jerks) during transit. The transformer shall be designed to withstand the mechanical stresses that may be encountered during rail or ship transport to the Buyer's site.

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- A.8.7.4 Two (2) impact recorders with sufficient running time shall be installed on the transformer prior to setting the transformer on the rail car or transport.
- A.8.7.5 Insulating oil shall be shipped in truck tankers or rail car tanker(s).
- A.8.7.6 High Voltage and (HV and) bushings and surge arresters shall be shipped loose for field assembly.
- A.8.7.7 Seller shall list all items that are shipped loose for field erection or assembly.
- A.8.7.8 One (1) complete set of new and unused gaskets shall be provided and shipped loose for installation during job site assembly. All gaskets used during shipment of the transformer to the job site will be removed and discarded.
- A.8.8. PROJECT / SITE CONDITIONS
- A.8.8.1 Refer to Section A.9 – Site Requirements and Design Criteria.
- A.8.8.1.1 Each transformer shall be suitable for an outdoor location.
- A.8.9. ACCEPTABLE MANUFACTURERS AND PRODUCTS
- A.8.9.1 Refer to Exhibit F, Approved Vendor List.
- A.8.10. TRANSFORMER TANK AND BASE
- A.8.10.1 The transformer tank shall be of welded steel construction. There shall be two (2) or more manholes in the transformer cover to facilitate the removal and installation of bushings and current transformers and to provide access to the terminal board without disturbing the leads. The inside diameter of manholes shall be at least 20 inches. All manhole covers shall be placed on gaskets which shall be confined in recesses machined in the tank flange or the lower side of the cover. The gaskets shall be at least 1/4 inches thick when compressed. All mounting bolts shall be external to the gasket. Manhole covers shall be round with 2 lift-handles.
- A.8.10.2 The tank shall be designed to withstand vacuum filling at full vacuum in the field.
- A.8.10.3 The transformer tank, cover and external accessories shall be thoroughly cleaned and painted with suitable primer Tnemec Series 66-1211 Epoxoline Primer and Tnemec Series 66-1212 Mid coat and Tnemec Series 71-Duranar-Blue Topcoat. The total dry film thickness shall be not less than 5 mils (0.127mm). The Seller may recommend an alternative oil based paint system suitable for sea-coast marine, high humidity environment for the Buyer's consideration. The final painting system shall be by the Seller with Buyer's approval on the type and color of paint. The paint color shall not affect the transformer heat dissipation.
- A.8.10.4 The external paint system(s) shall meet or exceed the coating system performance requirements of IEEE C57.12.29.
- A.8.10.5 The interior finish of the main tank shall be bright white without affecting the insulation system of the windings, including the insulating oil.
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- A.8.10.6 The tops of the main and the tap changer tanks shall have a non-skid coating for safety.
- A.8.10.7 All bushing mounting flanges shall be provided with a gasket which shall be at least 0.125 inch thick after being compressed. This gasket shall be confined in a recess machined in the tank flange or the base of the bushing flange inside the mounting bolt holes or otherwise satisfactorily restrained. The raised flanges shall be at least two inches above the tank cover. Glue shall not be used for the gasket retention.
- A.8.10.8 All gaskets shall be one piece, oil-resistant nitrile elastomer or Fluoroelastomer such as Viton, compatible with the transformer operating temperature, transformer oil and the fluids used in the bushings, verified in accordance with ASTM D3455 for their intended use. Alternative designs can be considered acceptable with Buyer's written approval.
- A.8.10.9 One set of new gaskets shall be furnished for all bushings, radiators, sudden pressure devices, manhole covers and any other accessories/equipment that require gaskets during field assembly. One additional complete set of radiator gaskets shall be shipped with the accessories package.
- A.8.10.10 Lifting, moving, and jacking facilities shall be in accordance with IEEE Standard C57.12.10.
- A.8.10.11 The transformer base shall be designed to permit rolling and skidding in the directions of the center lines of the segments. The tank base and the underside of the tank shall be coated with asphalt mastic or a coal tar epoxy-polyamide paint system.
- A.8.10.12 All metallic parts, exclusive of those energized, shall be bonded.
- A.8.10.13 Provision for a fall protection system shall be provided in accordance with Entergy Transmission Transformer Fall Protection Standard AQ0104, included in Exhibit A.16.2.1.
- A.8.10.14 A porcelain bushing with a minimum withstand voltage of 1000 volts shall be provided on the tank cover for the purpose of testing core insulation resistance. Design of the core ground shall be such that the Owner can field-test the core insulation by means of a disconnect type of core ground strap connection. The core ground shall be terminated on the bushing which is mounted on the transformer cover in a weatherproof terminal box. The core ground disconnect shall be located in the terminal box. The internal lead connection to the bushing shall be 1' - 0" (max.) for an adjacent manhole opening. The connections to the bushing shall consist of captive hardware. The terminal box cover for access to the core ground shall be permanently marked and identifiable.
- A.8.10.15 Provisions shall be made for a field-installed connection at the mechanical relief device opening for vacuum filling the transformer with oil. Opening is to be flanged and gasketed to adapt to a device such as a Qualitrol Type 213 Series with alarm contact or equivalent.
- A.8.11. TERMINAL CONNECTIONS AND BUSHINGS
- A.8.11.1 Transformer leads shall be brought out of the transformer case by outdoor type bushings per IEEE C57.19.00 and C57.19.01. Bushings shall be capable of withstanding the 60 Hz
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applied potential tests and the lightning impulse tests specified therein. The rated current of the bushing shall be not less than 1.25 times the transformer load current corresponding to its maximum MVA rating with full cooling in operation.

- A.8.11.2 All bushings rated 23/25 kV and above shall be oil filled. Adequate provision shall be made for distributing the mechanical stress at the mounting flange. On oil-filled bushings, the metal distributing plate shall terminate under oil. Oil-filled bushings shall have power factor test plugs.
- A.8.11.3 The bushing color shall be ANSI 70 Gray.
- A.8.11.4 Bushings for the high-voltage windings shall be cover-mounted for connection to exposed overhead conductors. Seller shall furnish a high-voltage bushing terminal adapter with a 3/4-in. thick 4-in square NEMA drilled 4-hole vertical pad, corona free for 230 kV and higher voltages. Conductor size and type will be determined by Seller. Doble Test Links shall be provided for all high-voltage bushings.
- A.8.11.5 Bushings for the low-voltage windings shall be cover-mounted, and have a flanged enclosure suitable for connection to an isolated phase bus duct. The low point of the flanged enclosure shall be provided with a 5/8-in. diameter screened drain. The low-voltage bushings shall be located in a junction box with flanges for connection to an isolated phase bus duct without forced air circulated through the bushing enclosure. The low voltage bushing ratings shall be based on IPB enclosure maximum temperatures. Buyer approved gaskets shall be used if the bus duct ratings exceed 100°C.
- A.8.11.6 The neutral bushings shall be cover-mounted.
- A.8.11.7 Oil-filled bushings shall be tested for power factor at the factory, and test values shall be included in test reports to the Buyer. Values of “C1” and “C2” shall be stamped on the bushing nameplates. Type A power factor testing terminals shall be supplied on all bushings.
- A.8.11.8 The oil sight gauges or sight glass on cover-mounted bushings shall face outward so that the oil level sight glass in the bushing can be seen from ground level. All bushing nameplates shall face outward to allow reading of nameplates with spotting scope.
- A.8.11.9 All bushings shall be paper-oil condenser type manufactured by ABB, PCORE, or Buyer-approved equivalent. LAPP POC bushings with integral 2 hole silver plated terminal pad for the bottom connection will be preferred for application up to 200 kV BIL. The bushing stud and the terminal connectors of all other high voltage bushings shall be silver plated copper. For protection during shipping, all bushings shall be wrapped in a protective layer of plastic.
- A.8.11.10 Corona rings on top of the bushings and corona shields on the bottom of the bushings shall be required for the high side ratings.
- A.8.11.11 All current carrying parts of power transformer bushings shall be copper or copper alloy material and surfaces shall be plated to inhibit deterioration.

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- A.8.11.12 A suitable copper bar shall be installed between neutral bushing on top of tank and ground pad on top of tank and all ground pads at base of transformer for connections. A clamp type terminal suitable for two (2) 4/0 AWG stranded copper conductors for horizontal takeoff shall be provided at the base.
- A.8.11.13 The core ground shall be brought out of the tank through a 2.5kV class 45kV BIL porcelain or Polycast (or Owner-approved equivalent) bushing located in a gasketed box at an accessible location on the top of the tank, with a ground connection that can be removed for testing purposes. Alternative designs can be accepted with Buyer's written approval.
- A.8.11.14 Copper bar connections shall be provided to ground the lightning arresters via insulated post type insulators.
- A.8.12. BUSHING CURRENT TRANSFORMERS
- A.8.12.1 Current transformers shall be factory installed. The quantity and ratings shall be determined by the Seller. The turns shall be equally spaced around the circumference of the core with fully distributed copper windings. The current transformers shall have a thermal rating of 2.0. All leads shall be brought out to shorting-type terminal blocks in the control cabinet. The leads shall be installed in conduit. Each wire shall be marked to identify the tap and the current transformer. The minimum wire size is #10 AWG and splices are not permitted.
- A.8.12.2 Multi-ratio current transformers shall be of the five-lead distributed-winding type with all leads brought out to a shorting-type terminal block in the weatherproof cabinet.
- A.8.12.3 When the bushing current transformers are located inside the transformer tank and suspended from the tank cover, the current transformers shall be individually supported with stainless steel hardware, such that the current transformers can be removed one at a time from the bottom, while the mounting hardware supports the remaining current transformers. The current transformer secondary leads shall be carried through eyelets welded to the tank cover. Spacing between the eyelets shall not exceed 24 inches.
- A.8.12.4 All exterior current transformer leads shall be protected in dedicated Schedule 40 aluminum, or hot-dipped galvanized steel conduit. Current transformer secondary leads shall be continuous (i.e., no splices) from the current transformer secondary terminals to the shorting terminal block in the transformer control cabinet.
- A.8.12.5 Provision shall be made to remove and replace the current transformers without removing the tank cover.
- A.8.12.6 Owner's Engineer may require both HV and LV current transformers to provide transformer differential protection.
- A.8.12.7 Neutral bushing H0 shall have two (2) current transformers with C800 accuracy class minimum.
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A.8.13. SURGE ARRESTERS

A.8.13.1 The following surge arresters shall be furnished mounted on and grounded to the transformer tank.

A.8.13.2 The following surge arresters shall be station class metal-oxide type surge arresters, designed to not be susceptible to failure because of external contamination, and shall be mounted such that the top terminal cap is at the same elevation as the top of the bushing terminal.

A.8.13.3 Not Used

A.8.13.4 Surge Arresters shall be station class metal oxide arresters. Unless specified otherwise by Owner or unless recommended otherwise by the transformer Manufacturer, the arrester rating shall be as listed below for application in an effectively grounded system:

System Voltage	Surge Arrester Rated Voltage	Surge Arrester MCOV
500 kV	420 kV	335 kV
345 kV	276 kV	220 kV
230 kV	192 kV	152 kV
161 kV	132 kV	106 kV
138kV	120 kV	98 kV
115kV	96 kV	76 kV
69 kV	60 kV	48 kV
34.5 kV	30 kV	24.4 kV
24 kV	21 kV	17 kV
14.4 kV	12 kV	10.2 kV
13.8 kV	12 kV	10.2 kV
13.2 kV	12 kV	10.2 kV
4.16 kV	6 kV	5.1 kV
2.4 kV	3 kV	2.55 kV

A.8.13.5 Each arrester shall be self-supporting, designed for base mounting. Support brackets shall be welded to the tank wall to support conductor for the neutral and surge arrester grounding. Post type insulators, support brackets and the copper bus bar down leads with necessary connectors from the neutral terminal and the surge arresters ground terminals to the grounding pads near the bottom of the transformer case shall be provided by the transformer manufacturer. Insulators for the down leads may be omitted when the associated surge arresters are installed without the insulating sub-bases, or the down leads are routed in insulated PVC pipes. Individual grounding shall be provided for each arrester set. Neutral and arrester grounding conductors shall be copper bus bar, ¼" x 2.0" minimum, with 2-9/16" holes drilled to NEMA standard spacing.

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- A.8.13.6 Corona-free connections shall be provided between the surge arresters and the associated bushings for 230 kV and higher voltages. These connections shall have a flexible arrangement, so that the bushings will not be overstressed during vacuum filling. NEMA drilled 4-hole pads shall be provided on arresters for bolting lugs.
- A.8.13.7 All ferrous parts exposed to the weather and subject to corrosion shall be zinc coated by the hot-dipped galvanized process.
- A.8.13.8 Each arrester shall have a pressure relief device which will act positively to vent gas pressures for the prevention of explosion of the porcelain or polymer in the event of arrester failure.
- A.8.13.9 The color of the arresters shall be ANSI 70 Gray.
- A.8.13.10 An automatic surge arrester discharge counter shall be provided with each surge arrester. The discharge counter shall be complete with arrester insulating sub-base and hanger hardware. Discharge counter shall be equipped with a leakage current meter.
- A.8.13.11 Seller shall mount discharge counters on surge arresters and shall furnish two 1.0 in. by 0.25 in. copper bars from the base of each surge arrester to the discharge counter.
- A.8.13.12 Surge arresters shall be porcelain or silicone polymer, as manufactured by ABB, Cooper, Siemens or Toshiba-Mitsubishi, or Buyer's approved equivalent.
- A.8.13.13 Connections between transformer bushings and lightning arresters shall be sized to carry full rating of transformer continuously.
- A.8.13.14 Surge arrestors applied above 230 kV nominal system voltage may be mounted and grounded separately
- A.8.14. ACCESSORIES AND FITTINGS
- A.8.14.1 The transformers shall be equipped with a complete set of manufacturer's standard accessories and fittings which shall include:
- A.8.14.1.1 Oil level gauge, magnetic type, Qualitrol or Owner approved equivalent, with low level alarm contacts rated for 250 VDC ungrounded service, with a minimum inductive rating of 0.25A. The oil level gauge on the conservator shall have a 6-inch dial, visible from the ground level. The oil level gauge shall be a two stage oil level monitor. Each stage shall be provided with two normally open contacts for alarm and trip functions. Contacts of the second stage shall close when the oil level in the transformer tank falls to a critical level and will result in an internal flashover of the unit.
- A.8.14.1.2 Oil drain and filter valve (2 inch minimum).
- A.8.14.1.3 Oil sampling valves (1-1/2" NPT gate valves): an "oil supply valve" located near the radiator top header and an "oil return valve" located near the transformer tank base, for connection to a "Dissolved Gas in Oil" monitoring system.
- A.8.14.1.4 One inch or larger valve for oil purifier with top connection.
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- A.8.14.1.5 Vacuum pump connection
- A.8.14.1.6 Oil filling connection with oil deflectors inside the tank
- A.8.14.1.7 Dial type hot oil thermometer, Qualitrol or Buyer approved equivalent, with manually reset maximum indicating hand (minimum 6-inch dial) and two adjustable normally open 250 VDC rated ungrounded alarm contacts, with a minimum inductive rating of 0.25A that will close on high temperature. The instrument shall be mounted at eye level and be insulated from transformer vibration. Top oil alarm contacts shall be set at 105°C and shall be used to turn on all of the cooling equipment.
- A.8.14.1.8 Dial-type winding hot spot indicator with four (4) N.O. adjustable contacts for control of cooling equipment and alarms.
- A.8.14.1.9 Low gas pressure alarm, if applicable.
- A.8.14.1.10 Resistance temperature element (RTD) and temperature transducer for measuring the hot spot winding temperature of each winding shall be furnished with external connections to remote indicating device.
- A.8.14.1.11 Pressure relief device, Qualitrol Type XRPD, or Buyer approved equivalent, complete with animal intrusion screen P/N SCN-600-1 mounted on the cover for relieving excessive pressure within the transformer tank, with DPDT 250 VDC rated ungrounded alarm contacts (with a minimum inductive rating of 0.25A) which close on operation of the device. Device shall be automatic reset (contacts to be manual reset) type with mechanical indicator. Transformer tanks containing more than 10,000 gallons of oil shall be provided with two pressure relief devices mounted on diagonally opposite corners of the transformer tank. The device(s) shall be equipped with directional shield to direct oil flow downward. Pressure relief value shall be stamped on the device.
- A.8.14.1.12 All equipment requiring frequent inspection shall be installed in easily accessible locations.
- A.8.14.1.13 All indicating thermometers, oil level gauges, etc., shall be located so they can be easily read from ground level.
- A.8.14.1.14 Gas sampling valve, when specified or required by ANSI Standards, shall be located opposite the nitrogen gas tank inlet.
- A.8.14.1.15 Two grounding terminal pads, mounted diagonally opposite each other and near the bottom of the transformer, plus grounding pad(s) on the cover of the transformer near neutral bushing(s), shall be provided.
- A.8.15. TRANSFORMER OIL PRESERVATION SYSTEM AND ACCESSORIES
- A.8.15.1 Oil Preservation System: Transformers shall have an oil preservation system for protecting the oil against atmospheric moisture and oxygen. Equipment shall be the manufacturer's standard.
- A.8.15.2 Inert Gas Equipment: If required, equipment shall have the necessary accessories including separate high-pressure nitrogen tank, automatic pressure regulating valve,
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pressure gauges and low-pressure alarm contacts. Seller shall furnish sufficient inert gas for purging and filling in order to make the transformer ready for service.

- A.8.15.3 Combustible Gas Device: A combustible gas device shall be provided. The device shall be complete with a meter calibrated in percent total combustible gas and an adjustable alarm contact which shall close at a preset level of total combustible gas. Contact shall be suitable for 125 VDC service. Transformers with a conservator tank shall be provided with Qualitrol Type 038-003-01 complete with a sampling valve and alarm contacts. Sample test valves shall be located within five (5) feet of the transformer base.
- A.8.15.4 Gas Detection Device: A Buchholz gas detector relay shall be provided only if a conservator/diaphragm oil preservation system is furnished. The device shall have a magnetically coupled and float-operated gauge mounted on a float chamber. The device shall have a gas sampling petcock and the gauge shall be mounted in a location visible from ground level.
- A.8.15.5 Fault Pressure Device: A transformer with conservator tank shall be equipped with two sudden pressure rise relays, Qualitrol Type 900-FLA-T-O-STD, located diagonally opposite corners of the transformer and flange mounted three (3) – six (6) feet above the transformer base. Sealed tank transformers shall be supplied with two sudden pressure rise relays, Qualitrol Type 910, flange mounted in the pas space on the tank wall. Seller shall review the application of the fault pressure device in order that the location chosen ensures proper operation. Qualitrol type 909-300-01 seal-in relays set up for 125 VDC and reset feature, shall be furnished with each pressure device. The auxiliary relays shall each have two normally open contacts. A reset push-button shall be provided. A target relay shall be provided to give visual indication of sudden pressure relay operation. The alarm and trip contacts of the relays shall be wired to the terminal blocks in the control cabinet.
- A.8.15.6 Dehydrating Breather(s): The oil preservation system of transformer with a conservator shall be equipped with a Waukesha/HVS, or Reinhausen or other Buyer-approved automatically self-regenerating, maintenance-free dehydrating breather containing an oil bath to prevent outside air from having direct contact with the desiccant.
- A.8.15.6.1 Top of the breathers shall be within approximately five feet of the transformer base.
- A.8.16. TRANSFORMER OIL
- A.8.16.1 The transformer shall be provided with the necessary amount of high grade insulating oil that contains no detectable PCBs and the oil shall be in accordance with the following:
- A.8.16.1.1 Type II mineral oil shall be furnished for apparatus where greater than normal oxidation resistance is required. This is usually achieved with the addition of a suitable oxidation inhibitor.
- A.8.16.1.2 The insulating oil shall be inhibited, The Type II, 0.3 percent DBPC, or DBP and comply with Entergy Specification SG0102 (Exhibit A.16.2.1), shall be manufactured and tested in accordance with the requirements of ASTM Standard D3487 "Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus."

- A.8.16.1.3 The insulating oil shall be non-corrosive when tested in accordance with ASTM D-1275 “Test Method for Corrosive Sulfur in Electrical Insulating Liquids” Part B requiring a minimum duration of 48 hours at a minimum temperature of 150°C.
- A.8.16.2 Determination of Quantities:
- A.8.16.2.1 The normal temperature for measurement of oil delivered under this Specification shall be 60°F. The temperature of the oil shall be determined at the time of volume measurement.
- A.8.16.2.2 The apparent quantity of oil shall be corrected to a 60°F basis in accordance with ASTM Standard D1250, "Petroleum Measurement Tables."
- A.8.17. NAMEPLATES
- A.8.17.1 The transformer shall be provided with a stainless steel nameplate in accordance with IEEE C57.12.00, which shall, in addition, include the following:
- A.8.17.1.1 Zero sequence impedances.
- A.8.17.1.2 Manufacturer’s Equipment Tag Number.
- A.8.17.1.3 Number of core grounds.
- A.8.17.1.4 Load tap changer model number and type (if applicable)
- A.8.17.1.5 Full load capability of the transformer with the loss of one radiator.
- A.8.17.1.6 Maximum transformer sound level at each transformer rating.
- A.8.17.1.7 The purpose of all CTs, winding temperature CT, as well as all CT ratios and taps on all CTs.
- A.8.17.1.8 The vacuum ratings for the main tank, conservator, radiators and tap changer compartment (if separate).
- A.8.17.2 The transformer bushings shall be provided with nameplates in accordance with IEEE C57.19.00.
- A.8.17.3 The surge arresters shall be provided with nameplates in accordance with IEEE C62.11.
- A.8.17.4 Nameplates shall be fastened to the equipment with stainless steel screws.
- A.8.17.5 PCB free statement shall be included in nameplate or a decal shall be affixed to the transformer tank and all oil-filled accessories.
- A.8.17.6 The control cabinet shall be labeled with its equipment tag number as assigned by the Seller in accordance with Seller’s procedures. The labels shall match the drawings provided by the Manufacturer.
- A.8.17.7 Meters, switches, automatic transfer switches, motor controllers, circuit breakers, fuses, terminal blocks, relays, etc., shall be labeled using lamacoid nameplates. Items shall be

labeled both with their function and the device number and/or letter(s) used on wiring and schematic diagrams.

A.8.17.8 The tap changer shall be provided with a nameplate, showing at minimum the LTC manufacturer, type, model number, S/N number and current rating.

A.8.17.9 Four center of gravity nameplates shall be permanently attached to the tank:

A.8.17.9.1 Two identical nameplates indicating CG for equipment fully assembled, with radiators attached and oil filled shall be installed on two adjacent walls.

A.8.17.9.2 Two identical nameplates indicating CG for equipment ready for shipping shall be installed on two adjacent walls. They are not required for transformers shipped fully assembled, with radiators attached and oil filled.

A.8.17.10 All nameplates shall be legible from ground level.

A.8.18. TAP CHANGER

A.8.18.1 A manually-operated de-energized tap changer (DETC), per IEEE Standard C57.12.10, shall be provided for operation from the outside of the tank when the transformer is not excited.

A.8.18.2 The tap changer handle shall be mounted on the side of the tank not more than five feet above the base and have a tap position indicator and provision for padlocking in any position. Each tap position, as marked on the transformer nameplate, shall be clearly and permanently marked on the operating handle in either raised or recessed letters in metal.

A.8.18.3 The de-energized tap changer internal mechanism shall be readily accessible for inspection and repair without untanking from the top of the transformer.

A.8.18.4 The tap changer shall have heavy brazed-on stationary and movable contacts with appropriate silver alloy. There shall be no requirement for moving the contacts to prevent coking unless the position is changed. The instruction book shall contain instructions for movement of the tap changer to wipe the contacts if the position is changed.

A.8.19. COOLING SYSTEM

A.8.19.1 The cooling system shall consist of the necessary radiators, heat exchangers and fans, separately, or in such combinations as required, complete with automatic control equipment required to maintain the specified temperature rise.

A.8.19.2 All cooling equipment shall include supports, mountings, automatic control equipment, conduits, and wiring.

A.8.19.3 All radiators and heat exchangers shall be equipped with bolted flanges and valves to permit the removal of any radiator or heat exchanger without draining the oil from the transformer or any other radiator or heat exchanger. A minimum 1/2-in. drain plug shall be provided in the bottom of each radiator or heat exchanger for installation of a drain valve by others. Vent holes with plugs shall be provided in the top of each radiator.

- A.8.19.4 Detachable radiators shall preferably be interchangeable and be provided with shut-off valves at both top bottom openings to the main transformer tank. All shut-off valves shall be mounted on the tank and shall turn in the same direction for opening and the opposite direction for closing. Their positions shall be clearly and permanently marked in either raised or recessed letters in metal.
- A.8.19.5 A spare installed radiator shall be provided for each transformer in case of loss of another radiator.
- A.8.19.6 All fan motors shall be totally enclosed fan cooled (TEFC) and provided with a weatherproof flexible lead and a threaded, locking-type plug-in connector which is readily accessible for maintenance removal, except when free-standing cooling equipment is provided. For this arrangement, leads shall be brought to a common terminal board enclosure. Radiator fans shall be installed on a separate support bracket attached to the tank. No fans shall be directly installed on the radiators.
- A.8.19.7 All protective devices, control switches and contactors, etc., required for the control of fans shall be located in the transformer control cabinet. Protective devices shall be adequately sized for the inrush current of the fan motors.
- A.8.19.8 Automatic control of double-stage cooling equipment for forced-cooled transformers shall be in accordance with and shall include:
- A.8.19.8.1 At least two separately controlled cooling groups for transformers with multiple cooling stages, that any group may be manually selected as the initial group or a subsequent group and both groups of cooling equipment can be started manually and run continuously if desired.
- A.8.19.8.2 A winding temperature device with electrically independent contacts to control the single- or double-stage cooling and initiate remote alarms.
- A.8.19.8.3 An Auto-Off-Manual switch for automatic and manual control.
- A.8.19.8.4 A switch for duty cycle selection for transformers with double-stage cooling.
- A.8.19.8.5 An alarm relay for each stage for cooling failure.
- A.8.19.8.6 Means to turn off the cooling system with a remote contact.
- A.8.19.8.7 Weatherproof cabinet enclosing switching equipment.
- A.8.19.9 Cooling controls shall be designed so that the spare cooler is cycled with the other normally run coolers for even wear (lead, lag switched).
- A.8.19.10 Control circuits shall be designed for operation on 120 Vac, 60 Hz and alarm circuits for 125 Vdc.
- A.8.19.11 Cooling controls shall be designed so that in case of failure of the initial source, the fans for both cooler groups will be started.

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- A.8.19.12 Two redundant sources of power at 480 Vac, 3-phase, 60-Hz shall be provided per transformer for operation of the cooling equipment. If motors for the cooling equipment are furnished for a voltage different than 480 Vac, the Seller shall furnish two suitable full-capacity transformers to change the supply voltage to the voltage required. One transformer shall be connected in the normal, and one in the reserve, 480 Vac, 3-phase supply.
- A.8.19.13 The Seller shall provide an ASCO automatic transfer switch for each transformer as follows:
- A.8.19.13.1 The automatic transfer switch shall be 3-pole and of the required ampere rating. The transfer switch shall have a continuous rating at least equal to the full-load current of all of the transformer auxiliaries and a 3-cycle withstand rating of rms asymmetrical amperes based on Seller's short circuit calculation. It shall be arranged to transfer the load from a normal source of 480 Vac, 3-phase, 60-Hz to an emergency source of 480 Vac, 3-phase, 60-Hz when any phase of the normal source drops below 70% voltage, and to automatically restore the load to the normal source when all phases are at 90% voltage or above.
- A.8.19.13.2 The automatic transfer switch shall be a double-throw switch operated by a single-coil mechanism momentarily energized. The switch shall be interlocked mechanically and electrically to prevent one contact from closing before the other opens. Operating current for the transfer shall be obtained from the source to which the load is to be transferred. Failure of any coil or disarrangement of any part shall not permit a neutral position. The switch shall be positively locked mechanically on either source without the use of hooks, delicate latches, or springs. Gravity-or spring-operated switches are not acceptable. All main contacts shall be segmented and shall be shielded by glass polyester interface barriers. All main contacts shall be protected by separate arcing contacts with blowout coils and arc chutes. The transfer switch shall meet the requirements of UL Standard 1008.
- A.8.19.13.3 The transfer switch shall not use current limiting fuses to limit the momentary current that it will be exposed to under fault conditions.
- A.8.19.13.4 The circuit breakers on the load side of the transfer switch shall have continuous and short-circuit current ratings that will provide for coordination with the transfer switch.
- A.8.19.13.5 The transfer switch shall be furnished with a normally closed auxiliary alarm contact and a 1-second time delay before transfer.
- A.8.19.14 Control equipment shall include necessary circuit breakers, control transformers, selector switches, temperature control relays, alarm actuating devices, and associated equipment required to provide a complete control system. The interrupting rating of the circuit breakers shall be in accordance with the Seller's short circuit calculation
- A.8.20. CONTROL DEVICES AND SMALL WIRING
- A.8.20.1 Control relays, breakers, contactors, etc., shall be furnished in a weatherproof cabinet. Refer to Section A.12 Electrical Design Criteria for additional requirements.
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- A.8.20.2 All small wiring for control or accessory equipment shall be installed in standard galvanized rigid steel conduits or ducts, with watertight joints. Drain holes with screens, 1/4-in. diameter, shall be provided in low points of all conduit runs.
- A.8.20.3 Control wiring shall be No. 14 AWG, except where larger size conductors are needed for current carrying requirements. The conductor shall be stranded copper for fixed wiring and extra-flexible copper for hinge wiring. The conductors shall have 600 Vac, 90°C, cross-linked polyethylene insulation, Type SIS, or Type XHHW or agreed-upon equal. Flexible connections between stationary and hinged panels or doors shall be made between terminal blocks or clamps in such a manner as to afford flexibility without damage to the wire. Wiring for current transformer circuits shall be No. 10 AWG.
- A.8.20.4 480V wiring shall be physically separated from 120V wiring with Plexiglas.
- A.8.20.5 All control and instrument wiring, alarm leads, and all instrument transformer secondary leads for connection to field cables, shall be terminated at terminal blocks within the weatherproof enclosure.
- A.8.20.6 The terminal blocks shall be spaced to allow for a 6 in. clearance from any side of the cabinet and with 6 in. between center lines of terminal blocks. Liberal space shall be provided for training and crossing incoming leads of field cables. The size of field conduits will be 2 in. or larger.
- A.8.20.7 All internal control wiring terminations shall be made with tin plated pre-insulated ring type compression lugs. The wire insulation shall be removed without nicking the conductor. The wire shall be firmly inserted into the lug and crimped with a ratchet type or positive action tool. Lugs with vinyl insulation are not to be used in high temperature areas. Insulating sleeves shall be polyvinyl-chloride (PVC). Substitution of an alternate material must be approved by the Buyer.
- A.8.20.8 Double lugging (two wires in one connector) and the use of shims to allow use of larger connectors are prohibited.
- A.8.20.9 The assembled control equipment and wiring connections shall be insulated for a working voltage of 600 volts and shall be subjected to a 1.0 minute test of 1500 Vac phase-to-ground at the factory after fabrication and assembly is complete.
- A.8.21. CONTROL CABINET
- A.8.21.1 A control cabinet shall be furnished for field connection to winding temperature and tank pressure alarms, current transformer secondary wiring, cooling fans and pumps. The cabinet shall meet the following requirements:
- A.8.21.1.1 Weatherproof NEMA 4 cabinet enclosing switching equipment, located on the transformer with the top at a height not greater than 72 inches above base. Equipment that requires local operation, i.e., breakers, control switches, alarm test switches, and etc., shall be located in the lower portion of the cabinet. A drain hole, minimum 5/8" diameter complete with screen, shall be provided at the low point of the enclosure.

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- A.8.21.1.2 The top of the cabinet shall be sloped to prevent water accumulation. A drip shield shall be provided above the cabinet door.
- A.8.21.1.3 The control cabinet shall be insulated from transformer vibration and heat.
- A.8.21.1.4 The control cabinet shall be supplied affixed to the tank, the bottom located at least 24 in. above the transformer base. The bottom of the cabinet shall be left clear to facilitate cable tray or conduit entry via removable entrance plates.
- A.8.21.1.5 The design of the cabinet shall be such as to inhibit the formation of condensation.
- A.8.21.1.6 The cabinet shall be equipped with an exterior hinged and pad lockable door complete with heavy duty, handle-type three-point latch and shall be capable of being latched open or closed.
- A.8.21.1.7 The cabinet shall be equipped with a switched LED light and thermostatically controlled 120 Vac space heater on the interior. A 120 Vac, 15 A weatherproof convenience duplex outlet with ground fault protection shall be mounted on the exterior. A circuit breaker for this outlet shall be provided inside the cabinet.
- A.8.21.2 The control cabinet door shall be equipped with a tamper switch wired to dedicated terminals on the Purchaser's field terminal block. Additionally, the control cabinet shall be positively ventilated to ensure the temperature inside the cabinet is maintained below the maximum ratings of the components at maximum ambient temperature conditions.
- A.8.21.3 The control cabinet interior shall be painted white. The cabinet exterior paint color shall be manufacturer's standard.
- A.8.22. TEMPERATURE MONITORING SYSTEM
- A.8.22.1 An electronic temperature monitoring (ETM) system shall be provided for each transformer in which the temperature rise of the winding hottest spot over the top oil temperature is added digitally by calculation.
- A.8.22.2 The transformers shall be equipped with an APT TTC-1000 from Advanced Power Technologies or Buyer approved equivalent temperature monitoring system with digital displays easily readable in daylight.
- A.8.22.3 The sensors, probes, thermowells, etc., shall be located on the transformer tank sidewall in an arrangement to allow installation or replacement without de-energizing the transformer, opening the transformer, or lowering the oil in the transformer.
- A.8.22.4 The ETM shall have the digital displays for the following:
- A.8.22.4.1 HV Winding Hottest Spot Temperature, each phase.
- A.8.22.4.2 LV Winding Hottest Spot Temperature, each phase.
- A.8.22.4.3 Transformer Tank Top Oil Temperature.
- A.8.22.4.4 Transformer Tank Bottom Oil Temperature.
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- A.8.22.4.5 Ambient Temperature.
- A.8.22.4.6 Control Cabinet Interior Temperature.
- A.8.22.4.7 The transformer shall be provided with a sufficient number of winding embedded fiber optic sensors; at least 3 fibers per phase per winding (HV & LV) for winding temperature monitoring and three fibers for top oil temperature monitoring (a minimum of 21 fibers). The fibers shall be terminated into Qualitrol Neoptix digital temperature monitors located inside the control cabinet. The fiber temperature monitors shall have 4-20ma analog outputs and Modbus capability to connect to other plant devices, DCS and monitors including the transformer on-line monitoring system. The ETM shall have the following functions besides monitoring and displaying temperatures:
- A.8.22.4.8 Indicating the maximum temperature(s) reached.
- A.8.22.4.9 Providing four (4) sets of contacts for the cooling system control and alarms. The cooling controls shall be in parallel with the Dynamic Ratings Monitoring Control System (DRMCC) controls in switching coolers. The contacts shall be set by the Seller to close at the following winding hottest-spot temperatures:
- A.8.22.4.9.a Contact 1 – to initiate first cooling stage.
- A.8.22.4.9.b Contact 2 – to initiate second cooling stage.
- A.8.22.4.9.c Contact 3 – set at 115°C for Alarm 1.
- A.8.22.4.9.d Contact 4 – set at 120°C for Alarm 2.
- A.8.22.4.10 Two (2) sets of contacts for Top Oil alarm set at 105°C and 110°C.
- A.8.22.4.11 DNP 3.0 (latest level) communications.
- A.8.22.4.12 Remote SCADA 4-20 mA output.
- A.8.23. TRANSFORMER ONLINE AND GAS MONITORING SYSTEMS
- A.8.23.1 An online monitoring system to continuously monitor the condition of LV and HV bushings, transformer dissolved gases and temperatures and other transformer parameters, including loss of insulation life shall be provided for each transformer.
- A.8.23.2 The online monitoring system shall be capable of controlling the coolers operation in parallel with the conventional cooler controls. Dynamic Ratings Monitoring Control System (DRMCC) online monitoring with bushing monitoring system or Buyer approved alternative shall be provided with the transformer.
- A.8.23.3 The online monitoring system shall have communications protocols built in to allow monitoring of all parameters in the DCS.
- A.8.23.4 The transformers shall be provided with the latest model of Vaisala OPT-100 multi-gas monitor for continuously monitoring and detection of fault gasses in the transformer oil. The system shall be complete with necessary hardware, software, and interfaces. Provisions shall be provided on the transformer to secure the required helium bottle(s) to

the transformer tank. This gas monitor shall perform the following functions including but not limited to:

- A.8.23.4.1 Detect, analyze, and correlate quantity of all dissolved fault gasses including hydrogen (H₂), oxygen (O₂), carbon monoxide (CO), carbon dioxide (CO₂), methane (CH₄), ethylene (C₂H₄), ethane (C₂H₆), acetylene (C₂H₂), nitrogen (N₂), moisture-in-oil and oil temperature.

A.8.24. ANNUNCIATOR / DATA LOGGER AND ALARMS

- A.8.24.1 A Schweitzer Engineering Laboratories (SEL) model 2523 (SEL-2523) annunciator/data logger shall be provided in the control cabinet of each transformer to monitor the system health and indicate occurrences of alarms, trips and other general signaling messages.

- A.8.24.2 Annunciators shall be mounted on hinged weather tight panels, for easy access to rear wiring, in a dead-front cabinet arranged to prevent water entering the wiring area of the cabinet when resetting the annunciator in rainy weather. A plexi-glass panel shall be provided for external viewing of the annunciators. The panel doors shall be equipped with a handle mechanism to allow easy access to the annunciators.

- A.8.24.3 The alarms generated by the monitoring devices that the annunciator system shall be required to monitor and display shall include but are not limited to the following:

- A.8.24.3.1 Loss of primary AC Control Power.
- A.8.24.3.2 Loss of backup AC Control Power
- A.8.24.3.3 High Winding Temperature (Hot Spot).
- A.8.24.3.4 High Oil Temperature (Top Oil).
- A.8.24.3.5 Low Oil Level.
- A.8.24.3.6 Loss of DC Supply.
- A.8.24.3.7 Oil Level Trip: Transformer Tank.
- A.8.24.3.8 Gas detector Relay.
- A.8.24.3.9 Low Nitrogen Cylinder Pressure.
- A.8.24.3.10 Transformer Tank Pressure High.
- A.8.24.3.11 Transformer Tank Pressure Low.
- A.8.24.3.12 Conservator Tank Vacuum.
- A.8.24.3.13 Pressure Relief Device Actuated.
- A.8.24.3.14 Sudden Pressure Relay Operation.
- A.8.24.3.15 Fan motor current excessive.

- A.8.24.3.16 Fan Fail.
- A.8.24.3.17 Cooling Contactor Fail.
- A.8.24.3.18 Cooling System Breaker Fail.
- A.8.24.3.19 Not Used
- A.8.24.3.20 Control Cabinet Temperature High.
- A.8.25. INSPECTION AND TESTS
- A.8.25.1 Buyer shall have the right at all reasonable times to inspect the Work and observe production tests and any other tests specified in this Specification. Seller shall make all necessary arrangements and provide all reasonable facilities and access for inspection and observation of such tests either at Seller's shop or at the mills or shops of any manufacturer where any major part of the work is being fabricated or manufactured.
- A.8.25.2 Seller shall ascertain the scope of any inspection, which may be contemplated and shall give ten working days' notice as to the time and place when each part of the Work will be ready for such inspection.
- A.8.25.3 Buyer may reject any part of the Work found to be not in accordance with this Specification, regardless of the stage of its completion or the time or place of discovery of such errors, and regardless of whether Buyer's inspection has previously accepted it through oversight or otherwise. Such inspection by Buyer shall in no way relieve Seller from obligations to furnish equipment in accordance with this Specification.
- A.8.25.4 The Seller shall notify the Buyer at least four weeks in advance of planned factory manufacturing inspections and factory acceptance tests and at least two weeks in advance when the test dates are firm.
- A.8.25.5 The Seller shall ensure all test equipment are within the required calibration tolerances, shall provide evidence of test equipment calibrations, last time the calibration was performed and shall include the calibration records in the test reports.
- A.8.26. ROUTINE AND OTHER TESTS
- A.8.26.1 The tests listed in IEEE Standard C57.12.00 and as specified below shall be performed per IEEE Standard C57.12.90.
- A.8.26.1.1 Resistance measurements.
- A.8.26.1.2 Ratio
- A.8.26.1.3 Polarity and phase relation.
- A.8.26.1.4 No-load loss and excitation current at 90%, 100%, 105%, 110% and 115% rated volts for a 24 hour duration
- A.8.26.1.5 Impedance voltage and load loss.
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- A.8.26.1.6 Zero-phase sequence impedance test, providing the follow values:
 - A.8.26.1.6.a Zero-phase sequence impedance voltage
 - A.8.26.1.6.b Zero-phase sequence short circuit impedance
 - A.8.26.1.6.c Zero-phase sequence excitation current and excitation losses
- A.8.26.1.7 Temperature rise (heat run) at full load for a 24 hour duration - The temperature monitoring equipment shall be operational during temperature rise tests and demonstrated during these tests. For the transformers equipped with fiber optic temperature sensor probes, the hottest probes for each phase shall be identified. Temperature data for all probes shall be recorded and reported in the test report. If the manufacturer's calculated values for the top oil and hot spot temperature fall below the fiber optic thermometer measurements the manufacturer shall determine the cause and may be required to repeat the temperature rise test.
- A.8.26.1.8 Dielectric tests required:
 - A.8.26.1.8.a Low-frequency applied voltage.
 - A.8.26.1.8.b Low-frequency induced voltage.
 - A.8.26.1.8.c Lightning impulse tests in the following sequence: One reduced full wave, two front of wave impulse tests, two chopped wave tests, one full wave test performed per IEEE C57.12.90. All applied impulse voltages shall be recorded and included in the test report.
 - A.8.26.1.8.d Switching impulse tests (on 230 kV and above winding terminals only).
 - A.8.26.1.8.e Internal partial discharge measurement.
 - A.8.26.1.8.f Two methods shall be employed:
 - A.8.26.1.8.g RIV (microvolt) method per IEEE Standard C57.12.90.
 - A.8.26.1.8.h Apparent charge (picocoulomb) method per IEEE Standard C57.113.
 - A.8.26.1.8.i Insulation power factor.
- A.8.26.1.9 During the one-hour low-frequency induced voltage test, internal partial discharges shall be measured by both the Apparent Charge and the RIV methods:
 - A.8.26.1.9.a The apparent charge measures shall be performed using the Apparent Charge circuitry outlined in IEEE C57.113, "Guide for Partial Discharge Measurement in Liquid-Filled Power Transformers and Shunt Reactors."
 - A.8.26.1.9.b The RIV measurements shall be performed using the circuitry and instrumentation outlined in IEEE C57.12.90, "Test Code for Liquid Immersed Distribution, Power and Regulating Transformers."
 - A.8.26.1.9.c Measurement shall be made at all terminals that have a condenser-type bushing.

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- A.8.26.1.9.d The apparent charge and RIV measurements shall be read simultaneously during the one-hour induced test at intervals outlined in IEEE C57.113.
- A.8.26.1.9.e During the one-hour induced voltage test, the partial discharge level (PD) shall not exceed 100 microvolts. During this test, the increase in PD level shall not exceed 30 microvolts. The PD levels during the test shall not show a rising trend and there shall be no sudden increase in levels during the last 20 minutes of the test.
- A.8.26.1.9.f No guaranteed limits for apparent charge (picocoulomb) will be set at this time.
- A.8.26.1.10 Audible sound level.
- A.8.26.2 In addition to the Routine Tests noted above, other tests as listed below shall be made on the transformer:
- A.8.26.2.1 Bottom Oil Temperature.
- A.8.26.2.2 Insulation power factor between any winding and ground and between the two windings. Test value shall not exceed 0.5% at 20°C.
- A.8.26.2.3 Bushing power factor test in accordance with ANSI/IEEE C57.19.01. The partial discharge shall not exceed 10 pC or 10 μ V.
- A.8.26.2.4 Pressure test on the tank and cooling system employing hot oil at 50°C and 5 psig pressure maintained for 24 hours.
- A.8.26.2.5 Vacuum test on the transformer tank and cooling system designed for vacuum filling.
- A.8.26.2.6 Dew point test to check the dryness of the transformer. Test dew point reading shall be less than 0.5%. This test shall be repeated on arrival at site to ensure that the tank did not leak during the transit.
- A.8.26.2.7 Current transformer Tests as required by IEEE C57.13 including the following:
- A.8.26.2.7.a Applied Potential Test.
- A.8.26.2.7.b Induced Potential Test.
- A.8.26.2.7.c Polarity Test (to be repeated at their control cabinet terminals after installation in the transformer).
- A.8.26.2.7.d Saturation Curve.
- A.8.26.2.7.e DC Resistance (to be repeated at their control cabinet terminals after installation in the transformer).
- A.8.26.2.7.f Megger.
- A.8.26.2.8 Winding Temperature
- A.8.26.2.9 Core Insulation Tests made with minimum 1000 Volt insulation tester and recorded on the completed core and coil assembly prior to the completed core and coil assembly prior
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to the tanking of the assembly and repeated after the transformer is loaded on the carrier immediately prior to shipping. The measured resistance and voltage of the tester shall be shown on the test report.

A.8.26.2.9.a Core to Frame.

A.8.26.2.9.b Core to Core-Frame insulation of all series transformers.

A.8.26.2.10 Control Wiring Insulation Test

A.8.26.2.10.a Control and voltage transformer secondary circuits shall be tested at 1500 Vac 60 Hz and current transformer circuits shall be tested at 2.5 kVac 60 Hz for a maximum of 1 minute duration.

A.8.26.2.11 Sweep Frequency Response Analysis (SFRA) Test

A.8.26.2.11.a Doble SFRA measurements shall be performed on the transformer just before shipment and after arrival on site for comparisons. All bushing leads shall be terminated on bushing covers equipped with spark plug type bushings for SFRA use at the delivery site. The transformer shall be tested by SFRA prior to shipping in the fully assembled position (bushings and oil installed) and in the shipping configuration via the spark plug bushings. These spark plug bushings shall be mechanically protected on the exterior of the tank to prevent shipping damage.

A.8.26.2.12 Single-phase exciting current test at 10 kV as outlined in Doble Test TECM-576, or approved equal.

A.8.26.2.13 Dissolved Gas-In-Oil Analysis Tests – A minimum of three (3) tests as follows:

A.8.26.2.13.a First – Before Any Tests.

A.8.26.2.13.b Second – After Insulation Tests.

A.8.26.2.13.c Third – After Heat Run Test.

A.8.26.3 Test results and oscillograms for all of the tests specified shall be recorded in the Test Report.

A.8.26.4 Test data for all testing shall be included in the Certified Test Report.

A.8.26.5 If the transformer fails to meet any of the tests, the Buyer's Engineer shall be notified immediately with a written report. A written report shall be made prior to acceptance of the transformer for shipment. This report shall include description of the failure, investigation of the causes, the corrective measures that were applied, impact on other parts of the transformer, and re-tests performed.

A.8.26.6 Photographs of the complete core and coil assembly shall be taken prior to tanking the unit. Photographic views shall be taken from each of the four side elevations and one or more overhead views to show the top construction. Five prints (8-1/2 in. x 11 in.) of each photo shall be furnished and each copy shall list the purchase order number, transformer description and identify the view.

A.8.26.7 The Seller shall furnish the Buyer with five (5) sets of certified test reports covering the guaranteed requirements, as well as manufacturer's standard and commercial tests, immediately following shipment.

A.8.27. TRANSFORMER LOSSES AND AUXILIARY POWER REQUIREMENTS

A.8.27.1 The load losses, efficiency and regulation shall be corrected to a reference temperature according to IEEE Standard C57.12.00.

A.8.27.2 The Seller shall furnish the Buyer with certified test reports covering the guaranteed requirements, as well as manufacturer's standard and commercial tests, immediately following shipment.

A.8.28. INSTALLATION

A.8.28.1 Seller shall perform all required installation and related activities as defined in Section A.1- Project Requirements of this Specification. For component locations and installation requirements, see Section A-12 Electrical Requirements and Design Criteria.

END OF SECTION



SECTION A.9
SITE REQUIREMENTS AND DESIGN CRITERIA

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SECTION A.9

SITE REQUIREMENTS AND DESIGN CRITERIA

A.9.1 GENERAL

This Section outlines the site conditions used as the basis for Facility Design.

Site Location and Access (see A.16.3)

Project Location	[Insert City, State] at approximate coordinates: xx°xx'xx.xx"N xx°xx'xx.xx"W
Main Access Road	Road Access: via [Insert Project Specific Access] Rail Access: [Insert Project Specific Access] Barge Access: [Insert Project Specific Access]

The governing code for all Work shall be the International Building Code (IBC) **[Insert Year based on state and local requirements]**. The IBC establishes minimum requirements for Buyer's acceptance of the totality of the Work performed under this Contract. Adherence to federal and other state regulations is also a requirement of the Work.

Where other codes or standards of practice are referenced in this Specification, and IBC is silent as to the provisions established by these referenced codes or standard, the referenced codes and standards shall be to the latest revision.

In cases of conflict between the requirements of this Specification and any applicable codes, the more stringent of the requirements shall govern.

A.9.2 FACILITY DESIGN LIFE

The Facility shall have a design life of 30 years operation without distress due to cycling loads.

A.9.3 METEOROLOGICAL / WEATHER DATA

The table below lists the meteorological data, which are based on ambient weather conditions taken from ASHRAE data adjacent to the Site.



Table 3-1 Meteorological Data



Parameter	Value(s)	Unit(s)	Reference
Ambient Outside Dry Bulb Temperature (DBT):			
Maximum, Summer Extreme	[Insert Value]	°F	ASHRAE (50 year max)
Summer	[Insert Value]	°F	ASHRAE 0.4%
Annual Average	[Insert Value]	°F	ASHRAE annual dry bulb average
Winter	[Insert Value]	°F	ASHRAE 99.6%
Minimum, Winter Extreme	[Insert Value]	°F	ASHRAE (50 year min)
Extreme Cold Weather Temperature (ECWT)	[Insert Value]	°F	NERC EOP-12 ECWT, Note 3
Freeze Protection Design Temperature	[Insert Value]	°F	
Relative Humidity (RH):			
Summer Extreme	[Insert Value]	%RH	NCDC Weather Data, mean coincident to DBT
Summer	[Insert Value]	%RH	NCDC Weather Data, mean coincident to DBT
Annual Average	[Insert Value]	%RH	NCDC Weather Data, mean coincident to DBT
Winter	[Insert Value]	%RH	NCDC Weather Data, mean coincident to DBT
Winter Extreme	[Insert Value]	%RH	NCDC Weather Data, mean coincident to DBT
Site Barometric Pressure:			
Pressure	[Insert Value]	psia	ASHRAE standard pressure at station elevation
Precipitation and Snow:			
Annual average rain, total	[Insert Value]	in.	NCDC Weather Data
2-year, 24-hour storm	[Insert Value]	in.	NOAA Atlas 14
10-year, 24-hour storm	[Insert Value]	in.	NOAA Atlas 14
25-year, 24-hour storm	[Insert Value]	in.	NOAA Atlas 14
100-year, 24-hour storm	[Insert Value]	in.	NOAA Atlas 14

Parameter	Value(s)	Unit(s)	Reference
Snow	[Insert Value]	in.	National Weather Service

References and Notes:

- American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), 2021. "Fundamentals". [Insert Site Specific Reference]
- National Oceanic and Atmospheric Administration (NOAA), [Insert Site Specific Reference]
- EWCT is the freeze protection design temperature for continued unit operation in extreme cold weather as determined in accordance with NERC EOP-12-2

A.9.4 LOADING AND NATURAL PHENOMENA DESIGN DATA

A.9.4.1 Seismic Design Criteria

Structures, along with non-building structures and components such as tanks, pipe racks, steam turbine supports, combustion turbine supports, heat recovery steam generator (HRSG) supports shall be designed in accordance with the State endorsed seismic design requirements of IBC and ASCE standard 7, using the following parameters:

A.9.4.1.1 Site Soil Class: [Insert Value]

A.9.4.1.2 Importance Factor (IE) = [Insert Value]

A.9.4.1.3 Risk Category III

A.9.4.1.4 S_s = [Insert Value], S_{MS} = [Insert Value], S_{DS} = [Insert Value]A.9.4.1.5 S_1 = [Insert Value], S_{M1} = [Insert Value], S_{D1} = [Insert Value]

A.9.4.1.5.a Site Seismic Design Category: [Insert Value]

A.9.4.2 Wind Design Criteria

Structures, along with non-building structures and components such as tanks, pipe racks, steam turbine supports, combustion turbine supports, heat recovery steam generator (HRSG) supports shall be designed for wind loads in accordance with State endorsed IBC and ASCE 7 standard, using the following parameters:

A.9.4.2.1 Ultimate Wind Speed (V): [Insert Value] miles per hour (3-second gust at 33 feet above ground)

A.9.4.2.2 Wind Exposure Category: [Insert Value]

A.9.4.2.3 Risk Category: III

A.9.4.2.4 Wind rose data to be provided for site design basis:

Figure 4-1 Wind Rose Annual

[Insert]

Figure 4-2 Wind Rose Winter

[Insert]

Figure 4-3 Wind Rose Summer

[Insert]

- A.9.4.2.5 Per SEI/ASCE 37, for erection and test loads that are less than 6 weeks in duration, the wind velocity can be taken as 75% of the maximum velocity specified, provided erection is planned during non-peak hurricane season.
- A.9.4.2.6 Reduction in wind loads due to shielding effects of nearby or adjacent structures shall not be considered.
- A.9.4.2.7 Vertical stacks or other similar slender structures, subject to slenderness effects shall be analyzed and designed for oscillation or side sway resulting from wind eddy shedding. Alternately, a means shall be developed to prevent the vortex shedding and its loading.
- A.9.4.2.8 Wind loads on steel stacks shall be in accordance with the wind load provisions of ASME STS-1. In addition, stacks shall be analyzed and designed for circumferential bending.
- A.9.4.3 Snow Design Criteria
- Structures shall be designed for snow loads in accordance with ASCE 7 using the following parameters:
- A.9.4.3.1 Ground Snow Load = **[Insert Value]** psf
- A.9.4.4 Ice Design Criteria
- Ice sensitive structures (including ice accumulation on transmission wires and support structures, switchyard structures, etc.) shall be designed for the effects of ice accretions formed by freezing rain, drizzle, snow, and in-cloud icing. Atmospheric ice loads shall be in accordance with ASCE 7 Chapter 10, as applicable, using the following parameters:
- A.9.4.4.1 Ice Thickness = **[Insert Value]** in
- A.9.4.4.2 Ice Wind Gust Speed = **[Insert Value]** mph
- A.9.4.4.3 Concurrent Ice Temperature = **[Insert Value]** F
- A.9.5 FREEZE PROTECTION
- A.9.5.1 Average Frost depth for this site is **[Insert Value]**. (for general foundation design).
- A.9.5.2 Extreme frost depth for this site is **[Insert Value]**. (per ANSI/AWWA D100-79 for underground piping and storage tank foundations).
- A.9.5.3 For underground fire loop yard piping, NFPA 24 recommends depth cover of 3 ft 0 in.

- A.9.5.4 Design temperature for freeze protection shall be [Insert Value] °F and a sustained 20mph wind.
- A.9.5.5 Fluid temperature in pipe shall be maintained above 40°F (minimum, unless higher temperature is required due to fluid properties or process)
- A.9.5.6 Application of different freeze protection measures shall be based on a time to freeze evaluation such that all piping and components are protected against a 72-hour freeze event with average temperature of 20 deg F.
- A.9.5.7 Time to freeze evaluation shall consider a maximum of 25% of pipe cross section freezing, and a sustained 20-mph wind.
- A.9.5.8 A project specific time to freeze table will be developed for the Project during execution.

A.9.6 GEOTECHNICAL SOIL INFORMATION

- A.9.6.1 To be provided by Seller. See Section A.16.4.4 for geotechnical data design basis.

A.9.7 SITE FLOODING INFORMATION

- A.9.7.1 Based on the Flood Insurance Rate Map for the Site, the project is located within Zone [Insert Flood Zone].

A.9.8 HVAC SYSTEM DESIGN

The table **Table 9-1** below lists the HVAC design parameters for various area types defined in Section A-15, Building and Equipment Enclosures.

Table 9-1 HVAC Design Parameters

OEM Supplied Areas (Ventilated and Heated): Including Combustion Turbine Enclosure, Combustion Turbine Auxiliary Enclosure, Steam Turbine HIP Enclosure, Enclosure between LP Turbine and Generator	
Maximum allowable indoor temperature	140°F
Minimum allowable indoor temperature	50°F

General Facility Areas (Ventilated and Heated): Including Warehouse, Water Treatment Building, Fire Pump House Enclosure	
Maximum allowable indoor temperature	20°F above summer ambient temperature ²
Minimum allowable indoor temperature	50°F
Air Change Rate ¹	15 per hour

**Electrical Equipment Areas, Excluding Battery Rooms (Ventilated, Heated and Air Conditioned):
Including Water Sample Enclosure, PDC Buildings, Combustion Turbine Control Package, CTG
and STG Excitation Equipment Enclosures.**

Maximum allowable indoor temperature	75°F
Minimum allowable indoor temperature	50°F

Battery Rooms (Ventilated, Heated and Air Conditioned):

Maximum allowable indoor temperature	80°F
Minimum allowable indoor temperature	74°F

**Personnel Areas (Ventilated, Heated and Air Conditioned):
Including Admin/Control Room Building, Guard Shack**

Maximum allowable indoor temperature	72°F
Minimum allowable indoor temperature	70°F

**Personnel Areas (Ventilated, Heated and Air Conditioned):
CEMS Enclosure**

Maximum allowable indoor temperature	75°F
Minimum allowable indoor temperature	65°F
Maximum allowable indoor relative humidity	60%
Minimum allowable indoor relative humidity	40%

Note 1: Listed numbers are for estimating purposes only.

Note 2: Fire Pump House Enclosure shall be limited to a 120°F maximum indoor temperature, in accordance with section A.11.

Critical areas (excluding turbine control package battery room) shall have redundant heating, cooling and ventilating equipment. Normally occupied areas shall have multiplicity of N + 1. Multiplicity indicates that the HVAC system should have multiple units.

A.9.9**FUEL GAS ANALYSIS**

For Guarantee Design Conditions for the Fuel Gas Composition see Section A.1.6.1.2, Table A.1.6.1.2.b.

The fuel is pipeline quality natural gas with the following specifications:

Table 9-2 Fuel Gas Properties

Fuel	Fuel Properties	Units	Design Range	
			Minimum	Maximum
Natural Gas	Temperature	°F	[Insert Value]	[Insert Value]
	Pressure at fuel gas supplier interface point (station boundary)	psig	[Insert Value]	[Insert Value]

A.9.10 **AMMONIA DESIGN DATA**

A.9.10.1 29% Aqueous Ammonia solution will be provided for use in the SCR section of the HRSG.

A.9.11 **MAKEUP / RAW WATER QUALITY**

A.9.11.1 Seller shall provide water sample reports in Exhibit A.16.4.14. Water parameters not available within Exhibit A.16.4.14 are to be determined at a later time for the project.

A.9.12 **FILTERED WATER QUALITY**

Filtered water shall be provided for the CTG evaporative cooler while satisfying OEM requirements and limitations.

A.9.13 **POTABLE WATER SYSTEM**

Potable water will be sourced from a municipal water connection for drinking water, safety showers, and eye wash stations.

A.9.14 **NOISE LEVEL LIMITATIONS**

Equipment shall not exceed 85 dBA when measured (Near Field) per ASME PTC-36 and ANSI S1.13, or, if not applicable, at 3 feet in the horizontal plane, 5 feet from the ground or personnel platform from any major surface on equipment and referred to 20 micro-Pascals. Noise from intermittent sources (e.g., relief valves, etc.) shall follow requirements specified in Section A.6.5.16.

During any operating conditions, including, but not limited to, start-up and normal operation, the maximum measured A-weighted sound level at Project's property boundaries, when measured in accordance with ASME PTC-36 and ANSI S1.13, shall not exceed Applicable Law/Code for the Project location. After the Applicable Law/Code is determined and the required sound levels are agreed to by Buyer and Seller. A far field noise study shall be provided by the Seller. Seller shall provide adequate sound attenuation measures to ensure the noise emission limits are not exceeded at the Project's property boundaries. The sound attenuation measures may include, but not be limited to, noise insulation blankets and sound barrier walls. The Seller's scope shall include baseline sound measurements before Facility Performance Tests and final sound testing during Facility Performance Tests to demonstrate the noise limits are not exceeded. Seller shall work with the Buyer to organize the baseline noise emission testing.

A Sound Measurement Protocol shall be developed by the Seller and submitted for approval prior to any measurements occurring. The protocol shall include references to specific methods (ANSI, ASME, ISO, etc.) and indicate specific locations for measurement.

A.9.15

WETLANDS

The proposed property shall be assessed for Wetlands (jurisdictional or otherwise) and any required mitigation of Wetlands shall be assigned to the appropriate party. A Wetland Delineation report shall be provided in A.16.4.6.

END OF SECTION

SECTION A.10
MECHANICAL REQUIREMENTS AND DESIGN CRITERIA

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SECTION A.10

MECHANICAL REQUIREMENTS AND DESIGN CRITERIA

A.10.1 GENERAL

- A.10.1.1 This section defines the minimum requirements for design, engineering and material requirements for mechanical systems including equipment, piping, and valves. This includes specific requirements for the Seller to engineer, design, procure and construct the Facility.
- A.10.1.2 It is Seller's responsibility to ensure that all of the specification requirements herein are incorporated into engineering and design. Seller shall develop complete P&IDs, in full and for all mechanical systems, based on these considerations. Dedicated P&ID sheets shall be developed for each Unit and each System, with unique tags for every component shown.
- A.10.1.3 Per ASME SA-941 Specification for Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys, the definition of "alloy steel" is as follows: "a steel, other than stainless steel that conforms to a specification that requires one or more of the following elements...". In the usage within this specification, the term "alloy steel" shall be synonymous with "low or intermediate alloy steel" which are steels with chromium percentages of 1.25 to 9% (e.g. P11, P22, P91 materials). However, per ASME, stainless steel is not considered to fall into the common terminology of "alloy steel" in the context of welding procedures, PWHT, PMI, etc.

A.10.2 SCOPE OF WORK

- A.10.2.1 Unless indicated otherwise, all redundant equipment configurations shall be two (2) x 100% or three (3) x 50%. When redundant equipment is supplied, the standby equipment or device shall be capable of fully backing up the operating equipment or device. The switch between the operating and standby equipment shall be automatic and executed through the control system, local controls or relaying and without the loss of function. Any redundant systems not designed with automatic switchover shall require Buyer approval.
- A.10.2.2 All Facility systems shall include connections necessary to accommodate startup and commissioning activities including, but not limited to flushing and cleaning.
- A.10.2.3 Overall facility design shall incorporate maintenance features to optimize long-term plant operations activities. Hoists and monorails, including load rating labels, shall be provided to facilitate material handling as outlined in Section A.15.
- A.10.2.4 All covers weighing less than 50 lb shall be provided with lifting handles. Otherwise, covers weighing 50 lb or more shall be provided with lifting points or lugs.

A.10.2.5 Equipment featuring threaded connections and located around areas subject to vibratory loads shall feature jam nuts or other means to preclude the need for regular tightening.

A.10.2.6 Clearance Requirements:

A.10.2.6.1. Good design practice shall be followed to optimize clearance between piping, equipment and passageways for operation and maintenance.

A.10.2.6.2. For the entire Facility, Seller shall maintain minimum horizontal and vertical clearances outlined in Section A.14.

A.10.2.6.3. Adequate space shall be provided to service control valves including their operators.

A.10.2.6.4. Adequate space shall be provided within enclosures, as well as removable enclosure panels, to allow for equipment removal.

A.10.2.6.5. Clearances shall be reflected in the 3D model to demonstrate that the appropriate clearances have been provided. This is subject to review by Buyer for approval.

A.10.3 APPLICABLE CODES AND STANDARDS

A.10.3.1 The Facility's design, construction, testing, commissioning, and Acceptance Tests shall be completed in accordance with internationally recognized codes, standards, and recommendations. Seller shall provide the equipment and systems whose design complies with the latest edition of the applicable Codes and Standards issued by the institutions and/or organizations as referenced throughout this Criteria. Seller may propose to the Buyer for the Buyer's consideration other institutions and/or organizations, if the Seller can demonstrate the proposed alternate(s) are technically equivalent to or more stringent.

A.10.3.2 Design shall take into account and comply with all of the statutory requirements of the federal, state, and local codes in addition to the applicable codes listed herein.

A.10.3.3 As a minimum, all design, fabrication and construction shall be based upon applicable codes, standards and regulations of the organizations including revisions and addenda in effect at the time of Award. In addition to the specific codes and standards specified elsewhere herein, Seller shall identify those codes and standards from the acceptable institutions provided in Section A.1 (Project Requirements), which shall govern the Work.

A.10.4 EQUIPMENT NUMBERING AND LABELING

A.10.4.1 Redundant Equipment Numbering:

- Seller's standard shall be used but with the following requirements:
- Use an "A, B, C" suffix for numbering redundant equipment.

A.10.4.2 Numbering of instrument and control devices shall be in accordance with ANSI/ISA-S5.1.

- A.10.4.3 Seller shall develop with the Buyer, a project specific numbering procedure derived from the Entergy Project Numbering Guideline, as specified in Section A.16.2.2 - Numbering Procedure. This procedure will include requirements for valve numbering for OEM valves connected to DCS (utilizing 5000 and 9000 series numbers). Numbering shall be in accordance with the Project Numbering Procedure.
- A.10.4.4 To maintain consistency within the Buyer's fleet of CCCTs, the components of the primary mechanical system flow paths shall be assigned numbers as provided by the Buyer. The systems specified in Sections A.10.5 - Steam, A.10.6 - Steam Turbine Bypass, and 10.8 - Feedwater, and A.10.9 -Condensate.
- A.10.4.4.1. The components included are the main control valves and pumps of the identified systems and other major components as identified during initial design.
- A.10.4.4.2. These numbers, along with a standard equipment descriptor will be supplied by Buyer during original scoping or initial design.
- A.10.4.4.3. The Buyer provided numbers will follow the guidance of A.16.2.2 – Numbering Procedure.
- A.10.4.4.4. This valve number and description harmonization does not apply to valves not in the primary flow paths or manual valves or Major Equipment supplier equipment.
- A.10.4.5 Mechanical equipment position and status indication shall be as follows:
- A.10.4.5.1. Valves and dampers with indication (includes all valves with indication, manual, automatic, isolation, control)
- A.10.4.5.1.a. Green shall indicate closed
- A.10.4.5.1.b. Red shall indicate open
- A.10.4.5.2. Active equipment:
- A.10.4.5.2.a. Red indicates on, running, or energized
- A.10.4.5.2.b. Green indicates off, stopped, or de-energized
- A.10.5 STEAM SYSTEMS
- A.10.5.1 The following steam systems shall be provided and interconnected between the HRSG and Steam Turbine:
- High Pressure (HP) Steam
 - Cold Reheat (CR) Steam
 - Hot Reheat (HR) Steam
 - Low Pressure (LP) Steam
 - Auxiliary Steam System (Supplied by CR and HP Steam Letdown Systems)

- A.10.5.2 Auxiliary steam system may include a natural gas fired or electric auxiliary boiler if necessary to meet the proposed plant startup times.
- A.10.5.3 Final (exit) stage attemperators shall be provided with the HP and HR Steam Systems at the HRSG interface.
- A.10.6 STEAM TURBINE BYPASS SYSTEM
- A.10.6.1 The Steam Turbine Bypass System shall be designed to allow passing 100% of the steam flow and attemperation water with the CTG at 100% load during non-duct fired operating cases and with the evaporative cooler in service. The bypass system shall include features that will allow steam conditioning for both rapid start-ups and shutdowns. The turbine bypass shall include pressure regulating and temperature attemperating equipment for conditioning of the steam sources, thereby shortening the start-ups and reducing the steam turbine thermal stresses to be within or below the acceptable manufacturer's tolerances.
- A.10.6.2 The HP and HR Steam Systems shall feature full bypass capability for the HRSG. HP Steam Bypass is sent to the CR Steam System, while the HR and LP Steam Bypasses are sent to the Air-Cooled Condenser.
- A.10.6.3 The stop/bypass valves shall be closed during normal operation of the unit; the system shall be operated automatically during start-up or in the event of a trip, shutdown, or sudden load reduction. The steam turbine bypass controls shall be integrated with DCS.
- A.10.7 STEAM DRAINS AND WATER INDUCTION PREVENTION SYSTEM
- A.10.7.1 Drain pots with control valves are required for all steam piping systems, including low points, upstream of control valves and downstream of attemperator stations to allow for automatic removal of condensate. Drain pots in the HP and HR steam systems shall use thermal elements to control the control valve while the other steam systems (CR and LP) shall use level switches or thermal elements in accordance with ASME TDP-1 recommended water induction prevention practices.
- A.10.7.2 Drain pots shall be provided as recommended by ASME B&PVC, Section I, or ASME B31.1, and ASME TDP-1, as applicable. Drain pot drains shall be routed with a continuous decline in elevation in the direction of flow. Controls for the drain pots shall be in accordance with ASME TDP-1.
- A.10.7.3 Automatically operated drain valves shall be used throughout the steam piping system drains (i.e., drain pots), to prevent condensate accumulation. No operator action shall be required to initiate the drains system. A temperature element should be added downstream of the drain valve for the main cycle steam systems.

- A.10.7.4 An atmospheric Blowdown Tank, suitably sized for all operating and maintenance conditions, shall be provided with the HRSG to collect steam drains around the HRSG. The Blowdown Tank vent shall discharge away from personnel areas.
- A.10.7.5 Steam Drains Tank(s), suitably sized for all operating and maintenance conditions, shall be provided near the STG area to collect steam drains around the STG. Atmospheric tank vent shall discharge away from personnel areas.
- A.10.7.6 The Blowdown Tank and Steam Drains Tank shall feature an automated quench water system for temperature control.
- A.10.7.7 Condensate from the Blowdown Tank shall ultimately be routed to the wastewater sump or cooling tower basin.
- A.10.7.8 Condensate collected in the Steam Drains Tank(s) shall be routed to the condenser.
- A.10.7.9 Combination of different pressure steam system drains into common drain headers / manifolds is prohibited.
- A.10.7.10 Drain piping materials shall be the same as that of the main piping system it is draining, including the drain pot automatic drain valve. Additional pipe thickness allowance shall be included for all lateral connections into headers to provide protection against wear erosion.
- A.10.8 FEEDWATER SYSTEM
- A.10.8.1 A high pressure feedwater system shall connect the HRSG LP drum to the HP HRSG economizer and the Combustion Turbine cooling air (TCA) system. An intermediate pressure feedwater system shall connect the single boiler feedwater pump to the IP economizer and to the fuel gas performance heater. Feedwater is also used as final attemperation and bypass system spray water.
- A.10.8.2 The system shall be designed to minimize flow disturbances and pressure drop, as well as prevent excessive loads on the interconnected equipment including HRSG, boiler feedwater pump and economizer headers.
- A.10.8.3 One (1) 100% fixed speed motor-driven boiler feedwater pump shall be provided for each HRSG. Refer to Section A.12 for motor requirements.
- A.10.8.4 The design flow and head requirements of the system shall consider all operating scenarios, full range of ambient conditions, full steam bypass and other unit trip conditions.
- A.10.8.5 The boiler feedwater pump shall be segmented ring, multiple stage pumps in accordance with Hydraulic Institute Standards.
- A.10.8.6 The pump lube oil system shall be equipped with oil sampling connections.

- A.10.8.7 Each pump shall be provided with a minimum recirculation control valve.
- A.10.8.8 A warm up line for each feedwater pump shall be provided if required by the manufacturer. Warmup design and piping configuration, if required, shall be agreed upon with pump manufacturer.
- A.10.8.9 Pumps and skid mounted items are to be constructed so that bearings, seals, and balance drum may be accessed without removing the pump.
- A.10.8.10 Pressure pulsations are designed to be below 3% of total pump head.
- A.10.8.11 The pumps shall utilize a vibration monitoring system. Refer to Section A.13.13 for vibration instrumentation requirements.
- A.10.8.12 Each pump and driver shall operate in dynamic balance as a unit without excessive vibration, as defined by the Hydraulic Institute.
- A.10.8.13 Maximum pump operating speed (full speed) shall not exceed 5,500 rpm. The impeller specific speed shall not exceed 1,700 rpm.
- A.10.8.14 Bearings shall be oil lubricated. Bearings shall be arranged to facilitate alignment and maintenance and to permit easy replacement. Provisions shall be made to prevent throwing of oil and to prevent contamination of the oil from moisture or dirt.
- A.10.8.15 The thrust bearing shall be of the double acting Kingsbury adjustable type or Buyer approved equal. Thrust bearings shall positively prevent contact of rotating and stationary pump parts in the axial direction.
- A.10.8.16 Mechanical cartridge type seals shall be of the pressure balanced design and furnished complete with gland plate and shaft sleeve designed and machined to fit on the shaft. The seal shall be assembled on the shaft sleeve, and spring compression shall be adjustable before the seal cartridge is installed in the pump.
- A.10.8.17 The pressure oil lubrication system (used with sleeve radial and disk and plate thrust bearings) shall be furnished complete with oil reservoir, oil level gauge, shaft driven oil pump, oil flow sight indicators, pressure relief valve, oil cooler, duplex filter, and interconnecting piping and valves to provide a complete pressure lubrication system for the pump and driver. The oil reservoir shall be complete with all necessary appurtenances, including fill and drain connections and suitable vent. Pressure and temperature gauges shall be included at all locations that will permit monitoring performance of the system.
- A.10.9 CONDENSATE SYSTEM
- A.10.9.1 The condensate system shall transfer condensate from the water cooled condenser hotwell or ACC condensate collection tank to the HRSG low-pressure (LP) economizers.

- A.10.9.2 The condensate system shall include two (2) 100% capacity motor driven vertical can type condensate pumps. Refer to Section A.12– Electrical Requirements and Design Criteria for motor requirements.
- A.10.9.3 Not Used.
- A.10.9.4 The pumps shall be provided with a minimum recirculation flow line and shall operate under a controlled condensate level that will ensure cavitation free operation.
- A.10.9.5 The pumps and system shall be sized for the maximum condensate flow and head requirements of the system.
- A.10.9.6 All operating scenarios shall be considered in determining the maximum design, full range of ambient conditions, full steam bypass, startup, and trip conditions.
- A.10.9.7 A demineralized water quench system shall be provided to operate during startup in order to maintain the required TCA inlet temperatures and prevent excessive temperature rise in the condenser and steam turbine back-end. Following are additional requirements:
- A.10.9.7.1. The quench system shall cool Condensate System water at the inlet to the TCA Cooler.
- A.10.9.7.2. The quench system shall be sized to handle the startup flow for the Combustion Turbine Unit, through Full Speed No Load (FSNL).
- A.10.9.7.3. Not Used
- A.10.9.7.4. Not Used
- A.10.9.7.5. Not Used
- A.10.9.7.6. Not Used
- A.10.9.8 Two (2) x 100% capacity iron filters shall be provided as part of the condensate system.
- A.10.10 CONDENSER AND ACCESSORIES
- A.10.10.1 The Project shall include either an Air Cooled Condenser (ACC) or a Water Cooled Surface Condenser. If a Water Cooled Surface Condenser is utilized, a Circulating Water System, Cooling Tower, and Cooling Tower Chemical Feed System shall be included as specified in Section A.10.11, A.10.15, and A.10.17 respectively.
- A.10.10.2 Air Cooled Condenser and Accessories
- A.10.10.2.1. The ACC shall be designed to condense the maximum exhaust steam flow from the ST; to accept the relevant steam system drains; and to condense the steam flows from the HR and LP bypass systems under conditions of HRSG start-up, turbine start-up and turbine trip. The ACC shall be designed to accept 100% steam bypass plus attemperating water

from the HR and LP systems. The ACC system shall be designed to work properly and satisfactorily under all operating conditions.

- A.10.10.2.1.a. ACC icing will be avoided by means of HRSG startup venting, where no steam will be admitted to the ACC until the flow is sufficient to avoid icing, therefore ACC sectionalizing valves are not included in the design.
- A.10.10.2.2. The ACC shall be designed to accommodate plant load swings and ramp rates from maximum to minimum as specified herein throughout range of ambient temperatures at the plant site per Section A.1.2.3.6. The condenser shall be capable of maintaining optimum turbine exhaust pressure by incorporation of various design features such as fan speed switching, sectionalizing, etc.
- A.10.10.2.3. The ACC shall be of the W-frame type, elevated sufficiently for proper air inlet distribution. Constructability provisions shall be provided to permit proper alignment of bundle tube sheets for purposes of seal welding.
- A.10.10.2.4. All portions of the condensing system that are associated with containing steam and condensate shall be seal welded. This includes ducting except steam duct expansion joints which may be flanged. Gasketed joints and threaded connections are acceptable only for equipment and maintenance/access connections.
- A.10.10.2.5. The ACC shall be designed for full vacuum and a positive pressure of 7.25 psig per requirements of HEI.
- A.10.10.2.6. The ACC shall be designed to allow winterization mode operation at minimum steam flow and concurrent minimum ambient temperature. The tubes, headers, drain pots, and piping shall be sized and designed to drain freely and completely to prevent damage due to freezing. Freeze protection features, e.g., ACC top dampers, reverse steam flow capability, variable speed fans, etc., shall be provided, if required by ambient conditions.
- A.10.10.2.7. Reverse buckling rupture disc type pressure relief device for each isolatable condenser section shall be provided. Where condenser sections are not isolatable, the device(s) shall relieve the entire ACC.
- A.10.10.2.8. ACC to include connections for complete draining, a vacuum breaker connection of ample size to decelerate the turbine rotor train and all local and remote (through the DCS) instrumentation including triple redundant condensate collection tank pressure transmitters, triple redundant condensate collection tank level transmitters, condensate collection tank level glass gage, and double redundant condensate collection tank temperature indicating transmitters.
- A.10.10.2.9. Fans:
 - A.10.10.2.9.a. Fan blades shall be constructed of fiberglass reinforced polyester (FRP). Fan blades shall be interchangeable. A fan guard shall be provided below each fan. For A-style ACCs, the

fan guard shall be designed such that it can be used as a maintenance platform using plywood or wooden planks. The fan shall be provided with backstops integral to the gearbox to prevent backward rotation prior to fan startup. An electro-mechanical brake shall be provided to prevent fan rotation during maintenance or high wind conditions.

- A.10.10.2.9.b. Each fan shall be driven through a speed reduction gearbox suitable for continuous service in a dry air cooled condenser environment. The gearbox shall be designed in accordance with AGMA standards. The minimum mechanical design service factor shall be 2.5 referred to motor nameplate rating. A sight gage shall be provided to indicate oil level from outside the fan cylinder. Bearings shall have an L10 life of 100,000 hours. An oil pressure or flow switch shall be provided for each gearbox. Design fan pitch shall not be set for maximum air flow, to provide margin for future increase.
- A.10.10.2.9.c. Fan motors shall be single speed.
- A.10.10.2.10. Steam Duct:
 - A.10.10.2.10.a. A carbon steel steam duct from the turbine exhaust to the ACC inlets shall be furnished including expansion joints and structural supports and/or hangers, as required.
 - A.10.10.2.10.b. Access manhole(s) in the steam duct to allow for internal inspection and maintenance of the steam duct system between the turbine and condenser shall be provided. Manholes shall be 24-inch steel pipe nozzles including a blind flange with hinge or davit for ease of opening.
 - A.10.10.2.10.c. The steam duct shall be designed for full vacuum and for a pressure of 7.25 psig per requirements of HEI, with a maximum steam temperature of 250°F.
 - A.10.10.2.10.d. Not Used
 - A.10.10.2.10.e. Steam Duct Drain Pot:
 - A.10.10.2.10.e.1 A low point drain pot sized to collect condensation during start up and normal operation shall be provided. Condensate shall be returned to the condensate collection tank. Seller shall provide freeze protection, as required, during plant shutdown.
- A.10.10.2.11. Turbine Exhaust Neck:
 - A.10.10.2.11.a. The turbine exhaust neck shall be of adequate size to resist erosion and to distribute and reduce the velocity of turbine exhaust steam. Internal bracing and miscellaneous structural members shall be designed to permit access to the expansion joint.
- A.10.10.2.12. Condensate Collection Tank:
 - A.10.10.2.12.a. The tank shall be designed in accordance with the requirements of the Boiler and Pressure Vessel Code, Section VIII if required by governing codes or per the Seller's design.

- A.10.10.2.12.b. The condensate collection tank shall be of the horizontal storage type located below the ACC.
- A.10.10.2.12.c. The condensate outlet from the condenser condensate collection tank shall be provided with anti-vortexing devices, with internal lip height of 3 inches to prevent the carryover of solids into the condensate.
- A.10.10.2.12.d. The minimum capacity of condensate collection tank between the normal water level and low-low water level shall correspond to at least five minutes of condensate flow at the design condition.
- A.10.10.2.12.e. The condensate collection tank shall include a gauge glass with overlapping connections (spanning both the control and alarm set points) for external visual indication of condensate collection tank level, socket weld connections for level transmitter instrumentation, temperature elements, and other connections.
- A.10.10.2.12.f. The condensate collection tank high-high level (HHWL) shall be a minimum of 10 inches above the normal water level (NWL). The condensate collection tank high water level (HWL) shall be a minimum of 6 inches above the normal water level. The low water level (LWL) shall be a minimum of 6 inches above the low-low water level (LLWL). The low-low water level (LLWL) shall be a minimum of 6 inches above the bottom of the condensate collection tank.
- A.10.10.2.13. Air Ejector System:
- A.10.10.2.13.a. Steam Jet Air Ejector (SJAE) for Holding: The ejection equipment capacity shall as a minimum conform to the applicable standards of HEI and be a minimum of 1x100% configuration skidded SJAE consisting of ejectors and aftercondensers.
- A.10.10.2.13.b. Liquid Ring Vacuum Pumps (LRVP's) for Hogging: Three (3) 50% electric motor-driven liquid ring vacuum pumps shall be provided for hogging operation. Materials of construction shall be as follows:
- A.10.10.2.13.b.1 Cast steel housing
- A.10.10.2.13.b.2 Stainless steel internals
- A.10.10.2.13.b.3 Mechanical cartridge type seals
- A.10.10.2.13.c. Not used.
- A.10.10.2.14. ACC will include a vacuum monitoring system to monitor operation of the ACC and detect air in-leakage. Vacuum Monitoring system will be RheoVac or Buyer-approved equivalent.
- A.10.10.2.15. Automatic Fin Cleaning System:

A.10.10.2.15.a. Seller shall provide a high pressure semi-automatic cleaning system to ensure peak performance of the ACC at all times. The system shall utilize plant service water and shall deliver 1100 psig minimum to clean the fins. The system shall be designed to completely and safely clean the entire finned area and shall have all necessary features included to function under all weather conditions if required.

A.10.10.2.16. Expansion Joints:

A.10.10.2.16.a. The expansion bellows at the turbine exhaust shall be non-metallic dogbone type and shall be sufficiently flexible to permit axial and lateral movement as specified in Datasheets. The joint shall be designed to withstand the specified ACC design conditions.

A.10.10.2.16.b. Expansion joints shall be incorporated in the steam ducting to accommodate thermal movements and to minimize loads on connection points. The expansion joints shall be metal bellows type stainless steel welded construction with internal flow lines, tie bolts, lifting lugs and accessories, designed in accordance with Standards of the Expansion Joint Manufacturers Association, Section C.

A.10.10.2.16.c. Provisions shall be made to protect the expansion joint from direct impingement of any incoming steam by use of stainless steel impingement shields.

A.10.10.3 Water Cooled Surface Condenser and Accessories

A.10.10.3.1. One (1) two-pass steam surface, water-cooled condenser shall be designed for continuous operation based on a 85% cleanliness factor and in accordance with HEI standards. Each condenser section shall be served by a butterfly valve. Condenser shall be shop-tubed using 304 stainless steel tubes. The waterbox shall be carbon steel and coated with high dielectric coating system suitable for the operating environment. The tube sheets shall be 304 stainless steel material. The condenser shall be of all welded construction with bolts only permitted at access manholes, water boxes and flanged expansion joints. Condenser shall be capable of absorbing the energy associated with operating continuously at all operating cases including maximum steam bypass mode.

A.10.10.3.1.a. Condenser hotwell capacity shall provide minimum storage capacity of at least 5 minutes between normal and low-low hotwell levels, at any mode of operation.

A.10.10.3.1.b. The condenser shall be designed and guaranteed to condense the maximum exhaust steam flow from the steam turbine, to accept the relevant steam system drains, and to condense the steam flows from the Hot Reheat and LP Steam bypass systems under conditions of HRSG start-up, turbine start-up and turbine trip.

A.10.10.3.1.c. The maximum velocity through the condenser tubes shall be 8 ft/sec.

A.10.10.3.1.d. The condenser shall be provided with a vacuum breaker connection (unless provided with the STG) of ample size to decelerate the turbine rotor train.

- A.10.10.3.1.e. Seller shall provide provisions for accepting intermittent high temperature drains as necessary for startup, trip and normal operation.
- A.10.10.3.1.f. Two (2) x 100% 2-stage liquid ring vacuum pumps (LRVP) shall be provided for shell side air removal. Two pumps shall be used for hogging duty and one pump shall be capable of holding duty. The air removal system and vacuum pumps shall be sized in accordance with HEI standards and shall be capable of evacuating the condenser and STG from atmospheric pressure to 10" HgA of vacuum in 30 minutes.
- A.10.11 CIRCULATING WATER SYSTEM – IF REQUIRED
- A.10.11.1 Seller shall supply a circulating water system to support Facility operation under all operating loads and conditions, including steam bypass, at all ambient conditions.
- A.10.11.2 Design pressure of the circulating water system shall be based on total pump shutoff head, plus allowable shutoff head test tolerance, plus head elevation gain to bottom of underground piping, plus 5% for cooling tower head design and future pump upgrade.
- A.10.11.3 The maximum discharge temperature shall be as defined in the state or local NPDES Permit.
- A.10.11.4 Makeup water for the circulating water system shall be clarified water using raw water. The circulating water system is expected to be operated at 8 cycles of concentration. Sodium hypochlorite, non-oxidizing biocide, sulfuric acid, anti-scalants, dispersants and corrosion inhibitors shall be added as required to maintain cleanliness and minimize scale deposition and corrosion. Seller shall advise if the cycles of concentration will be adjusted, for Buyer approval.
- A.10.11.5 Sodium bisulfite shall be added to the cooling tower blowdown for dechlorination prior to the blowdown being discharged.
- A.10.11.6 Two (2) 50% vertical pumps with air-cooled motors of a suitable design for new wet pit service shall be provided based on maximum anticipated condenser demand (i.e., STG operation at maximum steam design flow rate and maximum inlet water temperature). Each pump shall be sized for Facility operation at full load. The discharge pressure of the pump shall be based on the design flow rate, pressure drop through the condenser in a fouled condition and normal intake water level.
- A.10.11.7 Circulating water pumps shall be provided with an anti-reverse rotation mechanism on the motor. Refer to Section A.12 for motor requirements.
- A.10.11.8 The piping system shall consist of circulating water pumps complete with isolation valves and expansion joints. Seller shall perform a hydraulic analysis to evaluate water hammer impact on the system. Seller shall submit the hydraulic gradient and pump/pipe sizing analysis to Buyer for review and approval.

- A.10.11.9 A surge analysis shall be performed on the system to optimize valve closure of the circulating water pump discharge valve, system operation and minimize pressure peaks following transients. The system shall be capable of operation from the Operating Facility DCS.
- A.10.11.10 The design of the circulating water pipe shall incorporate, as a minimum, the groundwater and soil parameters indicated in the Geotechnical Report, provided in Section A.16.4.4. The pipe shall also be designed for the following loads applied at the ground surface: AASHTO HS20-44 or crane (mobile or crane mat) required for equipment maintenance including steam turbine components or construction whichever is greater.
- A.10.11.11 The Seller shall include the services of an independent physical flow modeling service to ensure that the circulating water intake design eliminates or reduces any turbulence and vortexing of flow going to the circulating water pumps. All equipment in the intake bay shall be modeled. The modeling service recommendations shall be addressed and presented to the Buyer for review and approval.
- A.10.12 RAW & MAKEUP WATER SYSTEM
- A.10.12.1 The plant's raw water system will deliver raw water to the water treatment equipment, where it is treated for Facility use, and to the plant's potable water system.
- A.10.12.2 Not Used
- A.10.12.3 A sodium hypochlorite feed system shall be provided at the Fire Water / Service Water Storage Tank to mitigate concerns with biofouling.
- A.10.13 DEMINERALIZED WATER TREATMENT SYSTEM
- A.10.13.1 A permanent demineralized water treatment system shall be provided, consisting of two (2) x 100% ultrafiltration (UF) and two (2) x 100% double pass reverse osmosis (RO) units followed by rental mixed beds. System shall be designed to enable simultaneous operation of both trains.
- A.10.13.2 The demineralized water treatment system shall be sized for 2% of total steam flow plus additional requirements for demineralized water supplied to evaporative coolers, sampling system, laboratory, etc. As outlined herein for the Evaporative Cooler, it is anticipated that 100% of the evaporative cooler makeup will be ultrafiltered water obtained from the UF product tank, which together with supply pumps shall be adequately sized to handle the instantaneous demand for short periods.
- A.10.13.3 The demineralized water treatment system shall also be designed in accordance with the raw water quality data developed by the Seller for the proposed raw water source.
- A.10.13.4 In addition to the UF and RO skids, the demineralized water treatment system shall include all components needed for a complete system including prefilters, UF product

tank, clean-in-place system, chemical metering skids, rental mixed bed piping manifold, etc. The Buyer will provide chemical totes for all chemicals used within the treatment system.

- A.10.13.5 The RO feed water, permeate and reject high pressure piping shall be stainless steel. The use of plastic piping is allowed for lower pressure feedwater, permeate, and reject piping.
- A.10.13.6 All chemical feed systems shall include two (2) x 100% metering pumps and accessories such as suction strainer, calibration column, relief valve piped back to tote, pressure gauge, pulsation dampener, etc. Chemical feed systems shall be constructed of stainless steel except where material compatibility requires use of alternate material, see Section A.10.30.20.
- A.10.13.7 Two (2) x 100% UF backwash pumps and air scour blowers (if applicable), shall be furnished.
- A.10.13.8 UF and RO cleaning waste shall be neutralized in-situ prior to discharge.
- A.10.13.9 Rental mixed bed piping manifold shall be designed to accommodate a total of four vessels including two trains with two vessels each in lead-lag configuration.
- A.10.13.10 In addition to the standard UF and RO instrumentation (flow, pressure, conductivity, etc.) the rental mixed bed effluent shall be monitored for pH, conductivity, sodium, and silica.
- A.10.13.11 Seller shall supply a Demineralized Water storage tank with capacity of 250,000 gallons (minimum). Tank shall include provisions to protect against contamination due to air in leakage.
- A.10.13.12 All tanks and chemical storage areas shall be located to be accessible by trucks.
- A.10.13.13 Permanent stub connections and power shall be provided for temporary hookups to rental water treatment trailers that may be needed either during startup and commissioning or long-term operation.
- A.10.13.14 The demineralized water treatment system shall be controlled by a PLC based control system with local workstation and data link to the Facility DCS. The DCS shall have monitoring capability but no provisions for process control. Software shall be included within the PLC for monitoring of the normalized performance of the RO units. The transmembrane pressure within the UF system shall be monitored and trended
- A.10.13.14.1. There shall be no uplink nor external communication of the PLC with any entities outside of the station boundary, for any reason. Any such communication is strictly prohibited.
- A.10.13.15 Demineralized water quality shall be in accordance with the following:

Parameter	Units	Limit
Sodium	ppb Na	< 2
Chloride	ppb Cl	< 2
Sulfate	ppb SO ₄	< 2
Silica	ppb SiO ₂	< 10
Conductivity	uS/cm @ 77°F	< 0.1
TOC	ppb TOC	< 100

A.10.13.16 Two (2) high pressure demineralized water pump shall be provided to supply quench water for condensate cooling as described in Section A.10.9.7. The high pressure demineralized water pumps shall be designed for single pump operation during typical hot startup conditions, with two (2) pumps operating during condensate high temperature conditions.

A.10.14 CLOSED COOLING WATER SYSTEM

A.10.14.1 Closed cooling water shall consist of a closed loop system featuring cooling water pumps, a water expansion tank, and an air-cooled heat exchanger.

A.10.14.2 Closed cooling water shall be a propylene glycol and water mixture. Glycol percentage will be determined based on ambient design conditions.

A.10.14.3 The pumps shall be capable of supplying cooling water under all operating conditions.

A.10.14.4 This system, including equipment, shall be designed based on Minimum Emissions Compliant Load through full operating conditions including maximum ambient conditions. Sufficient cooling water shall also be available during Island Mode operation.

A.10.14.5 Each piece of equipment served by the cooling water system shall be equipped with balancing valves. Flow through STG main oil coolers, EHC oil, CTG hydrogen coolers shall be regulated by a control valve, if required by OEM. Butterfly or globe valves shall be used to balance flow as needed.

A.10.14.6 Individual closed cooling water equipment users shall be capable of being isolated without interruption of said system.

A.10.14.7 Not Used.

A.10.14.8 One (1) x 100% closed loop cooling fluid expansion tank shall be provided for flow surges and to accommodate circulating fluid volumetric expansion due to temperature fluctuation. This tank shall feature level instrumentation.

A.10.14.9 Two (2) x 100% redundant closed cooling water pumps shall circulate the closed loop cooling fluid through the air-cooled heat exchangers and to the auxiliary cooling loads. Each pump shall be designed to provide 100% of the system flow requirement, with an additional 10% margin.

- A.10.14.10 One (1) x 100% air-cooled heat exchanger (ACHE) shall provide cooling to the closed cooling water system.
- A.10.14.10.1. Heat exchanger design shall allow sufficient margin for fouling. The design heat duty shall be full duct firing condition plus 10%.
- A.10.14.10.2. Heat exchanger shall be capable of handling the maximum expected heat requirements with 10% of the tubes plugged.
- A.10.14.10.3. Heat exchanger shall be capable of handling the maximum expected heat requirements while using 85% of the total air flow provided by the fans or less.
- A.10.14.11 One (1) x 100% chemical feeder tank shall be provided to accommodate chemical addition. Chemical feeder tank shall be incorporated into the closed cooling water pump skid.
- A.10.14.12 Closed cooling water system drains shall be collected, via local collection only, and separated from the other drainage systems. Pump seal drains shall be collected in a sump for retention and disposal by Buyer.
- A.10.14.13 Air Cooled (Fin-Fan) Heat Exchangers
- A.10.14.13.1. A Fin Fan heat exchanger shall be provided for the plant. The heat exchanger shall be sized to dissipate the heat from all of the equipment from the plant and shall include margin for 10% future capacity. Isolation of each cell from the CCW supply without affecting operation shall be provided.
- A.10.14.13.2. Heat exchanger design shall include provisions for expansion and contraction of all parts. Heat exchangers shall be designed so that there will be no flow-induced vibrations.
- A.10.15 COOLING TOWER – IF REQUIRED
- A.10.15.1 The Seller shall provide one (1) mechanical induced-draft counterflow cooling tower. The tower shall feature multiple cells, as required, and made of fiberglass construction. Each cell shall feature a fan, gear drive, motor, drift eliminators, low fouling film fill and vibration monitoring systems.
- A.10.15.2 The cooling tower shall be designed for all ambient conditions, including summer case and Operating Facility performance given in Section A.1. Cold weather system startup shall also be incorporated into design consisting of an active bypass design sized for the flow from one Circulating Water Pump. The design performance of the cooling tower shall be verified by tests based on CTI (“Cooling Tower Institute”) procedures.
- A.10.15.3 The cooling tower shall be designed such that one fan / cell can be taken out of service for maintenance without disrupting base load operation of the station. During base load operation, CTG shall operate at full load and the steam cycle shall operate without any

steam bypass or venting. During this time, the STG output may decrease slightly with one cooling tower fan out of service as a result of increased steam turbine back pressure.

- A.10.15.4 Fiberglass construction shall conform to CTI-STD-137.
- A.10.15.5 Seller shall supply any necessary mixing troughs for chemical injection into the Cooling Tower basin. Extra care shall be taken to avoid locating any metallic components (i.e. trough supports), around corrosive chemical injection points.
- A.10.15.6 All cooling tower components shall be composed of noncombustible, or fire resistant materials, FM rated, or with a flame spread classification of twenty five (25), as described in NFPA Standard No. 255. The environment of the tower is highly corrosive and the material to be used must be designed for a thirty (30) year life considering the circulating water and other elements it will come in contact with.
- A.10.15.7 Aluminum, fiberglass or PVC jacketed cable tray or conduit and fittings shall be used for all electrical wiring on or adjacent to the cooling tower.
- A.10.15.8 The fan deck shall be constructed and coated with such materials that prevent deterioration and delamination of the decking and be non-combustible. Fan deck and stairs shall be provided with a non-skid surface.
- A.10.15.9 The cooling tower shall be provided with two means of egress. One (1) Stairway and One (1) ladder shall be furnished and located on opposite ends of the cooling tower. The ladder design shall incorporate intermediate platforms to ensure a fall arrest harness is not required to be worn. The fan deck shall be provided with proper access hatches to each cell.
- A.10.15.10 Distribution nozzles shall be large enough to prevent clogging (at least as large as the condenser tube diameter).
- A.10.15.11 Distribution header terminal points shall be fixed to inhibit axial movement due to the hydraulic forces.
- A.10.15.12 Valving shall permit taking one (1) or more cells (up to a maximum of 25%) out of service while diverting the flow to the remainder of the tower. Individual cell distribution valves shall be capable of being throttled to control flow to each cell without damaging the valves.
- A.10.15.13 The complete water distribution system shall be self-draining.
- A.10.15.14 Tower fill shall consist of removable elements, shall be arranged to facilitate inspection and maintenance, and shall ensure even distribution of air and water. Fill shall be cleanable in-situ and shall be compatible with the raw water supply used directly without pretreatment. Appropriate fill support shall be provided to prevent swaying and creep. Minimum fill thickness at any point after forming shall be 0.01" (10 mils) or more.

Tower fill shall be of a low fouling film type. To be classified as a noncombustible fill, it must have a rating established by an insurance agency, or other approved source.

- A.10.15.15 The design of the drift eliminators and the number of passes shall ensure the maximum free water carryover (drift) does not exceed 0.0005% at full fan speed (to be confirmed by Buyer during the permitting process). The eliminators shall be assembled into stable removable units. Hardware shall be of the same quality as that is provided for the fill.
- A.10.15.16 Fans shall be suitable for continuous service. The fan blades, drive shafts, flanges, bolts, and flexible coupling shall be of standard materials. The fan shaft and hub material shall be chosen to resist corrosion, erosion, and fatigue. The fan plenum shall be large enough to induce a uniform airflow from all sections of the fill.
- A.10.15.17 Each fan shall be driven through a totally enclosed speed reduction gear, which is suitable for continuous service and requires a minimum of maintenance. Carbon steel portions of the fan and drive support shall be furnished with an epoxy coating. The load from this equipment shall be transmitted directly through the motor and gear supports to the tower foundation.
- A.10.15.18 Each fan shall feature grease/oil lubrication and flush piping provisions such that they can be readily accessed externally, without having to dis-assemble fan, motor and gearbox components.
- A.10.15.19 Each fan shall feature vibration monitoring instrumentation as outlined in Section A.13.13.
- A.10.15.20 A rotation isolator/safety device, including brake, shall be installed on each fan such that when maintenance is being performed on the fan, the blades are incapable of any rotation.
- A.10.15.21 Fans shall be evaluated for maximum wind speed for safe operation. Evaluation shall include fan shroud design and remote braking. Option(s) to be presented to Buyer for implementation.

A.10.16 CYCLE CHEMICAL FEED SYSTEMS

- A.10.16.1 Cycle chemical feed systems shall be provided for the addition of ammonia into the condensate system and oxygen (O₂) into the feedwater system.
- A.10.16.2 The ammonia feed system shall consist of a tote and a metering skid with two (2) x 100% chemical feed pumps. Metering skids shall include all accessories required for a complete system such as suction strainers, calibration columns, external relief valves piped back to the totes, pressure gauges and pulsation dampeners.
- A.10.16.3 Ammonia feed rate shall be controlled from the DCS based on condensate or feedwater flow and pH and/or specific conductivity. HRSG HP and IP drum connections and piping shall be provided for potential future feed of phosphate chemical injection.

- A.10.16.4 A local control station shall be provided with each chemical feed system to allow local start and stop of the metering pumps by the operators.
- A.10.16.5 Any chemical containment walls shall be 45" or less in height (therefore does not require confined space classification).
- A.10.16.6 O₂ injection shall be based on supply from external O₂ bottles (bottles supplied by Buyer).
- A.10.16.7 The O₂ injection system shall include all accessories required for a complete system such as bottle manifolds (if required), pressure regulation valve(s), relief valve(s), flow control rotameter, filter, and pressure gauges.
- A.10.16.8 O₂ level in the feedwater shall be monitored by the DCS, using an analysis element. Adjustment of the O₂ injection rates will be manual.
- A.10.17 COOLING TOWER CHEMICAL FEED AND SAMPLING SYSTEMS – IF REQUIRED
- A.10.17.1 Cooling tower chemical feed systems shall be provided for bleach, non-oxidizing biocide, sulfuric acid, multi-function product (i.e. scale inhibitor, corrosion inhibitor and/or dispersant) and sodium bisulfite.
- A.10.17.2 Dispersant (multifunction product) systems shall include a bulk storage tanks sized for 2000 gallon.
- A.10.17.3 Bleach (sodium hypochlorite) and sulfuric acid systems shall include bulk storage tanks sized for a 21 day supply or the minimum bulk shipment size plus a 20% margin, whichever is larger. The non-oxidizing biocide and sodium bisulfite shall be provided in totes by the Buyer.
- A.10.17.4 Each chemical feed system shall include a metering skid with two (2) x 100% metering pumps. Metering skids shall include all accessories required for a complete system such as suction strainers, calibration columns, external relief valves piped back to dosing tanks or totes, pressure gauges, pulsation dampeners, etc.
- A.10.17.5 Sulfuric acid feed system and piping shall be constructed entirely of Alloy 20. All other feed systems shall be constructed of 316 stainless steel except where CPVC is required based on material compatibility.
- A.10.17.6 Sulfuric acid feed system shall include a dry breather in the bulk storage tank and a mixing trough in the cooling tower basin.
- A.10.17.7 A small packaged sample panel including instrumentation for pH, conductivity and free available chlorine, residual chlorine or ORP shall be furnished for monitoring circulating water quality, controlling chemical feed rates and adjusting cycles of concentration. The sample panel shall also include instrumentation for monitoring free available chlorine,

residual chlorine or ORP in the blowdown line to control the bisulfite feed rate. The sample panel shall be located very close to the sample location within the circulating water system to minimize pressure drop in the sample line. Alternately, the circulating water and cooling tower blowdown sampling equipment can be located within the steam turbine sampling panel depending on the overall layout of the facility. In addition to this small packaged sample panel, the Seller shall include design provisions for a Nalco TRASAR system that will be provided by the Buyer.

A.10.17.8 Any chemical containment walls shall be 45” or less in height (therefore does not require confined space classification).

A.10.18 WATER AND STEAM SAMPLING SYSTEM

A.10.18.1 A continuously monitoring water and steam analysis/sampling system shall be provided. The system shall consist of two (2) sections: 1) a sampling section (wet panel), and 2) a chemical analyzer section (dry panel). The water and steam analysis/sampling shall be designed to provide for automatic and manual collection (from each sample point) and chemical analysis of liquid samples obtained from various locations throughout the steam cycle.

A.10.18.2 At minimum, the sample points listed below are required:

Service	Sample Scope	GS	DC	SC	CC	DO	pH	S (1)	Si (2)	Na (2)	CP for FE
HRSG											
LP boiler drum water/blowdown	HRSG	X		X		X	X		X	X	
IP boiler drum water/blowdown	HRSG	X		X	X		X		X	X	X
HP boiler drum water/blowdown	HRSG	X		X	X		X		X	X	X
Boiler feedwater to IP Economizer	HRSG	X	X	X	X	X	X			X	
HP SH Steam	HRSG	X	X		X		X		X		
HP boiler Saturated Steam	HRSG	X									
IP boiler saturated steam	HRSG	X									
LP boiler Saturated Steam	HRSG	X									
Hot reheat steam	HRSG	X	X		X				X	X	

Service	Sample Scope	GS	DC	SC	CC	DO	pH	S (1)	Si (2)	Na (2)	CP for FE
Common											
Condensate pump discharge	Seller	X		X	X	X	X	X	X	X	X
Demin. Water Storage Tank (pump discharge)	Seller	X		X				X	X	X	
Condensate after chem feed	Seller	X		X			X				

Notes:

- (1) Shared analyzer with sequencer for Na and Si.
- (2) Sodium and Silica analyzer shall be shared.

Legend for Analyzers / Meters:	
GS – Grab Sample	
DC – Degassed Cation Conductivity	S – Sulfate Grab Sample (shared analyzer for Na and Si)
SC – Specific Conductivity	Si – Silica
CC – Cation Conductivity	Na – Sodium
DO – Dissolved Oxygen	Fe – Iron
CP – Corrosion Product	

- A.10.18.3 The above sampling equipment shall be located within one (1) common enclosure for the project. The enclosure shall be provided completely pre-assembled with all necessary HVAC and electrical equipment such that little or no work is required within after it arrives onsite. Steam turbine/condensate sample enclosure shall also contain the water lab.
- A.10.18.3.1 Furniture consisting of cabinets, countertops, working surface shall be provided and included in the water lab.
- A.10.18.4 Sample streams shall be designed and engineered so that all analyzers receive required flow to each probe, from minimum facility operating load up to maximum facility operating load, while always maintaining 500 cc/min manual flow.
- A.10.18.5 Sequential sampling may be utilized to minimize the number of process analyzers. However, no more than four like parameters (e.g., steam sodium or silica) may be shared between a single analyzer. The use of analyzers with multiple functions is also permitted.
- A.10.18.6 Sampling for LP superheated steam cation conductivity shall include a timer function to limit the number of hourly sampling events to maximize the cation column run length.
- A.10.18.7 Sampling of HRSG Blowdown and Closed Cooling Water shall be obtained from local sample taps or drains from the piping system. These samples are not routed to the sample panel(s).
- A.10.18.8 Each sample stream shall include a total flow rotameter.
- A.10.18.9 A high temperature blowdown header shall be provided to allow samples to bypass the analyzers during startup or abnormal operation when high levels of debris may be present.
- A.10.18.10 A demineralized water flush header shall be provided to allow the analyzers to be flushed when the unit and the sample panel are out of service for extended periods.
- A.10.18.11 Samples shall be analyzed, and the information shall be displayed on local instruments and sent to the main DCS for trending and alarm.

- A.10.18.12 Cooling water for the primary sample coolers shall be provided from the closed cooling water system.
- A.10.18.13 A skid mounted chiller system shall be provided to further cool the samples to 77°F + 1°F. Individual secondary sample coolers shall be provided for each sample line. The use of an isothermal bath is prohibited.
- A.10.18.14 The wet section of the sample panel shall entail tube-in-tube sample coolers, valves, pressure reducers, sample sink and drain, and all the sample analyzers. For safety, the Equipment shall be designed to protect the operator from inadvertent sample spray at the sink and at the grab sample locations. Conditioned grab samples shall be collected at the wet panel sample sink for manual analysis. All other conditioned samples shall flow to the chemical analyzers also located on the wet panel. The analyzer outputs shall be sent to the dry section that shall contain an annunciator, various transmitters, indicators, and inputs to the control system.
- A.10.18.15 The dry section of the sample panel shall contain all electronic equipment including process analyzers. One (1) common alarm point for water and steam sampling system shall be made to the Facility DCS. In addition, each analyzed parameter for each sample point shall be transmitted to the main DCS for monitoring, trending, alarming and controlling chemical feed rates (where applicable). Adequate environmental controls shall be provided to protect the electronics located in the sample panel from damage or corrosion due to high humidity and/or ambient temperatures to which the panel is exposed.
- A.10.18.16 Sample panels shall feature valves and quick connect fittings so that analyzers can be connected to alternate sample sources.
- A.10.18.17 Sampling tubing shall be sized to have a velocity of approximately 6 ft/sec.
- A.10.18.18 Sample piping/tubing shall be seamless ASTM SA213 TP316/316L.
- A.10.18.19 The sample panel shall be centrally located to limit tubing runs from the source to the panel to < 300 feet.
- A.10.18.20 Sample lines shall be provided with Swagelok type quick disconnect fittings constructed of 316 stainless steel.
- A.10.18.21 Sample lines from the source to the panel shall be insulated where required for personnel protection and also to satisfy the site specific requirements for freeze protection.
- A.10.18.22 The table below provides analyzer selection for various sampling applications:

Analysis Parameter	Sample Application	Make	Model
pH	All	Hach	8362
Silica	Boiler	Hach	5500
ORP	Feedwater/Economizer Inlet	SWAN	AMI-UP

Analysis Parameter	Sample Application	Make	Model
	Boiler water	Thermo-Orion	450-4 Probe
	Wastewater Discharge	Emerson	1056
Conductivity	All	Hach	
Dissolved Oxygen	Feedwater/Condensate	Hach	Orbisphere 410
Sodium	Feedwater/Condensate	Thermo-Orion	2111XP
Cation conductivity column	All	Per AVL	
Degasser for degassed Cation Conductivity Measurement	All	Per AVL	
On-line Corrosion Product Sampler	All	Per AVL	
Inductive Conductivity	All	Rosemount Analytical	
Adjustable or Non-adjustable Sample flowmeters	All	ABB	Purgemaster
Sample Panels and Enclosures	All	Per AVL	
Cooling Water Isolation Skid	All	Per AVL	
Sample Coolers and Chillers	All	Per AVL	
Condensate	All	Powerflow	
Temperature	Water Discharge	Emerson	644

A.10.19 SERVICE WATER SYTEM

- A.10.19.1 The service water system shall be supplied from a combined Fire Protection and Service Water Tank, wherein a reserved volume (as required based on Fire Protection System sizing), shall be dedicated for the Fire Protection System. The tank shall include 48 hours of water storage capacity at the highest continuous demand of make-up flow rate.
- A.10.19.2 The service water system shall include two (2) 100% pumps sized to supply water to the water treatment system and necessary service water to meet normal system operation

demand. The pumps shall take suction from above the protected fire water volume in the Fire Protection and Service Water tank.

A.10.19.3 Not Used

A.10.19.4 Each service water hose station shall feature a standard ¾" hose coupling and isolation valve.

A.10.19.5 All outdoor service water hose station shall be designed to minimize the need for heat tracing. Yard hydrants shall be used for outdoor service water hose stations located away from heated enclosures.

A.10.20 FUEL GAS CONDITIONING AND DELIVERY SYSTEM

A.10.20.1 Buyer receives supply of natural gas from its gas transporters at the onsite gas yards. Gas pressure and constituents are provided in Section A.9.

A.10.20.2 Seller shall tie into the fuel gas supply lines at a flange at the existing fuel gas yards. Seller shall provide the insulating flange kit required to make the permanent connection.

A.10.20.3 The natural gas system shall be designed per ASME B31.1 or B31.3, as dictated by the CTG manufacturer.

A.10.20.4 The gas supplier will provide shut-off and overpressure protection at the gas yard interface connection for its supplied equipment. Seller shall provide shut-off and overprotection equipment for its supplied equipment.

A.10.20.5 Seller shall supply a total fuel gas flow meter on the fuel gas supply line.

A.10.20.6 Seller shall supply any fuel gas conditioning equipment required to meet the needs of the CTG(s) and duct burners. This equipment shall at minimum include pressure regulating, flow measuring equipment, natural gas drains tanks, startup dew point and performance heaters, filtration, and separation equipment. Each CTG shall be equipped with a dedicated flow measuring device conforming to AGA-7, Measurement of Natural Gas by Turbine Meters.

A.10.20.6.1. Startup dew point heaters shall be equipped with low NOx burners with a maximum of 0.04 lb NOx/MMBtu.

A.10.20.7 All fuel gas conditioning equipment shall include a minimum flow margin of 10%.

A.10.20.8 Fuel gas sample points shall be provided throughout the system for Buyer use.

A.10.20.9 Double block-and-bleed valve configuration is required to allow for safe isolation of the interconnecting equipment from the fuel gas supplier(s), for maintenance and during inert gas purging operation. For contract purposes, double block and bleed valves for the Project are supplied, however, final implementation of double block and bleed valves will

be based on an assessment of Buyer requirements considering the final design configuration, subject to a potential change order.

- A.10.20.10 The natural gas drains tank shall be double wall and installed above ground to accommodate regular maintenance and inspections. The tank shall feature interstitial (annular space), leak detection capability as well as level indicating transmitter.
- A.10.20.11 Fuel gas vents shall be routed to the highest steel structure and to a safe location, away from personnel areas, mutually agreed with Buyer.
- A.10.20.12 Appropriate hazardous area designation is required for any leak or vent source per NFPA 497.
- A.10.20.13 Contactor shall provide chromatograph with hydrocarbon dewpoint measurement capability.
- A.10.21 CTG INLET EVAPORATIVE COOLING SYSTEM
- A.10.21.1 The CTG Inlet Evaporative Cooling System shall be operable over the entire ambient air temperature range to a minimum temperature established by the CTG manufacturer.
- A.10.21.2 Quality of the makeup water supply to the system shall be coordinated with and approved by the CTG manufacturer.
- A.10.21.3 Adequate sample valves shall be installed to collect representative water samples from the Evaporative Cooling System makeup and blowdown to confirm the required cycles of concentration and need for additional treatment (if any).
- A.10.22 SUMP PUMPS
- A.10.22.1 Vertical sump pumps shall be furnished in areas not capable of being drained by gravity. For sumps that contain normal process flows, duplex pumps shall be provided. For sumps that hold no normal flow other than rainwater, simplex pumps shall be provided. Where duplex pumps are provided, the pumps shall be sized for lead / lag operation.
- A.10.22.2 Sump pumps in oil drain areas shall be designed for pumping oil and shall be non-emulsion and non-shear design.
- A.10.22.3 A local control panel complete with auto/manual control, alternator, starters, level switches, etc., shall be included. Pumps shall alternate in automatic mode at high level, and both pumps shall operate at high-high level.
- A.10.22.4 Vertical pumps shall feature shaft bearing lubrication system to minimize the amount of manual intervention by station personnel. Options may consist of clean water source for continuous lubrication, product lubricated bearings (using pumped fluid, if OEM water quality is met), or continuous automatic grease injection system. Alternate systems,

acceptable to the OEM, may be considered with Buyer approval. Buyer will not accept pumps that require maintenance cycles with less than 60 day durations.

A.10.23 TANKS & PRESSURE VESSELS

- A.10.23.1 Double wall tanks shall meet the EPA Guidance SPCC Guidance for Regional Inspection.
- A.10.23.2 Atmospheric pressure, field erected, outdoor, steel water tanks shall be designed in accordance with AWWA D100 (welded tanks) or AWWA D103 (bolted tanks).
- A.10.23.3 Pressurized tanks with an internal design pressure greater than 15 psig shall be designed in accordance with ASME B&PVC.
- A.10.23.4 Pressure vessels shall be designed, fabricated, stamped, tested, and documented to ASME VIII standards and in accordance with state and local requirements.
- A.10.23.5 Pressure vessels shall include the following features and appurtenances:
- A.10.23.5.1 Process, vent, and drain connections for startup, operation, and maintenance.
- A.10.23.5.2 A minimum of one manhole and one air ventilation opening (e.g., handhole) where required for maintenance or cleaning access. Manhole shall be a minimum of 24 inches in diameter. Smaller manhole size may be provided where the size is limited by the dimensions of the pressure vessel.
- A.10.23.5.3 Shop-installed insulation clips spaced not greater than 18 inches on center, or shop installed insulation support rings, for vessels requiring insulation.
- A.10.23.5.4 Relief valves in accordance with the applicable codes
- A.10.23.6 Carbon steel tanks shall have a minimum corrosion allowance of 1/16 in.
- A.10.23.7 Tanks for storage of chemicals shall be constructed of material appropriate for the application or alternatively, lined with a suitable material and designed to the requirements of applicable codes and manufacturer's standards.
- A.10.23.8 Atmospheric storage tanks (those that do not have sufficient working pressure to prevent releases to the atmosphere), that store organics (i.e., VOC), are subject to 'control' requirements consisting of submerged fill pipe. Tanks that store VOC with a true vapor pressure less than 1.5 psia are only subject to record keeping to document the vapor pressure exemption. This shall be verified during permitting efforts, to ensure tanks comply with all authority requirements.
- A.10.23.9 Tanks shall be lined with a material comparable to these listed in the table below:

Ammonia Storage Tank (If Carbon Steel)	Demineralized Water Tank (Carbon Steel)	Fire Protection Water / Service Water Tank
N/A	Epoxy Phenolic (e.g., Carboline 7156)	NFPA 22
	Amine epoxy (e.g., K&L3500 or Amerlock 400GF)	Polyamide epoxy (e.g., KL3200 or Amercoat 240)
N/A		Amine epoxy (KL3500)

A.10.24 PUMPS

- A.10.24.1 All pump materials shall be suitable for safe and satisfactory operation under the operating conditions and under all climatic conditions prevailing at the Project site. Two (2) 100% capacity pumps shall be provided for all systems unless otherwise noted. Where there is at least one installed spare pump in the system, it shall start automatically upon failure of the primary operating pump. Seal oil vacuum pumps may be changed manually with indication / alarm on of loss of pump.
- A.10.24.2 All pumps (excluding sump pumps) shall be provided with a minimum flow protection system. The minimum flow protection system will be designed with appropriate margin beyond the minimum flow requirement.
- A.10.24.3 Pumps shall be capable of delivering their rated capacity at efficiency of no less than 50%, or where applicable, NEMA MG1 efficiencies shall apply.
- A.10.24.4 All pumps shall be suitable for continuous single pump and/or parallel operation, as applicable, at the specified conditions. In the case of centrifugal pumps, this shall mean from minimum flow to pump run-out flow, without vibration, cavitation and without undue noise under all operating conditions.
- A.10.24.5 In sizing of the pumps, consideration shall be given to the possibility and effect of driver overspeed and pump run out.
- A.10.24.6 Pumps shall include design margins outlined herein. The pumps shall be equipped with impellers sized smaller than the maximum allowable for the pump casing such that an additional 5% head can be achieved with replacement of a larger impeller. In addition, the motor shall be specified to be 10% larger than the rated requirement of the pump. The following defined terms shall apply.

Normal Flow = Largest flow from Heat and Material Balances (including HRSG duct firing and/or STG bypass)

Rated Flow = Normal Flow x Flow Margin

Calculated Head = Pressure drop calculated with 20% frictional design margin at Normal Flow condition

Rated Head = Calculated Head x Pressure Drop Margin

Service	Flow Margin	Pressure Drop Margin	NPSH margin
Circulating Water Pumps	0% margin on the Normal Flow	10% margin on the calculated head	$NPSHA \geq NPSHR + 3\text{ft}$ at rated operation based on pump trip level.
Condensate Pumps	10% margin on the Normal Flow	0% margin on the calculated head	$NPSHA \geq NPSHR + 1.5\text{ft}$ at rated operation based on pump trip level in the hotwell. $NPSHA$ at pump suction centerline = 0 ft.
Feedwater	10% margin on the Normal Flow	0% margin on the calculated head	$NPSHA \geq NPSHR + 20\text{ft}$ at rated operation based on pump trip level in the LP Drum.
Closed Cooling Water	10% margin on the Normal Flow	0% margin on the calculated head	$NPSHA \geq NPSHR + 3\text{ft}$ at rated operation based on pump trip level.
Centrifugal pumps, other than those listed here	10% margin on the Normal Flow	0% margin on the calculated head	$NPSHA \geq NPSHR + 3\text{ft}$ at rated operation based on pump trip level.
Positive Displacement Pumps (chemical injection)	10% margin on the Normal Flow	0% margin on the calculated head	$NPSHA \cdot (1-0.2) \geq NPSHR$ [equivalent to $NPSHA \geq NPSHR \cdot 1.25$] or $NPSHA = NPSHR + 50''$, whichever is greater.
Jockey Fire Protection Pump	NFPA20	NFPA20	NFPA20
Electric Motor Driven Fire Protection Pump	NFPA20	NFPA20	NFPA20
Diesel Engine Driven Fire Protection Pump	NFPA20	NFPA20	NFPA20

- A.10.24.7 Base plates for horizontal pumps shall be of cast iron or fabricated steel extended to receive the motor. If required, a sub-base under the motor or pump shall be furnished as part of the base plate. The base plate shall extend under all parts of the pump and motor from which fluid may drip. A drip lip shall extend along the two sides to a tapped drain connection located in the middle of the pump end of the base. Steel wedges for leveling, leveling screws, support plates, foundation plates, grouting, etc., shall be included. Major Equipment supplier may provide standard pump base plate with the compressor blade wash pump.
- A.10.24.8 Unless otherwise stated, all pumps shall be furnished with all necessary vents, drains, leak-offs, and gauges.
- A.10.24.9 All pumps shall use cartridge type mechanical seals.
- A.10.24.10 Piping systems connected to the suction and discharge connections of the pumps shall be designed based on the manufacturer's allowable nozzle loads.
- A.10.24.11 Pump motors shall be furnished and mounted by the Seller on a common baseplate in accordance with the motor identified in electrical section of this specification. All pump motors shall be air cooled.
- A.10.24.12 Pumps with seal drains shall have seal drains directed to the oil-water separator funnel drains without effluent running across the floor.
- A.10.24.13 Pumps shall be equipped with gauges to indicate the discharge and suction pressure. Process tapplings for these gauges shall be into piping and not into pump nozzles. Major Equipment supplier's pumps, drawing from atmospheric tanks, do not require a suction pressure gauge. For fouling duties, a differential pressure gauge shall be fitted across the suction filter.
- A.10.24.14 Fire protection pumps, drivers, and controllers shall be UL listed for their intended class of service.
- A.10.24.15 Centrifugal Pumps (Horizontal & Vertical):
- A.10.24.15.1 All horizontal centrifugal pumps shall be complete with fully balanced impellers, AC electric motor driver, common base plate, coupling and base mounted coupling guard, arranged for easy disconnection and re-assembly and designed to withstand all service conditions. Spacer type couplings shall be used in conjunction with end suction pumps to allow impeller removal without moving the motor. Grid type flexible couplings shall be provided for pump less than 100 hp. Gear type or disc type couplings shall be provided for pumps 100 hp or greater. All pumps shall be direct drive. Major Equipment supplier may utilize standard coupling designs for centrifugal pumps.
- A.10.24.15.2 Minimum flow/recirculation lines from a pump's discharge to a pump suction line are not acceptable for centrifugal pumps.

- A.10.24.15.3. All vertical centrifugal pumps shall be complete with AC electric motor drive, curb plate for mounting on the pump deck, rigid type adjustable coupling and coupling guard. All pumps shall be arranged for easy disconnection and reassemble.
- A.10.24.15.4. Centrifugal pumps shall have a rising head/capacity characteristic from design point toward shutoff and the pump/motor combination shall be designed to be non-overloading.
- A.10.24.15.5. The Net Positive Suction Head (NPSH) required by centrifugal pumps at any capacity up to and including the rated condition NPSH shall be less than the available head. This assumes the required NPSH is the onset of cavitation or 3% head breakdown.
- A.10.24.15.6. Vertical wet pit or tank pit pumps, except pumps fitted with non-reversing ratchets, shall be capable of reverse rotation up to 125% of the rated speed due to back flow of fluid, without causing damage to the pump. Such pumps, if cast into a concrete well, shall be located with the suction flange above floor level, such that only the mounting and discharge flange bolts require removal to pull out the pump.
- A.10.24.15.7. The rotating assembly shall not have a critical speed within 25% of the pump operating speed. The rotating part of the pump shall be balanced statically and then dynamically at a speed below the first critical speed after its rated speed.
- A.10.24.15.8. Additional pump requirements are included in the circulating water system, condensate system, feedwater system, and cooling water system sections.
- A.10.24.15.9. Shop Testing (BFP, Condensate, Circulating Water, Cooling Water, all Fire Protection Pumps, Demineralized Water Pumps, and Service Water Pumps):
 - A.10.24.15.9.a. All pumps shall be subjected to a hydrostatic pressure test in accordance with HI Standards, or NFPA for fire protection system pumps.
 - A.10.24.15.9.b. A shop performance test with tolerances per ANSI/HI 14.6 Grade 1U shall be performed.
 - A.10.24.15.9.c. An NPSHR test, vibration test and sound level test shall be performed with the shop performance test.
 - A.10.24.15.9.d. The shop performance test of developed head, efficiency, brake horsepower and NPSHR vs. flow shall be performed at design operating speed.
 - A.10.24.15.9.e. Seller shall furnish a pump performance test report which, at a minimum, describes the tests performed and provides the results. This report shall also discuss any standard test corrections the Seller makes to achieve the final results.
 - A.10.24.15.9.f. All tests shall have a minimum of five flow points including the design minimum flow, design flow and runout flow (if applicable, to be assumed as 125% of design flow, unless otherwise specified).

A.10.24.15.9.g. Efficiencies and brake horsepower shall be determined preferably by use of a calibrated torque-measuring device. Alternately, a motor furnished for the pumps can be used for the shop tests if the motor performance has been tested and certified by the manufacturer and witnessed by Buyer.

A.10.24.15.9.h. If a certified motor is used to determine pump efficiency and brake horsepower, the tolerances of the electrical instruments used on the pump tests shall be factored into the test readings so that the calculated power input at the pump coupling would be the maximum expected values.

A.10.24.15.9.i. Vibration shall be tested in the radial direction, in two orthogonal positions at each radial bearing and in the axial direction at the thrust bearing. Values shall not exceed the required limits, at the guaranteed rated flow and operating speed.

A.10.24.16 Positive Displacement Pumps:

A.10.24.16.1. All positive displacement pumps shall be of the horizontal screw, piston, or gear type.

A.10.24.16.2. All positive displacement pumps shall be complete with electric motor driver, common base plate, gear type flexible coupling and base mounted coupling guard, arranged for easy disconnection and reassemble and designed to withstand all service conditions. The pump/motor combination shall be non-overloading at 125% of the normal system operating pressure at the maximum pumping viscosity value. Spacer type couplings shall be used if required to allow pump disassembly without moving the motor. All pumps shall be direct drive, except the seal oil vacuum rotary piston pump which is provided as belt drive to comply with manufacturer requirements.

A.10.24.16.3. Pumps of the rotary screw type shall have two or three rotors in accordance with manufacturer's standard. Where the lubricity of the medium being pumped is insufficient to prevent excessive wear of the pump internals, externally lubricated gears and bearings shall be provided.

A.10.24.16.4. Unless specified otherwise, mechanical seals shall be used exclusively. Ample space shall be provided for seal maintenance.

A.10.25 INSTRUMENT AND SERVICE (COMPRESSED) AIR SYSTEMS

A.10.25.1 The compressed air systems comprise both the instrument air and the service air systems. The compressors and auxiliary components shall be designed for outdoor environment with provisions for maintaining inlet air conditions within range of manufacturer's requirements.

A.10.25.2 The scope of supply comprises, but is not limited to, all piping, valves, fittings, hangers, traps, utility stations, air hoses, controls and instrumentation, compressors, drivers, heat exchangers, moisture separators, receivers, filter/silencers, filters and dryers, miscellaneous equipment, and piping specialties. This includes the following:

- A.10.25.2.1. Three (3) x 50% capacity or two (2) x 100% capacity, 125 psig, air-cooled, oil-free, rotary screw air compressors with motors, each complete with suction air filter/silencer, inter-cooler and after-cooler with moisture separators. Oil lubrication of the instrument compressor parts in contact with compressed air is prohibited. The compressors shall be designed for a wide operating range and frequent on/off or load/unload switching.
- A.10.25.2.2. Two (2) x 100% air filters and automatic dual tower desiccant type dryers shall be provided. This includes two (2) pre-filters in parallel configuration, as well as two (2) after-filters in parallel configuration. Dryers shall be heatless regenerative absorption type, rated at 125 psig and air outlet dewpoint of -40°F. A dewpoint meter shall be provided with each dryer including local indication and DCS signal.
- A.10.25.3 An air receiver shall be provided for combined instrument and service air system. The air receiver shall be designed per ASME B&PVC Section VIII and shall have the appropriate ASME stamp. The air receiver shall keep an ample amount of air available during short time air consumption peaks, reduce the frequency of compressor cycling, reduce flow pulsation, allow for settling of any moisture droplets and allow for the maintenance of air supplies during compressor switch-overs, shut-downs and trips, while maintaining air pressure supplies at or above an acceptable minimum level. The receiver shall have a pressure gauge and code stamped relief valve(s). The receiver shall be furnished with an automated drain valve.
- A.10.25.3.1. One (1) x 100% air receiver shall be provided for the Instrument Air/Service Air System with 1,550 gallon capacity (minimum).
- A.10.25.3.2. Additional remote receivers shall be provided, if required to reduce air compressor loading due to sudden large air demands.
- A.10.25.4 Service air taps shall be provided to allow users to access air with a maximum hose length of 75 ft. Hose station locations shall be reviewed and approved by Buyer.
- A.10.25.5 Service air connections shall be taken from the combined piping system and provided with an isolation valve, pressure regulating valve and anti-whip check valves. A connection with a manual isolation valve shall be added to the compressed air system piping upstream of the dryers to allow connection of a portable air compressor.
- A.10.25.6 Air shutoff valves shall be provided at each compressed air user.
- A.10.25.6.1. All air operated control valves shall feature dedicated air supply isolation valves to allow for operator maintenance of one (1) valve without disturbing operation of any other valves.
- A.10.25.7 Header branch lines shall be taken off from the top of the air header. Minimum branch line size is ½”.

- A.10.25.8 Manifolds shall be used for compressed air supply in areas with multiple users. Each manifold shall consist of a three (3") pipe with welded end caps, ½" takeoff connections and a ½" drain valve. A shutoff valve shall still be provided near each user. The manifold supply pipe header shall be sized based on the following criteria:

Number of Users	Size
1 – 5	½"
6 – 10	¾"
11 – 20	1"
21 – 50	1½"

- A.10.25.9 Redundant pneumatic devices shall be piped to the air header with separate branch lines.
- A.10.25.10 Equipment Controls: Each compressor shall have a dual control system allowing for modulating and on-line/off-line operation. Each compressor shall be arranged for automatic start-up in the event the running compressor cannot meet the demand as indicated by loss of system pressure. Instrumentation shall be provided to allow for local monitoring and control and remote DCS monitoring. Operation of instrument air dryers shall be fully automatic. Drying and regenerating cycles shall be controlled by timers and by terminating heating and purging upon reaching low water loading of desiccant. Overpressure protection and high heater element temperature cut- out shall be provided as a minimum to safeguard the Equipment. The dryers shall include all instruments and controls required for local monitoring and control and remote monitoring.
- A.10.26 AMMONIA SYSTEM
- A.10.26.1 Ammonia supplied to the HRSG SCR system shall be from the Seller supplied and installed 29% aqueous ammonia storage facility.
- A.10.26.2 The Seller shall provide ammonia storage tank(s) with a working storage tank capacity based on one (1) week of continuous operation of the facility at maximum output.
- A.10.26.3 Not Used
- A.10.26.4 The ammonia storage tank(s) containment walls shall be 45" or less in height (therefore does not require confined space classification).
- A.10.26.5 Seller shall provide two (2) 100% ammonia forwarding pumps, any necessary piping, valving, and instrumentation for filling the tank and to supply ammonia to the HRSG ammonia flow control unit.
- A.10.26.6 Ammonia leak detection system shall be provided at locations mutually agreed with the Buyer.
- A.10.26.7 Ammonia storage tank(s) shall be designed to prevent venting of ammonia.
- A.10.27 BULK GAS SYSTEMS
- A.10.27.1 Nitrogen Gas

- A.10.27.1.1. Provisions for nitrogen blanketing system shall be included to protect the HRSG tubes and drums and other critical Equipment subject to corrosion during prolonged shutdowns. All drums and Equipment shall be provided with a valved nitrogen purge connection including a check valve to prevent backflow of steam into the nitrogen system.
- A.10.27.1.2. The Seller shall provide all the necessary piping, valves, flexible hoses, regulators, and relief valves associated with the Equipment, as well as any required instrumentation.
- A.10.27.1.3. Flexible hoses shall be of a non-degradable material and U/V resistant.
- A.10.27.1.4. Seller shall determine the quantity of nitrogen gas and the amount of storage area required.
- A.10.27.1.5. Nitrogen gas bottles will be provided by the Buyer after Substantial Completion.
- A.10.27.2 Hydrogen and Carbon Dioxide Gas
 - A.10.27.2.1. Gas Storage:
 - A.10.27.2.1.a. Gas storage tanks, pressure vessels and manifolds shall all be situated together and shall be located a safe distance from the main equipment and away from any fire hazards. Storage tanks, pressure vessels and manifolds shall be located in a fenced-in area accessible by delivery gates/doors. Enclosure(s) shall be provided by Seller, as required. Bollards shall be provided outside of the fenced-in area to protect the equipment from traffic.
 - A.10.27.2.1.b. Refer to Section A.10.25 for Tanks and Pressure Vessels requirements.
 - A.10.27.2.2. Seller shall provide equipment, piping, instrumentation, and valving (including relief valves and control valves), to accommodate interconnection between Buyer supplied bulk storage equipment and the STG and CTG interfaces.
 - A.10.27.2.3. Each system shall utilize double block and bleed valves and removable spool pieces upstream of the CTG and STG manufacturer piping interface points.
 - A.10.27.2.4. Each system shall utilize total flow meters to monitor and record gas usage. These instruments shall be tied into the Facility DCS.
 - A.10.27.2.5. Hydrogen System Design Criteria:
 - A.10.27.2.5.a. Pressure shall be as required the CTG(s) and STG(s), per the respective manufacturer's requirements.
 - A.10.27.2.5.b. Flow shall be as required to purge and fill the CTG(s) and the STG(s), per the respective manufacturer's requirements. System shall be capable of simultaneous filling of one (1) CTG and one (1) STG in less than three (3) hours.

- A.10.27.2.5.c. Volume shall be as required to supply one (1) complete purge and fill quantity, at a minimum, for the CTG(s) and STG(s), per the respective manufacturer's requirements.
- A.10.27.2.5.d. Buyer shall supply one (1) hydrogen tube trailer.
- A.10.27.2.6. Carbon Dioxide System Design Criteria:
- A.10.27.2.6.a. Pressure shall be as required by the CTG(s) and the STG(s), per the respective manufacturer's requirements.
- A.10.27.2.6.b. Flow shall be as required to purge the CTG(s) and the STG(s), per the respective manufacturer's requirements. System shall be capable of simultaneous flow to the CTG(s) and the STG(s).
- A.10.27.2.6.c. Volume shall be as required to supply two (2) complete purge quantities the CTG(s) and the STG(s), per the respective manufacturer's requirements.
- A.10.27.2.6.d. Seller shall supply one (1) carbon dioxide storage tank, an electric vaporizer, a recondensing unit and all other associated equipment, piping, valves, instrumentation, and power.

A.10.28 POTABLE WATER

- A.10.28.1 Potable water source shall be determined by Seller. The Potable Water System consists of emergency safety showers and eyewashes, as well as water supply to restrooms, breakrooms, kitchens, and other potable water users. In particular, emergency safety showers and eyewashes, or combination thereof, shall be designed with consideration for maintenance activities to be performed by Facility personnel.
- A.10.28.2 The potable water system shall comply with local plumbing codes. Seller shall coordinate with local municipality for making the potable water connection.
- A.10.28.3 Anti-scald, tepid water and freeze protection provisions shall be included in the system design.
- A.10.28.4 Eyewash and/or shower station shall be provided as follows:
- A.10.28.4.1. Each eyewash and shower shall be provided with a flow switch and alarm indication in the BOP DCS when the system is used.
- A.10.28.4.2. Design, quantity, location and accessibility of safety showers and eyewashes shall comply with ANSI Z358.1 and OSHA safety requirements.
- A.10.28.4.3. At a minimum, safety showers and eyewash stations shall be provided at the following locations:
- Main PDC Battery Room

- CTG(s) Battery Rooms
- Water Treatment Building Equipment Area
- Cooling Tower Chemical Storage Area
- Condensate Chemical Feed Skid Area
- Make Up Water Treatment Area
- Raw Water Treatment Area
- Aqueous Ammonia Tank and Unloading Pad Area
- Aqueous Ammonia Flow Control Skid Area
- Sample Panels / Buildings
- Lubricating Oil Equipment Areas

A.10.29 HEATING, VENTILATION, AND AIR CONDITIONING

A.10.29.1 All buildings shall be provided with electrical heating, ventilation and/or air conditioning systems (HVAC) as specified herein. Seller shall be responsible for complete engineering and design of the HVAC systems, in accordance with ASHRAE, other relevant standards and local jurisdictions.

A.10.29.2 Seller shall supply all equipment necessary to provide complete and efficient HVAC systems including filters, ductwork, duct thermal insulation, silencers, fire dampers, humidity control and automatic control for temperature and humidity. All buildings or enclosures generally and individual battery rooms, switchgear rooms, electronics rooms and control rooms shall include a minimum of two (2) 100% capacity air handling units for heating, cooling, and ventilating. Each individual room/area or unit shall be complete with dedicated controls that can be adjusted by the room users.

A.10.29.2.1. Control system(s) shall be redundant to eliminate single points of failure.

A.10.29.3 Explosion resistant construction and appropriate ventilation shall be used in all battery rooms where hydrogen may be developed or released.

A.10.29.4 Refer to the site design criteria in Section A.9, including noise limitations that also apply to the HVAC equipment (most notably for equipment adjacent to rooms/areas that are normally occupied) for HVAC system design requirements.

A.10.30 PIPING

A.10.30.1 In general, and unless specified otherwise, the design of all pipes, bends and fittings shall comply with ASME B&PVC, Section I, or ASME B31.1, as applicable.

A.10.30.2 Unless specified otherwise, all piping system engineering and design shall conform to the latest edition of the following codes and standards, as required for the given application, in effect at time of Contract execution. All discrepancies or conflicts between codes, standards, specifications, and these design criteria shall be reviewed with Buyer for resolution:

ASME Section I
ASME B31.1-2022 - Shall apply to all piping systems except fire protection water,
potable water and building drains
ASME TDP-1
ASME B&PVC
IPC - Shall apply to potable water and sanitary drains up to a point five (5) feet
beyond exterior building walls
ASTM
ANSI
AWWA
MSS
PFI
SSPC

- A.10.30.3 Piping shall be seamless for Critical Systems (High Pressure / Main Steam, Cold Reheat Steam, Hot Reheat Steam, Low Pressure Steam, Condensate, Boiler Feedwater, Auxiliary Steam, Hydrogen Gas and Fuel Gas). Helical, longitudinal, or spiral wound seam welded pipe is prohibited. Some applications with pipe sizes 26" and above may consider longitudinally welded pipe, but only with Buyer approval and based on technical justification including QA/QC provisions (i.e., 100% radiography of welds). The use of welded pipe on non-critical systems for pipe sizes 2.5" through 48" is allowed. Inconel piping material transitions may be supplied as welded.
- A.10.30.4 Counterfeit and fraudulent piping system materials shall not be used. Seller shall receive and maintain material certifications for all piping, along with material receipt inspections. This documentation shall be submitted to the Buyer for record.
- A.10.30.5 Engineering and design of piping systems shall account for field pressure testing requirements.
- A.10.30.6 Threaded pipe connections are only permitted on drains that are atmospheric at both ends such as pump base plate drains, silencer drains, etc.
- A.10.30.7 Victaulic Grooved Pipe may be used at Sellers discretion for a pressure class of 150, low temperature water service.
- A.10.30.8 Maximum fluid velocities for the purpose of pipe sizing shall be selected primarily on the basis of allowable pressure drop for the service and good engineering practice, but shall also be within the fluid velocity limits provided in the following table. Drains, vents, or lines sized on available pressure drop may exceed these values.

Recommended Maximum Pipe Velocities	
Superheated Steam with a minimum of 25°F superheat	20,000 fpm (333 fps)
Superheated Steam greater than 25 psia and superheated steam with less than 25°F superheat when 90° elbows are present	9,000 fpm (150 fps)

Recommended Maximum Pipe Velocities	
Saturated Steam greater than 25 psia and superheated steam with less than 25°F	12,500 fpm (208 fps)
Low pressure wet steam (including saturated steam up to 25 psia)	7,500 fpm (125 fps)
Circulating Water:	
Steel	8 to 14 fps
Concrete	7 to 10 fps
Water, General Service (except minimum flow recycle lines) and Cooling Water	10 fps
Water, minimum flow recirculation lines	15 fps
Condensate:	
Pump Suction	3 to 4 fps
Pump Discharge	12 fps
Boiler Feedwater:	
Pump Suction	8 to 12 fps
Pump Discharge	12 fps
Potable water	7 fps
Compressed Air Header	20 fps
Compressed Air (Branch Line < 50 ft)	20 to 100 fps
Chilled water systems	8 fps
Fuel Gas	8,000 fpm
Fire water	Per NFPA

A.10.30.9 Pump suction piping velocity shall not exceed 4 fps if there is suction lift.

A.10.30.10 Following is additional criteria for minimum pipe sizes that the Seller shall follow:

Application	Minimum Nominal Pipe Size
Piping on the Pipe Rack	2"
Underground Circulating Water Piping	2"
Underground Potable Water Piping	2"
Underground Fire Protection Piping	Refer to Fire Protection Design Criteria
Underground Drain Line Headers	4"
Other Underground Piping	1½"
Piping Drains and Vents	¾" (½" acceptable where Major Equipment Supplier's standard design)
Instrument Connections	¾"
High-Pressure Steam Drains	2"
Drain Boot or HRSG Common Drain Header Lines	2"

A.10.30.11 Piping and Instrumentation Diagrams (P&IDs):

- A.10.30.11.1. P&IDs including a complete and accurate legend shall be prepared by Seller to define each system and show all piping, regardless of size, with each line identified by size, specific line number and material specification. Tag numbers shall uniquely identify all valves and specialty items such as traps, strainers, expansion joints, etc. Depiction of “black boxes” is prohibited; details contained within “black boxes” shall be included within the drawing or as an additional P&ID sheet.
- A.10.30.11.2. Maximum operating and design, temperature, and pressure conditions shall be defined on the P&IDs. Major Equipment supplier may show maximum operating and design, temperature, and pressure conditions on piping isometrics. Seller to work with Buyer to determine the minimum acceptable amount of information to be shown on drawings, subject to a potential change order.
- A.10.30.11.3. All valves including instrument root valves, regardless of size, shall be shown on the P&IDs.
- A.10.30.11.4. To the greatest extent possible, the P&ID shall depict the actual physical system installation.

A.10.30.12 Pipeline List and Documentation:

- A.10.30.12.1. Seller shall develop and maintain a Pipeline List for the entire project. This document shall include pipeline number, system code, line size, material, P&ID, class specification, insulation requirements, hydrostatic pressure test, design pressure and temperature as well as minimum, normal and maximum operating conditions.
- A.10.30.12.2. The material requirements for each pipeline class specification shall be further defined on Piping Class Sheets.
- A.10.30.12.2.a. Piping Class Sheets shall define the pressure ratings, material, and construction code. Material requirements shall include pipe type, schedule, fittings, flanges, bolting, gaskets, valve class and specifications, and notes for special requirements or exceptions.
- A.10.30.12.3. The Pipeline List and Piping Class Sheets (BOP only) shall be regularly submitted to the Buyer, as engineering and design progresses, for review and ultimately submitted for record upon completion of the project.

A.10.30.13 Pipe Isometric Drawings:

- A.10.30.13.1. Drawings shall include bills of materials and specific design requirements.
- A.10.30.13.2. Drawings shall incorporate any and all necessary equipment interfaces.
- A.10.30.13.3. Locations, types, and tags of pipe supports shall be incorporated with piping isometric drawings.

- A.10.30.13.4. Vents and drains shall be included and shown.
- A.10.30.14 Pipe Support Drawings:
 - A.10.30.14.1. Drawings shall locate each engineered hanger and include support details for all piping.
 - A.10.30.14.2. Composite drawings with bills of materials and specific design requirements of each type of support shall be submitted to the Buyer.
- A.10.30.15 Design Pressure:
 - A.10.30.15.1. The piping system design pressure shall equal the design pressure of its associated equipment with allowance for static head and friction loss.
 - A.10.30.15.2. As a minimum, pump suction piping design pressure shall be equal to the design pressure of the suction vessel plus hydrostatic head at maximum liquid level.
 - A.10.30.15.3. As a minimum, and until certified OEM information is provided, the value of differential head at zero flow for conventional constant speed, single stage, motor driven centrifugal pumps shall be taken as 1.25 times (or 1.5 for turbine driven pumps), the duty differential head.
 - A.10.30.15.4. All possible cyclic operations, such as predictable transient conditions as well as start-up, shutdown, and fault conditions, shall be considered for design. If durations of these variations are greater than the short term condition allowed by the applicable code, the most severe combination of pressure and temperature shall be regarded as the design condition.
- A.10.30.16 Design Temperature:
 - A.10.30.16.1. The piping system design temperature shall equal the most severe temperature condition expected during normal and/or upset operating conditions plus additional margin of 10°F (5°F for steam piping systems).
- A.10.30.17 Stress Analysis and Support:
 - A.10.30.17.1. Stress analysis shall be performed on those piping systems required by code and standard engineering practices. This analysis shall include temperature conditions over 300°F and dead weight load conditions, as well as wind and other occasional loading, as required.
 - A.10.30.17.2. Large bore (greater than 2" NPS) piping systems with fluid operating temperatures over 300°F shall be stress analyzed in accordance with the requirements of ASME B31.1.
 - A.10.30.17.3. Calculations of thermal expansion shall be based on an ambient temperature of 70°F.
 - A.10.30.17.4. Expansion bends or loops shall be provided where required for thermal expansion.

- A.10.30.17.5. Seller's analysis package shall include stress isometrics, input and output data for all analyzed load cases. Output should include nodal displacements, hanger loads and deflections, internal system forces and moments, and calculated Code stresses.
- A.10.30.17.6. Design of pipe supports shall consider the design pressure, weight, operating temperature, and fluid dynamic loads.
- A.10.30.17.7. Design of all supports for steam piping shall account for hydrostatic test loads.
- A.10.30.17.8. Calculations shall be performed for non-standard pipe supports to ensure compliance with applicable codes, standard engineering practices and verification of appropriate safety factors or margins.
- A.10.30.17.9. Insulated piping shall include the insulation weight when calculating dead load.
- A.10.30.17.10. Piping shall be adequately supported throughout the various operating conditions (cold through hot), with no noticeable sagging between supports.
- A.10.30.17.11. Seller is allowed to use B-line type material (uni-strut type material is not allowed) to support cold small bore piping systems.
- A.10.30.18 Pipe Schedule and Wall Thickness:
- A.10.30.18.1. Pipe wall thickness shall be dictated by ASME B31.1.
- A.10.30.18.2. Minimum wall thickness for carbon steel piping is Standard schedule. Minimum Schedule XS or 80 shall be used for all piping 2" and smaller except for stainless steel construction where Schedule 40S may be used.
- A.10.30.18.3. The ASTM manufacturing tolerances shall be subtracted from the nominal thickness when calculating minimum wall thickness.
- A.10.30.18.4. Corrosion allowance for carbon and low alloy steel piping shall be a minimum of 0.0625". Corrosion allowance for stainless steel pipe may be 0".
- A.10.30.19 Pipe Sloping:
- A.10.30.19.1. Steam piping not located on a pipe rack shall be sloped to allow for drainage of condensate to accessible drains under hot and cold operating conditions.
- A.10.30.20 Piping Materials:

Service / Piping System	Material	
	Aboveground	Underground
Ammonia	ASTM A 312 Grade TP 304	HDPE
Auxiliary Steam	ASTM A106 Grade B	N/A

Service / Piping System	Material	
	Aboveground	Underground
Main (High Pressure) Steam	ASTM A335 Grade P91	N/A
Main (High Pressure) Steam Bypass 15 pipe diameters downstream of bypass valve	ASTM A335 Grade P22	N/A
Cold Reheat Steam	ASTM A335 Grade P22 or P11	N/A
Hot Reheat Steam	ASTM A335 Grade P91	N/A
Hot Reheat Steam bypass up to 15 pipe diameters downstream of bypass valve	ASTM A335 Grade P22	N/A
Hot Reheat Steam bypass piping after 15 pipe diameters downstream of bypass valve	ASTM A 106 Grade B	N/A
Low Pressure Steam	ASTM A106 Grade B	N/A
Compressed Air (Instrument Air and Service Air)	ASTM A 312 Grade TP 304L	Asahi Air-Pro or ASTM A 312 Grade TP 304L
Condensate	ASTM A106 Grade B	N/A
Chemical Feed	ASTM A312 Grade TP 304 or as required to accommodate chemical; plastic material not acceptable	ASTM A312 Grade TP 304 or as required to accommodate chemical; plastic material not acceptable
Carbon Dioxide	ASTM A106 Grade B	ASTM A106 Grade B
Fire Protection	Refer to Fire Protection Design Criteria	Refer to Fire Protection Design Criteria
LP and IP Feedwater	ASTM A106 Grade B	N/A
HP Feedwater	ASTM A106 Grade C	N/A
Hydrogen	ASTM A106 Grade B	ASTM A106 Grade B
Instrument Air Tubing	ASTM A312 Grade TP 316	N/A
Fuel Gas (Natural Gas) – General and Upstream of Fuel Gas Compressor	ASTM A106 Grade B	ASTM A106 Grade B
Fuel Gas (Natural Gas) – Downstream of Fuel Gas Compressor	ASTM A312 Grade TP304/304L or A312 TPXM-19	ASTM A312 Grade TP304/304L or A312 TPXM-19
Nitrogen	ASTM A106 Grade B	ASTM A106 Grade B
Lube Oil	ASTM A312 Grade TP304 or ASTM A106 Grade B	N/A

Service / Piping System	Material	
	Aboveground	Underground
Seal Oil	ASTM A312 Grade TP304 or ASTM A106 Grade B	N/A
Hydraulic Control Oil	ASTM A312 Grade TP304	N/A
Potable Water	Copper Type K (NSF compliant) or Stainless Steel (NSF compliant) per plumbing code	HDPE (NSF compliant)
Demineralized Water	ASTM A312 Grade TP304	HDPE
Service Water including Water / Wastewater Treatment	ASTM A106 Grade B	HDPE
Circulating Water	ASTM A106 Grade B ($\leq 24"$ NPS), AWWA C200 ($> 24"$) (Helical seam welded pipe is prohibited)	Pre-Stressed Concrete; HDPE
Raw Water	ASTM A106 Grade B	HDPE

A.10.30.20.1. Plastic PVC/CPVC piping is prohibited. Some applications may consider this pipe material but only with Buyer approval and based on technical justification including QA/QC provisions.

A.10.30.20.2. Press-fit piping materials, including fittings and components, are prohibited.

A.10.30.21 Small Bore Piping

Small bore piping will be supplied as Schedule 80 other than the following:

1. Schedule 40 small bore may be utilized in accordance with NFPA 13
2. Schedule 40S stainless steel small bore

A.10.30.22 Critical Piping:

A.10.30.22.1. Critical piping systems comprise the feedwater and steam circuit. This includes all systems that operate under two phase flow conditions. Hazardous gases and liquids are also considered critical piping systems. This system designation includes piping, pipeline components, pipe supports, valves and instrument root valves. Critical piping systems consist of the following:

- High Pressure (Main) Steam
- Cold Reheat Steam
- Hot Reheat Steam
- Auxiliary Steam
- Feedwater
- Condensate

- Fuel Gas
- Hydrogen Gas

A.10.30.22.2. Positive material identification is required for all alloy pipe, flanges, and fittings.

A.10.30.23 Fuel Gas Piping

A.10.30.23.1. Fuel gas piping shall be seamless, welded steel pipe. The exterior underground portion of the carbon steel pipeline and at least one-foot above grade shall be coated with a fusion-bonded epoxy material suitable for underground installation. The exterior underground portion of the pipeline shall be cathodically protected. The exterior portion of the pipeline above ground shall be coated to prevent atmospheric corrosion. Coating shall be tested for continuity and imperfections.

A.10.30.23.2. The piping shall include spool pieces at each end and appropriate bending radius to accommodate pigging.

A.10.30.23.3. Piping shall include connections for chromatographic gas analysis.

A.10.30.23.4. Electrical potential test stations are to be installed along the underground pipeline route.

A.10.30.23.5. Underground fuel gas piping from the gas conditioning yard to the combustion turbine area shall be designed for transport of 100% hydrogen fuel. Pipe size and materials shall be selected to accommodate this future operating condition. No other BOP piping design considerations shall be included for future hydrogen firing.

A.10.30.24 Branch Connections:

A.10.30.24.1. The use of direct pipe insertion (branch to run) connections on any steam or feedwater lines is prohibited.

A.10.30.25 Pipe Sleeves:

A.10.30.25.1. All pipes passing through masonry walls or floors shall have sleeves provided. Sleeves shall be sized and have clearances to allow for packing and sealant installation. Sleeves shall be 18 GA carbon steel minimum. The annular space between the pipe and sleeve where required shall be packed with fiberglass, except where special materials are required for fire or air pressure barriers.

A.10.30.26 Dissimilar Metal Joints:

A.10.30.26.1. In all cases when a piping connection is made between steel, aluminum or copper the mating surfaces shall be electrically isolated. For 2-1/2" and larger piping, flanges shall be used and the flanged joint shall be made using an electrically non-conducting gasket and flange bolts fitted with plastic ferrules and plastic washers under the bolt heads. The electrical isolation shall be verified after installation. 2" and smaller connections may be

made using flanges, as stated above, or with dielectric type couplings, bushings, or unions.

A.10.30.27 Vents and Drains:

- A.10.30.27.1. Vents and drains required to support filling and venting of a system, and any other frequent system operation, shall be routed to appropriate floor drain systems. Vents and drains designated for pipe routing shall be approved by Buyer.
- A.10.30.27.2. Extra care shall be taken during design and layout of relief valves on water systems so that they do not unexpectedly discharge water continuously nor intermittently (i.e., due to pressure control valve leak-by at low to no flow conditions).
- A.10.30.27.3. Skid mounted equipment drains shall generally go directly to the floor drains or drain hubs without piping or effluent running across the floor. These drains shall ultimately be routed to the Oil Water Separator system.
- A.10.30.27.4. Skid mounted drains and vents shall be provided with the equipment, as required, including isolation valves.
- A.10.30.27.5. The CTG water wash system drains shall be drained directly to a dedicated sump.
- A.10.30.27.6. Vents and drains shall be provided with isolation valves.
- A.10.30.27.7. Drain connections shall be provided near all control valves, between the inlet isolation valve and the control valve.
- A.10.30.27.8. Seller shall provide a vent and drain valve on the equipment or piping associated with each control valve, pump, heat exchanger and other equipment that is designed to be isolated while the Facility is in operation.
- A.10.30.27.9. Silencers shall be provided for all HRSG power assisted start-up vent valves used during startup and steam blows. Silencers are also required for safety relief valves. Silencers for these relief valves shall be designed not to exceed 110 dBA at the nearest operating platform.
- A.10.30.27.10. Vents shall feature rain caps, except in high point locations. Buyer shall review and approve vent cap locations.

A.10.30.28 Sample and Test Connections:

- A.10.30.28.1. All lube oil sampling locations shall be confirmed by the Buyer.
- A.10.30.28.2. Permanent connections shall be included with equipment and piping to perform acceptance testing. This shall include considerations for the following areas: performance testing of the CTG, HRSG and STG, as well as flue gas and effluent water testing.

A.10.30.29 Root Connections:

A.10.30.29.1. Root connections on horizontal or sloping lines shall not be located below the center of the line.

A.10.30.29.2. The following root connection guidelines shall also be observed:

A.10.30.29.2.a. Connections for service on steam and condensable vapors or wet gas shall be taken from the top or side of pipe.

A.10.30.29.2.b. Connections for service on liquids shall be taken only from the side of the pipe, with the root nipple oriented in the horizontal position.

A.10.30.29.2.c. Connections for service on dry gases shall be taken from top of pipe.

A.10.30.30 Fabrication and Installation:

A.10.30.30.1. Fabrication shall be in accordance with ASME B31.1 for power piping and NFPA for fire protection piping. Fabrication, materials, installation, and examination of HDPE shall be in accordance with ASME B31.1 Appendix III.

A.10.30.30.2. All piping, valves and other mechanical components shall be new and clean.

A.10.30.30.3. General Piping Requirements:

A.10.30.30.3.a. Piping shall be installed in a neat and workmanlike manner while maintaining cleanliness requirements (in the shop and field).

A.10.30.30.3.b. Double block and bleed valving shall be provided when penetrating into the confined space. This requirement does not apply to the following equipment: Oil/Water Separator, Wastewater Sump, Blowdown Tank, Turbine Drains Tanks, Fuel Gas Drains Tanks.

A.10.30.30.3.c. All steam lines and drains from drain pots shall be free draining in the direction of flow so that condensed steam will flow towards the drainage points. Steam mains include HP steam, HP steam bypass, HR steam, HR steam bypass, CR steam, LP steam, LP steam bypass and auxiliary steam.

A.10.30.30.3.d. All high pressure drain pipes on the inlet side of drain valves, together with the drain valves, shall be designed for the same pressure and temperature as the valve, pipe, or vessel which they drain and shall be subject to the same specification and tests relevant thereto.

A.10.30.30.3.e. All drain pipes discharging to a drain manifold shall be connected at an angle to the manifold so as to discharge in the direction of flow in the manifold connected to a blowdown tank, water cooled condenser hot well, or ACC condensate collection tank. All drain pipes shall be free draining towards the discharge ends and freeze protected if not free draining. Headers or manifolds for drain pipes are only allowed where the drain

connections are at a blowdown tank, water cooled condenser hotwell, or ACC Condensate collection tank.

A.10.30.30.3.f. Jointing of High Pressure Steam, Feedwater, Drain and Blowdown Piping:

A.10.30.30.3.f.1 The pipe-to-pipe joints that are necessary shall be in approved positions and shall be welded butt joints without the use of internal backing rings. All valves and fittings shall be butt welded into the pipelines except where otherwise approved. Socket weld connections for small bore piping are allowed. At terminal points, the joints shall be of the butt weld or bolted non-weld flanged type.

A.10.30.30.3.g. Steam, Water, Drain and Air Services:

A.10.30.30.3.g.1 Joints for low pressure steam, water, drain and air services shall be of approved design, in which all coupling together of pipes and valves 2½" and larger, shall be by means of butt welded or flanged joints, unless otherwise specified or approved by Buyer.

A.10.30.30.3.h. Unless otherwise approved, all HDPE piping joints shall be made using automatic welding machines with displayed jointing cycle times and countdown facilities. A flanged joint shall be provided at connections to valves and at such other points in the piping system as necessary to facilitate dismantling of piping for maintenance purposes. Screwed joints shall not be used for HDPE piping.

A.10.30.30.3.i. Oil and Gas Services:

A.10.30.30.3.i.1 Joints for oil and gas services shall be socket welded, flanged, or butt-weld construction. Screwed fittings shall not be used for fuel gas service.

A.10.30.30.3.j. Pipe End Details

- Piping 2" and smaller: socket welded.
- Piping 2½" inches and larger: butt welded except flanged at Equipment.
- Galvanized carbon steel: threaded or flanged.
- Below ground fire HDPE piping systems: fusion welded or flanged at valves or hydrants.
- Instrument air system piping: socket welded.

A.10.30.30.3.k. Final installation of piping systems shall satisfy the clearance requirements herein.

A.10.30.30.3.l. Drain piping, including instrument tubing, shall be properly installed to ensure drainage, where applicable.

A.10.30.30.3.m. Adequate clearances shall be provided for insulated piping, including areas where pipes cross or run parallel, as well as pipe runs that are adjacent to equipment or buildings.

A.10.30.30.3.n. Valves shall not be installed until they have been thoroughly cleaned, inspected, and tested to verify operating conditions including closure tightness. Upon installation of

welded valves, and after stress relieving, the valves shall be inspected and tested to ensure that they have not been damaged. Seller shall tighten valve stuffing boxes or replace packing, as required, to correct leaks during testing.

- A.10.30.30.3.o. All pipes, valves, fittings, and other components shall be verified as clean inside and out before installation. Inside of said components shall be free of rust, scale or dirt when installed. All piping shall be thoroughly inspected before being placed into initial service to ensure that foreign matter has been completely removed.
- A.10.30.30.3.p. A high-pressure pipe cleaning process, hydrolazing, shall be used to pre-clean condensate, feedwater, and steam piping systems, to the greatest extent possible. After flushing and hydrolazing, feedwater systems shall be chemically cleaned as part of the Heat Recovery Steam Generator (HRSG) pre-operational cleaning process.
- A.10.30.30.3.q. Steam piping shall be cleaned by means of steam blowing prior to operation to prevent damage to the turbine from rust, weld slag or other foreign matter that accumulates in the piping during construction. This includes, as a minimum, HP steam, LP steam and RH steam. Special consideration shall be given to protecting valves and equipment from damage. The steam blowing procedure and acceptance criteria shall be reviewed and approved by Buyer, prior commencing of cleaning. For limited sections of piping where steam blows are not practical, high pressure water cleaning or other approved means shall be utilized to achieve the desired cleanliness. All temporary piping and silencers for the steam blow shall be provided by the Seller. The cleanliness of the piping shall be determined based on the STG manufacturer's criteria for indications at the target plate.
- A.10.30.30.3.r. The fuel gas piping shall be cleaned prior to operation to prevent damage to the combustion turbine from rust, weld slag or other foreign matter that accumulates in the piping during construction. The cleanliness of the piping shall be determined based on the CTG manufacturer's criteria. Air or nitrogen shall be used to perform the fuel gas blows.
- A.10.30.30.4. Welding:
 - A.10.30.30.4.a. Welding of piping shall be in accordance with the applicable requirements of the governing codes, drawings, and supplements.
 - A.10.30.30.4.b. Seller shall be responsible for the welding performed by his organization and shall establish his own welding procedures for each class and type of weld that will be used.
 - A.10.30.30.4.c. Qualification of welding procedures to be used and qualification of welders and welding operators shall comply with the latest requirements of Section IX of ASME B&PVC and ASME B31.1.
 - A.10.30.30.4.d. Seller shall conduct the tests required to qualify their welding procedures and shall conduct performance qualifications of welders and welding operators who apply these procedures. All performance qualifications shall be conducted at one of the following: on-site, at Seller's other Buyer's project sites, or at the Seller's off-site training site. All

certification shall be under the supervision of Buyer's qualified representative. Procedures or qualification of procedures or welders by organizations other than the Seller is not acceptable. Welder performance qualifications transferred from Seller's other Buyer project sites or the Seller's off-site training site will only be allowed if current within 30 days.

- A.10.30.30.4.e. Weld procedures shall identify appropriate qualification code and the corresponding construction code for all work.
- A.10.30.30.4.f. Seller shall submit WPS and PQR documentation for each field welding procedure. Shop welding procedures will be prepared and can be reviewed in the shop.
- A.10.30.30.4.g. Each welder/welding operator shall be qualified by the Seller. WPQ certified by Others shall not be acceptable.
- A.10.30.30.4.h. Alternate Welding Processes: Alternate welding procedures will be considered if complete WPS and PQR are approved by the Buyer.
- A.10.30.30.4.i. For field welds, the root pass and one fill pass shall be made with the Gas Metal Arc Welding (GMAW) process.
- A.10.30.30.4.j. The short circuit transfer mode for the Gas Metal Arc Welding (GMAW) process shall be allowed with advanced waveform-shape technology machines in conjunction with a properly qualified welding procedure. Advanced waveform-shape will be permitted on ASTM A335 P22 and P91. Seller is allowed to use phased array ultrasonic inspection in lieu of Radiography for butt welds on pipe NPS 4 inches and larger with thickness's greater than 0.5 inches.
- A.10.30.30.4.k. All temporary welded attachments shall be removed so as to not damage base material.
- A.10.30.30.4.l. Temporary welded attachments shall be removed and surface inspections performed using MT or PT in the affected area.
- A.10.30.30.4.m. Care shall be taken to protect low hydrogen electrodes from the elements after removal from their sealed container. If the electrodes are not to be used for an extended period they shall be stored in vented oven.
- A.10.30.30.4.n. Purge will be performed where required by qualified welding procedures.
- A.10.30.30.5. Inspection and Testing:
 - A.10.30.30.5.a. Seller shall be responsible for inspection of all shop fabricated piping material. Seller shall periodically test and inspect shop-fabricated piping in accordance with the Seller's QA/QC program. Qualified personnel shall check shop and field fabrication for material specifications, dimensional accuracy, and weld integrity.

A.10.30.30.5.b. The following systems shall be hydrostatically tested in accordance with ASME B31.1 (all underground piping shall be leak tested prior to backfill):

- Steam Systems
- Boiler Feedwater
- Fuel Gas (or pneumatic testing with Buyer approval)
- Condensate
- Fire Protection (in accordance with NFPA requirements)
- Service Water
- Compressed Air (underground)
- Closed Cooling Water (underground)
- Sample Systems
- Chemical Feed Systems
- Wastewater Treatment System
- Potable Water (in accordance with local plumbing codes)
- Demineralized Water
- High Energy Pressurized Drains

A.10.30.30.5.c. The following systems shall be pneumatically tested in accordance with ASME B31.1:

- Lube Oil
- Circulating Water (underground: joints tested prior to backfill; in-service tested)

A.10.30.30.5.d. Upon Buyer review and approval, Seller may service test, in lieu of hydrotest, water and air services with design pressures and temperatures less than 200 psig/200°F (ASME B31.1 Section 137.7.1).

- Compressed Air (aboveground)
- Closed Cooling Water (aboveground)
- Blowdown
- Gravity Drains
- Air Removal System

A.10.30.30.5.e. Leak testing of HDPE pipe shall be in accordance with ASTM F2164.

A.10.30.31 Underground Piping:

A.10.30.31.1. Special consideration shall be given to design of underground piping. Excessive loading and movement shall be prevented during operation and ambient temperature variations by season. Piping subject to freezing shall be installed below the frost line.

A.10.30.31.2. Cathodic protection, sacrificial anodes or coating and wrapping shall be provided as a means of corrosion protection by an active or passive protection system. This design shall take into account soils analysis for all underground piping, as well as vessels and metallic equipment in contact with the earth. Natural excavated soil for pipe bedding materials shall be used wherever practical. Refer to Section A.12 for additional cathodic protection system requirements.

- A.10.30.31.3. Gravity drain slopes and turns shall be properly designed and routed.
- A.10.30.31.4. Carbon and low-alloy steel piping for underground applications shall feature shop coated exterior surfaces in accordance with AWWA C213. Application of a shop or field applied coating (e.g., Duraplate 8200 or approved equal) after pipe fabrication is acceptable in lieu of a factory applied AWWA C213 coating system. All underground steel piping shall be coated for corrosion protection.
- A.10.30.31.5. All field welds, field repairs and short pipe segments shall be taped and wrapped in accordance with AWWA C216 after any necessary field welding is completed.
- A.10.30.31.6. All underground non-metallic piping systems shall be provided with metallic tape to allow the pipe to be located by means of a metal detector or similar device.
- A.10.30.31.7. Tank, vessel, and equipment drains, interconnected with the Facility drains system, shall not tie into the storm water system. Drain lines, including sanitary sewers, shall run in the general direction of collection or disposal without sharp turns, bends, or angles.
- A.10.30.31.8. Underground Piping Materials:
 - A.10.30.31.8.a. Unless specified otherwise, HDPE piping shall be the primary material type. The HDPE material shall be in accordance with ASTM D3350. HDPE used in potable water applications shall be certified to NSF/ANSI-61.
 - A.10.30.31.8.b. Drain lines may consist of cast iron, ductile iron, or HDPE.
 - A.10.30.31.8.c. Plastic PVC/CPVC piping is prohibited, except ASTM D1784 is allowed for sanitary drains applications. Some applications may consider this material, but only with Buyer approval and based on technical justification including QA/QC provisions. If PVC/CPVC is approved by Buyer, the material shall be in accordance with ASTM D1784 and ASTM D2664.
- A.10.30.31.1. For buried stainless steel, copper and brass pipe not encased in concrete, pipe shall be wrapped with a cold applied pipe wrap meeting the requirements of AWWA C209 Type II or AWWA C217. Alternatively, a liquid epoxy coating meeting the requirements of AWWA C203 or C210 may be used. Coatings, primer, and solvents used on stainless steel shall be chloride free.

A.10.31 PIPE SUPPORTS

- A.10.31.1 All piping systems shall be supported, anchored, and guided so they are not overstressed from operating, design, or transient conditions. The piping systems shall not react beyond the limits established by ASME B31.1 or the interconnecting equipment manufacturers.
- A.10.31.2 Pipe supports shall be designed in accordance with ASME B31.1, AISC and MSS code requirements.

- A.10.31.3 Construction materials of pipe supports including guides, restraints and anchors shall be in accordance with ASME B31.1.
- A.10.31.4 Pipe support materials shall include corrosion protection.
- A.10.31.5 All clips, lugs, plates, saddles, etc. welded to piping shall be of the same material as the piping to which they connect.
- A.10.31.6 Areas subject to sliding conditions between piping and supports shall feature a sacrificial material to protect against wear.
- A.10.32 INSULATION
- A.10.32.1 Seller shall furnish and install all insulation and lagging for piping, ducts, tanks, and Equipment to reduce system heat losses, provide personnel protection, and prevent freezing or sweating as required by the specific application. Blanket insulation shall be provided for valves and maintenance items.
- A.10.32.2 Insulation shall be provided, as required on hot surfaces, to limit the outside lagging surface temperature to 140°F or less at all operating conditions and site max ambient temperature (based on 3 mph wind speed).
- A.10.32.3 Anti-sweat insulation shall be designed on the basis of the relative humidity of the ambient air considering the minimum fluid temperature within the system in a given area. Anti-sweat insulation is included for potable water piping. Additional anti-sweat insulation application is to be evaluated and agreed upon during detailed design and negotiated as a potential change order.
- A.10.32.3.1. Anti-sweat insulation shall be applied where minimum operating fluid temperature is anticipated to be 60°F or below.
- A.10.32.3.2. Protrusions or attachments shall be insulated for a minimum of 12" from the surface of the pipe / equipment insulation.
- A.10.32.4 Insulation Materials:
- A.10.32.4.1. All insulation for hot surfaces shall be of high thermal efficiency and shall be capable of withstanding the maximum specified work temperatures to which they will be subjected without deterioration and without loss of thermal efficiency. All insulation for cold surfaces shall be highly effective in preventing sweating and shall be capable of resisting the effects of moisture. Any insulation that is cracked or damaged during installation shall be removed and replaced.
- A.10.32.4.2. Mineral Wool and E-Glass Fiber (ESLIN or equivalent) insulation materials are acceptable for all but HRSG and anti-sweat applications, as follows:

- A.10.32.4.2.a. BOP systems: Mineral Wool for temperatures up to and including 350°F (ASTM C547 Type I)
- A.10.32.4.2.b. BOP systems: E-Glass Fiber for temperatures greater than 350°F
- A.10.32.4.2.c. Major Equipment supplier systems: Mineral Fiber (ASTM C547 Type II Gr. A) for piping up to 1200°F.
- A.10.32.4.2.d. Major Equipment supplier systems: High Temperature Fiber Blankets (ASTM C892 Type III Gr. 12) for temperatures above 1200°F
- A.10.32.4.3. All material shall be asbestos and refractory ceramic fiber (RCF) free and shall have a fire rating of 25 or less when tested by ASTM E84 method.
- A.10.32.4.4. Anti-sweat insulation material should be closed-cell elastomeric (Armacell Armaflex or equivalent), and shall feature an all service vapor retarder jacket (factory applied). Minimum anti-sweat insulation thickness shall be 1".
- A.10.32.5. Lagging Material and Thickness:
 - A.10.32.5.1. Ductwork, Breaching, Drums, and field erected tanks: 0.036" embossed, box ribbed aluminum, weather-proofed appropriately
 - A.10.32.5.2. Piping and Equipment: 0.016" embossed aluminum
 - A.10.32.5.3. Valves and Fittings: 0.016" embossed aluminum
 - A.10.32.5.4. Anti-sweat insulation: Metal jacket (OEM Armacell approved or technically equivalent)
- A.10.32.6. All block, segmental, and sectional insulation for all piping, etc., 3" and above in total thickness or ½" less than the thickness of the outer layer where this is not practical shall require multiple layers of insulation. Staggered joint construction shall be used for joints in both directions on all multiple layer insulation. Major Equipment supplier may utilize their standard insulation designs.
- A.10.32.7. All insulation shall be laid with butted joints, and all voids, chipped corners, or other openings in the insulation sections or blocks shall be filled with approved insulating cement, finished smooth and neat.
- A.10.32.8. In addition to the specified insulation, personnel protection insulation shall be provided for the following:
 - A.10.32.8.1. On surfaces above 140°F and within 3 ft horizontally for areas accessible to personnel or 7 ft- 6 in vertically of walkways, ladders, and platforms. Insulation thickness shall be such as required by the hot face of piping surface temperature to limit outside lagging surface temperature to 140°F or less.

- A.10.32.8.2. Alternately, OSHA compliant personnel protection via shields may be utilized but only with Buyer approval.
- A.10.32.8.3. Steam trap bodies and condensate pots shall not be insulated, but shall be provided with personnel protection shields. The shield shall be fabricated from minimum 18 GA expanded galvanized or stainless steel. Shields shall be of the removable type, employing screws and nuts for servicing of the steam traps.
- A.10.32.9 Freeze Prevention:
- A.10.32.9.1. All outdoor piping and equipment subject to freezing shall be provided with freeze protection including insulation and heat tracing.
- A.10.32.9.1.a. Application of different freeze protection measures shall be based on a time to freeze evaluation such that all piping and components are protected against a 72-hour freeze event with average temperature of 20 deg F.
- A.10.32.9.1.b. Time to freeze evaluation shall consider a maximum of 25% of pipe cross section freezing, and a 20-mph wind.
- A.10.32.9.2. All outdoor instruments sensing tubing shall be heat traced and insulated.
- A.10.32.9.3. Lines that are 2-1/2" NPS and smaller shall include insulation and heat tracing. Larger line sizes that have flow conditions that can be stagnant or not self-draining, require heat tracing. Line sizes identified in the time to freeze evaluation that require freeze protection of 3 inches or greater thickness of insulation shall be heat traced and insulated.
- A.10.32.9.4. Freeze prevention shall be included around control valves, their trim accessories and adjacent piping if the potential operating conditions (i.e., high pressure drop due to throttling), may result in significant temperature drop. In particular, this may occur around Fuel Gas system pressure regulating control valves.
- A.10.32.9.5. All heat traced lines shall be insulated to the appropriate thickness based on the heat trace design with at least 1" of insulation thickness.
- A.10.32.9.6. Refer to Section A.12, Electrical Design Criteria for additional heat tracing design conditions and requirements.
- A.10.32.9.7. Insulation and lagging shall extend 12 inches below grade at all ground penetrations.
- A.10.32.10 Fire Protection Freeze Prevention:
- A.10.32.10.1. Where subject to potential freezing conditions, Dry Pipe fire protection water systems shall be used.
- A.10.32.10.2. Outdoor control valves for Fire Protection Water-Based Systems shall be installed in heated weather resistant enclosures to preclude the need for heat tracing.

A.10.33 VALVES (EXCLUDES STEAM TURBINE STOP & GOVERNOR VALVES)

- A.10.33.1 All valves shall operate smoothly and steadily in both opening and closing directions. All valves shall be free from flow induced vibration and shall comply with all noise levels when specified. The pressure and temperature ratings of all valves shall comply with the criteria outlined in ASME B16.34. Large bore valve end to end dimensions (other than control valves) shall comply with ANSI B16.10.
- A.10.33.2 Valve material selection shall match or be comparable to the piping system on which they are installed. Material shall conform to appropriate ASTM standards. Steel gate, globe, and check valve bodies shall be of forged material in sizes 2" and smaller. Steel quarter turn or control valve bodies 2" and smaller may be forged or cast. Steel valve bodies 2½" and larger may be forged or cast except as restricted by A.10.33.25.1 and A.10.33.26.1 for steam service. Cast iron body valves may only be used for wastewater systems.
- A.10.33.3 A coating shall be applied to carbon steel valves to protect against corrosion.
- A.10.33.4 Double block and bleed valves shall be provided where positive isolation is required on systems that contain either combustible fluids or gases, chemical reactive substances, temperatures greater than 200°F or pressures greater than 500 psig. For contract purposes, double block and bleed valves for the Project are supplied, however, final implementation of double block and bleed valves will be based on an assessment of Buyer requirements considering the final design configuration, subject to a potential change order.
- A.10.33.5 For systems with conditions less than 300°F temperature and class 300 rating:
- A.10.33.5.1. High performance butterfly valves are preferred for large-bore piping systems (> 2" NPS)
- A.10.33.5.2. Ball valves are preferred for small-bore piping ($\leq$ 2" NPS), including drains.
- A.10.33.5.3. For systems with higher operating conditions, gate valves shall be used for isolation and drain connections. Major Equipment supplier may utilize globe valves per their standard design.
- A.10.33.6 Globe valves shall be used for vents and where flow throttling is required.
- A.10.33.7 Bypass valves shall not be installed around trip valves that close to protect equipment or prevent a hazardous situation.
- A.10.33.8 Block valves shall not be used to isolate automatic valves that open to prevent a hazardous situation unless the block valves feature a locked open mechanism
- A.10.33.9 All gate valves greater than 2" nominal diameter shall be of the full-port gate type and when in the full open position, the bore of the valve shall not be obstructed by any part of the gate.

- A.10.33.10 With the exception of control valves, valves shall match their respective pipeline size (except for applications requiring a different size).
- A.10.33.11 Check valves may be smaller than their pipeline size contingent upon acceptable system hydraulic calculations (by Seller), to ensure proper functionality.
- A.10.33.11.1. With the exception of the turbine steam extraction lines and HP exhaust line, swing check valves shall be limited to 6" nominal diameter or less. Tilting disc design shall be used for larger sizes and for all boiler feed pump and condensate pump discharges. Butterfly style check valves with resilient seats may be used for water and air service provided the design pressure does not exceed 400 psig. The resilient seat material shall be suitable for the operating fluid. Where check valves are installed, examination or replacement of the internal parts shall be possible without removing the check valve from the line.
- A.10.33.12 Check valves shall not be used for isolation purposes unless they are of a locking check type and are one of the valves in a double block and bleed configuration.
- A.10.33.13 Where system conditions and valve type create the potential for thermal binding, over pressurization, and/or pressure locking, valves shall be designed to mitigate these impacts. If equalization lines are used to mitigate such impacts, isolation valves shall be provided to ensure equalization lines can be isolated when operating conditions could create an unintended, backward, flow path.
- A.10.33.14 Metal seated ball valves shall be provided for liquid and steam services in automatic on/off service class 300 or greater. Soft seated ball valves shall be provided for air and gas services. Fuel gas valves will use combination soft and metal seats, as required for fire sealing requirements.
- A.10.33.15 Gate, angle, and globe valves used for hydrogen services shall have a stem sealing feature and disc to seat of a construction suitable for containing the fluid without any leakage.
- A.10.33.16 Cast Carbon steel, A216 Gr. WCB valves shall be limited to a maximum system design temperature of 775°F. Cast chrome-moly steel valves, A217 Gr. WC6, 1% chrome – 1/2% molybdenum material shall be limited to 950°F. P22 A217 Gr. WC9, 2-1/2% chrome – 1% molybdenum materials shall be limited to 1200°F, A217 Gr. C12A may be used for higher temperatures. Forged equivalents may also be used in accordance with ANSI B 16.34. Major Equipment supplier may provide valves per standard design, in accordance with recognized ASME application limits.
- A.10.33.17 Cast iron material shall be limited to non-shock service, a system design pressure of 200 psig and a design temperature of 200°F. Cast iron valves shall not be used in steam, condensate, and natural gas or oil service.
- A.10.33.18 Ductile iron material shall be limited to a system design pressure of 350 psig and a design temperature of 400°F.

- A.10.33.19 Bronze and brass materials shall be limited to a system design pressure of 350 psig and a design temperature of 200°F.
- A.10.33.20 All isolating valves necessary for lock out/tag out shall be capable of being locked in both the open and closed positions via a chain or a padlock. Seller shall provide the necessary devices and locks. Valves requiring locking devices shall be identified on the P&IDs based on the Systems Operation / Functionality Review.
- A.10.33.21 All valves shall be fitted with open/shut indicators that may be readily seen, unless valve position is clearly indicated by valve handle position, etc.
- A.10.33.22 Valves shall be fitted with limit switches where required for interlocking purposes.
- A.10.33.23 Valves shall feature handwheel extensions and other special features, as required, to allow for valve operability by Facility personnel.
- A.10.33.24 Valves utilized for containment drains shall feature locking capability as well as post indicators to check valve position.
- A.10.33.25 Valves for HP Steam, Feed water, Drain and Other High Pressure, High Temperature Services:
- A.10.33.25.1. All valves intended for HP steam, feed water, drain, or any other services subject to high pressure and temperature shall be of approved make and shall have cast or forged steel bodies for valves over 2" nominal bore and forged steel bodies for valves 2" and smaller with covers and glands of approved construction.
- A.10.33.25.2. Approved means shall be provided to prevent any accumulation of pressure between the discs of high-pressure steam or feedwater parallel slide valves. If required by operating parameters, each valve shall be equipped with its own integral bonnet equalization line
- A.10.33.25.3. Seller may utilize intermediate or special class valves for systems above class 1500. Seller may utilize intermediate or special class valves for systems below class 1500 as approved by Buyer.
- A.10.33.26 Valves for LP Steam, Water, Drain and Air Services:
- A.10.33.26.1. Valves over 2" nominal bore intended for steam or steam drain services shall have bodies of cast or forged steel, those intended for water, water drains or air services shall have cast or forged steel or cast iron bodies; gate, globe, check, and quarter turn or control valves of 2" nominal bore and under intended for steam or steam drain services shall have bodies of forged steel or bronze and may be of the inside screw type; quarter turn or control valves of 2" nominal bore and under intended for water, water drains, or air service shall have bodies of cast or forged steel or bronze and may be of the inside screw type. Sealing between the disc and body of butterfly type valves shall be renewable metal to rubber facings secured to the disc and body in an approved manner.

A.10.33.27 Valves for Fuel Gas Services:

- A.10.33.27.1. All isolating valves intended for use in natural gas services shall be full bore, 90° turn, ball or plug valve type, with PTFE seats unless other materials are required for elevated temperatures (PTFE is not acceptable for heated fuel gas), with cast or forged steel bodies and flanged or butt welded ends. Major Equipment supplier may supply valves per their standard design.
- A.10.33.27.2. The valves shall be classified as fire safe, in as much as the valves shall incorporate either a primary or secondary metal to metal seal to ensure negligible external leakage which could contribute to the risk of fire and, when closed, shall minimize through leakage when in a fire. Major Equipment supplier may supply valves per their standard design. Seller will ensure sufficient additional fire safe valves are provided in series with non-fire safe valves provided by Major Equipment supplier.
- A.10.33.27.3. All valves shall be fitted with an anti-static device, which shall ensure electric continuity between the ball stem and the body of the valve.
- A.10.33.27.4. No aluminum or zinc alloys or similar low melting material shall be included in their construction.
- A.10.33.27.5. Valves up to 2" in size may be of the non-lubricated type, valves greater than 2" in size shall incorporate design features that enable lubricant to be injected under pressure between the plug and body whilst the valve is in service. Major Equipment supplier may supply valves per their standard design.
- A.10.33.27.6. All valves shall incorporate sliding sealing surfaces such that further movement of the closing part is provided after gas shut-off.
- A.10.33.27.7. All valves shall provide reliable tight shut-off and be capable of easy operation after long periods in one position.
- A.10.33.27.8. Where solenoid operated valves are used in conjunction with gas-powered actuators for automatic isolation, the valves shall be generally in accordance with ANSI standards. The solenoid shall be of the normally closed, direct operated type, such that the valve is closed when the coil is de-energized.

A.10.33.28 Valves for Oil Services:

- A.10.33.28.1. All valves intended for lubricating oil services shall be of cast or forged steel construction with flanged, butt weld, screwed or socket-welded ends. Weld-on flanges are prohibited. All valves shall be fire safe and shall be provided with suitable features in the valve to ensure electrical continuity between the valve stem and the body of the valve. No aluminum or zinc alloys or similar low melting material shall be included in their construction. All valves shall provide reliable tight shut-off and be capable of easy operation after long periods in one position.

A.10.33.29 Safety and Relief Valves:

- A.10.33.29.1. Safety and relief valves shall be provided on all pressure vessels where required by ASME B&PVC, Section I or Section VIII, as applicable, and where it is conceivable that the actual pressure could exceed the design pressure under any possible circumstance. Appropriate ASME Code label/nameplate shall be included.
- A.10.33.29.2. ASME B31.1 Appendix II shall be used to determine developed backpressures for all compressible flow discharges. This shall also be applied to all safety and relief valve installation.
- A.10.33.29.3. All safety and relief valve types shall be direct, spring-loaded angle body with flanged inlet and outlet piping interfaces, unless specified otherwise.
- A.10.33.29.4. For steam, compressed air or gas service, safety valves shall be of the high capacity, flat seated, reactive type attaining full lift on pop and having a maximum blow down of 3% (or as specified by the applicable Code and Standards) of the set gauge pressure. Adjustments for blowdown range shall be included with these valves.
- A.10.33.29.5. Water or oil valve type shall be liquid relief with slow action opening / closing.
- A.10.33.29.6. Valves shall have port and body flow areas adequate to pass flow to atmosphere. Pressure accumulation shall not exceed 10% of the set pressure for gas or vapor applications and 25% for liquid applications, unless specified otherwise. ASME B&PVC Section VIII compliance for capacity ratings shall be certified.
- A.10.33.29.7. Valves shall be equipped with lifting levers. Where required, test gauges shall be furnished for hydrostatic testing of the system when higher than the valve set pressure. Valves shall be factory set for pressure.
- A.10.33.29.8. Isolating valves shall not be installed on either the inlet nor outlet of safety valve piping.
- A.10.33.29.9. Discharges shall be directed to a safe location, away from occupied buildings or confined areas. Extra care shall be taken with safety and relief valve vent routing for fuel gas systems.

A.10.33.30 Pressure Reducing Valves and Control Valves:

- A.10.33.30.1. All pressure reducing valves shall be perfectly stable, quiet, and free from vibration in operation when pressure reducing any flow up to the maximum flow, and shall be suitable for continuous use at the operating temperature.
- A.10.33.30.2. A pressure relief valve shall be provided on the downstream (outlet) side of each pressure reducing valve, where the downstream piping system is not designed for the upstream pressure, and shall be capable of exhausting to atmosphere the maximum discharge of the reducing valve without undue build-up of pressure on the low pressure side. The discharge from the relief valve shall be routed to a safe location outside of buildings, a

minimum above 14 ft above the roofline. Pressure and temperature gauges and transmitters shall be provided upstream and downstream of the reducing valve.

- A.10.33.30.3. All control valves shall have a sufficient overload range. At full load and normal operation, the control valves shall be 70-80% open. Valves shall be sized for flow requirements taking into account the appropriate Cv factor. Where load fluctuations are excessive, dual split range control valves shall be installed in parallel. One valve handles the start-up condition and the other valve covers normal or higher load operation. Examples are split range HRSG HP drum control valves and split range ACC Condensate Collection Tank level control valves.
- A.10.33.30.4. Valves intended for modulating or control service shall be specifically designed as such. Separate isolation valves shall be installed in series with the modulating or control valve if required by code.
- A.10.33.30.5. Control valves shall be pneumatic, hydraulically, or motor operated modulating valves. On/off service valves shall be pneumatic, hydraulic, or motor-operated.
- A.10.33.30.6. Control valves positioned by an electronic signal shall be supplied with electro-pneumatic or smart electro-pneumatic positioners integrally mounted on the control valve. Valve position feedback shall be via a positioner purchased with the control valve and installed on the valve by the manufacturer or via a HART feedback signal from the smart positioner.
- A.10.33.30.7. Control valve body type and trim shall be determined based on the application and in accordance with the applicable Piping Material Specification. Consideration shall be given to rangeability, noise, cavitation, flashing, fluid characteristics, FCI shutoff leakage class, and any other special requirements.
- A.10.33.30.8. Self-actuated regulators may be used for local control in services where a variation above or below the set point is not objectionable.
- A.10.33.30.9. Instrument air shutoff valve and air set, consisting of a combination regulator, filter, pressure gauge, and relief valve, shall be provided on each pneumatic control valve assembly
- A.10.33.30.10. All integrally mounted instrumentation (positioners, regulators, etc.) shall be designed to operate with an air pressure range between 80 psig and 125 psig.
- A.10.33.30.11. Limit switches and mounting brackets shall be installed and set by the valve Seller. Electric switches shall meet the electrical area classification and shall normally be one or more magnetic or proximity switches. SPDT microswitch type switches shall be used in non-severe services.
- A.10.33.30.12. Solenoid Valves
 - a. Solenoid valves shall be continuous duty type equipped with encapsulated Class H coils suitable for the environmental and electrical area classification.

- b. Solenoid valves shall typically be 120 VAC. It is acceptable for TCS solenoids to be 24 VDC.

A.10.33.30.13. Steam turbine bypass control valves shall be designed as a combination modulating and stop valve.

A.10.33.30.14. Cast iron bodies for control valves are prohibited.

A.10.33.30.15. Block and bypass valves shall be provided around control valves only when:

A.10.33.30.15.a. Maintenance of the valve would prevent Facility operation.

A.10.33.30.15.b. Valve failure would require Facility shutdown.

A.10.33.30.16. Non-critical modulating control valves are provided with isolation valves and a manual bypass. Non-critical control valves are valves in water services that can be set at one position and do not affect startup, normal operation, or shutdown of the plant. On-off operating block valves are not considered control valves and are not provided with a bypass.

A.10.33.31 Vent Valves:

A.10.33.31.1. Except for fuel gas piping, all low and high-pressure vent valves shall be of a globe valve style. For fuel gas service, only plug or ball valves shall be used.

A.10.33.32 Valve Operators:

A.10.33.32.1. Bevel gear operators shall be provided with valves that require more than 80 lb push/pull to operate. While other applications may also require gear operators, Seller shall provide gear operators for manually operated valves based on the following criteria:

Valve Pressure Class	Valve Size
300 & below	8" and larger
600	6" and larger
900	4" and larger
1500	3" and larger
2500	3" and larger

A.10.33.32.2. All valves shall be accessible without climbing devices. Otherwise, hand wheels located more than 7 ft above floors or platforms shall be provided with chains or platforms.

A.10.33.32.3. Seller shall comply with the following guideline for providing powered or manual valve operators:

A.10.33.32.3.a. Maintenance isolation valves shall have manual operators.

- A.10.33.32.3.b. Valves that are frequently operated to control process flow and cannot reasonably be manually operated by a roving operator to facilitate operation (including startup and shutdown) shall have power operators capable of positioning from the control room.
- A.10.33.32.3.c. Valves (other than check valves) that are required to change position to perform an automatic safety function shall be power operated.
- A.10.33.32.4. Air operators shall be provided for valves designed to fail in the “open” / “closed” position, and where continuous control / modulating or fast-acting stroke is required.
- A.10.33.32.5. Air operated, double acting valves shall include manual override, air cylinder bypass capability (i.e., handwheel, lever, jacking pump), for manual operation.
- A.10.33.32.6. Motor operators shall be provided for valves requiring tight shut off and for automatic valves where instrument air is not available.
- A.10.33.32.7. Motor operated valves shall be complete in all respects including the motor and the necessary controls for automatically stopping the motor when the valve gate has reached the full open or full closed position. A clutch mechanism shall be included to prevent damage in the event of jamming. The motor and control gear shall be placed in such a position relative to the valve that there is no possibility of leakage of steam or water from the valve joints or glands blowing on to the motor or control equipment. Hand operation facility shall be provided and be so arranged that the hand-operated mechanism must be disengaged before the operating motor can be energized.
- A.10.33.32.8. The operation of opening or closing motor operated valves shall be controlled by means of three push button controls labeled respectively 'open', 'stop' and 'close'. The local control station shall include a local/remote selector switch to permit operation from a point remote from the valve. The control shall be so arranged that the motor can be stopped with the valve in any position and can then be restarted in either direction.
- A.10.33.33. Valve Mounted Accessories
- A.10.33.33.1. Pneumatic relays, solenoid valves, pressure gauges, valve positioners, filter-regulators (air sets), volume boosters, and limit switches, shall be provided if required to support operation.
- A.10.33.33.2. Pneumatic actuators on modulating control valves shall be provided with valve positioners with integrally mounted supply and output gauges, instrument air shutoff valve, and integrally mounted filter-regulator (if required by valve manufacturer for proper operation) and have a NEMA 4X enclosure. Where available from the selected valve manufacturer, positioners shall be capable of split range sequencing and direct or reverse action and positioner action shall be field changeable without additional parts.

A.10.33.33.3. Valve position feedback shall be provided from the DVC valve positioner and shall be indicated on the graphics. Deviation alarms from drive signal versus feedback position shall be indicated on the Facility DCS graphic.

A.10.33.34 Fire Protection System Valves:

A.10.33.34.1. Valve design, materials and classification specified by the applicable NFPA standard and shall include UL Listing for their intended service class.

A.10.34 PAINTING / COATING

A.10.34.1 Engineered Equipment shall be supplied with Vendors standard paint system, finish paint touch-up shall be provided by Seller / Vendor.

A.10.34.2 Painting of safety signs, labels, and tags, as well as identification and location of fire extinguishers, first aid kits, traffic aiseways and trip hazards, shall comply with ANSI/NEMA Z535.1 for safety colors.

A.10.34.3 Piping:

A.10.34.3.1. Unless indicated otherwise, piping shall be color coded per Buyer Standard contained in Section A.16.2.7.

A.10.34.3.2. Insulated, stainless and/or chrome pipe is not required to be painted, with the exception of carbon steel insulated pipe that may be supplied with standard shop primer and fuel gas insulated pipe.

A.10.34.4 Aluminum lagging and insulation covering shall not be painted.

A.10.34.5 Dangerous parts of equipment or energized equipment as defined in ANSI 253.1 shall be identified and coated Safety Yellow.

A.10.34.6 First Aid Kits, Stretchers, Eye Wash Stations, and Flush Showers shall be coated in Safety Green (FS 595 Color 14120) to the extent indicated, include white lettering.

A.10.34.7 Section A.11 contains additional painting / coating requirements for the Fire Protection System.

A.10.35 PROTECTION FOR SHIPMENT

A.10.35.1 All flange faces, machined surfaces and threads shall be clean and protected from damage during shipment. Flange faces and machined surfaces shall be protected with wood, plastic, or metal covers. Couplings, openings, and threads shall be protected by fitted and taped steel pipe plugs, caps, or plastic protectors.

END OF SECTION



Entergy Texas, Inc.
Combined Cycle Plant RFP

Technical Specification: ETI-CCCT
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SECTION A.11
FIRE PROTECTION REQUIREMENTS AND DESIGN CRITERIA

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SECTION A.11

FIRE PROTECTION REQUIREMENTS AND DESIGN CRITERIA

A.11.1 INFORMATION AND SCOPE OF WORK

A.11.1.1 General

- A.11.1.1.1. The intent of this specification section is to describe the minimum equipment and systems requirements to be provided by the Seller for the fire protection system.

A.11.2 FIRE PROTECTION AND DETECTION

A.11.2.1 Regulations and Codes:

- A.11.2.1.1. Design of the fire protection and alarm system and the associated Equipment shall be in accordance with the latest applicable codes and standards published by the National Fire Protection Association (NFPA), including NFPA 850, all local, State, and Federal requirements, and with the requirements of this Technical Specification. NFPA 850 is a Recommended Practice. Some recommendations from NFPA 850 are specifically included in this document and are therefore required to be included in the design. Protection for other hazards listed in NFPA 850 may be listed with several options "based on a Hazard Evaluation". Where Protection is proposed to be omitted based on such an evaluation, the evaluation shall be submitted for review and approval to Buyer's Risk Engineering, acting as the Authority Having Jurisdiction (AHJ) prior to being issued for construction.
- A.11.2.1.2. Fire protection system design shall comply with state and local building codes, including IBC, as well as American Water Works Association (AWWA) Standards, OSHA, and environmental regulations.
- A.11.2.1.3. The scope of work for the fire protection installation comprises the complete system design and all related piping and Equipment within the limits defined herein. It is not the intent to specify all details of design and construction; however, the system components described herein shall be construed as the minimum requirements for the system. The system shall comply with all Applicable Laws, Codes and Standards.
- A.11.2.1.4. All fire protection design drawings and calculations shall be signed and sealed by a Registered Professional Engineer in the state where the project is located. In addition to other submittals required by these specifications, the Seller shall design a submittal package for transmittal to the Buyer, the Buyer's insurance carrier, and the Buyer's Consulting Engineer for review, comments and approval of the fire protection system design documents, components, devices, and equipment.
- A.11.2.1.5. All mechanical fire protection system design drawings and calculations shall be prepared by a National Institute for Certification in Engineering Technologies (NICET) Level III technician/technologist and reviewed by a NICET Level IV technician/technologist. The

names of the preparer and reviewer, their NICET level, and their NICET Certification ID Number shall all be clearly indicated in all documents and calculations.

- A.11.2.1.6. All fire detection, alarm, and notification system design drawings and calculations shall be prepared by a National Institute for Certification in Engineering Technologies (NICET) Level III technician/technologist and reviewed by a NICET Level IV technician/technologist. The names of the preparer and reviewer, their NICET level, and their NICET Certification ID Number shall all be clearly indicated in all documents and calculations.
- A.11.2.1.7. The Seller shall be subject to the interpretation of the Local Statutory Authorities and the Buyer as final arbitrator of any disputes relative, to the applicable statutory requirements. Acceptance of all the Seller's design documents, associated equipment, methods of installation and testing of the installed systems by the Local Statutory Authorities is required.
- A.11.2.1.8. In the event of differences between the requirements of the applicable codes, standards, recommendations and this document, the more stringent requirement(s) shall apply.
- A.11.2.1.9. If there are conflicts between the applicable codes and standards and this specification, it is the Seller's responsibility to immediately bring those conflicts to the attention of the Buyer for resolution, in writing.
- A.11.2.1.10. All fire protection, fire suppression, and fire detection, alarm and notification system components, devices, equipment, and materials provided shall be new, listed by Underwriters Laboratory (UL) and/or approved by Factory Mutual Research Corporation (FM) for their intended use. All system components, devices, equipment, and materials shall be designed and installed in accordance with the applicable codes and standards, the manufacturer's recommendations, and within the limitations of their UL listing and/or FM approvals. The Seller shall provide evidence of listing of all proposed devices, equipment, and combinations of equipment to Buyer.
- A.11.2.2 The scope of supply includes all related piping, valves and operators, hangers and supports including secondary steel, instrumentation and controls, miscellaneous Equipment, and piping specialties. Major Equipment and Systems shall be as specified herein and shall include, but not be limited to, the following:

<u>Area</u>	<u>Equipment</u>	<u>Accessories</u>	<u>Sprinkler System & Other Design Details</u>
Administration / Control Building			Automatic wet pipe sprinkler system throughout offices and general areas. Automatic water mist fire suppression system consistent



<u>Area</u>	<u>Equipment</u>	<u>Accessories</u>	<u>Sprinkler System & Other Design Details</u>
			with NFPA 750 in DCS Room, Tele/Comm Room, and Electrical Equipment Room. Triple redundant dry pipe system may be considered as an alternative. Automatic smoke detection; portable fire extinguishers throughout.
Warehouse			Automatic wet pipe sprinkler system. Automatic smoke detection; portable fire extinguishers throughout.
Water Treatment Building			Automatic smoke detection; portable fire extinguishers (dry chemical).
CEMS shelter			Automatic smoke detection; portable fire extinguishers; O2 sensor (externally visible).
Electrical equipment			Automatic smoke detection; portable fire extinguishers.
DCS equipment (outside of Admin Building DCS Room)			Automatic smoke detection; portable fire extinguishers.
PDC enclosure(s)			Automatic smoke detection; portable fire extinguishers.
Fire Pump House	Located 50 ft (min.) away from a fire hazard structure		Automatic wet pipe sprinkler system. Automatic smoke detection and/or heat detection; portable fire extinguishers.

<u>Area</u>	<u>Equipment</u>	<u>Accessories</u>	<u>Sprinkler System & Other Design Details</u>
Transformers	Separation and fire-rated walls or automatic fire protection system	Containment pits shall feature rock layer in-between grating	If separation cannot be provided: Automatic deluge dual ring.
Standby Diesel Generator			Minimum separation of 50 ft. from other structures or fire-rated barriers. Heat detection for enclosure.
Steam turbine and generator bearings			Automatic single interlock pre-action sprinkler system.
Under steam turbine operating deck			Automatic dry pipe or deluge sprinkler system (contingent upon layout of side exhaust Steam Turbine to Condenser).
Steam turbine lube oil tank and pumps			Automatic dry pipe or deluge sprinkler system.
EHC system			Automatic dry pipe or deluge (unless provided with a Listed, Less Flammable Hydraulic Fluid).
Hydrogen seal oil			Automatic dry pipe or deluge sprinkler system.
Combustion turbine CT enclosure, auxiliary package and turning gear	turbine / generator shall feature standalone system The system shall be designed for two full discharges of the largest hazard during safe coast-down of the combustion turbine / generator		CO ₂ based fire protection system, per article A.5.4.13. Combustible gas detectors for turbine compartments for DCS monitoring.
Combustion turbine and generator electrical / control package			Portable fire extinguishers. Automatic smoke detectors.

<u>Area</u>	<u>Equipment</u>	<u>Accessories</u>	<u>Sprinkler System & Other Design Details</u>
Motor driven pumps			If more than 100 gallons of oil: Automatic, wet or dry pipe or single interlock pre-action.
Cooling Tower (if utilized)			If design features combustible material: Automatic dry pipe Not required if FM approved (documentation required) If design includes fire retardant materials with a flame spread rating less than 25 for all components (includes basin, fills, drift eliminators, cooling tower fan blades, water distribution piping, fan deck and fan cylinder, cooling tower louvers, gear box, drive shafts, valves, nozzles, stairs) and fill, omission of fire suppression is permitted subject to design submittal and approval by Owner's Risk Engineering.
Yard hydrants	Dry barrel type with two 2½" outlets and 4½" Fire Department pumper outlet; NST National Standard Fire Hose Thread connections		Located throughout entire station and placed at 300 foot spacing and no closer than 40 feet from the Building/ Equipment/Structure/ Hazard to be protected. (NFPA 24).
Yard piping	HDPE pipe material underground	HDPE shall include shop applied red stripe color identification; post indicating valves required throughout system for sectionalizing	FM approved for fire service; designed, installed, and tested in accordance with NFPA 24 and FM Global Property Loss Prevention Data Sheet 3-10, <u>Private Fire Service Mains</u> .

<u>Area</u>	<u>Equipment</u>	<u>Accessories</u>	<u>Sprinkler System & Other Design Details</u>
Hydrant hose house	Minimum requirements: 2 hydrant wrenches; 4 universal spanners; 2 curb box valve operator extensions; 1 adapter to connect to 4½" Fire Department pumper outlet on yard hydrants (or adapter required by local fire department)		One house located at hydrant that is nearest to Facility entrance.
Aqueous ammonia storage tank and transfer pumps			Ammonia leak detectors for DCS monitoring.

- A.11.2.3 Portable fire extinguishers shall be provided and located throughout the Facility including ancillary buildings in compliance with NFPA 10. This includes the following criteria:
- A.11.2.3.1. In general areas, including small oil hazards, ABC Fire Extinguishers including stored pressure dry chemical shall be utilized.
- A.11.2.3.2. For areas with large oil hazards (oil volume exceeding 55 gal and requiring containment, e.g., turbine lube oil equipment), a single portable 250-lb unit or two portable 150-lb units shall be located between 10 and 50 ft. of the hazard.
- A.11.2.3.2.a. For the Standby Diesel Generator, there shall be 20 lb dry chemical extinguishers inside and outside of every entrance door into the enclosure.
- A.11.2.3.3. Computer or controls-type electrical equipment areas shall feature Clean Agent Fire Extinguishers, mist water or other agents that do not leave residue. Clean agent extinguishers containing PFAS are not acceptable. Fire extinguishers containing dry chemicals shall not be used.
- A.11.2.3.4. Other electrical equipment areas shall feature CO₂ or other clean agent fire extinguishers. Clean agent extinguishers containing PFAS are not acceptable. Fire extinguishers containing dry chemicals shall not be used.
- A.11.2.3.5. At minimum, fire extinguishers shall be located near entrances / exits, at exit doors of occupied buildings and at access doors of unoccupied buildings / enclosures / shelters.
- A.11.2.4 Piping up to the various water control valves shall be continuously charged with high-pressure water.

- A.11.2.5 The number and type of nozzles used and their disposition shall be selected with regard to the water delivery requirement and the physical make-up of the risk. Particular attention shall be given to covering those parts of a risk where an obstruction might shield them from receiving water spray. In the case of oil piping, the protection shall provide complete coverage of all pipe runs along the whole of their length, using approved nozzles. Additional nozzle positions shall be provided to achieve proper coverage of all joints, of areas where multiplicity of piping occurs and of the floor areas and Facility, if any, immediately beneath. The whole area within transformer compounds shall be protected.
- A.11.2.6 Generally, in the design of buildings, materials shall be fire resistant and structures shall be protected against fire in accordance with the appropriate regulations and codes, including local codes and regulations. The layout of Equipment shall be spaced in accordance with these codes and standards. Piping and cabling shall be segregated and protected from physical damage. Fire brigade access and escape routes and fire barriers are to be arranged to mitigate the spread of flame.
- A.11.2.7 Spatial separation and/or fire barrier criteria for transformers and other equipment complying with NFPA 850 is preferred. Where separation or barriers are not practical Seller shall provide an automatic deluge fire suppression systems.
- A.11.2.8 Fire rated seals, if required for openings / penetrations through fire-rated barriers, shall be provided and commensurate with the fire rating of the respective barrier. Penetrations through electrical structures / enclosures shall feature non-combustible or fire rated sealing materials.
- A.11.2.9 Bulk hydrogen supplies for Hydrogen Cooled Generators shall be equipped with excess flow prevention/alarm devices to protect against undetected hydrogen leaks.
- A.11.2.10 Cabling for redundant Lube Oil Pumps (AC/DC Motors) shall be separated such that a single event cannot render both inoperable by one of the following means:
- A.11.2.10.1. Maintain a minimum 10 ft. horizontal physical separation throughout the cable run.
- A.11.2.10.2. Place DC Driven Pump cabling in separate dedicated conduits.
- A.11.2.11 Pressurized Lube Oil for turbines and generators (bearings or seal oil) shall be per articles A.5.4.6 and/or A.7.4.11.
- A.11.2.12 Piping containing steam or other fluids, with temperatures in excess of the flash points of any oils located within 25 ft. of the piping, shall be insulated.
- A.11.2.13 To the greatest extent possible, lube oil lines shall be separated by a minimum of 10 ft. horizontal physical separation or run below steam lines (or other piping that could exceed lube oil flash points) to minimize the potential for ignition.
- A.11.2.14 Project Site Fire Main:

- A.11.2.14.1. The Facility areas shall be provided with a buried fire main appropriately sized, which shall be complete in all respects.
- A.11.2.14.2. All piping valves, hydrants and associated equipment needed to provide a ring main system, which shall include sufficient section isolating valves for maintenance purposes, shall be supplied. The buried piping and fittings shall be HDPE material and ductile iron to AWWA standards unless otherwise approved. Above ground piping and fittings shall, unless otherwise approved, be carbon steel per ASTM specifications A106 and ASTM A234, respectively. The number of hydrants shall be such that two (2) hose streams can be directed to any single outbreak of fire. If used, heat fusion welded HDPE is considered a self-restrained joint and no additional restraints are required. This applies to the need for joint restraint only. The need for thrust blocks at changes in direction shall be evaluated and provided if needed.
- A.11.2.14.3. The use of mechanical joint fittings that use set screws to clamp the fitting to HDPE pipe is prohibited. Transition pieces that use fusion welding and a standard flange shall be used to transition between HDPE and non-HDPE components.
- A.11.2.14.4. Fire hydrants shall be located to avoid causing an obstruction for activities associated normal operation and for maintenance, while in compliance with NFPA 850 and NFPA 24.
- A.11.2.15 Fire Pump House:
- A.11.2.15.1. The Facility water requirements for the fire protection system shall be met by a combined fire fighting system via a buried ring main around complete perimeter of the Facility. This system shall also supply water to the fire hydrants and hose reels.
- A.11.2.15.2. The fire pump house shall feature one (1) 100% motor-driven fire pump, one (1) 100% diesel engine-driven fire pump, and one (1) motor-driven jockey pump. The system shall be fully redundant (i.e., a single failure cannot impair operation of both pumps), and complete with UL listed automatic controllers.
- A.11.2.15.3. The Fire Pump House shall be equipped with heating and ventilation as required to maintain the temperature at a minimum of 50°F and a maximum of 120°F, unless specified otherwise by the pump/controller OEM.
- A.11.2.15.4. Supply water to the fire pump house shall be drawn from a shared Fire Protection and Service Water Tank complying with NFPA 22. The stored volume of water required for the fire protection system shall be contained in a dedicated portion of this tank. The Reserved capacity for Fire Protection use shall be a minimum of 2 hours at the rate equal to the largest sprinkler system, plus one (1) 500 gpm total hose stream. Time to refill is a maximum of 8 hours from minimum tank level to total reserve capacity.
- A.11.2.15.5. The motor-driven and diesel engine-driven fire pumps shall be separated by a 2 hour (min.) fire rated wall.

- A.11.2.15.6. Any/all drain discharges from the fire pump house (eg. relief valves and heat exchanger cooling water discharge), shall be routed to individual open drain hubs with means for visual inspection within the pump house.
- A.11.2.15.7. The main fire pumps shall be designed in accordance with NFPA 20 such that the maximum system demand is 90-140% of the pump rating. Oversized pumps are not conservative and shall be avoided.
- A.11.2.15.8. Each fire pump shall comply with NFPA 20 and shall be capable of supplying water to all spray nozzles, sprinklers, hydrants, or hose reels associated with the largest single fire risk. The largest single fire risk shall be the largest fixed fire suppression system plus the maximum hose stream demand for a minimum of 2 hours.
- A.11.2.15.9. System design shall account for the following fire hose demand, which is in addition to the automatic suppression system demand:
 - A.11.2.15.9.a. 500 gpm for all lube oil and liquid fuel hazards (if any), regardless of quantity
 - A.11.2.15.9.b. 250 gpm for all outdoor transformers containing less than 1,000 gallons of mineral oil
 - A.11.2.15.9.c. 500 gpm for all outdoor transformers containing more than 1,000 gallons of mineral oil
- A.11.2.15.10. The diesel engine-driven fire pump shall be complete in all respects including fuel tank and hand operated pump for tank filling. Shall be arranged to accommodate filling operations from truck.
- A.11.2.15.11. The fire pump's diesel engine shall utilize a water-cooled heat exchanger. Cooling water shall be supplied directly from the pump discharge and shall discharge to an open drain cup in the pump house.
- A.11.2.15.12. The Diesel Engine air intake/filter shall be protected from direct water impingement from the building sprinklers.
- A.11.2.15.13. The fuel supply tank shall have a capacity such that the diesel engine can be run at full load for at least 8 hours or 1 gallon per rated engine horsepower (plus 5% for expansion plus 5% for tank sump), whichever is greater. The outlet from the tank shall be at a height of not less than 24" above the inlet to the fuel injection pump on the engine.
- A.11.2.15.14. A UL Listed fire pump controller shall be included for the diesel pumping set and the battery charger internal to the controller shall be entirely suitable for returning the starting batteries from a fully discharged to a fully charged state within 24 hours.
- A.11.2.15.15. A UL listed fire control panel for each pump shall be provided in the fire pump house to facilitate maintenance and to allow the pumps to be started both manually and automatically and stopped only manually.

- A.11.2.15.16. Automatic starting of the pumps shall be arranged in sequence by means of switches and/or time delays, which, on pre-determined drops in pressure in the fire protection system, will start the pumps. The control equipment shall include a logic circuit, which will initiate starting of the standby diesel engine-driven pump if the motor-driven pumps fail to start in a pre-determined time or if the pressure is not restored after operation of the motor-driven pumps. All control devices and cabling shall be included.
- A.11.2.15.17. Full flow testing capability of the fire pumps shall be included by means of calibrated flow meter back to the fire water storage tank and through a test header with adequate test valves based on the rated flow. The test meter shall be easily accessible for annual use. The test header shall be located outside of the fire pump house and not more than 5 ft. above finished grade or made accessible via a permanent platform.
- A.11.2.16 Painting / Coating of Fire Hose Cabinets, Extinguishers and Hose Outlet Areas:
- A.11.2.16.1. Coat fire hose cabinets (excluding hose and hose connections) and branch piping to approximately 5 feet on both sides of the fire house cabinets.
- A.11.2.16.2. Mounted on Walls: Apply a background panel of Safety Red color extending approximately 1 foot on both sides of the fire hose cabinets. (FS 595 Color 11120)
- A.11.2.16.3. Mounted on Columns or Posts: Apply a band of Safety Red color completely around the column or post, extending approximately one foot above and one foot below the facility.
- A.11.2.16.4. Fire hose cabinets in architecturally finished areas shall not be coated.
- A.11.2.17 General Electrical Requirements:
- A.11.2.17.1. All cable, regardless of voltage level and application, shall utilize a fire-retardant jacketing material, and shall have successfully passed the appropriate flame spread and smoke test for the class, voltage rating and cable size (compliant with UL, IEEE, or ASTM).
- A.11.2.17.2. All large station DC system batteries, either vented and/or sealed batteries shall be installed in dedicated battery rooms, and associated equipment, with ventilation system designed in accordance with approved NFPA, NEC and/or API standards. Battery Rooms shall be provided with ventilation (either natural or forced) designed to limit the concentration of Hydrogen to 1% or less. The loss of forced ventilation shall be monitored and alarmed at a constantly attended location. As an alternative to ventilation monitoring, Hydrogen concentration may be monitored and alarmed at constantly attended location.
- A.11.2.18 Fire Detection and Alarm Systems:
- A.11.2.18.1. All equipment and material shall be UL listed and/or FM Approved.

- A.11.2.18.2. The fire alarm system shall be complete in all respects and shall include the main and local fire alarm/control panels, the fire detection system, alarm contacts for local and remote signaling, all cabling between the fire detectors and alarm contacts and the local and main fire alarm/control panels.
- A.11.2.18.3. An electronic historian shall be included with the Main Fire Alarm Control Panel, capable of retrieving record of alarms.
- A.11.2.18.4. The following alarm facilities, including initiating devices shall be provided:
 - A.11.2.18.4.a. Graphic display panel on the system control panel in the control room, showing status of all fire system/devices and equipment.
 - A.11.2.18.4.b. Local remote audible and visual indications of the operation of any suppression system.
- A.11.2.18.5. A fire alarm system comprising the main fire alarm panel and all contacts and cabling between the main fire alarm panel, to be located in the control room and the various protection, detection and alarm systems located throughout the Facility which shall include the combustion turbine detection/alarm system fire alarm panel. Each covered area shall have a local manual release station within sight of the covered area.
- A.11.2.18.6. Each initiating device shall be individually addressable.
- A.11.2.18.7. For equipment maintenance platforms that are more than 30 ft. above grade, manual pull stations and notification appliances shall be provided at every level of egress including ground. Locations to include at the Inlet Filter House and stack platform.
- A.11.2.18.8. The local alarm and indicator panels shall be mounted in Buyer approved locations adjacent to the areas being protected including the existing fire water supply system. The remote alarms and indicators covering all sections of the Facility shall be mounted on a fire alarm panel of approved design, which shall be supplied and installed in the central control room.
- A.11.2.18.9. Smoke detection and alarm equipment shall be provided for environmentally controlled buildings / enclosures including those containing MCC, UPS, switchgear, battery rooms, DCS, control rooms (including false floor space). The system shall be arranged to give local audible alarm and remote audible and visual indication of the presence of smoke.
- A.11.2.18.10. Very Early Warning Aspirating Smoke Detection (Vesda) shall be provided for rooms with computer- or controls-type electrical equipment (e.g., DCS room, control room, etc.).
- A.11.2.18.11. The fire alarm system shall be networked with the combustion turbine fire protection system package to provide audible and visual indication on the main fire alarm panel located in the central control room.

- A.11.2.18.12. Communication / network wiring shall be Class A, while individual initiating, notifying, and releasing circuits may be Class B.

A.11.3 FIRE PROTECTION MASTER PLAN AND DESIGN BASIS DOCUMENTS

- A.11.3.1 The Seller shall be responsible for preparing Fire Protection Master Plan and Design Basis Documents. These documents are subject to Buyer approval to ensure that it contains the appropriate Table of Contents as well as general layout and content.
- A.11.3.2 The Seller shall comply with design requirements of the specification and the Fire Protection Master Plan and Design Basis Document. In the case of conflict between the two, the more stringent of the two documents shall apply in all cases.
- A.11.3.3 The documents shall be prepared by a professional Fire Protection and Engineering (FPE) Consulting Firm experienced in the preparation of fire protection and life safety master plans, building code reviews and analysis, detailed exit/egress analysis calculations and diagrams and building code negotiations. The Seller shall not prepare these documents using their own employees.
- A.11.3.4 The documents and subsequent revisions shall be signed and sealed (including the detailed formal exit analysis drawings) by a Fire Protection Engineer (FPE) having a current professional membership grade in the Society of Fire Protection Engineering and by a licensed architect.
- A.11.3.5 The Seller shall submit The Protection Master Plan and Design Basis Document to the Buyer, Buyer's Representative, Buyer's Insurance and AHJ for review.
- A.11.3.6 Documents shall consist of, as a minimum, the following:
- A.11.3.6.1. Building and Fire Codes and Life Safety Compliance Review Report
- A.11.3.6.1.a. The report shall identify and address for each building, pre-engineered and/or pre-fabricated building, equipment enclosure and/or structure the applicable federal, state, and local building and fire codes, standards, recommendations, and amendments.
- A.11.3.6.2. Fire Risk Evaluation Report
- A.11.3.6.2.a. An NFPA 850 fire risk evaluation, in accordance with Chapter 4 of NFPA 850, shall be initiated as early in the design process as practical to ensure that the fire prevention and fire protection recommendations have been evaluated in view of the Facility-specific considerations regarding design, layout and anticipated operating requirements. The evaluation should result in a list of recommended fire prevention features to be provided based on acceptable means for separation or control of common and special hazards, the control or elimination of ignition sources and the suppression of fires.
- A.11.3.6.3. Fire Protection Design Basis Document

- A.11.3.6.3.a. An NFPA 850 fire protection Design Basis Document (DBD) shall be developed as early in the design process as practical. This shall be developed and maintained in compliance with NFPA 850.
- A.11.3.6.4. Hazardous Area Classification Evaluation Drawings
 - A.11.3.6.4.a. The basis for classification evaluation shall be NFPA 70 (National Electrical Code [NEC]), NFPA 497, API 500, vendor information and other standards, as applicable.
- A.11.3.6.5. Fire Hydrant Location Drawings
 - A.11.3.6.5.a. Drawings shall indicate the location, spacing and type of fire hydrants, including the separation distance between buildings and equipment structures. Fire hydrants shall be located adjacent to and aligned so that the 4 ½ in outlet would be accessible from fire apparatus on the access roads.
- A.11.3.6.6. Portable Fire Extinguisher Location Drawings
 - A.11.3.6.6.a. Drawings shall indicate the location and type of portable fire extinguishers.
- A.11.3.6.7. Fire Protection System Construction Execution Plan
 - A.11.3.6.7.a. Execution plan shall be developed to outline the implementation strategy from engineering and design, through construction. This shall identify any/all contractors that are performing work related to complete design, engineering and installation of the fire protection system and their qualifications to perform said work.

END OF SECTION

SECTION A.12
ELECTRICAL REQUIREMENTS AND DESIGN CRITERIA

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SECTION A.12

ELECTRICAL REQUIREMENTS AND DESIGN CRITERIA

A.12.1 ELECTRICAL SYSTEMS AND EQUIPMENT

- A.12.1.1 This section defines the minimum requirements for design, engineering and material requirements for electrical systems including equipment, raceway, and cabling. This includes specific requirements for the Seller to engineer, design, procure and construct the Facility.-
- A.12.1.2 In general, the electrical systems and equipment described in this section shall, as a minimum, meet the requirements of ANSI, NERC, IEEE, NEMA, and NFPA 70E (NESC) and as applicable NFPA 70 (National Electric Code). Where the requirements of these conflict with the requirements of this document, these conflicts shall be referred to Buyer for resolution.
- A.12.1.3 All Facility electrical equipment, including bus, breakers, transformers, motor control centers, distribution panels etc., shall be designed to withstand the maximum available fault current from the switchyard and/or generators, as applicable.
- A.12.1.4 The failure of any single major piece of electrical equipment shall not cause a loaded generator to trip, with the exception of the Generator Step-Up (GSU) Transformer, Generator Breakers, Isolated Phase Bus Duct, Unit Auxiliary Transformer(s) (UAT(s)) and cable bus to switchgear, Boiler Feed Pump (BFP) feeder breaker, MV switchgear main breakers and HV breakers and disconnect switches
- A.12.1.5 All project electrical system studies shall be performed using ETAP to calculate the available fault values in order to specify continuous, momentary, and interrupting ratings of the electrical equipment, including arc flash incident energy studies. This includes sizing of HV equipment, and connection to the Bulk Electric System (BES).
- A.12.1.6 Emergency bus required for safe shutdown shall automatically energize without operator action to transfer or energize buses or loads.
- A.12.1.7 During all operating conditions with all electrical power distribution equipment in service other than during the starting of large motors, the voltage at motor terminals shall be maintained between 90% and 110% of motor rated voltage. Temporary voltage drops during a single medium voltage motor start shall not extend below 80% of the motor rated voltage at the terminals of the motor being started, and non-starting motors on the same bus shall not have a voltage of less than 90% of rated voltage at their motor terminals. On normal operation the voltage at motor terminals shall be maintained between 90% and 110% of motor rated voltage.
- A.12.1.8 The electrical design criteria shall be used by the Seller during the procurement of all sub-specifications.

- A.12.1.9 Seller shall provide to the Buyer at the completion of the project an electronic cable database which includes, cable identifier, to/from identifiers, lengths, number of conductors, termination, service, raceway information (tray/conduit/ductbank etc.), reference drawing numbers, startup code, cable numbers, service level, size such that future Facility modifications can be tracked.
- A.12.1.10 Vendor supplied equipment is delivered on site and instruments are pre calibrated at factory and calibration records shall be provided.
- A.12.1.11 For electrical equipment operating status indication shall use the following colors at power source equipment (SWGR, MCC, Panels) and locally:
- A.12.1.11.1. Red shall indicate energized, breaker closed, on in operation.
- A.12.1.11.2. Green shall indicate OFF, de-energized, open.
- A.12.1.11.3. White, blue and amber used to signify conditions such as available, ready, standby, locked out or blocked, not ready. Actual color use to be determined during details design with input from, and agreement of, Buyer.
- A.12.2 HAZARDOUS AREA CLASSIFICATION
- A.12.2.1 Locations where fire or explosion hazards may exist due to flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or fillings shall be defined as classified areas. The Seller and project shall meet NEC requirements regarding hazardous area classifications. Seller shall issue area classification drawings which shall define physical boundaries of these specified areas.
- A.12.2.2 Equipment specified for a Class 1 Div 1 or Div 2 area shall be supplied with explosion proof fittings, junction boxes, power panels to meet the requirements of the area classification per NEC.
- A.12.3 GENERATION SYSTEM
- A.12.3.1 The Generation System shall consist of the generators, generator buses, generator breakers, and the generator step up transformer. Associated with the Generation System is the Automatic Generation Control (AGC). The AGC function shall be part of the Facility DCS and shall interface with the Control System furnished with the Turbine Generators. The Generation System shall be designed to function within NERC Requirements.
- A.12.3.2 Seller to provide power and communication to Combustion Turbine and Steam Turbine Remote Monitoring Systems.
- A.12.3.3 Generators

- A.12.3.3.1. The generator for the combustion turbine and steam turbine will be in accordance with the enclosed combustion and steam turbine generator specifications, Sections A.5 and A.7 respectively.
- A.12.3.3.2. Generator voltage shall be OEM standard as shown in Sections A.5 and A.7 and A.16.4.7 - Electrical Conceptual Single Line Diagram.
- A.12.3.4 The combustion turbine generator shall have the ability to automatically operate in Island Mode.
- A.12.3.4.1. CTG separation from the grid and activation of Island Mode shall be on a Buyer approved element set in the relaying scheme of the operating Facility without operator intervention.
- A.12.3.4.2. Island Mode shall mean the CTG unit will continue operating providing BOP auxiliary loads (“house loads”) while isolated from the transmission grid (or bulk power system) without support from any off-site power sources (e.g., Distribution System), or the onsite emergency power sources
- A.12.3.4.3. The plant shall be capable of Islanding from all normal operating power levels as well as from output levels less than MECL down to the Island Mode target load value as determined by MPWA.
- A.12.3.4.4. The BOP DCS Front End display page/screen (or other mutually agreed page/screen) shall include an ISLAND MODE SELECT button that will enable/disable Island Mode and include a double acting manual initiate control for operator initiation of Island Mode. This display page Front End shall include indication of Island Mode enable status and notification of house load sufficiency for Island Mode operation.
- A.12.3.5 The STG will trip during islanding based on its standard relay settings. Subsequent to the STG trip, the process systems required (e.g., Steam Bypass system, ACC, etc.) for the Heat Recovery Steam Generator (HRSG) to dump steam to the condenser shall continue to operate.
- A.12.3.6 Grid Interconnect Standards Requirements:
 - A.12.3.6.1. Seller shall meet all NERC requirements as detailed in Section A.1.5.3 and generators shall be capable of compliance specially with NERC PRC 24-2 which defines various operating conditions such as frequency and voltage that shall be maintained in the event the system voltage and frequency deviations. Seller shall also meet NERC PRC-19 coordination of Generating Unit or Plant limiting and protection capabilities, and voltage regulating controls.
- A.12.3.7 In Island Mode operation the CTG will automatically maintain the frequency at 60Hz. Any change i-n load altering the islanding CTG’s frequency shall be compensated for by the CTG control system.

- A.12.3.8 Once the transmission grid has been restored after Island Mode operation, the Operators will re-synchronize the unit to the grid using normal procedure and synch controls in the CTG.
- A.12.3.8.1. Not Used
- A.12.4 HIGH VOLTAGE SYSTEM
- A.12.4.1 Transmission voltage – [insert voltage] kV (nominal,)
- A.12.4.2 Preliminary (post unit installation) Available Short Circuit – The transmission system three-phase contributions at the [insert voltage] kV Switchyard is to be provided by the transmission provider.
- A.12.4.3 Basic Insulation Level (BIL) – Seller to determine BIL levels with Buyer approval for HV equipment, CTG, STG and GSU bushings and as specified in relevant equipment specific sections of this specification.
- A.12.4.4 Facility HV system consists of the below equipment:
- A.12.4.4.1. Potential Transformers (PT) and Current Transformers (CT) accuracy shall meet ANSI C12.1.
- A.12.4.4.2. Surge Arrestors
- A.12.4.4.3. HV Circuit breakers with current transformers (CT).
- A.12.4.4.4. HV motor operated disconnect switch and associated manually operated mechanically interlocked ground switch on the line side of the breaker for applications 230 kV and below. Higher voltage ground switches shall be motor operated.
- A.12.4.4.5. Dead End Structure(s) – total [insert number here] for [insert voltage] kV system, including structure foundation and installation for GSUs to Transmission Line Tower connections.
- A.12.4.4.6. RTU cabinet and revenue metering cabinets to be installed in the Main PDC
- A.12.4.5 Seller's scope for the HV conductors and OPGW wire will end at the BES Point of Interconnection. Seller shall be responsible for the procurement, installation, and termination of the HV conductors within the facility to the Point of Interconnection. See A.17 – HV Transmission Line Design Requirements.
- A.12.4.6 The Seller's Facility protection system design engineer shall interface with the transmission provider to ensure that selective coordination and inter-trips are NERC compliant.

- A.12.4.7 At the time of Facility design, Seller shall obtain current transmission system planning data with respect to transmission system capacity.
- A.12.4.8 Individual pole operated (IPO) circuit breakers to address stability concerns to be included in design pending final stability analysis.
- A.12.4.9 High voltage breakers will be supplied by Seller. High voltage breakers ratings will provide capacities including maximum fault currents (single line to ground or 3-phase to ground as applicable), X/R ratios, and system maximum MVA and Thevenin impedances. Breaker will include design margin.
- A.12.4.10 Not Used.
- A.12.4.11 PTs and CTs to be provided by Seller for all protection and control including for Buyer provided revenue metering. CT accuracy requirements for revenue metering shall be 0.15B1.8 and PT accuracy 0.3Z. The Seller shall provide the revenue metering cabinet(s) to the Buyer's specifications. Seller shall provide primary and backup metering. The Seller shall design and install all interface wiring needed for revenue metering. The Buyer will make the final connections to the meters.
- A.12.4.11.1. Seller is responsible for the design, purchase, and installation of the Facility side line protection relays and cabinets per Buyer's specifications. Facility side line protection relays shall be a replication (copy) of the relays installed in the existing switchyard by the transmission provider. The Seller shall also be responsible for Facility side line protection relay settings and will coordinate with transmission provider to perform testing. The Seller shall be responsible for developing and testing to their own Facility side test procedure. All control and instrument cabling run in the Facility switchyards to be shielded.
- A.12.4.11.2. Line protection relays shall, at a minimum, display voltage and current reading on the HV transmission line(s).
- A.12.5 ISOLATED PHASE BUS DUCT
- A.12.5.1 It shall be the responsibility of the Seller to design, manufacture, test, deliver, and install isolated phase generator bus for each generator, as described below.
- A.12.5.2 Generator bus shall be provided between the generator and generator breaker for the Combustion Turbine Generator (CTG) and between the generator breaker and the GSU. Generator bus shall be provided between the generator and the GSU on the Steam Turbine Generator (STG). A section of tap bus shall be provided to connect the UAT(s) on the CTG. Sections of tap bus shall be provided, as required, for the generator excitation system of both the CTG and STG, STG voltage transformer/surge arrester cabinet.

- A.12.5.3 All generator buses shall be rated to carry the maximum generator output continuously at 95% of rated voltages and without exceeding the bus design limits of 60°C rise, over the ambient temperature of 40°C per IEEE C37.23.
- A.12.5.4 Each section of generator bus shall be self-cooled, isolated phase bus construction.
- A.12.5.5 Bus space heaters shall be supplied on bus sections for condensation control. Expansion joints shall be provided as required to accommodate thermal expansion of the bus.
 - A.12.5.5.1. Isolated Phase Bus Duct (IPBD) General
 - A.12.5.5.1.a. Manufacturer of the isolated phase bus duct shall design, manufacture, test and deliver isolated phase bus duct and auxiliary equipment as specified herein.
 - A.12.5.5.1.b. The isolated phase bus duct shall interconnect the following Equipment:
 - A.12.5.5.1.b.1 Turbine Generators (including the excitation transformer)
 - A.12.5.5.1.b.2 Generator Circuit Breaker (CTG unit)
 - A.12.5.5.1.b.3 UAT(S) (CTG unit)
 - A.12.5.5.1.b.4 VT Surge Cubicle (STG unit)
 - A.12.5.5.1.b.5 GSU Transformers
 - A.12.5.5.2. Preliminary bus ratings to be provided by the Seller in the Electrical Conceptual Single Line Diagram.
 - A.12.5.5.3. General Requirements
 - A.12.5.5.3.a. The isolated phase bus structure shall consist of rigid aluminum electrical conductors mounted on porcelain insulators. Each phase shall be enclosed in a separate weather and dust-tight nonmagnetic metal enclosure, separated by an air space from the adjacent phases. The three phases shall be securely braced, mounted on and supported by a substantial hot dipped galvanized steel structure. Where taps are specified from the bus to cubicles housing auxiliary equipment, the tap connections and cubicles shall be of the isolated phase construction. The isolated phase bus enclosures shall have inspection Infra-Red (IR) inspection windows for main runs between the generators, GCB and GSUs.
 - A.12.5.5.3.b. The bus shall be suited for outdoor installation and shall include all necessary equipment connections, flanges, seals, taps, elbows, offsets, splicing materials, adapter bars, supporting structure, and any material required to make a complete coordinated bus installation. A complete set of drawings and installation instructions shall be furnished with each run of bus.

A.12.5.5.3.c. All bus conductors and connections, insulators, supports, enclosures and supporting structures, when installed, shall have sufficient mechanical strength to ensure continuous, satisfactory operation under normal operating conditions and shall withstand, without incurring damage, the effect of any momentary current resulting from a three-phase, line-to-line or line-to-ground short circuit. The momentary current shall be of the rms value, including the direct current component, of the maximum cycle that corresponds to the rms asymmetrical currents specified in this specification.

A.12.5.5.3.d. The Steam Turbine Generator IPBD shall also be provided with IPBD taps to feed the VT/SA cubicle.

A.12.6 GENERATOR STEP-UP TRANSFORMERS

A.12.6.1 Refer to Section A.8 GSU Transformer Specification.

A.12.7 GENERATOR CIRCUIT BREAKER

A.12.7.1 The generator circuit breaker for the CTG shall be SF₆ type and designed, manufactured, and tested in accordance with the latest standards of IEEE, particularly IEEE C37.013, and NEMA. There shall be an access platform and access staircase provided. Access to SF₆ gauges and lockout mechanisms, and control panels shall be on the same side of the generator circuit breaker.

A.12.7.2 GCB shall be sized with a continuous rating which exceeds the maximum generator output current by a minimum 10% at all ambient conditions.

A.12.7.3 Tripping logic and control power circuit shall be independent with two redundant trip coils. GCB shall have its own independent breaker failure relay protection scheme.

A.12.7.4 GCB shall be designed for operation within the TRV values for faults on either side of the breaker.

A.12.7.5 Disconnect and Ground Switches

A.12.7.5.1.a. Generator circuit breaker shall have two grounding switches and one disconnect switch per pole. One grounding switch shall be installed on each side of the circuit breaker, and the disconnect switch shall be installed on the transformer side of the circuit breaker. The grounding switch on the transformer side of the circuit breaker shall be installed between the disconnect switch and the transformer. Remote breaker operation, (open/close), alarm and trouble input status signals shall be provided to the Control Room

A.12.7.5.2. Grounding and disconnect switches shall be rated for both the continuous current rating and the short time rating of the installed system.

A.12.8 UNIT AUXILIARY TRANSFORMER (UAT(S))

A.12.8.1 The UAT(S) transformer(s) shall be designed, constructed, and tested in accordance with IEEE Standard C57.12 series and the applicable National Electrical Manufacturers

Association (NEMA) standards. The Seller shall provide guaranteed maximum losses per IEEE standard C57.12 series.

- A.12.8.2 The UAT(s) rating shall include margin above the maximum Facility initial design requirement.
- A.12.8.3 The unit auxiliary transformer(s) shall be three-phase, three-winding, 60 Hz, outdoor, step-down, outdoor mineral oil (non-PCB) immersed type, Class ONAN/ONAF/ONAF. Transformers shall have copper windings. Transformers impedances shall be sized to allow across-the-line starting of the largest MV motors with all other motors in the full load and operating mode condition within the specified voltage drop.
- A.12.8.4 The maximum (hottest spot) winding temperature rise above ambient temperature shall not exceed 80°C at rated load for the particular combination of connections and taps that give the highest maximum (hottest spot) winding temperature rise. This requirement is the standard allowed maximum (hottest spot) winding temperature rise of 80 °C in IEEE Std. C57.12.00.
- A.12.8.5 UAT(s) shall have $\pm 2 - 2 \frac{1}{2} \%$ HV taps, manually adjusted (See Electrical Conceptual Single Line Diagram). Taps shall be selectable by an externally mounted, lockable switch handle which shall also function as an indication of the tap position. Neutral shall be resistance grounded.
- A.12.8.5.1. A manually-operated tap changer shall be provided for operation when the transformer is not excited. The tap changer hand wheel shall be between two and four feet above the transformer base. The tap changer shall have a visual indication of tap position with padlocking capabilities at any tap position.
- A.12.8.6 Angular Displacement: The transformer(s) shall have a standard phase relationship.
- A.12.8.7 Impedance at the rated connections shall be based on the Seller's design basis with an IEEE standard $\pm 7.5\%$ design tolerance. BIL, sound level, and voltage connections shall be in accordance with ANSI, IEEE, and NEMA standards.
- A.12.8.8 Control Devices and Small Wiring
- A.12.8.9 Control relays, breakers, contactors, etc., shall be furnished in a NEMA 4 enclosures for outdoor cabinet.
- A.12.8.9.1. The control cabinet shall comply with the requirements of IEEE Std C57.148.
- A.12.8.9.2. The control cabinet shall include space heaters and ventilation, as required to maintain control of humidity and temperature.
- A.12.8.10 All small wiring for control or accessory equipment shall be installed in standard galvanized rigid steel conduits or ducts, with watertight joints. Drain holes, 1/4-in.

diameter, shall be provided in low points of all conduit runs. Low point drains shall not be drilled, conduit drain fittings shall be used.

A.12.8.11 Short Circuit Capability

A.12.8.11.1. The transformer(s) shall be capable of withstanding, without damage, the mechanical and thermal stresses caused by short circuits of the external system of any winding in accordance with IEEE Standard C57.12.00.

A.12.8.11.1.a. Short circuit values shall be determined during the ETAP analysis done by the Seller as indicated.

A.12.8.11.2. Available short circuit capabilities shall be considered as well as turbine supplier specific requirements (start-up w/ static start system) when specifying transformer impedances.

A.12.8.12 Thermal Connections and Bushings

A.12.8.12.1. Transformer leads shall be brought out of the transformer case by means of bushings of the outdoor type. Bushings shall be capable of withstanding the 60 Hz applied potential tests and the lightning impulse tests shall be the responsibility of the Seller. Viton Gaskets shall be used

A.12.8.13 Bushing Current Transformers: The CT rating, quantities and ratios shall be determined by Seller, reviewed and approved by the Buyer. Bushing Current Transformers shall be factory installed. The turns shall be equally spaced around the circumference of the core with fully distributed copper windings. The current transformers shall have a minimum thermal rating of 2.0. All leads shall be brought out to shorting-type terminal blocks in the control cabinet. The leads shall be installed in conduit. Each wire shall be marked to identify the tap and the current transformer. The minimum wire size is #10 AWG and splices are not permitted.

A.12.8.14 Project/Site Condition

A.12.8.14.1. Refer to Section A-9 – Site Requirements and Design Criteria

A.12.8.14.2. Transformers shall be suitable for outdoor location.

A.12.8.15 Each transformer shall be provided with the following accessories:

A.12.8.15.1. Winding temperature indicator

A.12.8.15.2. Surge Protection

A.12.8.15.3. Liquid temperature indicator

A.12.8.15.4. Seller shall provide dry contact outputs for alarm status to BOP DCS

A.12.8.15.5. Fiber Optic Temperature Monitoring Sensors

- A.12.8.15.5.a. The transformer shall be provided with a sufficient number of winding embedded fiber optic sensors; at least 3 fibers per phase per winding (HV & LV) for winding temperature monitoring and three fibers for top oil temperature monitoring (a minimum of 30 fibers). The fibers shall be terminated into Qualitrol Neoptix digital temperature monitors located inside the control cabinet. The fiber temperature monitors shall have 4-20ma analog outputs and Modbus capability to connect to other plant devices, DCS and monitors including the transformer on-line monitoring system.
- A.12.8.15.6. The transformer shall be equipped with an APT TTC-1000 from Advanced Power Technologies or Buyer approved equivalent temperature monitoring system with digital displays easily readable in daylight.
- A.12.8.15.7. A Schweitzer Engineering Laboratories (SEL) Model 2523 (SEL-2523) annunciator/data logger panel shall be provided in the control cabinet of each transformer to monitor the system health and indicate occurrences of alarms, trips and other general signaling messages.
- A.12.8.15.8. Ground pads shall be furnished on each transformer tank in accordance with the requirements of IEEE C57.12.10 – 1977, Article 9.2.8.
- A.12.8.15.9. Transformer tank design shall be such that ventilation is provided between the concrete supporting slab and the bottom of the transformer tank. Only supporting steel beneath the transformer tank may touch the concrete slab. Design of the steel supporting the transformer tank bottom shall be such that the bottom is accessible for inspection after installation.
- A.12.8.15.10. Transformer shall have online dissolved gas monitoring using a Vaisala OPT-100.
- A.12.8.15.11. The transformer shall be provided with online monitoring system to continuously monitor the condition of LV and HV bushings, transformer dissolved gases and temperatures and other transformer parameters, including loss of insulation life. The online monitoring system shall be capable of controlling the coolers' operation in parallel with the conventional cooler controls. The latest DRMCC monitoring system or better system as approved by Buyer shall be provided with the transformer.
- A.12.8.16 Transformer Losses and Auxiliary Power Requirements
- A.12.8.16.1. The load losses, efficiency and regulation shall be corrected to a reference temperature according to IEEE C57.12.00.
- A.12.9 SYSTEM RELAYING
- A.12.9.1 Generator Step Up transformer to Switchyard Interconnect Transmission Line Protection
Seller is responsible to accommodate the required interface signals in their design. Each GSU transformer will be connected to the local substation breaker. The transmission line will be protected by separate primary and secondary differential relay circuits. Connection between the Switchyard and Facility differential relay panels shall be via

fiber optics. The primary and secondary fiber connections shall be made with separate cables placed in separate conduits. All differential relays, interface devices, lockout relays, cutoff switches and fiber optic cables will be purchased and installed by the Seller. Coordination will be required with the transmission provider regarding manufacturer type for relays and interface devices. Wiring from the switchyard circuit breakers to the switchyard differential relay panels shall be performed by transmission provider.

A.12.9.2 Generator Protective Relaying

A.12.9.2.1. See Section A.5.5.5.16.d and Section A.7.6.8.5.

A.12.9.3 Generator Bus and Transformer Protective Relaying

A.12.9.3.1. Protection for the generator bus and generator step up transformers shall be provided by the same relaying systems used to protect the generator against phase faults and ground faults.

A.12.9.3.1.a. Differential (87B)

A.12.9.3.1.b. Neutral over voltage (59N)

A.12.9.3.2. An overall unit non-redundant differential relay shall be provided for each unit (CTG and STG) which wrap the HV breaker to generator ground and all devices in between. This shall be a SEL relay.

A.12.9.4 Generator Step Up Transformer Protective Relaying

A.12.9.4.1. The following generator step up transformer relays and protection schemes shall be provided:

A.12.9.4.1.a. The GSU shall be protected by a primary and backup (SEL) differential relay.

A.12.9.4.1.b. Generator Step Up Transformer, generator breaker, and generator bus zone differential relaying

A.12.9.4.1.c. Fault pressure relaying, two devices with either device alarming, and two-out-of-two logic to trip

A.12.9.4.1.d. Mechanical fault pressure relief device

A.12.9.4.1.e. Lockout relay for generator step up transformer, generator bus, and unit auxiliary transformer trip

A.12.9.4.1.f. Transformer differential relays, primary and backup.

A.12.9.5 Auxiliary System Relaying

A.12.9.5.1. The auxiliary system relaying design shall be based on C37.102 and included references.

A.12.9.5.2. The auxiliary system shall be protected as listed and described below:

A.12.9.5.2.a. Unit auxiliary transformer shall be protected by a primary and backup (SEL) differential relays.

A.12.9.5.2.b. Fault pressure relaying, with both alarm and trip

A.12.9.5.2.c. Unit auxiliary transformer shall be low resistance grounded and provide alarm and trip

A.12.9.5.2.d. Lockout relay for generator step up transformer, generator bus and unit auxiliary transformer trip

A.12.9.5.2.e. Unit auxiliary transformer shall have instantaneous and over current protection, as well as differential protection

A.12.9.5.2.f. Medium-voltage bus supply and tie breakers shall have over current relays

A.12.9.5.2.g. Bus transfer synchro-check relaying

A.12.9.5.2.h. Medium-voltage bus differential

A.12.9.5.2.i. Unit substation (load center) transformers shall be provided with differential protection.

A.12.9.5.2.j. Motors greater than 3000 HP shall be provided with differential protection.

A.12.9.6 Lockout Relay Actions

A.12.9.6.1. An independent lockout relay (Device 86) shall be associated with each set of primary and backup generator protection, and all trips requiring the opening of the generator breaker and removing excitation shall operate these lockout relays. The operation of these relays shall not cause the trip of the combustion turbine, which will continue to fire to provide heat and airflow for the HRSG. Each 86 Device shall be powered from independent 125V dc circuits. A second lockout relay shall be provided for the generator to clear the associated substation breakers via a transfer trip. All lockout relays provided must be monitored and alarmed on coil failure, with the monitoring being handled in such a manner that the reliability of the circuit is not compromised. LED indicating lights shall be used to monitor the integrity of the lockout relay power. An alarm shall be provided to alert on loss of power. Primary and secondary protective relays shall each trip separate lockout relays. The GSUs and UAT(S) shall also have independent lockout relays.

A.12.9.6.2. All protective relays shall be provided with external targets to show relay operation to assist operator in determining which relays have operated.

A.12.9.6.3. Protective relaying as described above not provided by generator OEM shall be installed in a protective relay panel(s) provided by Seller.

A.12.9.6.3.a. Protective Relay Panel General

A.12.9.6.3.a.1 The Seller shall procure, design, and determine size length, height, and depth of the protective relay panel. Seller shall provide 20% spare internal mounting capacity. Buyer shall approve final board and instrument arrangement. The protective relay panel shall be arranged to accommodate all controlling and indicating devices, instruments, switches, relays, dials, signal lights and alarms, etc., furnished by Seller. These panels shall include the primary and backup GSU and UAT differential protection relays, IPBD protection, and auxiliary power metering. These relays shall be SEL as the primary relay and backup relays, where required, shall be SEL of different model. All relays shall be microprocessor based and shall also provide overcurrent protection functions for phase and ground faults in the windings of the transformer, and or backup of other overcurrent relays in the external system.

A.12.10 AUXILIARY POWER SYSTEM

A.12.10.1 The auxiliary power system shall be consistent of the following voltage levels:

MV –	6.9 kV, 3 Phase, 60 Hz, low resistance ground
LV –	480V, 3 Phase, 60 Hz, high resistance ground (with exception of admin building, as applicable)
Essential Power –	480V ESS (high resistance grounded), 120 VAC UPS (grounded), 125 VDC (ungrounded)

A.12.10.2 Voltage Drop

- 3% for branch circuits and feeder circuits
- Not to exceed 20% voltage drop at the largest motor (terminals) on any given bus during motor start
- Bus voltage drops – 10% normal, 15% during motor starting

A.12.10.3 The auxiliary power system shall be designed to accommodate a minimum 10% future load growth.

A.12.11 POWER DISTRIBUTION CENTER (PDC) BUILDINGS

A.12.11.1 Prefabricated PDC shall contain major electrical distribution equipment including but not limited to MV SWGR, LV SWGR, MCC, Facility DCS cabinets, relay and metering cabinets, AC, DC, and UPS distribution systems at the approval of the Buyer's requirements. PDCs shall also include:

A.12.11.1.1. Fire Detection

A.12.11.1.2. Redundant HVAC system (N-1)

A.12.11.1.3. Dedicated climate controlled battery room

- A.12.11.1.4. Interconnecting wire between internal components (coiled during shipping splits)
- A.12.11.1.5. Platform and stairways for all access and switchgear maintenance and access to all HVAC equipment located at the exterior of the PDC
- A.12.11.1.6. Remote racking capabilities for LV and MV Switchgear (SWGR) breakers
- A.12.11.1.7. Sealed conduits top to bottom to prevent rodents from damaging equipment
- A.12.11.1.8. Reserved space to accommodate two (2) 24"x36"x72" cabinets for Buyer's locker storage
- A.12.11.1.9. Reserved space to permanently store all special tools for operating and testing of the equipment housed in the PDC
- A.12.11.1.10. Reserved space and floor/wall openings to accommodate the following: a) Seller provided cabinets - "RTU", 36"x36"x96" and "Revenue Metering Panel", 36"x36"x96", b) LAN Cabinets, c) Seller shall provide power and communication cabling and conduits to the reserved space.
- A.12.11.1.11. Redundant exhaust fans with fan running status switches located in Battery Room.
- A.12.11.1.12. All power cables to MV and LV switchgear and MV MCC shall be bottom entry. Power cables from LV MCCs, distribution boards and panels serving loads external to the PDC shall be bottom entry
- A.12.12 BALANCE OF PLANT NON-SEGREGATED PHASE BUS DUCT / CABLE BUS
- A.12.12.1 Seller shall design, procure, test, deliver, and erect non-segregated phase bus to interconnect the Secondary Unit Substation Transformers to the 480V Switchgear and MCCs. Non-segregated phase bus shall be copper bus insulated with a thermosetting insulation. Non-segregated phase bus duct shall be a self-cooled design.
- A.12.12.2 Seller shall design, procure, test, deliver, and erect cable bus to interconnect the UAT(S) with the 6900 V switchgear. Cable bus conductors shall be rated 90°C, fully insulated and shielded power cables. Conductor ampacities shall be based on full-load application, with consideration given to site conditions and the effects of solar radiation and the raceway or enclosures in which they are installed. The temperature rise of the conductor carrying continuous current shall not exceed 50°C rise over 40°C ambient. Conductors shall be suitable for indoor or outdoor use. Even current distribution between paralleled conductors shall be ensured by proper phasing and spacing arrangements between conductors. Transposition and interleaving of conductors shall be done as required to ensure equal current distribution and impedance. The installation shall be completed with continuous conductors, no splices, running the full length of the system.
- A.12.12.3 Space Heaters

- A.12.12.3.1. Outdoor bus non-segregated duct sections shall be furnished with space heaters to prevent condensation of moisture within the bus duct. Space heaters shall be thermostatically controlled.
- A.12.12.3.2. The heaters shall be located and thermally insulated such that no painted surface or bus insulation shall be damaged or discolored. Space heater capacity shall be as required to maintain the compartment and the bus duct internal temperature above the dew point. Voltage normally applied to the space heaters will be 120 VAC.
- A.12.13 ARC FLASH
- A.12.13.1 Arc flash levels on signage shall be posted at all switchgear, motor control centers, 480/240/208/120 VAC and 125 VDC distribution panels and panelboards in accordance with per NFPA 70E and OSHA standards. All switchgears and motor control centers shall be arc resistant.
- A.12.13.1.1. Maximum allowable incident energy for all AC and DC system equipment is 8cal/cm².
- A.12.13.1.2. This includes, but not limited to, medium voltage switchgear and MCCs, and low voltage system equipment (e.g., MCCs, distribution panels, switchboards, panelboards, etc.).
- A.12.13.1.3. Fiber Optic and/or differential protection shall be provided. Bus differential protection shall also be incorporated on the MV switchgear to mitigate incident energy. Maintenance mode switches are not preferred unless absolutely necessary to meet the incident energy requirement with proof acceptance by Buyer.
- A.12.13.1.4. This requirement applies to BOP and OEM packaged equipment.
- A.12.13.1.5. This requirement applies to all DC system equipment with the exception of the battery terminals and main switchboard battery disconnect switch.
- A.12.14 MEDIUM-VOLTAGE SYSTEM
- A.12.14.1 Medium Voltage Requirements General
- A.12.14.1.1. A medium-voltage auxiliary system shall be provided by the Seller to feed motors and other medium-voltage loads. This medium-voltage system distributes power to HRSG, STG, and CTG 6900V electrical auxiliaries (including the Combustion Turbine static starter or starting motors) during normal operation, startup, and shutdown. The system shall consist of one 3-winding Unit Auxiliary Transformer and switchgear lineups supplied by the UAT(S).
- A.12.14.1.2. Control and monitoring of the aux system shall be via remote I/O input through the Facility DCS. All control and position monitor, as well as relay status/alarms, shall be hardwired from the DCS I/O card to the breaker. Other status data and system parameter information shall be provided via a data link.

- A.12.14.1.3. It shall not be possible to operate the breaker from a control switch mounted on the front of the frame while the breaker is in the operate racked-in (engaged) position.
- A.12.14.2 Medium Voltage System Configuration
 - A.12.14.2.1. The Medium Voltage Switchgear and Medium Voltage MCC shall be hard coupled together as referenced in Section A.16.4.7. The medium-voltage system shall consist of a low resistance grounded system powered through Unit Auxiliary Transformer.
 - A.12.14.2.2. The medium-voltage system provides power to large loads and load center transformers. Relay protection shall be as specified in this Section and in Section A.12.9 of this document. All medium-voltage relaying shall be Schweitzer SEL relays. Buyer shall be consulted to specific model types. The Schweitzer relays shall be provided with displays.
 - A.12.14.2.3. An alternate power feed from the local distribution system shall provide power to the MV switchgear when power from the UAT is not available, as follows:
 - A.12.14.2.3.a. Shall use a dedicated breaker on the MV switchgear interlocked with the main bus supply breakers to prevent paralleling of independent sources.
 - A.12.14.2.3.b. Intended to supply plant support loads during non-operational conditions and is not intended for black start of the unit. Loads include, but are not limited to, asset protection, lighting, HVAC, security, and communications.
 - A.12.14.2.3.c. May use a repurposed construction power transformer or a separate dedicated transformer. See Section A.1 – Project Requirements.
- A.12.14.3 Medium Voltage 6900V Switchgear and Motor Controllers
 - A.12.14.3.1. The 6900-Volt Switchgear shall be designed, manufactured, and tested in accordance with the latest standards of ANSI and NEMA. The switchgear shall be arc resistant Type 2B with arc flash monitoring.
 - A.12.14.3.2. Medium voltage switchgear with tie breakers shall be secondary selective. Seller shall provide automatic bus transfer relays to facilitate fast bus tie closing in the event of loss of voltage source. This function shall be disabled if a fault exists on the load bus.
 - A.12.14.3.3. MV switchgear/MCC shall be utilized to feed motors greater than 250 HP, CTG starting system, critical loads (e.g., motor driven fire pump), and load center transformers.
 - A.12.14.3.4. The circuit breakers shall be horizontal draw-out type capable of being withdrawn on extendable rails self-contained in the Switchgear housing. The breakers shall be operated by a remote racking motor charged spring stored energy mechanism. The stored energy mechanism shall be front accessible and will be charged normally by a universal electric motor and in an emergency by a manual handle. The primary disconnecting contacts shall be silver-plated copper. Switchgear and circuit breakers shall be sized such that when one main breaker is out of service and the tie breaker is closed, the equipment can carry full loads.

A.12.14.3.5. MV Switchgear supplied with bus-tie breakers, shall be supplied with manual transfer scheme with 3 position selector switch, to select which breaker needs to open, or change switch and other opens. The manual transfer scheme shall not allow for continuous parallel operation.

A.12.14.3.5.a. MV motor contactors shall be non-latching type with integrally mounted fuses.

A.12.14.3.5.b. Each MV motor feeder shall be provided with an SEL-710 or SEL-749M type motor protective relay. RTD's and other alarm signals shall be hardwired to the SEL relay. The SEL relays shall transfer this information to the Facility DCS via soft link or serial link I/O.

A.12.14.3.5.b.1 The following functions shall be provided in the digital display by the relays:

- Bearing temperature
- Line current in each phase – 'rms' amps
- Line current in each phase in % of motor full load current
- Motor start exceeded
- Operation count
- Remaining starts
- Running time (cumulative) in hours
- Winding temperature.

A.12.14.3.5.b.2 Following control and protective devices shall be part of the relaying design in the motor protective relays. Final elements shall be coordinated based on load protection and equipment used to interrupt load currents, with Buyer input.

- 27 – Under Voltage
- 37 - Under Power
- 40 – Loss of Excitation
- 46 – Phase balance of current unbalance Element
- 47 – Phase sequence Element
- 49 – Thermal Element
- 50 – Overcurrent Element
- 52 – AC circuit breaker
- 55 – Power Factor Element
- 59 – Overvoltage Element
- 66 – Jogging Device
- 78 – Out of Step
- 81 – Frequency Element
- 87 – Differential Element

A.12.14.3.5.b.3 Metering quality CTs and PTs shall be provided as determined by Seller to feed revenue quality meters located in the protective relay panel. Instrument transformers shall have an accuracy of 0.3% or better. Revenue meters shall have ANSI C12.1 metering accuracy.

- A.12.14.3.5.b.4 With each circuit breaker, contactor, isolating device, and grounding device there shall be supplied all necessary auxiliary switches and mechanisms for indication, protection, control, interlocking, supervisory, and other functions to meet the requirements of the Technical Specification. The control shall be arranged to provide local operation at the circuit breaker when in the test position and remote in the control room.
- A.12.14.3.5.b.5 All auxiliary switches shall be wired to a terminal board on the fixed portion of the switchgear.
- A.12.14.3.5.b.6 Suitable handling equipment shall be provided where necessary for easy handling of circuit breakers. Remote racking devices shall also be provided for the MV breakers. Equipment lifting and racking devices to be provided in each location (PDC) where equipment is located.
- A.12.14.3.5.b.7 Safety interlocks to ensure correct system operation, to avoid unsafe switching conditions, and to ensure safe isolation for maintenance shall be provided by mechanical or electrical means.
- A.12.14.3.5.b.8 Cable and bus bar grounding facilities shall be provided. The design of any grounding devices shall be such that the device cannot be connected unless the breaker is open and in the isolated position.
- A.12.14.3.5.b.9 Each of the switchgear line-ups shall include one spare motor feeder and one spare feeder equipped cubicle and will be installed inside the MV Switchgear complete with all accessories completely wired at the time of handover. Each MV switchgear/MCC shall have provision to add a vertical section at the end of each line-up.
- A.12.14.3.5.b.10 The MV switchgear enclosure shall have Infra-Red (IR) inspection windows.
- A.12.14.3.5.b.11 Each MV main breaker shall have a microprocessor based relay with digital displays and be connected to the CT wrapping the supplying UAT(S) and main breaker for the bus differential protection.

A.12.15 LOW VOLTAGE 480 VOLT SYSTEM

- A.12.15.1 The low-voltage auxiliary system shall be provided by the Seller distributes power to the Facility electrical auxiliaries during normal operation, startup, and shutdown. The main components are the transformers, switchgear, and motor control centers.
- A.12.15.2 The low-voltage system consists of a 480V high resistance grounded system (with exception of the admin building, as applicable) powered from the 6.9 kV – 480V transformers.
- A.12.15.3 The plant low voltage system shall provide alternate/back-up power to the fuel gas metering yard to support Island Mode operation.

A.12.16 480V SWITCHGEAR

- A.12.16.1 The 480V Switchgear shall be suitable for indoor installation, shall be arc resistant NEMA 1, Type 2B designed, manufactured, and tested in accordance with the latest edition of ANSI/IEEE C37.20.1 and related standards.
- A.12.16.2 480V switchgear with tie breakers shall be secondary selective. Seller shall provide automatic bus transfer relays to facilitate fast bus tie closing in the event of a main breaker trip. This function shall be disabled if a fault exists on the load bus.
- A.12.16.3 All 480V switchgear breakers shall be electrically operated air circuit breakers with solid state trip devices with status indication visible at all times while energized. Low-voltage electrically operated breakers shall typically be operated by remote control from the Facility DCS and from control switches or push buttons mounted on the breaker compartment doors. In addition, some motor feeder breakers may also be controlled from local system control panels. Fused breakers are not acceptable.
- A.12.16.4 Main breakers, tie breakers, and breakers supplying MCCs or other loads that contain trip devices shall have adjustable long-time and short-time solid state trip device elements for phase protection. The pickup point and time settings shall be adjustable to allow for proper coordination with all upstream and downstream trip devices. Closure of the main breakers and bus tie breaker shall be supervised by synchronism check relay.
- A.12.16.5 Local control stations shall be provided at motors which are not controlled from the Facility DCS. Examples of these motors are hoists, cranes, door openers, heaters with fans, etc.
- A.12.16.6 Feeder breakers which supply power to motors or other equipment which do not require coordination with downstream protection devices shall have adjustable long time and instantaneous elements for phase protection.
- A.12.16.7 Metering shall consist of a voltmeter and ammeter on each 480 V bus. Voltmeter and ammeter shall be monitored by DCS.
- A.12.16.8 Upon loss of power on a bus (doubled ended configuration), the main breaker shall open, and the tie shall close automatically. This function shall be disabled if a fault exists on the load bus.
- A.12.16.9 Trip units shall be capable of switching from the normal settings to maintenance settings via an input from a downstream selector switch at each MCC. Maintenance mode setting activation shall be alarmed in the DCS. Interposing relays shall be utilized, as necessary, to ensure the proper functioning of maintenance mode settings when the downstream selector switches at the MCCs are located remotely from the switchgear.
- A.12.16.10 The Switchgear main breakers shall include a pad lockable switch and blue LED Armed Status Indicating Light.

- A.12.16.11 Seller shall provide a minimum of one spare breaker and one spare cubicle in each 480V Switchgear lineup. 480V switchgear shall be capable of adding additional vertical sections.
- A.12.16.12 Low Voltage 480 Volt System Protection
- A.12.16.12.1 Overcurrent protection for power center devices shall be provided by solid-state trip relays. At the MCC level, motor circuit protectors shall be used for motor circuits, and non-motor feeder breakers shall be protected by thermal magnetic circuit breakers. The thermal overload relays provided with MCC combination starters shall be wired to trip.
- A.12.16.12.2 The 480V system shall be a high resistance grounded. A ground detection scheme shall be provided to alarm when a ground fault is detected. Admin Build 480V may be solidly grounded as necessary.
- A.12.16.12.3 Main current carrying parts, insulators, supports and housings shall have sufficient mechanical strength to withstand, without incurring damage, the effect of any momentary current resulting from a three-phase, line-to-line, or line-to-ground short circuit. The current shall be the rms value, including the direct current component, during the maximum cycle corresponding to the rms symmetrical and asymmetrical currents specified.
- A.12.16.13 Low Voltage Switchgear Transformers
- A.12.16.13.1 The transformers shall be installed indoors or outdoors and be delta-wye connected, with the neutral of the wye high resistance grounded. The transformers may be VPI dry type with fan cooling, or oil immersed type. Oil filled transformers shall be located outdoors only and shall have containments.
- A.12.16.13.2 Transformers shall be 6.9 kV delta connected primary and 480 V wye connected secondary, 60 Hz, three-phase, high resistance grounded secondary. Oil-filled transformer shall be built and tested in accordance with IEEE C57.12 (latest revision) and references found within. Transformer shall be constructed with full capacity taps. VPI dry type transformers shall be built and tested in accordance with IEEE C57.12.01 (latest revision) and references found within. Oil-filled transformers shall be designed for an 80 degree C temperature rise and constructed with full capacity taps ($\pm 2 \times 2.5\%$). Dry type transformers shall be designed for a 115 degrees C temperature rise and constructed with full capacity taps ($\pm 2 \times 2.5\%$).
- A.12.16.13.3 The transformer windings and all bus material shall be copper.
- A.12.16.13.4 The transformer shall be capable of withstanding, without damage, the mechanical and thermal stresses caused by external short circuits in accordance with IEEE Standards C57.12 and C57.12.01.
- A.12.16.13.5 The transformer shall be designed and constructed so that the noise level shall not exceed the values listed in ANSI/NEMA Standard ST 20.

- A.12.16.13.6. Transformer cooling fan motors shall be totally enclosed with an operating voltage not to exceed 120 Vac. The fan controls shall automatically turn on the fans whenever the transformer temperature rise requires their operation. The controls and 480-120 V transformers for the fans shall be mounted in the switchgear building or in a transformer mounted terminal box and all interconnecting control and power wiring shall be furnished.
- A.12.16.13.7. A second ground pad shall be provided and located in the same segment as the high voltage connections. The ground pad shall meet the requirements in IEEE Standard C57.12.51.
- A.12.16.13.8. The transformer shall be provided with either a winding temperature simulator or hot spot device and equipped with a dial type temperature indicator and adjustable contacts that close on high temperature for automatic fan control and electrically separate and ungrounded contacts.
- A.12.16.13.9. The VPI dry type transformers shall be furnished in their own weatherproof enclosure with a suitable filter shall be provided to exclude dust. A clogged filter alarm shall be provided for each filter. The transformer secondary shall be connected to the LV switchgear bus with cable bus or non-segregated bus duct through the wall of the switchgear building.
- A.12.16.13.10. Fault levels shall be limited by a combination of adjustable grounding resistors to a level just above the charging current of the 480 V system with everything in service. The phase windings shall have full line-to-line voltage rated insulation. The neutral of the transformer shall be connected to a fully rated neutral bushing for connection to the high-resistance grounding resistors. Pulsing ground fault detection system shall be provided. The transformer shall be sized for its normal operating load in the self-cooled condition. The transformer and its impedance shall also be sized to allow across the line starting of the largest 460 V motor with all other motors in the full load condition within specified voltage drop.
- A.12.16.13.11. When power is required to two or more identical major equipment items on each generating unit, the power to one of these items shall be supplied from the other bus. Auxiliary equipment shall be fed from the same bus as its associated major equipment.
- A.12.16.13.12. Instruments and Meters
- A.12.16.13.12.a. All indicating instruments, meters and relays shall have semi-flush mounting cases. The meter dials shall have white backgrounds with black expanded scales, black figures, and black pointers.
- A.12.16.13.12.b. Meter potential coils shall be 120 volt, 60 Hz. Meter current coils shall be 5 amperes.
- A.12.16.13.12.c. Indicating meters shall be 1 percent accuracy, 4 –1/2 inch square switchboard type, with taut band suspension.

A.12.16.13.12.d. Equipment on each panel shall be arranged with a maximum amount of space allowed for possible future additions.

A.12.16.13.13. Instrument Transformers

A.12.16.13.13.a. Instrument Transformers: Ring type current transformers shall be furnished. The thermal and mechanical ratings of the current transformers shall be coordinated with the circuit breakers. Their accuracy rating shall be equal to or higher than ANSI standard requirements. Instrument transformers shall be insulated for a test voltage corresponding to the insulation level of the switchgear. Current transformers shall have 5 ampere secondary windings. Secondary windings shall terminate at barrier type terminal block suitable for connection to Seller's cables. All current transformer terminal blocks shall be short circuiting type. The standard location for the current transformers on the bus side and line side of the breaker units shall be front accessible to permit adding or changing current transformers without removing high-voltage insulated connections.

A.12.16.13.13.b. Each set of voltage transformers and their protective fuses shall be assembled in a separate compartment, and shall be arranged so that the unit can be readily withdrawn from the operating position. In the withdrawn position, voltage transformers and fuses shall be completely disconnected from service, with all exposed parts visibly grounded. Fixed type VTs and fuses are acceptable.

A.12.16.13.13.c. The primary and secondary of voltage transformers shall be fused. Voltage transformers shall have a 480-120V ratio. Minimum rating shall be 200 VA (thermal). Voltage transformers shall have ANSI 0.3W, X, Y, and 1.2Z accuracy.

A.12.16.13.13.d. The accuracy rating of current transformers shall be as shown in ANSI/IEEE Standard C37.20.1.

A.12.16.13.13.e. All instrument transformers shall be grounded directly to the ground bus, not to the housing.

A.12.17 480V MOTOR CONTROL CENTER (MCC)

A.12.17.1 480V MCC's shall be arc resistant type 2 in accordance with IEEE C37.20.7. MCCs shall be main lug only when fed directly from LV Switchgear. 480V MCC buckets shall have the ability to be electrically isolated from the vertical bus using retractable stabs (or similar mechanisms based on OEM standard design and as approved by Buyer) prior to opening the compartment door.

A.12.17.2 Enclosures shall be NEMA 12 for indoor applications. All 480V MCCs shall be located indoors.

A.12.17.3 OEM provided distribution equipment (motor control centers) shall have a withstand rating of 65kAIC on the 480V main bus.

- A.12.17.4 Each combination starter shall have a three-phase electronic overload relay. Combination starters shall consist of magnetic-only circuit breakers and contactors with thermal overloads. MCC feeder circuits shall have solid state trip devices for protection against sustained short circuit currents.
- A.12.17.5 Each magnetic starter in an MCC which provides power to a motor shall be equipped with an adjustable motor circuit protector and an electronic overload in the starter to protect against overload. Seller shall furnish and install overload relay heaters after final motor sizes have been determined. Excepting motors supplied for the CTG MCCs, each phase of each 480V motor shall be monitored by the DCS via Profibus or other protocol as agreed upon by Buyer. Spare starter cubicles shall be fitted with monitoring capability. Profibus or other Buyer agreed protocol modules shall be powered from redundant power supplies with alarming capability hardwired to the DCS
- A.12.17.6 The short circuit withstand capability of the combination of starters and circuit breakers equal or exceed 65,000 rms symmetrical amperes in accordance with UL508.
- A.12.17.7 Space Heaters:
- A.12.17.7.1. Thermostatically controlled space heaters shall be furnished at the bottom of each vertical section of all motor control centers to prevent condensation of moisture within the enclosures. The heaters shall be located and thermally insulated such that no painted surface shall be damaged or discolored. Space heater location shall not interfere with the normal entrance of cables into the sections.
- A.12.17.7.2. Space heater capacity shall be as required to maintain the compartment and section internal temperature above the dewpoint.
- A.12.17.8 Not Used.
- A.12.17.9 Utility and lighting transformers or panels shall not be located within MCCs.
- A.12.17.10 Redundant pumps and other redundant systems shall be fed from independent 480 V MCCs. Loads not fed from the 480 V SWGR shall be fed from MCC feeder circuit breakers. The breakers shall be thermal magnetic molded case breakers sized to protect supply cable and individual loads
- A.12.17.11 Each magnetic starter in an MCC supplying power to a motor shall be equipped with an adjustable motor circuit protector and overload device in the starter.
- A.12.17.12 Motors shall be started and stopped via the Facility DCS or appropriate turbine control system. Motor status signal for the Facility DCS shall be included. These described signals shall be hardwired.
- A.12.17.13 The numbers of vertical sections and positions available for future components shall be provided by Seller. Future positions shall include all bus work and details required for

installation of combination starters and circuit breakers. Seller shall provide minimum 10% spares and 10% spaces in each motor control center lineup.

A.12.18 DISTRIBUTION PANELS

A.12.18.1 LV distribution panels shall be designed and built in accordance with NEMA ICS standards. Panels for outdoor locations shall be type NEMA 4. Panels for indoor location shall be NEMA type 12

A.12.18.2 Panelboards shall be UL-listed and conform to the latest issues of the National Electrical Code and NEMA Panelboard Standard PB 1. Each panelboard shall be rated for 480/277 VAC service, 208/120 VAC service, or 125/250 VDC service. A minimum of 20% spare breakers shall be provided for each panelboard. A machine printed directory card with protective film and frame shall be provided on the inside of the door.

A.12.19 ESSENTIAL SERVICE AC AND DC SYSTEMS

A.12.19.1 General Requirements for Essential Service System

A.12.19.1.1. The Seller shall design, manufacture, test, deliver, and install an essential service AC and DC systems, as described below:

A.12.19.1.2. 480V AC Essential Bus (Switchgear)

Essential Bus Loads – including but not limited to:

Stack Lighting

PDC battery room exhaust fans per NEC

Control room lighting and HVAC systems

HVAC and lighting in PDCs

Turning Gear

Instrument Power

Emergency Shut down loads for Turbines

Battery Charger AC supply system

UPS Supply – AC input

A.12.19.1.2.a. Requirements for 480V switchgear, MCC and distribution panel apply to the AC Essential Bus equipment

A.12.19.1.3. An Emergency Diesel Generator shall be connected to the 480V AC Essential Service Bus to provide power in the event of a Facility blackout. The EDG shall have design provisions such as:

Online within 10 seconds

Ability to synchronize with the Facility electrical system

Capability of parallel operation for testing purposes

Generator Circuit Breaker

8 hour fuel tank reserve

Standalone generator control panel

A.12.19.2 UPS System

A.12.19.2.1. UPS shall be fed from a DC bus, which in turn shall be fed from the battery charger system, which is powered from the Essential Service 480V MCC bus. UPS shall also provide power requirements for safe emergency shutdown.

A.12.19.2.2. Emergency shutdown scenario is defined by a simultaneous trip of the turbine-generator with a simultaneous loss of HV switchyard connection, which would result in total loss of power to the generator bus and consequently to the UAT's and Medium Voltage Switchgear.

A.12.19.2.3. The essential-service AC subsystem (UPS) provides 120V AC, single-phase, 60-hertz power to essential control, instrumentation, and equipment loads that require uninterruptible AC power. The following services as a minimum shall be powered from the UPS:

- Facility DCS equipment power supplies
- UPS powered receptacles
- Leak detection gas monitors
- Radio system
- CEMS
- LAN and telecommunication network cabinets
- Control Room operator and engineering workstations
- Printers, disk drives, and printers in the Control Room
- PLCs
- Process analyzers and computer systems
- RTU
- Vibration monitoring systems (except for CTG and STG)
- Fuel Gas Emergency Shutoff Valve and STG reheat non-return valve
- Security system (including all security devices, badge readers, electronic locks, door sounders, cameras, etc.)
- Steam drum level monitors
- HRSG requirements
- Fire alarm and detection

A.12.20 DC SYSTEM

A.12.20.1 The essential-service DC subsystem provides a reliable source of power for the essential-service AC subsystem and 6900V and 480V switchgear control and power functions during normal and emergency station operating conditions. The following services as a minimum shall be powered from the DC system:

- UPS
- HV breaker control and protection
- MV switchgear control and protection
- LV switchgear control and protection
- Emergency DG switchgear control
- GPS clock for protection relaying
- Each primary and backup protective relay panel

- Emergency lighting system
- Motor loads (STG emergency lube oil and seal oil pumps)
- Turbine Control System

A.12.20.2 A DC system shall be supplied with each CTG sized to provide total DC power requirements of each individual turbine generator. The STG DC loads shall be powered from the Common Balance of Plant DC System.

A.12.20.3 Battery room floor shall be treated with an acid-resistant floor sealant. Vent fans exhausting outdoors shall be provided to avoid a buildup of hydrogen. Curbed areas without drains shall be provided surrounding the battery cells for the containment of acid spills in the event of a cell crack or rupture. In a separate, nearby area of the battery room, an eye wash and shower station shall be located for rinsing eyes and skin in the event of acid contact. A monorail or other means shall be included in the design of the battery rooms to assist in removing or replacing cells. A Hydrogen gas detector shall be installed and hardwired to DCS for monitoring/alarm in the Battery room.

A.12.20.4 Batteries

A.12.20.4.1. Batteries General

A.12.20.4.1.a. Seller shall design, fabricate, test, deliver and install one (1) 125V DC battery system for the Balance of Plant (BOP). The battery shall supply the ST DC auxiliaries, HV breaker control, switchgear control, emergency DC motors, certain alarms, DC essentials auxiliaries. The combustion turbine shall have its own dedicated battery and UPS.

A.12.20.4.1.b. Batteries shall be designed to maintain a 2-hour duty cycle.

A.12.20.4.1.c. BOP Batteries shall be installed in a battery room in the main PDC designed in accordance with NEC. Battery system shall be ungrounded and provided with a ground detection scheme. CT battery shall be located in a separate battery room within the CT Control Package

A.12.20.4.1.d. Batteries shall be load tested based on recommendations from the OEM on approved factory testing methods and IEEE standards.

A.12.20.4.1.e. Batteries shall be rated in accordance with industry standards on the basis of minimum allowed battery room temperature as documented in A.9.8.

A.12.20.4.2. Specification for 125V DC Batteries

A.12.20.4.2.a. 125 VDC Batteries Specification General

A.12.20.4.2.a.1 The batteries shall be sized based on the 125 Vdc Battery Load Profile to be determined by Seller. DC battery system voltage range shall be 105V to 140V and all DC load fed from this system shall be specified accordingly.

A.12.20.4.2.a.2 The capacity of the batteries shall be determined by the Seller in accordance with IEEE 485-2020 and these specifications. If two strings are used to achieve the needed capacity then each string shall be connected to the main switchboard by its own fused disconnect switch.

A.12.20.4.2.a.3 The battery cells shall be lead-acid type with pasted plate grids of lead-calcium alloy contained in transparent plastic jars. The minimum battery terminal voltage shall not drop below 105V.

A.12.20.4.2.a.4 Battery run down testing, load test and documented results shall be performed by the Seller in accordance with IEEE standards and test reports provided to the Buyer.

A.12.20.4.2.a.5 Battery service life shall be 20 years.

A.12.20.5 Battery Chargers Specification

A.12.20.5.1. General

A.12.20.5.1.a. A total of two (2) battery chargers per system are to be furnished. The battery chargers shall be connected to the 125 VDC main distribution panel. Each battery charger shall be sized in accordance with IEEE Std. 946, and based on a discharge rate determined by Seller. Each battery charger shall be sized to furnish 100 percent of the current required to recharge the battery from discharge condition to the fully charged condition in 12 hours while maintaining the continuous normal steady-state loads

A.12.20.5.1.b. In the event of a battery charger malfunction, an alarm shall be sent to the control system. Chargers shall be solid state. Chargers shall provide equalizing voltage and shall include standard alarms, meters, controls, paralleling circuit abilities and filtering to allow battery elimination under steady state.

A.12.20.6 125V DC Distribution Panel Specification General

A.12.20.6.1. The distribution panelboard covered by this specification shall provide centralized switching and circuit protection of DC power for auxiliaries, control, and lighting. The DC source will be supplied from the Seller's 125 VDC battery and battery chargers.

A.12.20.6.2. The panelboard shall consist of one or more vertical sections bolted together to form a rigid, free standing assembly. All bare bus (except the ground bus) and power connections shall be covered to prevent accidental contact by personnel. Panelboards shall be designed so as to permit future additions of vertical sections and the interchanging of units by Buyer. The incoming cables will enter the panel from the top or bottom. Removable cover plates shall be provided for drilling in the field.

A.12.20.6.2.a. The panelboard shall be UL-listed, where applicable, and conform to the latest issue of the National Electric Code (NEC) and NEMA Panelboard Standard PB 1.

A.12.21 DC MOTOR CONTROLS

- A.12.21.1 DC motor starters shall be across-the-line type with start/stop and reverse controls as required by the application. Each starter shall be rated for the horsepower of the motor being controlled, the line voltage applied, motor amps per nameplate of the motor, and field type. Motor starters shall be specified to contain necessary resistors and shall have stepped starting as required by the motor acceleration time and the armature current. The enclosures shall be NEMA Type 12 for indoor and NEMA 4 for outdoor applications. The enclosure shall include an externally mounted overload reset push button.
- A.12.21.2 Controls shall operate from line voltage (125 VDC). Control circuits shall provide for local and/or remote start/stop operation, field protective devices and overloads as required and shall provide an automatic mode, which does not bypass any protective devices.
- A.12.22 UNINTERRUPTIBLE POWER SUPPLY (UPS)
- A.12.22.1 Specifications for the Uninterruptible Power Supply
- A.12.22.1.1. Uninterruptible Power Supply System (UPS) Specification General
- A.12.22.1.1.a. One (1) UPS system is to be furnished by Seller. The UPS system shall be supplied with 30% spare capacity above calculated requirements.
- A.12.22.2 Each power supply shall consist of an Integrated UPS System three phase 120/208 volt, four-wire, 60Hz static inverter with a static switch, dc circuit breaker, a manual bypass switch for ac circuits, solid state rectifier, auctioneering input, ac circuit breaker, one alternate supply voltage regulating transformer, and ac distribution panel. The power source for the alternate supply shall not be the same MCC/Switchgear as the Battery Chargers.
- A.12.22.3 Distribution Panelboard
- A.12.22.3.1. Each rated 208/120VAC, three-phase, four-wire and 120VAC, single phase, two-wire, distribution panelboard shall include a main breaker and neutral bus. The rating of the main breaker, bus, and interconnections shall be equal to the rated continuous full load current on the panel plus 20% without exceeding 65°C rise. The main breaker shall have a minimum interrupting rating of 10 kA. Fault ratings shall be based on the maximum expected fault current or the minimum rating whichever is higher. Outdoor panels shall be NEMA 4 and indoor panels NEMA 12 unless in a wet environment then they shall be NEMA 4. Panels may be surface mounted in all buildings except the Admin Building which shall be flush mounted except in the electrical and mechanical rooms.
- A.12.22.3.2. The distribution panelboard(s) shall have a minimum of twenty-four (24) poles. Minimum breaker rating is 20 amps. Tandem breakers are not allowed. Panels shall have 10% spare breakers (with a minimum of two spares of single pole and 2-pole) and 10% spare spaces. Panelboards shall be furnished with a single hinged door with lock and key, cardholders for circuit identification and trim over the entire panel. 208/240

VAC loads shall be supplied from two-pole breakers. Panelboards shall not be sub-feed – all distribution panelboards shall be supplied from the Main Panelboard.

A.12.22.3.3. The main panelboard shall be 208/120VAC, three-phase, four-wire. Main panelboard shall be furnished with a single hinged door with lock and key, cardholders for circuit identification and trim over the entire panel. The Main Panelboard shall be flush mounted within a freestanding enclosure that matches and is aligned on a common base with the other UPS System panels. The rating of the main bus and interconnections shall be equal to the rated continuous full load current of the inverter without exceeding 65°C rise. The main bus and breakers shall have a minimum withstand or interrupting rating of 10 kA. The Main Panelboard shall have 10% spare breakers (with a minimum of two spares of single pole and two 2-pole) and 10% spare spaces.

A.12.22.3.4. The panelboard shall be UL-listed and conform to the latest issues of the National Electric Code and NEMA Panelboard Standard PB 1

A.12.23 MOTORS

A.12.23.1 General Requirements for Motors

A.12.23.2 The Seller shall design, manufacture, test, deliver, and install all motors to comply with the following criteria.

A.12.23.2.1. All AC motors shall be designed for direct across the line starting (except for OEM Turning Gear motor) and shall not exceed a class B insulation system temperature rise as defined by ANSI C50.41. For large inertia driven loads, soft start or VFDs may be used. Soft start or VFDs may be used in other process applications or for specific equipment (e.g., turning gear) as appropriate with Buyer approval. Motors shall be of the highest efficiency available for the specified application. Motors shall be NEMA MG-1 compliant unless otherwise stated. All stator windings and rotor squirrel cage shall be copper.

A.12.23.2.2. Single terminal box shall be provided for the motor leads. Motor pigtails shall be supplied with Raychem or 3M kits for motor connections.

A.12.23.2.3 Medium Voltage Motors

A.12.23.2.4. MV Motors shall be provided as follows: MV motors shall be in accordance with ANSI C50.41

A.12.23.2.5. For MV motors, a separate box shall be provided for equipment, i.e., space heaters and instruments.

Type: Single-speed, squirrel-cage, induction in accordance with ANSI Standard C50.41.

Voltage rating, phase, frequency 6600 volt, three phase, 60 Hz, rated above 250 HP.

Horsepower rating:	The horsepower nameplate rating shall not be less than 110% of the brake horsepower required by the driven equipment to operate at its maximum requirements.
Service Factor:	1.0
Nameplate:	Shall state the service factor, maximum number of starts per hour and comply with ANSI C50.41.
Enclosure:	Outdoor: WPII or TEFC Indoor: WPI or TEFC
Class of insulation:	Class “F” vacuum pressure impregnated. Insulation system shall be sealed in accordance with NEMA MG-1-20.49.
Temperature rise of windings (maximum by resistance):	In conformance with ANSI C50.41 standards for Class B insulation.
Bearings:	Horizontal motors - split sleeve bearings of the oil ring type. A sample drain line shall be provided for obtaining bearing oil samples. Vertical motors - sleeve guide and thrust
Ambient temperature range:	Per Project site design conditions.
Limitations on starts:	In accordance with ANSI C50.41, a nameplate shall designate the maximum permissible number of starts and the required cooling period when motor is started under conditions of (a) cold rotor and (b) warm rotor (after running continuously at full load for a period of one hour).
Locked rotor (starting) torque at rated voltage and frequency:	Not less than 80% of full-load torque.
Pull-up and breakdown torques:	The torque of the motor shall be 15% above the load torque requirement throughout the entire speed range at 85% of motor-rated voltage with 80% pull-up torque as a minimum.
Locked rotor current:	Not to exceed 650% of full load.
Base:	Soleplates shall be provided if required by Seller design.
Sight glasses:	Sight glasses shall be furnished in place of oil cups on all oil-filled bearings.

Preparation of storage:	Motors shall be prepared for extended outdoor storage by protecting the motor bearings with either a protective grease covering or liquid preservative. The motors shall be tagged to show that a preservative has been used. The procedure to be followed before motors are placed in operation shall also be indicated on that tag.
Partial discharge	N/A
Heaters:	Heaters shall be included. Heaters which total more than 1200 watts in capacity shall be rated for 480 volt AC three-phase and heaters totaling less than 1200 watts in capacity shall be rated for 240 volt ac, single phase and operated at 120 V ac. They shall be derated for extended life and shall be sized to prevent condensation at the lowest Project site design temperature. 120Vac heater circuit shall be powered from a single circuit or utilize 2-pole breakers to preclude a common neutral potential.
Grounding:	Seller shall provide two copper ground pads, one on each side of the motor with drilled and tapped holes suitable for attaching two-hole NEMA grounding lugs. Motors shall have grounding provisions inside termination enclosure
Direction of rotation:	Motors shall have the direction of rotation marked on a nameplate for the supply voltage sequence of T ₁ - T ₂ - T ₃ .
Magnetic center:	The magnetic center at rated load shall be marked on all motors.
Motor test:	Motor tests shall be performed with motor terminal housing installed on motor and in accordance with ANSI C50.41.
Air filters:	Removable dry type complete with stainless steel filter screens.
Lifting lugs:	Suitable lifting lugs shall be provided for hoisting motors during installation and for maintenance purposes.
Sound levels:	Warranted maximum A-weighted sound level shall not exceed 85 dBA re: 0.0002 microbar at any point one meter from motor when tested as per IEEE Standard 85.
Instrumentation:	Motor winding temperature(s) shall be provided using 100 OHM platinum RTD's only. External junction box shall be provided for easy termination of these motor winding temperature(s) which will be connected to the Facility control system for monitoring. There shall be 2 RTD's per phase.

Motors with sleeve and plate type thrust bearings shall have Type E bearing thermocouple (TC). External junction box shall be provided as per above. There shall be two TC's per bearing installed per API 670.

For motors having a nameplate of a 1,000 rev/min or more proximity probes shall be used to monitor all bearings for radial shaft vibration or axial position.

For motors having a nameplate rpm less than a 1,000 rev/min. bearing case vibration monitors shall be used to measure vibration.

Installation shall be in accordance NEMA MG-1-2009; Revision 2010; Part 7. All conditioned signals shall be compatible with BOP Bently Nevada Orbit 60 vibration monitoring equipment with exception of ECA compressor motor which is monitored in the Turbine Control System.

A.12.23.3 Low-Voltage Motors

A.12.23.3.1. 480V & 115V Motors shall be provided as follows:

Type:	Horizontal or vertical as required, single-speed, squirrel-cage induction, energy efficient, mill and chemical dry type. Cast iron frames and copper windings only per IEEE 841 requirements.
Voltage rating, phase, frequency:	460 volts, three-phase, 60 Hz, for all motors rated at ½ hp through 250 hp, 115 volts, single-phase, 60 Hz, for all motors below ½ hp.
Horsepower rating:	The horsepower nameplate rating shall not be less than 110% of the brake horsepower required by the driven equipment to operate at its maximum requirements.
Service factor:	1.15.
Ambient temperature range:	Per Project site design conditions in section A.9.
Nameplate:	Shall state the service factor and comply with NEMA MG-1.
Enclosure:	TEFC or TENV
Class of Insulation:	Class F
Temperature rise of winding (maximum by resistance):	In conformance with ANSI C50.41 standards for Class B insulation.

Heaters: Motors 25 hp or greater shall be supplied with heaters. The heaters shall be rated 240VAC for operation at 120V AC. Heaters rated above 1200 W shall be 480VAC, 3 phase.

A.12.23.3.2. All LV motors shall be designed for operations on a high resistance grounded system where voltages may equal to the line-to-line effective to ground during fault conditions and continue until the fault is cleared.

A.12.23.4 Additional Requirements:

A.12.23.4.1. Motors shall be rated on a continuous duty basis.

A.12.23.4.2. Motors shall be sized such that continuous operation above a 1.0 service factor is not required. Applications where a temporary overload such as shutoff or runout, and a 1.15 service factor can provide such rating, a 1.15 service factor motor may be used

A.12.23.4.3. LV Motors shall have an internal ground conductor installed with the power conductors. Motors shall also be independently grounded from separate power or ground source installed, and connected to outer frame. Minimum ground conductor size shall be #4 AWG.

A.12.23.4.4. MV motors shall have an independent ground conductor separate from the power cable, but routed in same conduit can be used. MV motors and transformers shall have 2 #4/0 grid stub ups, pigtails, installed in mounting pad, typically at opposite corners, for frame connections to the grid.

A.12.23.4.5. DC motors shall be designed for continuous operation at any voltage between $\pm 10\%$ of nominal voltage or 100 - 140Vdc, whichever are more stringent, without exceeding permitted temperatures and without injurious sparking at the commutator.

A.12.23.4.6. All enclosures shall be corrosion resistant and provided with galvanized screens over all openings to prevent debris and animals from entering

A.12.23.4.7. Hazardous location specified motors shall meet NFPA 70 and UL 674 for the specified class, division, and group.

A.12.24 COMMUNICATIONS

A.12.24.1 Seller shall furnish and install the communications system as described below.

A.12.24.2 Seller shall furnish equipment per the Buyer's specifications including but not limited to fiber patch panels, Ethernet patch panels, cabling, network cabinets, server cabinets, connectors, etc.

A.12.24.3 Network and server cabinets shall be electrically insulated from their mounting surface.

- A.12.24.4 Voice over Internet Protocol (VOIP) telephone shall be single-mode fiber cables. Fiber terminations shall not be made in Junction Boxes.
- A.12.24.5 Local Area Network (LAN) and Wide Area Network (WAN) data system shall be provided for communication for on-site, between the Control room, CEMS Buildings, PDC's, electrical buildings, exciter buildings, thyristor buildings, administration building, warehouse, water plant building, control packages, operating areas, with Buyer input. The buildings shall be provided with VOIP LAN/Ethernet connections.
- A.12.24.6 A minimum of a 24 strand (12 pair) single-mode fiber optic cable to each building with the main fiber feeds into the facility being a minimum of 96 strand (48 pair) single mode fiber cable. All communications fiber cabling shall be single-mode fiber cabling with LC connectors and shall not be used for any other purpose except for the project LAN and WAN network and VOIP telephones. Outdoor fiber cabling shall be orange armored cabling and the armor shall be grounded. The armor shall be discontinued at the entrance to each building or when exiting the ground to go up a pole. Orange fiber inner-duct shall be utilized when armor is discontinued and inside of buildings where conduit is not being used.
- A.12.24.7 Seller shall provide redundant power sources to each network cabinet with one source being uninterruptible power supply (UPS) and the other being generator backed power supply (essential power). Seller shall provide redundant generator backed power supplies to the telecom racks. Seller shall work with Buyer to determine the voltage and amperage ratings for the circuits.
- A.12.25 NOT USED
- A.12.26 GROUNDING AND LIGHTNING PROTECTION SYSTEM
- A.12.26.1 Grounding
- A.12.26.1.1. The outdoor station grounding system shall be an interconnected network of bare copper conductors and copper-clad ground rods installed throughout the facility including the turbine-generators areas, around buildings, structures, and major electrical equipment.
- A.12.26.1.2. The system shall protect Facility personnel and Equipment from the hazards, which can occur during power system line to ground faults and lightning strikes.
- A.12.26.1.3. The Facility grounding system shall be interconnected with the switchyard grounding system. The new grounding system shall be designed by calculation in accordance with IEEE 80, NEC, NFPA and NESC requirements.
- A.12.26.1.4. The outdoor station grounding grid shall be designed to ensure that safe step and touch voltage gradients are maintained in the Facility. Seller shall, after ground grid system is installed and complete, ensure an overall fall of potential test of the ground grid is conducted within the Facility grid, including switchyard portion of the Facility.

- A.12.26.1.5. Size of conductors and ground grid layout shall be determined by the Grounding calculation. Overall grid resistance shall be less than 1 OHM and shall be verified by test by the Seller.
- A.12.26.1.6. Isolation hardware shall be installed on the telephone circuits, railroad tracks, steel pipelines and fences leaving the Facility ground grid area to ensure safe conditions outside the Facility area. All fencing on site shall be grounded at appropriate intervals but not exceeding 300 ft. and at all gateways. Gate posts which form part of the switchyard fence shall be bonded together with below ground connections. The movable portion of each gate is to be grounded via a flexible copper connection to the gate stanchion or perimeter fence.
- A.12.26.1.7. Bare conductors shall be installed 18 inches below grade and shall be spaced in a grid pattern. Each junction of the grid shall be bonded together by compression fittings (UL 467 listed). Throughout the site, grounding conductors shall be brought from the grid through the ground slab and weld connected to the building steel. The grounding pigtailed shall not be run exposed over finished concrete slabs.
- A.12.26.2 The grounding system shall be extended, by way of conductors through the floor and conductor installed in raceways, to the remaining Facility Equipment. Stub-up connections from the ground grid to building steel columns shall be exothermically welded. Building structural members shall be electrically continuous. Bonding jumpers are required across building expansion joints and across steel members that are painted or coated with fireproofing material. Structural steel members which will be isolated from ground because of the specific building design shall also be connected to the nearest grounded structural steel member or directly to the grounding system by bonding jumpers.
- A.12.26.3 Major building (not applicable to enclosures) transformer foundation rebar shall be connected to the main grounding grid using approved compression fittings or ufer (exothermic) type connections. Connections to rebar shall be made around the perimeter of the foundation with a minimum of two connections per isolated foundation.
- A.12.26.4 MV motors and transformers shall have 2 #4/0 grid stub ups, pigtailed, installed in mounting pad, at opposite corners, for frame connections to the grid. All vendor supplied skids should be equipped with a minimum of 2 ground connections generally opposite corners of skids.
- A.12.26.5 Fencing under HV transmission line and adjacent to transformers (areas susceptible to high fault currents) shall be connected to the grounding system. For HV crossings, fence posts shall be connected at intervals of approximately 50 feet to a parallel copper ground conductor buried 3 feet outside the fence. Posts on each side of a gate or removable fence section shall be bonded together below grade.
- A.12.26.6 Underground duct bank installation shall include one #4/0 AWG ground cable routed above or along the side, for connection to the grid at each end of the duct bank. At manhole locations these duct bank ground cables shall be tapped with minimum one #1/0

lead routed to the interior of the manhole. All underground connections shall be compression fittings (UL 467 listed).

- A.12.26.7 Each end of a continuous cable tray or metallic conduit run shall be connected to the grid. At any installation discontinuities of a continuous run (expansion joints, hinged fittings, etc.) bonding jumpers shall be installed unless a bare copper ground conductor is installed in accordance with A.12.26.8. The sizing of the jumpers shall be as required by the NEC for the tray application.
- A.12.26.8 All power and control cable trays shall have a bare copper ground conductor, sized as required and bolted to the outside of the tray at a maximum of every 10 feet. Cable trays shall be connected to the ground grid at 50 foot intervals. Where dissimilar metals are in contact, measures shall be taken to mitigate galvanic reaction.
- A.12.26.9 Non-metallic flexible conduit shall have a ground wire bridging from last rigid conduit/tray to the equipment.
- A.12.26.9.1. Individual equipment grounding shall be as follows:
- A.12.26.9.1.a. Major items of Equipment, such as MV & LV switchgear, MCCs, relay panels, and control panels, shall have integral ground buses connected to the station grounding system.
- A.12.26.9.1.b. Electronic panels and Equipment, Sensitive Equipment (including, but not limited to: vibration monitoring, Facility DCS), shall be grounded utilizing a separate isolated and insulated ground cables. The ground cable shall take the most direct route in non-metallic conduit with minimal bends. For instrumentation circuits routed to the Facility DCS, the cable shields shall be connected to an independent ground bus in the Facility DCS cabinet and cut and taped at the field end.
- A.12.26.9.1.c. Facility DCS cabinets shall have 2 grounds, cabinet ground connected to grid, and clean ground from isolated ground rod system. Typical configuration of isolated ground system consists of 3 rods in a triangular form installed into the ground that does not connect to the Facility grid.
- A.12.26.9.1.d. For low and medium voltage power supply circuits, which utilize ground conductors or connections, the ground conductors shall be sized in accordance with the National Electric Code (NEC).
- A.12.26.9.1.e. Remote buildings and outlying areas with electrical equipment shall be grounded by establishing local ground grids and equipment grounding systems in a manner similar to the Facility area. All buildings within the grounding system shall be connected to the grounding system.
- A.12.26.9.1.f. All underground metal pipes, including the bell and spigot pipe joints, shall be electrically continuous. Reinforcement of any concrete pipes shall be electrically continuous and connected to the station grounding system.

A.12.26.9.2. Grounding materials shall be as follows:

- A.12.26.9.2.a. The buried grounding cable size shall be bare copper conductor minimum 4/0 awg and the minimum conductor for above ground primary stub ups from the grid shall be 2 awg. Seller shall provide and install PVC conduit to protect riser conduits.
- A.12.26.9.2.b. Ground rods shall be copper-clad and shall be installed throughout the project including CTG and STG areas, PDCs, Control Room, GSU/ UAT(S) / HV equipment areas connected to the facility ground grid.
- A.12.26.9.2.c. Ground rod lengths shall be minimum 10' and shall be installed throughout the Facility with Buyer review and approval prior to releasing grounding drawings 'Issue for Construction'.
- A.12.26.9.2.d. Ground protection calculations shall be based on actual measured soil conditions including project fill material.
- A.12.26.9.2.e. Cable shall be soft-drawn copper with Class B stranding.
- A.12.26.9.2.f. Exothermic welds shall use molds, cartridges, and materials as manufactured by Cadweld.
- A.12.26.9.2.g. Clamps, connectors, and other hardware used with the grounding system shall be made of copper.

A.12.26.10 Lightning Protection

A.12.26.10.1. Lightning Protection System shall be designed and constructed as follows:

A.12.26.10.2. Not used

A.12.26.10.3. The Project site is subject to frequent lightning strikes thus the new Facility shall be designed accordingly. Lightning protection for buildings and structures shall consist of air terminals installed around the top of the structure. Air terminals shall be arranged to provide protection for roof penetrating devices, such as piping and air handling equipment.

A.12.26.10.4. A complete lightning protection system shall be designed, furnished, and installed for the HRGS stacks, on-site buildings, roofs, structures, switchyard, and other important areas of the Facility in accordance with NFPA 780.

A.12.26.10.5. The air terminals shall be connected together with copper cable and connected to the Facility ground grid with copper down conductors.

A.12.26.10.6. The lightning protection system design shall be designed to NFPA 780. The lightning protection system installation shall be master labeled by UL with the exception of the HV Switchyard.

A.12.27 LIGHTING

- A.12.27.1 All lighting fixtures for the Facility shall be LED type including roadway.
- A.12.27.2 Average lighting levels shall be in accordance with the latest issue of the Illuminating Engineering Society (IES) Handbook recommendations for luminary values for an electric generating station. Lighting design shall follow IES RP-7. Lighting levels (foot candles) shall be measured as average levels from IES RP-7.
- A.12.27.2.1. Control rooms shall be maintained at 30 foot candles from bottom of drop ceiling to top of finished floor.
- A.12.27.3 Lighting intensities shall be appropriate for each area of the facility and the work functions to be performed in the area.
- A.12.27.4 Lighting power supply shall be three phase, four wire, 120/208 V. Roadway lighting power supply shall be three phase, four wire, 277/480 V. Lighting and power distribution panels shall have 20% spare load capacity for future load additions. Lighting transformers shall be dry type and shall have 20% spare capacity for future load additions. Panel boards fed from a circuit breaker in an MCC or another panel board can be furnished with incoming main lugs only if the circuit breaker trip rating does not exceed the panel board rating. Branch circuit breakers shall be "bolt-on", and shall be thermal-magnetic.
- A.12.27.5 LED lights shall be used for high bay lighting applications. Reflectors or other means shall be used to limit lighting effects outside the Project. In general, photocell controlled lighting contactors shall be used for general outdoor areas however; circuit arrangement shall permit selective on/off switching of lights in areas where personnel are absent.
- A.12.27.6 In areas of the Project that contain display screens for programmable controllers and computers, glare can be a nuisance. In these areas, consideration should be given to control schemes which allow operators to switch selected groups of luminaires on and off as needed using dimmers or various light switches.
- A.12.27.6.1. INDOOR: LED lamps shall be used indoors in all areas. Protective lenses shall be provided. Lights shall be placed as close as practical to the center of aisle-ways. Interior lighting in structures shall be operated by three way switches located inside and next to each man-door.
- A.12.27.6.2. OUTDOOR: LED fixtures shall be used outdoors and controlled by photoelectric cells using contactors with manual overrides in general equipment areas, power block and fuel receiving areas. Exterior area lighting shall be mounted either on poles or building structures. Outdoor lighting shall consider dark sky initiative design criteria.
- A.12.27.7 Emergency

- A.12.27.8 Indoor paths of egress shall be illuminated as required by NFPA 101. LED emergency units with integral battery shall be used. Emergency lighting shall provide sufficient emergency lighting in equipment areas to allow safe movement of personnel on loss of station power.
- A.12.27.9 Emergency lighting and exit lights shall be provided by self-contained battery packs capable of maintaining rated output for two hours. Emergency lighting and exit sign power shall be sourced from the non-essential source except for those in the Control Room & PDC which should be from the essential source since the normal lighting in these areas is from the essential source. Emergency lights and exit signs will be located in the control room, PDCs, STG enclosure, elevated areas, and any areas that will be needed to allow someone to egress safely per OSHA.
- A.12.27.10 Receptacles
- A.12.27.10.1.a. 480 VAC, 3 phase, 60A welding receptacles with integral disconnect switches shall be located, as a minimum, at the heat recovery steam generator (HRSG), each turbine, maintenance shop (2) and shall not be located in classified areas. There shall be a minimum of one receptacle on each HRSG platform level.
- A.12.27.10.1.b. 120 VAC, single-phase duplex convenience outlets shall be located for convenient access in all buildings, control cubicles, and not located in classified areas. "GFCI" outlet ground fault interrupter type, with watertight covers are required for all outdoor locations. Convenience receptacles outdoors shall be installed such that a 75-foot extension cord will reach all areas. Indoors receptacles shall be located in accordance with the NEC.
- A.12.27.10.1.c. Equipment designated receptacle outlets shall be routed with a separate neutral, rated for the Equipment connected load which shall not exceed 80% of the breaker rating.
- A.12.27.11 Not Used
- A.12.28 CABLE AND RACEWAY SYSTEMS
- A.12.28.1 Materials of Construction
- A.12.28.2 All cable insulation (including cable furnished with equipment) shall be cross-linked polyethylene or ethylene propylene rubber (XLPE or EPR). All cable jackets shall be Polyvinyl Chloride (PVC) or Chlorinated Polyethylene (CPE) cable jacket unless otherwise approved by the Buyer. The outer protection cover for all cable (the jacket in the case of multiconductor cable and the insulation in the case of non-jacketed single conductor cable) will be officially designated by the manufacturer as flame retardant.
- A.12.28.2.1. All cables shall meet UL 1685 and the IEEE 1202 flame exposure standard and tests.
- A.12.28.3 Cable Service Classifications

- A.12.28.4 Cables shall be classified by voltage level and circuit function. Letters shall be assigned to the different application to indicate service designation and shall be part of the unique identifying number for a given cable. Table 1 – Cable Service, Construction, and Installation Method in Tray, below, summarizes these service designations. This requirement is not applicable to OEM wire/cables completely contained or routed completely within a cabinet, panel, on a skid, or completely within an OEM equipment enclosure
- A.12.28.5 To enable complete redundancy to be maintained, two separate routes shall be used for the data highway, communication, and all other redundant circuits. Redundant cables shall take two distinct paths, when not routed in ductbanks. Two separate conduits will be used when run in duct bank.
- A.12.28.6 Cable tabulation report from Excel spreadsheet or Access database including pertinent information such as terminations, cable routing and drawing references shall be submitted to client prior to cable pull. Cable bending radius should be maintained at least 12 times the outside diameter of the cable. During cable pulling, a tension meter, potentiometer shall be on tuggers to for monitoring cable pulling tension. Subsequent data shall be part of the system turnover packages along with cable pulling and route sheets, termination sheets (each end of the cable), continuity checks, megger/hi-pot, and torque sheet.

Table 1

Cable Service Letter	Cable Type & Rated Cable Voltage (ICEA) ⁴	Circuit Voltage	Special Conductor Configuration	Method of Installation in Tray
J	25 kV Power	23.5kV 21kV 18kV	None.	1 layer maintained spacing or touching ³
H	15 kV Power 8 kV Power 5 kV Power	13,800 V 6,900 V 4,160 V	None.	1 layer maintained spacing or touching ³
L	600V Power	480V	For 4/0 AWG and larger 1/C or Triplex shall be used.	1 layer maintained spacing or touching ³
K	600 V Power	480 V, 120 VAC and 125 VDC	3/C for 3/0 AWG and smaller.	Random Fill – 40% ²
C	600 V Control	120 VAC or 125 VDC	None.	Random fill – 50% ²
X	Instrument, RTD, and Communication	Max 50 V	None.	Random Fill – 50% ²
Z	Fiber optic	n/a	Armored (outdoor) Jacketed (indoor)	Random Fill – 50% ²

Notes for Table 1:

1. Control cable in K tray shall be permitted where small quantities of C cables are installed along the route and a separate C raceway is not available
2. K-Tray fill area shall be calculated on the basis of using a 3 inch deep tray (inside dimension) which is in agreement with NFPA-70 (NEC). When deeper trays are used, tray fill shall be based on a 3-inch tray, resulting in reduced percentage fill. Per the NEC, the maximum conductor size permitted in random filled tray installation is 3/0. Maximum fill for C and X adder type tray shall be 50% and 40% for solid bottom tray.
3. One layer touching installation method for tray shall be acceptable. Per NEC the single conductor power cable and triplex power cable shall be a minimum of 1/0 AWG for installation in tray.
4. Insulated Cable Engineers Association (ICEA) nominal line-line voltage rating for cable.
5. Orange Innerduct shall be used for fiber optic cables when used indoors and armored cables are not required.

A.12.28.7 Medium Voltage Cable (Service Level J and H)

- A.12.28.7.1. MV Cable shall be shielded, jacketed, single conductor or triplexed construction with XLP or EPR insulation cable rated at the 133% Level. Triplex or multi-conductor shall be allowed for short pulls and tray installations. Minimum conductor size shall be 4/0 AWG Copper (to be confirmed for project specific conditions using conductor or fault current sizing criteria).

A.12.28.8 Low Voltage Power Cable (Service Level L and K)

- A.12.28.8.1. Cable rated 600 V with XLPE or EPR insulation shall be used to supply power to low voltage equipment. Service designation shall be L for large power cable used for 480V MCC feeders and transformer secondary leads (typical size shall be 1/0 AWG and larger). Service designation shall be K for all other power cable application including 480V, 120VAC, and 125 VDC (sizes ranging from 12 AWG to 3/0 AWG).
- A.12.28.8.2. Cable shall be multiple conductor with an overall jacket up to 2/0 AWG and triplex or multiple single conductor insulated/jacketed conductors shall be used for 3/0 AWG and larger.
- A.12.28.8.3. Minimum conductor size shall be #12 AWG for low voltage power and #14 AWG for control unless specified otherwise. Cables for CT circuits shall be #10 AWG minimum.
- A.12.28.8.4. 600 Volt control cable shall be used for 120VAC and 125 VDC circuits unless otherwise specified.
- A.12.28.8.5. Cables completely within an occupied building such as a control room shall be low smoke, flame retardant.
- A.12.28.8.6. Above ground lighting cable may utilize Teck cable.
- A.12.28.9 Control Cable (Service Level C)
- A.12.28.9.1. Multi-conductor cable rated 600V and sized 12 AWG and smaller shall be used for 120VAC and 125 VDC control applications (the exception is current transformer leads which shall be minimum 10 AWG). Service designation shall be C.

- A.12.28.9.2. Color coding shall be per NEC when utilized for power wires and per NEMA when used in control circuits.
- A.12.28.10 Instrument Cable (Service Level X)
 - A.12.28.10.1. Multiple pair and multiple triad cable rated 600V or 300V shall be used for analog signals. Service designation shall be X for instrument, thermocouple, and RTD applications. Minimum conductor size shall be 18 AWG for multi-pair cables.
 - A.12.28.10.2. Shrink tube should be installed on shield wires of all instrument wiring at termination points.
- A.12.28.11 Communication Cable (Service Level X)
 - A.12.28.11.1. Phones, Ethernet, and Network Switches
 - A.12.28.11.1.a. Telecom cables shall be low smoke zero halogen, Cat 6e, XLPE jacketed cable.
- A.12.28.12 Fiber Optic (Service Level Z)
 - A.12.28.12.1. Unless otherwise approved by Buyer, armored single mode fiber cable shall be used in telecommunication systems (see additional requirements in Section A.12.24).
 - A.12.28.12.2. Facility DCS networks are typically multimode fiber cables, unless the supplied equipment design or the length of cable dictates use of single mode fiber optic cable. Multimode fiber optic cables shall be armored cables when routed outside. The armor shall be terminated and grounded as close as practical to the building entrance. Armored fiber optic cable can be used for cable runs within a building, however it is not required. Orange fiber inner-duct shall be utilized when armor is discontinued.
 - A.12.28.12.3. Fiber-optic patch-panels shall be provided in or adjacent to all cabinets that have a fiber-optic cable in it. Prefabricated cables from patch panel to the appropriate equipment shall be provided.
 - A.12.28.12.4. Fiber Optic cables shall not occupy the same raceway; in ductbank these shall be routed in separate conduit cells; in cable tray, they shall be routed with dividers.
- A.12.28.13 COAXIAL SIGNAL CABLE (Service Level X with Exceptions)
 - A.12.28.13.1. Coaxial cable is a specialty cable construction designed to achieve specific attenuation and impedance characteristics and generally has lower signal losses than standard twisted pair cables. Coaxial cables shall be used when specified by equipment and shall be designated as X.
- A.12.28.14 AMPACITY/CABLE SIZING

- A.12.28.14.1. Overload protective devices shall be set to disconnect the load at less than 125% of the nameplate current in the case of transformers, and 125% of the continuous duty rating for motors. Settings subject to NERC review, if any, shall be approved by Buyer. Therefore cable ampacity shall be a minimum of 125% of the load rating.
- A.12.28.14.2. Additionally, all cables connected to buses shall be sized to withstand a fault at the load terminals that are subsequently cleared by the feeder breaker
- A.12.28.14.3. Feeder cables for 125 VDC loads that have overload protective devices shall have an ampacity rating that is equal to or greater than the trip device setting. For those motor loads that have only fault current protection, the cable ampacity shall be equal to or greater than the locked-rotor current of the motor. Cable for DC loads without overload protection shall be installed in a dedicated steel conduit.
- A.12.28.14.4. Derating of cable due to installation in the various types of raceway shall be in accordance with IEEE 835, and NEC.
- A.12.28.14.5. Underground cable derating calculations shall be performed using actual measured soil conditions.
- A.12.28.14.6. All wires and cables shall be continuous without splices, but if necessary, splices shall be made in accordance with cable manufacturer's recommendations and located in approved pull boxes. Prior to performing any splice, it shall be brought to the attention of Buyer for approval
- A.12.28.14.7. Terminating control wiring for relays and other terminations should be made using ring lugs only. Ferrules are also used in terminations.

A.12.29 RACEWAY SYSTEM REQUIREMENTS

- A.12.29.1 All raceways, cable tray, cable trench, conduit, and ductbank shall be tagged or labeled and listed in the raceway schedule.
- A.12.29.2 All Seller installed cables shall have cable tags (ferrules) or identifiers, per the Seller's wiring diagrams. All Individual wires shall be labeled with tags (ferrules) as identifiers.

A.12.30 CABLE TRAY

- A.12.30.1.1. The Seller shall design, furnish, and install a cable tray system as required for a complete installation.
- A.12.30.1.2. The cable tray system shall be designed, fabricated, and installed in accordance with the latest edition of NEMA Standard Publication No. VE-1 - Cable Tray Systems, load/span class designation NEMA Class 20C.
- A.12.30.1.3. Aluminum ladder type tray shall be used unless required otherwise by a specific Supplier. Tray inside the PDCs shall be manufacturer's standard.

- A.12.30.1.4. The cable tray system shall be designed using tray manufacturer's standard sizes, lengths, fittings, tees, elbows, risers, covers, cable dropouts, splice plates, and connection hardware. Expansion joints shall be provided as required when the tray system is subjected to temperature variations or movement. The tray shall be continuous by the use of standard manufacture fittings. Cables shall enter/exit trays through conduits that are attached to the top tray rails or through cable dropouts. Deviation from this requirement will require approval from the Buyer. Tray locations shall be installed per engineering locations/dimensions provided on the IFC drawings. Tray dividers must be continuous, at least as all as utilized fill depth or same as rail height and securely fastened in place before installing cables. Where cable tray ends, Seller shall utilize means and methods to prevent sharp edges from damaging cables or injuring personnel.
- A.12.30.2 Not used.
- A.12.30.2.1. Not used.
- A.12.30.3 Cables shall be installed per engineering design including single layer or random fill. Cables shall be installed evenly within the full width of the tray to avoid bunching of cables. Cables shall be properly trained within all fittings such that cables follow the curvature of the tray. Excess coiled cable shall not be left in the tray and should be fed through/out of trays. Cables shall be secured in the tray with clamps or cable tie wraps. All upper layer outdoor cable trays and trays passing under gratings shall have vented cable tray covers to protect cables from UV and falling foreign objects. Cable Trays under Electrical PDCs shall be excluded from this requirement. Cable trays running vertically near walkways shall be covered for a distance of 8 feet minimum above grade. In addition cable trays installed horizontally in close proximity to high personnel traffic areas shall have covers installed to protect cables from physical damage.
- A.12.30.3.1. Junction and pull boxes shall conform to UL Standard UL 50. Galvanized coatings for steel boxes shall conform to ASTM A 525 designation G90 for dry locations and G210 for wet and outdoor locations. Seller shall be responsible for pull box dividers to prevent signal interference between various voltage levels.
- A.12.31 CONDUITS
- A.12.31.1 The Seller shall furnish and install all conduit required for the Facility in accordance with Section A12.31. It shall be the Seller's responsibility to determine the most efficient routing of all conduit runs. It shall be the Seller's responsibility to determine the proper size of all conduits in accordance with the NEC.
- A.12.31.2 All conduits shall be sized in accordance with the number and total area of cables that they contain using the National Electric Code.
- A.12.31.3 All outdoor exposed conduits shall be rigid galvanized steel.
- A.12.31.4 All outdoor exposed conduits shall have low point conduit drains.

- A.12.31.5 All underground conduit, with the exception of vertical risers and vertical elbows, will be Schedule 40 PVC.
- A.12.31.6 Use of thinwall EMT conduit shall be limited to indoor concealed areas in walls and ceilings typically for lighting and convenience outlets. Outdoor and Indoor minimum conduit size is 3/4 inch (diameter)
- A.12.31.7 Seller shall furnish raceways for Seller located telephone, LAN, PA, and communication circuits.
- A.12.31.8 PVC conduits shall be Schedule 40 for use in concrete encased duct banks. The conduits shall be supported by pre-fabricated spacers.
- A.12.31.9 Ductbanks shall provide for additional separation of the control and instrumentation cables routed through the raceway system to avoid signal interference during commissioning and Facility operation. This additional separation shall be the equivalent of standard conduit row with the control and instrumentation cables routing in the lowest level conduits. Seller to maintain separation in manholes, and where cables exit ductbank raceway systems into PDCs.
- A.12.31.10 Uni-strut shall be inserted into manhole cast embedded for tray support racks. Cables shall be installed neatly, separated voltage classes, and secured with cable ties securely. Conduits shall be identified in the raceway schedule.
- A.12.31.11 Flexible conduit shall be installed from the last rigid conduit to the equipment connection point per the NEC with external copper ground conductor where required. Seller to ensure if conduit is to be installed inside the combustion turbine compartments, appropriate high temp flex conduit is used.
- A.12.31.12 Concrete encased duct banks shall be reinforced under roadways and other areas to withstand heavy Equipment forces (H-20 / HS-20 rated) over the duct during construction and operations. Reinforcement of duct banks is not required for areas that will not experience heavy loads during construction (e.g., cranes, heavy haul paths) and have sufficient cover (burial depth) such that the H-20 / H-S20 loading is not exceeded. Seller shall provide analysis demonstrating acceptable depth and loading acceptability for ductbanks which are not reinforced.
- A.12.31.13 All duct banks terminating at manholes shall have a minimum slope of 0.25 percent and arranged to drain toward manholes.
- A.12.31.14 Manholes and Handholes: Manholes and handholes shall be placed at distances that facilitate cable pulling without exceeding permissible tensions and/or side wall pressures. Sump areas shall be provided in each manhole, either in a corner or in the middle for a portable pump.
- A.12.31.15 Conduits and duct banks shall be installed as required to complete the raceway system. Duct banks shall use bends with large radius sweeps to minimize pulling tensions. The

main duct bank runs shall be designed with margin. Underground duct bank installation shall include one #4/0 AWG ground cable routed above or along the side, for connection to the grid at each end of the duct bank. At manhole locations these duct bank ground cables shall be tapped with minimum one #1/0 lead routed to the interior of the manhole. All underground connections shall be compression fittings (UL 467 listed).

- A.12.31.16 Duct bank risers shall be hot dipped galvanized, rigid steel conduit, duct bank sweeps shall be fiberglass, and long radius 90's shall be used.
- A.12.31.16.1. Seller shall provide all electrical conduit and fittings, built in, concealed or a part of the concrete work.
- A.12.31.16.2. All conduits embedded in floors, walls, foundations, duct, etc., shall be PVC conduit. Bends and sweeps shall be fiberglass. Conduit stub ups shall be under the Equipment intended.
- A.12.31.16.3. Conduit terminations to motors and equipment subject to vibration shall be made with flexible conduit and maximum of 6 feet length.
- A.12.31.16.4. Conduit in hazardous areas shall be supplied with fittings and seals suitable for the hazard encountered.
- A.12.32 HEAT TRACING
- A.12.32.1 The Facility shall be designed to operate in freezing weather as defined below and to go through periods of freezing weather while shut down, without damage. The freeze protection system shall be designed to maintain fluid temperatures (in pipes, tubing, valves, vessels, etc.) at 40°F. Heat loss calculations will be based on an outdoor installation, per Section A.9 freeze protection temperature and wind requirements.
- A.12.32.2 Not Used
- A.12.32.3 Freeze protection power will be supplied from motor control centers through dry type transformers to freeze protection distribution panels containing thermostatically controlled contactors. The contactor will energize the branch circuits within the freeze protection panel.
- A.12.32.4 The heat tracing system shall consist of self-limiting resistance type or mineral insulated type cables when higher exposure temperature ratings are required.
- A.12.32.5 When used for temperature control of a process, the heat trace system will be designed to maintain the process fluid at the desired temperature. Heat loss calculations will be based on the conditions of the specific installation.
- A.12.32.6 All equipment shall be capable of being operated at ± 10 percent of rated voltage without damage.

- A.12.32.7 The heat trace system shall be designed from off-the-shelf components to ensure availability.
- A.12.32.8 Heat trace sensors.
 - A.12.32.8.1. Electric heat tracing for freeze protection shall be controlled by ambient air temperature sensors, each sensor shall energize the heat tracing circuits.
 - A.12.32.8.1.a. All instrument sensing lines, which upon loss of function can initiate a unit trip, runback, or are redundant, shall have freeze protection heat trace and shall have temperature monitoring using wired RTDs.
 - A.12.32.8.1.b. Monitoring RTDs shall be located within the portion of tubing that is field insulated and shall be placed on bare tubing opposite of the heat trace cable and away from process line to prevent influence from these heat sources.
 - A.12.32.8.1.c. Each freeze protection circuit using SR Cable shall include an end-of-circuit LED light to provide visual indication of circuit continuity. For MI cable the visual indication is located at the junction box.
 - A.12.32.8.1.d. Separate heat trace circuits shall be provided for sensing lines which upon loss of function can initiate a unit trip, runback, or are redundant.
 - A.12.32.8.2. Electric heat trace to maintain process piping temperatures shall be controlled by individual line sensing RTDs.
- A.12.32.9 Electric heat tracing located on skid packages shall be the responsibility of the skid vendors. A feeder cable shall be provided by the Seller and shall be connected to the vendor provided skid mounted junction box for heat tract power.
- A.12.32.10 Heat Trace Panels and Alarms.
 - A.12.32.10.1. Heat trace circuits shall be designed for connection to 120 VAC, single phase, 60 Hertz Power. Power circuits shall be connected to obtain a balanced load on the three-phase power supply panels.
 - A.12.32.10.2. Heat Trace Panels shall be Smart Panels (Thermon Genesis or similar) with ability to monitor individual heat trace circuit current in real time and receive temperature monitoring signals from the protected/heated piping and process RTD signals.
 - A.12.32.10.3. Heat Trace panels shall have audible and visible alarms and shall transmit all monitored parameter information and alarm information to the DCS.
 - A.12.32.10.3.a. All temperature monitoring RTD signals shall be provided to the DCS via the Smart Panels. These RTDs shall provide input for multi-point alarms in the DCS including a low priority alarm set point of 38°F and a high priority alarm setpoint of 34°F.

- A.12.32.10.3.b. DCS screens shall be developed to display temperature, current, etc. readings by heat trace panel.
- A.12.32.10.3.c. Transmitter sensor temperatures shall be brought into the DCS screens and alarming shall include setpoints as described in Section A.12.32.10.3.
- A.12.32.11 The installation of the heater shall not require the use of heat transfer cement or compounds in any form.
- A.12.32.12 The heater shall be flexible (capable of bending and spiraling). It shall be jacketed with a material which will protect it from its working environment.
- A.12.32.13 As-built Heat Tracing drawings shall show the approximate location of heaters, thermostats and any other equipment installed.
- A.12.32.14 Drawings should include:
Isometric drawings showing the heat tracing system over the piping layout.
Layout drawings showing the physical position of the panels and transformers with approximate coordinates.
Freeze protection circuit design and loading schedule including circuit numbering.
Panel elementary wiring diagrams of the power, control, and alarm circuits.
Panel outline and assembly drawings.
General panel arrangement drawings.
Equipment interconnection wiring diagrams.
- A.12.32.15 Power supply to space heaters for instrument enclosures shall be supplied such that there is no thermostat control of the power source. The space heater thermostat shall be the only control thermostat.
- A.12.32.16 Where heat trace circuits are installed at ground penetrations, the heat trace shall extend 12 inches below grade.
- A.12.32.17 Refer to Section A.10.32.9 for insulation requirements for heat trace and freeze protection system.
- A.12.33 CATHODIC PROTECTION
- A.12.33.1 The system shall be reviewed and approved by the Buyer prior to installation, however, where dissimilar metals are in contact or close proximity and corrosion may occur through electrolytic action or differences in electrical potential, protection shall be afforded by electroplating, suitable gaskets, cathodic protection, or other means. Underground piping shall be electrically isolated from aboveground piping and other steel components to allow the underground piping to be cathodically protected. At a minimum isolation shall be achieved by installation of isolation flanges with insulating gaskets, bolt tubes, and washers.

- A.12.33.2 The cathodic protection system shall control electrochemical corrosion on the external surfaces of designated metal piping buried in the earth, bottoms of above-ground, pad-mounted steel tanks, and interior surfaces of designed, steel water storage tanks. Additionally, Seller shall evaluate the need for cathodic protection for buried foundations, and provide cathodic protection if so determined.
- A.12.33.3 The cathodic protection system shall be designed and installed in accordance with the latest issue of NACE International and any applicable local or national Codes and Standards.
- A.12.33.4 Chromium plated parts shall not be used in any damp or corrosive atmosphere.
- A.12.33.5 All surfaces shall be adequately protected in transit, and any damage shall be renovated immediately on off-loading and on completion of erection. After cleaning and inspection but before the equipment leaves the Seller's works, the machined surfaces of steel and ironwork shall be covered with a preserving fluid or otherwise protected to the Buyer's satisfaction.
- A.12.33.6 All external steel screw fixings shall be supplied in the hot dipped spun galvanized condition, stainless steel, or sherardized with passivation treatment
- A.12.33.7 It is the responsibility of the Seller to provide the permanent Facility cathodic protection system as soon as possible to prevent corrosion of installed piping during construction activities. Temporary cathodic may be provided with Buyer approval.
- A.12.33.8 After the system is operational, it shall be verified by a final corrosion surveyor/inspector.
- A.12.34 STANDBY EMERGENCY DIESEL GENERATOR (EDG)
- A.12.34.1 Codes and Standards:
- A.12.34.1.1. NEMA MG 1, "Motors and Generators"
- A.12.34.1.2. Not used
- A.12.34.1.3. IEEE 115 – Test Procedures for Synchronous Machines
- A.12.34.1.4. IEEE 126 – Recommended Specifications for Speed Governing of Internal Combustion Engine – Generator Units
- A.12.34.1.5. NFPA 110 – Standards for Emergency and Standby Power Systems
- A.12.34.2 General Requirements:
- A.12.34.2.1. Seller shall furnish, deliver, and install complete and ready for operation an Stand by EDG and accessories. The system shall include, but not be limited to, the engine, generator, controllers, instrumentation, enclosures, alarms, tanks, panels, skids, other

appurtenances and shall also include all wiring, bus work, raceway, and supports to connect the diesel generator system to a 480 V motor control center or switchgear.

- A.12.34.2.2. The EDG shall be rated 480 volt, 3-phase, 0.8 pf, 60 Hz. The design rating of the diesel-generator shall be “standby” and shall be minimum 1750 kW, or as required by loading calculation. The Seller shall provide a diesel generator in accordance with the single line diagram and shall be operated in parallel with the grid for testing and sized with design margin. The EDG shall have a disconnect device for isolation/maintenance.
- A.12.34.2.3. The EDG unit shall be capable of successfully operating at all loads, up to and including rated load, under the operating requirements, and 125 percent of rated load for 2 hours out of every 24 hours without adverse effect for the full range of power factors.
- A.12.34.2.4. The EDG shall be capable of unattended remote, manual, and automatic starting. It shall reach full speed and be ready for loading in 10 seconds or less, and pick up full rated load in not more than 30 seconds after it receives the start signal. The diesel-generator set shall be capable of continuous unattended operation at full load for a minimum period of 24 hours. The EDG shall be capable of being manually started as required.
- A.12.34.2.5. Lube oil leak detector switches shall be provided on the EDG and fuel oil module.
- A.12.34.2.6. Final ratings and operational philosophy shall be determined during detailed design with approval with the Buyer.

A.12.35 CALCULATIONS

- A.12.35.1 Seller shall use the latest version of ETAP.
- A.12.35.2 Not used
- A.12.35.3 Calculations shall be performed for non-standard type tray and conduit supports to ensure they meet applicable codes, standard engineering practices, and provide appropriate safety margins.
- A.12.35.4 Cable pull tension calculations shall be performed for conduits exceed 360 degrees of total bends or pulls in excess of 1000 feet
- A.12.35.5 Not Used

A.12.36 ON-SITE STORAGE OF EQUIPMENT CARE

- A.12.36.1 Seller shall provide to Buyer a procedure defining the preventative maintenance of equipment prior to installation. This procedure shall include process for tracking equipment maintenance logs such as rotating motor shafts, meggering motors, GSUs, providing space heaters. This procedure shall be submitted to Buyer for review and approval prior to any equipment deliveries to site.

- A.12.36.2 Generators, motors, and other equipment requiring space heaters should be connected to temporary power. Also, when installed but before commissioned they should be connected to temporary power until final operation. Temporary power should be connected without the use of extension cords such that they are not easily unplugged by someone needing a receptacle to use.

END OF SECTION

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SECTION A.13

INSTRUMENTATION AND CONTROL REQUIREMENTS AND DESIGN CRITERIA

A.13.1 INTRODUCTION

A.13.1.1 The purpose of this document is to define the Project Design Criteria for instrumentation, including selection, installation, and testing.

A.13.2 SCOPE OF SUPPLY

A.13.2.1 The Seller shall design, integrate, supply, factory test, pack and deliver to Project site, erect, install, and perform site calibration, testing, commissioning, operator training and provide drawings, operating and maintenance manuals for the instrumentation and control systems provided for the Facility. The Facility Distributed Control System (DCS), System Architecture and the Buyer's Communications Architecture drawings contained in Section A.16.4.8 describe the scope and arrangement of the control system and communications. Any equipment from vendors/manufacturers which are not listed in the Approved Manufacturers List must be approved by the Buyer.

A.13.2.2 Balance of Plant (BOP) and overall plant control is implemented in the Emerson Ovation DCS. The plant DCS interfaces with the Turbine Control System (TCS) and other PLCs for supervisory control, monitoring, and status. The BOP DCS is not configured to mimic the turbine proprietary control functions or other functions of the turbines or equipment, including control duplication, alarm rationalization, and alarm acknowledgement capabilities. The Facility DCS shall be a redundant microprocessor based system. The Seller shall identify how each of such control systems interfaces with the BOP Facility DCS, the Control Room operator interface and any local control panels. Any such equipment, not being directly controlled by the Facility DCS, shall have the proposed interfaces to the Facility DCS, the Control Room operator interface and local control panels reviewed and approved by Buyer.

A.13.2.2.1 Systems to be controlled directly by the Facility DCS shall include, but not be limited to, the following:

A.13.2.2.1.a Heat Recovery Steam Generator auxiliaries control

A.13.2.2.1.b Unit load control

A.13.2.2.1.c Steam bypass system

A.13.2.2.1.d Steam temperature control

A.13.2.2.1.e Feed water control

A.13.2.2.1.f Condensate control

- A.13.2.2.1.g Cooling water systems
- A.13.2.2.1.h Make up water control
- A.13.2.2.1.i Chemical injection control
- A.13.2.2.1.j Selective catalytic converter and auxiliaries control
- A.13.2.2.1.k Steam turbine auxiliaries not controlled directly by the steam turbine control system
- A.13.2.2.1.l Combustion turbine auxiliaries not controlled directly by the combustion turbine control system
- A.13.2.2.1.m Plant auxiliary power system
- A.13.2.2.1.n Balance of plant equipment
- A.13.2.2.2 The Combustion Turbine Generators and Steam Turbine Generator controls and monitoring screens (referred to as Turbine Controls, Turbine Control System, or TCS) shall be duplicated in the Facility DCS with limited functionality as agreed upon with Buyer. Two (2) individual dedicated operator workstation HMIs shall be provided for the Turbine Controls in the Control Room. One (1) dedicated engineering workstation shall be provided for the Turbine Controls in the Control Room. The following systems shall be controlled by the Facility DCS in a supervisory mode through hardwired I/O and monitored with a data link:
 - A.13.2.2.2.a Steam turbine
 - A.13.2.2.2.b Combustion turbine
 - A.13.2.2.2.c Water treatment
 - A.13.2.2.2.d Air compressors
 - A.13.2.2.2.e Standby Diesel generator
 - A.13.2.2.2.f Electrical switchyard
 - A.13.2.2.2.g Skid mounted systems controlled by a PLC or dedicated controller as approved by Buyer.
 - A.13.2.2.2.h Generation Management System (GMS)
- A.13.2.2.3 The systems listed below shall be interfaced to the Facility DCS through a data link for monitoring and alarming and shall be accessible from the BOP Facility DCS HMI. Each system shall be specified with a data link capable of using the Modbus protocol or other approved by Buyer. This interface shall be discussed during detail design stage. All external interface connections to the DCS require communication protocol break with serial

connections to the DCS using RS232 input to an ELC module. Field devices using RS485 shall be converted to RS232.

- A.13.2.2.3.a Continuous emissions monitoring System (CEMS) shall be connected to the plant Facility DCS through RS-232 or RS-485. The RS-232 or RS-485 can either be at the data loggers or the plant Facility DCS. CEMS shall require a communication protocol break. Seller shall implement the agreed upon scheme for providing communication protocol break as required by Buyer.
- A.13.2.2.3.b Protective relaying and metering
- A.13.2.2.3.c Gas chromatograph and metering station
- A.13.2.2.3.d Generator Step-Up Transformer (GSU)
- A.13.2.2.3.e Unit Auxiliary Transformer (UAT)
- A.13.2.2.3.f Heat Tracing
- A.13.2.2.3.g Weather Station
- A.13.2.2.3.h BOP Vibration Monitoring
- A.13.2.3 The extent of supply described shall consist of, but not be limited to, the following:
 - A.13.2.3.1 Complete control hardware and software, instrumentation, monitoring, and alarm equipment packages for all plant equipment being supplied, including all local control and electrical room and Control Room consoles, and engineering consoles for all of the control systems.
 - A.13.2.3.2 A Facility DCS with remote drops, to provide centralized monitoring and control of all Facility systems from the Control Room including high resolution HMI screens, keyboards, pointing device, printers, data storage devices, redundant data highway, uninterruptible power supply, interconnecting cables, software with full licenses and all associated hardware.
 - A.13.2.3.3 Equipment hardware and software interfaces between Facility DCS equipment and all control and instrumentation packages of individual Facility systems, such that all plant areas are integrated into Facility DCS control scheme.
 - A.13.2.3.4 Redundant network communications links between the Facility DCS and all plant equipment control computer systems.
 - A.13.2.3.5 All instrumentation as described in the control system design requirements of this Section including pressure, differential pressure, temperature, level, and flow using gauges, transmitters and switches and all associated instrument taps, tubing, pipe-work, valves, manifolds, thermowells, local panels and racks.

- A.13.2.3.6 Instrumentation suitable for performance metering and monitoring, for the display and logging of actual and integrated plant parameters and the processing of the data to produce calculated data such as individual unit efficiencies.
- A.13.2.3.7 The DCS shall be designed to integrate analog input signals, as required, over time to produce totalized values for water flow, fuel flow, ammonia flow, and MW.
- A.13.2.3.8 All hardwired signals and equipment for the plant's protection systems to ensure safe startup, operations, and shutdown in both normal and emergency situations.
- A.13.2.3.9 The redundant master clock system shall be provided, for the purposes of synchronizing data acquisition, data logging, alarm and trip events, Facility DCS, TCS, CEMS, protective relays, etc., for all systems employed in such a manner on the Project site. The master clock system would be driven by a signal received from a global positioning satellite (GPS). The equipment shall be supplied with sufficient outputs of the correct type to meet the operating requirements of the Facility.
- A.13.2.3.10 Factory acceptance testing and inspection of all systems.
- A.13.2.3.11 Facility erection, installation, and commissioning.
- A.13.3 NERC CIP – PHYSICAL SECURITY AND CYBERSECURITY
- A.13.3.1 The Facility physical security shall include cameras, card readers, intercom, fencing, gates, etc.
- A.13.3.1.1 The Buyer shall supply specifications of hardware and software during the Project design phase, as necessary for the Seller's detailed design.
- A.13.3.1.2 The Buyer shall be responsible for the supply and installation of all cameras, intercom, cabling, and video security system servers and monitors required.
- A.13.3.1.3 The Seller shall supply and install camera poles and foundations necessary to accommodate the security camera design.
- A.13.3.1.4 The Buyer shall be responsible for the supply and installation of the badge readers, cabling, and security system servers and software required.
- A.13.3.1.5 The Seller shall ensure that all buildings are equipped with the necessary power supply, conduit, fiber, and power wiring to facilitate the installation.
- A.13.3.1.6 Section A.14.7.14 identifies security requirements (cameras, card readers, etc.) for fencing and gates.
- A.13.3.1.7 Sections A.15.1.8 and A.15.1.9 identify security requirements (cameras, card readers, etc.) for building exterior and interior doors, respectively.
- A.13.3.1.8 In addition to the cameras for doors and gates as described in the cross-referenced sections above, exterior cameras shall be strategically placed around the Facility to provide visual

coverage of the entire perimeter and primary driveways inside the Facility. Stationary cameras should be used to cover the perimeter and controllable pan tilt zoom cameras may be used on the interior of the Facility.

A.13.3.1.9 All security devices, badge readers, electronic lock, door sounders and cameras, shall be powered by the UPS power system (see Section A.12.19.2.3).

A.13.3.2 The design will comply with the latest North American Electric Reliability Corporation (NERC) Critical Infrastructure Protection (CIP) standards and Compliance Application Notices (CANs) as listed below for a low impact facility including:

CIP-003-9 Cyber Security - Security Management Controls
CIP-005-7 Cyber Security- Electronic Security Perimeter(s)
CIP-006-6 Cyber Security - Physical Security of BES Cyber Systems
CIP-007-6 Cyber Security - Systems Security Management

This section covers the security requirements associated with physical and cyber security for the Project. The equipment shall be designed to comply with all physical and cyber related security policies, standards, requirements, and procedures as outlined herein.

A.13.3.2.1 See Section A.16.2.5, NERC CIP Requirements Applicability, for a summary of each CIP standard and the applicable requirements of each standard.

A.13.3.2.2 External vendor access to control systems, for example packaged systems supplied with a PLC control system (compressors, water treatment, etc.), shall be prohibited. External access to Major Equipment OEM control systems shall require explicit, advanced approval by Buyer.

A.13.4 INSTRUMENTATION & CONTROL SYSTEM REQUIREMENTS

A.13.4.1 The following sections describe the technical requirements for the design, supply and installation of the instrumentation and control (I&C) system and equipment necessary to allow the safe, reliable, and efficient operating conditions at the plant site.

A.13.4.2 Basis of Design

A.13.4.2.1 Instrument and control devices shall be provided to monitor and control process variables and to protect supplied systems and equipment. This shall include, but not be limited to, primary elements, transmitters, temperature sensors, flow meters, control valves, control drive units, temperature/pressure/vibration switches, and other instrumentation and controls required to make a complete system.

A.13.4.2.2 Instruments, controls, and associated items will be fit for purpose i.e., suitable for the application given the functional requirements, process conditions, environmental conditions, and hazardous area. Instruments will be protected from extremes of temperature and other adverse conditions.

- A.13.4.2.3 Instrument, control, and sampling tubing systems will be designed, fabricated, and tested in accordance with ASME B31.1.
- A.13.4.2.4 Local self-acting controllers or pneumatic controllers may be used for simple applications where no regular operator intervention is required. Field and local panel-mounted controllers for applications except displacement-type level instruments and blind pressure controllers will be of the indicating type.
- A.13.4.2.5 Instrument wetted parts will be compatible with the fluid to which they are exposed.
- A.13.4.2.6 Emergency stop devices shall be provided where deemed necessary. When emergency stops are specified, they shall be provided in accordance with NFPA 79. Emergency stop switches shall have means to prevent accidental operation, such as clear plastic/Lexan covers or pushbutton guards. Main Control Room emergency stop pushbuttons shall include, but not be limited to, the following:
 - A.13.4.2.6.a CT Emergency Stop
 - A.13.4.2.6.b ST Emergency Stop
 - A.13.4.2.6.c Fuel Gas Emergency Stop (one pushbutton to shut main fuel trip valve(s))
- A.13.4.2.7 Process transmitter inputs shall be provided with sufficient redundancy such that failure of any single instrument will not reduce Project load or shut down the Project. A single transmitter input is provided for process monitoring and non-critical controls. Dual transmitter inputs with average or single input selection are provided for controls which are required to maintain Project output. Three transmitter inputs with median, average, or single input selection are provided for controls which are required to prevent Project shutdown.
- A.13.4.2.8 Redundancy of control instruments should be provided as follows:
 - A.13.4.2.8.a For situations where codes require direct initiation of a plant shutdown upon input failure, three independent measurement inputs will be provided for process control and alarm. These situations are to be identified during initial P&ID development.
 - A.13.4.2.8.b For situations where plant generation is directly reduced upon input failure, two independent measurement inputs will be provided for process control and alarm. These situations are to be identified during initial P&ID development.
 - A.13.4.2.8.c Non-critical parameters may utilize single process measurements.
 - A.13.4.2.8.d Additional required trip inputs will be documented during initial P&ID review.
 - A.13.4.2.8.e First out trips shall be captured in DCS historian or TCS historian (If available).

- A.13.4.3 The control system shall be based upon a Facility DCS that has redundant controllers and redundant network communications as described herein. All functions shall be performed via the Facility DCS display screens with the minimum of conventional hard panel controls and displays. Therefore, other than emergency stop buttons, there will be no conventional hard panel controls for the operation of plant, no alarm panels, or paper chart recorders. All plant operation and plant history (alarm records, alarm reports, sequence of events etc.) shall be through the Facility DCS with, if necessary, hard copy reports from the Facility DCS printers.
- A.13.4.4 A consistent control, instrumentation and data acquisition philosophy shall be applied. The objective shall be to standardize all equipment, wherever possible, throughout the plant in order to simplify operation, maintenance and reduce spare parts.
- A.13.4.5 The Facility shall include semi-automatic start-up sequencing with manual override programmed in the Facility DCS. Once the Combustion Turbine Generator (CTG) has started, the Facility DCS shall manage the start-up of the HRSG, including venting and draining requirements, drum-level control, and steam system initial set points and ramping of these set points to facilitate starting the Steam Turbine Generator (STG). This shall include managing of the steam turbine bypass systems, managing steam temperature, and establishing condenser vacuum. Once all STG permissives are met, the STG shall be started.
- A.13.4.6 The operating staff of the Facility will be kept to a minimum. Therefore, a high level of automation and reliability is required.
- A.13.4.7 The main objectives of the control and instrumentation scheme shall be as follows:
- A.13.4.7.1 All systems shall be designed to provide safe, efficient, and reliable operation of the Facility in accordance with all applicable codes and standards.
- A.13.4.7.2 To give a high level of automatic control incorporating synchronizing, ramp loading, unloading, start-up and shut-down to minimize operator manning levels.
- A.13.4.7.3 To reduce start-up and shutdown sequence times to an optimum through the use of thermal stress management.
- A.13.4.7.4 To provide facilities for comprehensive monitoring, storage and presentation of information concerning plant conditions and performance with dedicated systems for sequence of events, energy management and plant data history.
- A.13.4.7.5 Standardization of instrumentation and control equipment where practicable to reduce spare parts requirements.
- A.13.4.7.6 Eliminate unnecessary interfaces.
- A.13.4.7.7 Minimize installation, testing and commissioning time.

- A.13.4.7.8 Minimize maintenance downtime.
- A.13.4.7.9 Minimize staff training requirements.
- A.13.4.8 The control system will provide safe shutdown of the Facility systems and equipment in the event of a Facility DCS failure. Fail-close, fail-open, and fail-in-place lock-up features, for all devices as required, upon loss of air or signal will be provided as appropriate for the application.
- A.13.4.9 The Facility DCS and local controls shall be designed such that it shall not be possible to operate any equipment of plant from the local and remote control unit simultaneously. The DCS shall display the local/remote control status of the equipment.
- A.13.4.10 The controls associated with each of the main plant equipment or components shall be physically and electrically segregated to minimize common mode failure and possible fault transfer from one area to another.
- A.13.4.11 The manufacturers' standard package of control and instrumentation shall be supplied for all Equipment where the package meets the requirements of this specification. Protection systems for the STG and CTG shall be redundant and use two-out-of-three majority voting for I/O and shall be independent of the control system for that plant equipment. The control and instrumentation package shall allow automatic control facilities for the plant and auxiliaries, including safety interlocks, emergency tripping, process control, alarm equipment and local instrumentation. The control and instrumentation package shall be designed and manufactured to enable the equipment to be interfaced with the Facility DCS to allow centralized control and monitoring.
- A.13.4.12 Any control system failure shall not drive the plant into an unsafe state or require immediate operator action to avoid plant damage or hazards to personnel.
- A.13.4.13 The failsafe condition shall be set for all discrete I/O.
- A.13.4.14 Fully open/closed limit switches shall be provided when required for control sequence purposes.
- A.13.4.15 When local manual controls are provided as part of an OEM standard, e.g., actuators, drives, self-contained skids, the status of the control selection (local or remote) shall be transmitted via the Facility DCS to the Control Room in order to inform the operator and to inhibit the automatic control and sequence programs, where appropriate.
- A.13.4.16 Profibus, Foundation Fieldbus, and wireless communications/protocols shall not be installed on instruments and valves required for control. Utilization of HART position feedback for control valves is acceptable.
- A.13.4.17 Local instrumentation and indication shall also be provided where necessary for test and commissioning purposes and where intermittent, local supervision is required. Interlock

and safety protection for all drives shall be implemented at the drive level for individual plant equipment.

- A.13.4.18 Unit protection shall be independently implemented in separate hardware to the control system(s) to avoid common mode failure and with appropriate redundancy to ensure security of operation. The Unit Equipment shall have separate protection systems, designed and installed to the manufacturer's standard. The main inter-tripping functions between the steam turbine - generator, HRSG and combustion turbine - generator will be implemented via the Unit protection (e.g., lock out relays).
- A.13.4.19 Permissive interlocks shall be active at all levels to prevent incorrect operation of the plant and to ensure safe, reliable operation. Interlocks shall be capable of being tested with the plant in operation, where possible excluding TCS. The protection and interlocks systems shall incorporate comprehensive diagnostics to plant input level and shall be visible during the plant start-up and shut-down sequences via the Facility DCS displays for troubleshooting purposes. First out screens shall be developed for all trips for each CTG, HRSG, and the STG.
- A.13.4.20 All control systems shall operate satisfactorily for the environment which it is installed. All control devices and components shall be heavy-duty type suitable for operation at nominal 120 VAC or 125 VDC for DCS digital output commands (see Section A.12 – Electrical Requirements and Design Criteria for detailed DC voltage requirements). Insulation of coils shall permit continuous operation at a temperature of 130°C.
- A.13.4.21 Contacts for external control circuits shall be heavy-duty type. The contacts shall have an AC interrupting capacity of ten times their normal rating and shall not exhibit excessive arcing or contact bounce. Relays with exposed contacts shall not be used.
- A.13.4.22 Mercury encapsulated switches shall not be used.
- A.13.4.23 All control systems power and grounding systems shall be per the manufacturer's installation instructions and shall comply with all applicable standards listed in this specification.
- A.13.5 FACILITY DISTRIBUTED CONTROL SYSTEM (DCS)
- A.13.5.1 A fully integrated Facility DCS shall be an Emerson Ovation system. The Emerson Ovation DCS shall be supplied to monitor, control, display, alarm and record the process and electrical parameters associated with all plant control systems and areas. To ensure that a common and integrated approach across the entire Facility is achieved, the Facility DCS system design shall be coordinated through a single point of contact within the Seller's organization.
- A.13.5.2 Facility DCS Hardware
- A.13.5.2.1 The Facility DCS shall be provided with spare capacity, (in percentage of total capacity) as follows after factory acceptance test (FAT) and prior to shipment to Project site:

- A.13.5.2.1.a Control Processors: 50% of total processing capacity per module
- A.13.5.2.1.b Power Supplies: 25% of full capacity for the rack
- A.13.5.2.1.c Cabinet Spare Rack Slots: 20%
- A.13.5.2.1.d I/O: 20% by wired I/O type at each I/O and remote I/O location
- A.13.5.2.1.e System Communications: 70% (maximum design throughput 30%)
- A.13.5.2.2 All work stations, HMIs, engineering stations, historians, etc. shall be rack mounted server class machines with KVM extenders or thin clients, to allow the keyboards, monitors, and mice to be located elsewhere in the room or an adjacent room (e.g. DCS Room). Supplied DCS system shall also be provided with control room speakers to provide the ability for audible alarms.
- A.13.5.2.3 Communication Network
 - A.13.5.2.3.a Communications between the Facility DCS drops, located in different plant areas, and the operator and engineer workstations located in the Control Room shall be performed over a redundant high-speed fiber optic data highway with redundant communication hardware (see Section A.12.28.5). The communications system shall be designed to perform at the speed necessary to ensure that all variables are updated and control commands are issued without loss of system performance under all circumstances, (e.g., major plant transients and alarm flooding, etc.). The communications system shall include all control equipment, redundant controllers, redundant data highways, error detection correction facilities and cabling. Controllers (primary and back-up) shall connect to each redundant data highway.
 - A.13.5.2.3.b The Facility DCS shall include all equipment and software for a redundant data communications link between the Facility DCS and all other plant control system interfaces. All information on the Facility DCS shall be addressable, using the tag identifier, from any drop and shall include the large-scale block transfer of analog and digital parameters extracted or derived by calculation from the parameters in the Facility DCS database. The equipment shall include the Facility DCS communications port, both local and remote routers and cabling at the Facility. All necessary software shall be provided, including for example the communications protocol, data compression, error detection and data display application software for use on the interface control systems.
 - A.13.5.2.3.c The communication hardware shall have automatic loop transfer capability to provide protection against a single loop failure. Loss of either data-highway loop shall be alarmed. No single equipment failure shall interrupt communications between subsystems. Comprehensive system diagnostics shall be incorporated to assist in maintenance and trouble-shooting. These shall include, but not be limited to continuous monitoring of the redundant data highway. The occurrence of a fault condition shall be indicated to the operator together with details of the cause and location of the fault down to card level. The Facility DCS communication cards and cables shall be replaceable without causing a Unit shutdown.

- A.13.5.2.3.d The redundant data highways must be physically separated from each other (see Section A.12.28.5).
- A.13.5.2.3.e Communication networking going to the BES point of interconnection switchyard shall be fiber-optic cable.
- A.13.5.2.3.f All Controllers, both Primary and Backup, all HMI workstations, all servers, and any other special PC or processor shall have two (2) network connections with unique IP addressability.
- A.13.5.2.4 Processors and Cabinets
- A.13.5.2.4.a The Facility DCS shall be divided into subsystems. The number of subsystems shall be agreed to by Buyer and the Seller. The logic hardware for each subsystem shall be independent from the other subsystems. Critical control and safety-related communications between subsystems shall be by hardwired I/O. Redundant processors shall be provided for each subsystem and its control I/O.
- A.13.5.2.4.b The system shall be designed to have a functionally and geographically distributed architecture utilizing a number of independent Facility DCS drops. The equipment located in the Facility DCS cabinets shall include all necessary control processors, I/O cards, power supplies, data highway interfaces, marshalling and termination facilities etc. The control processors shall be capable of autonomous operation and perform all necessary data acquisition, calculation and open loop and closed loop control functions.
- A.13.5.2.4.c All necessary hardware for marshalling and terminating incoming and outgoing plant cabling shall be provided. This shall include gland plates, glands, terminal blocks, barriers, isolation devices, labeling and wiring. All equipment shall be designed to operate in hazardous areas where necessary.
- A.13.5.2.4.d Cabinets in dedicated electrical rooms shall be capable of both top and bottom cable entry. Cable entry into system cabinets located outside dedicated electrical rooms shall be through the bottom. Cable supports shall be provided in each cabinet. Cables shall not block access to any cabinet hardware for equipment inspection, maintenance, or removal and replacement.
- A.13.5.2.4.e The maximum scan time for digital signals shall be 100 milliseconds and 250 milliseconds for analog signals.
- A.13.5.2.4.f Comprehensive system diagnostics shall be incorporated to assist in maintenance and trouble-shooting. These shall include, but not be limited to continuous monitoring of memory and control processors. The occurrence of a fault condition shall be indicated to the operator together with details of the cause and location of the fault down to card level.
- A.13.5.2.4.g Facility DCS processors (redundant) shall be replaceable without causing a Unit shutdown, and it shall be possible to modify and download configuration changes on line, ensuring that necessary QA procedures are in place.

- A.13.5.2.4.h A high temperature alarm for each Facility DCS cabinet including controller cabinets and I/O cabinets shall be provided and displayed on the console HMIs.
- A.13.5.2.5 Facility DCS Inputs and Outputs (I/O)
- A.13.5.2.5.a Comprehensive system diagnostics shall be incorporated to assist in maintenance and trouble-shooting. These shall include, but not be limited to, continuous monitoring of the input and output modules. The occurrence of a fault condition shall be indicated to the operator together with details of the cause and location of the fault down to card level. Facility DCS cards shall be replaceable without causing a Unit shutdown.
- A.13.5.2.5.b The Facility DCS shall have a sequence of events (SOE) input module monitoring capability to allow analysis of the causes of trips or plant disturbances. The SOE shall scan all operated designated digital inputs continuously with a resolution of one millisecond. The Facility DCS shall provide scanning of no less than 200 digital (contact) inputs for the sequential of events recording (SOE) system. These inputs shall be scanned to discriminate between contact operations which occurs a minimum of one millisecond apart and print them in their proper sequence when they are opening and closing.
- A.13.5.2.5.c Where redundancy is required for primary/standby drives or systems, the I/O shall be segregated such that no control card or cable failure shall affect both drives. All redundant inputs shall be on separate cards. For example, HRSG drum level transmitters and steam temperature trip instrumentation shall be triplicated with inputs brought into three (3) different I/O modules for integrity. Median select for analog signals and two-out-of-three logic for digital signals shall be used in the BOP Facility DCS for these instruments.
- A.13.5.2.5.d Inputs, outputs, and other connections shall meet the surge withstand requirements of ANSI C37.90a. The Seller shall provide devices that have input to output isolation and state any shielding, separation of circuits, surge suppression or other measures which may be required in Facility Equipment and wiring to meet these provisions.
- A.13.5.2.5.e For the Facility DCS I/O, compression type terminations shall be acceptable. Spring type termination is not acceptable. With the exception of thermocouples, all I/O cables at the field end shall be terminated using crimped on, ring tongue lugs except where (based on manufacturer standard) it is not feasible to use ring tongue lugs. No more than one wire shall be connected to one terminal, except where jumper wires are necessary.
- A.13.5.2.6 Control of Starters, Motor Operated Valves, and Solenoid Valves
- A.13.5.2.6.a Switchgear contactors with multifunctional protective relays shall have datalinks to the Facility DCS for data acquisition of operating parameters and status. Devices shall be networked together as appropriate by device type and location to Facility DCS interfaces. Data included in the links shall be at a minimum:
- A.13.5.2.6.a.1 Open, closed, trip and closed power status, relay status, tripped status, phase voltage, phase current, watts, vars, trip coil status, and a heartbeat signal to confirm communication.
- A.13.5.2.6.b Switchgear Motors and Breakers (if necessary) shall have the following hard wired I/O:

- A.13.5.2.6.b.1 DI: Stopped/Opened, Running/Closed, Trip Power Available, Close Power Available, DO: Stop/Trip, Start/Close
- A.13.5.2.6.c Motor Control Center (MCC) Starters and Contactors shall have the following hard wired I/O:
 - A.13.5.2.6.c.1 DI: Running, Stopped, Power available, DO: Start
- A.13.5.2.6.d Motor Operated Valves shall have the following hard wired I/O:
 - A.13.5.2.6.d.1 DI: Not Full Open, Not Full Closed, Torque Switch Open, Torque Switch Closed, Power available/no overload, DO: Open, Close
- A.13.5.2.6.e Solenoid Operated Valves shall have the following hard wired I/O:
 - A.13.5.2.6.e.1 DI: Full Open, Full Closed, Power available, DO: Open (energize to open only) or Close (energize to close only)
- A.13.5.2.7 Facility DCS Power
 - A.13.5.2.7.a Two sources of power shall be supplied to the Facility DCS, its servers (HMIs), monitors, etc. terminated in its cabinets or consoles. The primary source shall be 120 VAC from a UPS. The secondary source shall be from a 120 VAC source independent from the primary source. Automatic transfer power switches shall be installed in the cabinets for equipment without dual power feeds. The main control workstations and engineering workstations shall have automatic transfer power switches with these two sources of power feeding them.
 - A.13.5.2.7.b A failure of a Facility DCS power supply shall not affect system operation. Failure of any power supply shall be alarmed on the Control Room DCS HMI and Facility maintenance personnel shall be capable of replacing power supplies with the system on-line. DCS power supplies shall be redundant. Comprehensive system diagnostics shall be incorporated to assist in maintenance and trouble-shooting.
- A.13.5.2.8 Workstation and Human Machine Interface (HMI)
 - A.13.5.2.8.a The preliminary Facility Control System Communications Overview is included in Section A.16.4.8. The specific servers listed in this subsection (Section A.13.5.2.8 and shown in Section A.16.4.8 are intended to be a functional list. All of the server functions shall be included in the design, but the physical workstations delivered may be a combination of functional servers based on the Facility DCS vendor's recommendations. Combining server functions in specific physical workstations shall be approved by Buyer.
 - A.13.5.2.8.b The Control Room shall have the Facility DCS operator HMIs, located on a control console/desk. The console/desk shall be as approved by Buyer. Two (2) operator HMI's shall have quad, 24 inch (minimum) state-of-the-art, high resolution LCD or LED displays, with keyboard and mouse, and shall allow monitoring, control and adjustment of Facility operation conditions. One (1) operator HMI shall have dual, 55 inch (minimum) state-of-the-

art, high resolution LCD or LED displays, with keyboard and mouse, and shall allow monitoring, control and adjustment of Facility operation conditions. The rack mounted servers associated with each HMI will be located in the adjacent DCS Network Room to reduce heat load and noise in the Control Room.

- A.13.5.2.8.c The Control Room shall contain the Facility DCS Engineering workstations on the engineering console/desk. The two (2) engineering workstations shall include dual high resolution 24 inch (minimum) LCD or LED screens, keyboards and mice, and program loading mechanism. These workstations shall provide the interface between the engineer and the plant processes and equipment for control system tuning and control strategy modifications. The Asset Management Suite (AMS) shall be part of one of the engineering workstations.
- A.13.5.2.8.d The Facility DCS shall include an Enterprise Data Server workstation, Database Server workstation, Anti-Virus Server workstation, and two (2) OPC workstations (for the TCS datalink) on the engineering console/desk. Each of these servers shall be provided with one high resolution 24 inch (minimum) LCD or LED screen All of these rack mounted servers shall be provided with keyboards and mice.
- A.13.5.2.8.e The AMS system software license (with ValveLink SNAP-ON) shall be licensed for up to 400 AMS Devices and 100 ValveLink Devices.
- A.13.5.2.8.f Seller shall solicit and use Buyer's input on the design, configuration and materials of the control panels, shape and form of consoles/desks and other equipment in the Control Room.
- A.13.5.2.8.g The response times for the operator workstation under all operating conditions (i.e., transients and alarm flooding) shall be as follows irrespective of the Facility DCS size and loading. The time between selection and display of a new HMI screen, fully updated, from the database shall not exceed two (2) seconds. The time between execution of a control function on an operator workstation and the command reaching the output terminations of the field processor shall not exceed one (1) second. The time between the occurrence or change of signal at the field processor and the change of state/value/alarm on the HMI shall not exceed one (1) second.
- A.13.5.2.8.h A control panel shall be provided and integrated into the console/desk for fuel gas, CTG, and STG trip push buttons, and other hard wired operator interface instruments as required by code and this specification. Buyer will specify the location of the remote drum level indicators.
- A.13.5.2.9 Printers
 - A.13.5.2.9.a The Seller shall provide two (2) network multi-tray color laser-jet printers capable of 8 ½" x 11" paper in one tray and 11" x 17" paper in one tray.
- A.13.5.2.10 Data Historian, Historical Storage Retrieval (HSR)
 - A.13.5.2.10.a The purpose of the HSR system shall be to have available detailed information at long intervals, after events have occurred. To be properly used, it shall not be necessary to detail what is to be stored. The HSR shall have the capability to provide two (2) years of on-line

access with user-friendly backup. All alarms and returns to normal shall be stored, as shall all logs, and all trended variables that are identified for archiving. The HSR shall be furnished with a server class machine, redundant power supplies, hot-swap disk capability, RAID disk arrays, at least 2 TB of storage, and a DVD writer for backups and archival purposes. The HSR system shall be furnished with two – 24” (minimum) LCD or LED monitors, keyboard, mouse, and shall be capable of storing at least 20,000 points.

- A.13.5.2.10.b All I/O values, feedback signals, calculated and composed point values, and control loop process variables, setpoints, and outputs shall be archived at a minimum.
- A.13.5.2.10.c The historian shall be completed and configured at the plant site before the unit start-up.
- A.13.5.2.10.d The system shall inform the operator or Facility engineer when the storage media is a stated percentage full and needs to be changed, and if an invalid device has been mounted. The HSR functions shall run in parallel and independently of all other software functions.
- A.13.5.2.11 Control System Interfaces
 - A.13.5.2.11.a The Facility DCS will provide the required hardware and software to bring all of the plant control system packages into one operator interface scheme. The control system interfaces shall include, but not limited to the interfaces as listed in Section A.13.2.2, The operator shall have supervisory control, the ability to monitor and control these interfaced systems from the Facility DCS consoles, in the Control Room.
 - A.13.5.2.11.b The Facility DCS shall be connected to every other plant control system that has a redundant communication network. Supervisory control from the Facility DCS will be performed on all plant control systems. In addition, all supervisory control interfaces with plant control systems shall be hardwired to the BOP Facility DCS, as required.
 - A.13.5.2.11.c The Facility DCS shall also receive inputs from the TCS for bearing temperatures, bearing shaft vibration, differential expansion, eccentricity, thrust position, temperatures, pressures, flows, switches, etc. through the data link. The inputs shall be monitored, trended, alarmed, logged, and displayed on the BOP HMI. Balance of Plant (BOP) and overall plant control is implemented in the DCS. The plant DCS datalinks interface with the TCS controllers and other PLCs for monitoring and status only. The data link between the DCS and TCS shall be redundant. The BOP DCS is not configured to mimic the turbine proprietary control functions or other functions of the turbines or equipment, including graphics and control duplication, alarm rationalization, and alarm acknowledgement capabilities.
 - A.13.5.2.11.d The Seller shall provide sufficient automatic and manual control capability for CTG and STG speed, generator voltage, megawatts, vars, and excitation such that operators can control the Facility from the Facility DCS control console.
 - A.13.5.2.11.e Seller shall supply OSIsoft Plant Information (PI) system software. See Section A.13.5.3.6.b for additional requirements.

A.13.5.2.11.f Automatic Generation Control (AGC)

A.13.5.2.11.f.1 The AGC load demand signal shall be received by plant Facility DCS through a Remote Terminal Unit (RTU). RTU shall be a SEL RTAC model as determined and supplied by Buyer. The plant Facility DCS shall generate CTG's load demand signals for the CTG.

A.13.5.2.11.f.2 RTU shall be the interface point between the transmission grid and the Facility. The Facility DCS connection to RTU shall be RS-232 or RS-485 to comply with Owner's CIP requirements. Communication protocol shall be dictated by the Buyer.

A.13.5.2.11.f.3 In addition, telecom circuits shall also interface with the RTU.

A.13.5.2.11.f.4 The RTU interface details shall be provided during detailed design stage.

A.13.5.2.12 Control System Fault Tolerance

A.13.5.2.12.a No single component failure shall cause or prevent a CTG or STG trip, regardless of function or system (i.e., power, communication, processing, input/output devices, terminations, etc.) All instruments used for control shall be redundant and all signals and instruments used for tripping shall be triply redundant. Any single component should be replaceable for maintenance purposes without causing or preventing a CTG or STG trip, regardless of function or system. Output signals used for modulating control valves and solenoid operated valves, are impractical to make redundant and are excluded from the requirements of this section.

A.13.5.2.12.b The Facility DCS shall include redundant control processors, redundant data highway and redundant power supplies with automatic changeover to the standby unit upon detection of a fault or failure of the operating Unit.

A.13.5.2.13 Not Used

A.13.5.3 Facility DCS Software

A.13.5.3.1 The Facility DCS shall include the following major software components, in the latest versions supplied by the Facility DCS Subcontractor:

A.13.5.3.1.a High level regulatory control oriented languages for control and monitoring function development, with full documenting and printing capabilities.

A.13.5.3.1.b High level boolean diagram oriented language for development of discrete control logic functions with full documenting and printing capabilities.

A.13.5.3.1.c High level graphic generation language for HMI graphic display development, with full documenting and printing capabilities.

A.13.5.3.1.d High level log generation language for development of log report formats.

- A.13.5.3.1.e All software to provide the functions described and control, communications, and scheduling within the Facility DCS.
- A.13.5.3.1.f System database for identification of all process and calculated variables and for definition of the system attributes associated with each variable.
- A.13.5.3.1.g Windows based operator/engineering consoles.
- A.13.5.3.1.h Microsoft Excel on the engineering consoles.
- A.13.5.3.1.i Performance and optimization software based on the plant thermodynamic model for use in the unit start-up.
- A.13.5.3.1.j Anti-virus software.
- A.13.5.3.2 Configuration
 - A.13.5.3.2.a The Facility DCS configuration shall be designed to control by feed forward action, with system calibration and final correction provided by feedback action. The control equipment furnished shall include all feed forward devices and other equipment to provide complete stability under all conditions of dynamic steam load changes. Feed forward demands shall be developed for CTG demand, feedwater flow, fuel flow, steam pressure.
 - A.13.5.3.2.b The following operational sequences for the plant shall be fully automated through synchronization. Agreed “Hold” points for operator intervention shall be clearly defined:
 - A.13.5.3.2.b.1 CTG start-ups through synchronization
 - A.13.5.3.2.b.2 STG start-ups through synchronization
 - A.13.5.3.2.b.3 Not Used
 - A.13.5.3.2.c The Facility DCS shall be capable of the following for BOP equipment:
 - A.13.5.3.2.c.1 Providing automatic and manual control of individual drives and systems with bump less transfer (manual-auto-manual). A drive is an individual pump, motor operated valve, solenoid valve, etc.
 - A.13.5.3.2.c.2 Automatic start-up including permissive checks at the individual drive level.
 - A.13.5.3.2.c.3 Sequencing a group of drives to an optimized program of plant operation.
 - A.13.5.3.2.c.4 Sequencing functional groups to provide full automatic plant operation.
 - A.13.5.3.2.c.5 Coordinated load control of all generation including frequency response and MVAR control. The load range shall be maximized down to the Lowest Sustainable Limit (LSL) while maintaining emissions within the environmental requirements.

- A.13.5.3.2.c.6 Automatic speed and load control.
- A.13.5.3.2.c.7 Automatic steam temperature control.
- A.13.5.3.2.c.8 Automatic sequencing of setpoints for the steam by-pass system pressure control.
- A.13.5.3.2.d The operator interface software shall enable the operator to carry out the necessary actions in a safe and efficient manner. In particular the following features shall be included as a minimum:
 - A.13.5.3.2.d.1 Software shall be structured in such a way so as to provide a hierarchy of control from automatic sequential plant start-up through to manual control of an individual piece of equipment.
 - A.13.5.3.2.d.2 During manual intervention by the operator (sequence initiation and individual device control under normal and failure conditions), all software and hardwired permissives, and overrides, shall be indicated and visible to the operator.
 - A.13.5.3.2.d.3 Where process measurements have been duplicated into the Facility DCS for improved reliability, the signals shall be averaged (for two signals) or median selected (for three signals) for control purposes and quality monitoring shall be employed to automatically switch from the median to the average, or to the remaining good signal in the event of an interruption. In addition, the maximum of two or the minimum of two signals may be selected in place of the average, where appropriate.
 - A.13.5.3.2.d.4 The operator shall have the on screen ability to select any of the redundant signals, or the average or median (as appropriate), as the measured variable for control.
- A.13.5.3.2.e Mechanical equipment on standby status shall automatically start upon a trip of the operating equipment.
- A.13.5.3.3 Graphics
 - A.13.5.3.3.a The Emerson Ovation graphics displays for use by the operators on the HMIs shall be developed in accordance with the Vendor's High Performance or Advanced Operator Graphics format.
 - A.13.5.3.3.b Graphics shall be a combination of animated P&ID symbols, text, pop up face plates, bar graphs and trend graphs.
 - A.13.5.3.3.b.1 Face plates include manual/auto stations, set point stations, start/stop controls, and permissive and interlock displays.
 - A.13.5.3.3.b.2 Animated P&ID graphics shall include, valves that change color and fill as they open or close, tanks with changing levels, process lines that change color when active or energized, and single line diagrams for auxiliary power monitoring and control that change color when energized.

- A.13.5.3.3.c Graphic sketches shall be supplied for Buyer's review and comment before they are configured. As a result of Buyer's comments all system I/O and calculated values shall be subject to be displayed on graphics without additional cost to the Buyer. Graphic displays shall be subject to approval by Buyer. Approximately two hundred (200) graphic displays will be required. (Annunciation displays are not included in this display count.) All graphics, alarms, and trending points shall be labeled according to its specific process application.
- A.13.5.3.3.d In addition, the Seller shall configure up to 10 Buyer defined graphics.
- A.13.5.3.3.e Graphics colors shall be used consistently throughout all graphics. Unless otherwise specified in the Ovation High Performance standards and as agreed to by the Buyer, the following minimum standards shall apply:
- A.13.5.3.3.e.1 Green shall depict valves closed and electrical drives (circuit breakers, contactors, switches, etc.) open, off or de-energized.
- A.13.5.3.3.e.2 Red shall depict valves open and electrical drives closed, on, or energized.
- A.13.5.3.3.e.3 Yellow or Amber shall be used exclusively for an alarm state. The alarm color shall not be used for any other function or graphic.
- A.13.5.3.3.e.4 White or cyan shall be used for changing process values.
- A.13.5.3.3.e.5 The remaining color shall be used for text that does not change.
- A.13.5.3.3.f All drives and remotely controlled valves shall have their positions displayed and confirmed on the operator interfaces.
- A.13.5.3.3.g Facility DCS controlled regulating valves shall provide actual position indication in "percent open" to the operator in the Control Room.
- A.13.5.3.3.h The operator shall have the ability to tag out equipment (fans, pumps, valves, dampers, etc.) from the HMIs for work performed by maintenance personnel. When a piece of equipment is tagged out by the operator, the operation of that device by the control system shall be inhibited. The graphics displays shall indicate when a device is tagged out.
- A.13.5.3.3.i The operator shall have the ability to present real time data and recall data held in the data logger memory or from archives by specifying the time period of interest. The information requested may be presented on the operator workstations either in tabular form or as selected variables on a trend display. It shall be possible to compare on the same display, multiple trends of real-time data or historical data from the data logger or archives.
- A.13.5.3.3.j All graphics shall have its name displayed on the graphic.
- A.13.5.3.3.k A logical hierarchy shall be developed by the Seller to aid in navigating from graphic to graphic.

A.13.5.3.4 Alarm Management

- A.13.5.3.4.a To facilitate efficient operator interface for the entire combined cycle plant, there shall be a comprehensive alarm management policy to avoid alarm flooding and to ensure that non-critical alarms are grouped to cover an area of plant for display on the Facility DCS monitors and shall be restricted to conditions that only require to be advised for information to the operators. All critical alarms for each area of plant that require immediate operator action shall be individually displayed on the Facility DCS. Alarms shall also be provided to meet the requirements of all applicable Fire Protection Codes. Fire Protection alarms are independent of the DCS; and are part of the Fire Protection System; however, a general master alarm shall be provided from the Main Fire Panel (MFP) to the DCS for fire and fire detection system trouble.
- A.13.5.3.4.b Each of the major control systems (TCS and DCS) shall utilize its vendor's standard alarm management system.
- A.13.5.3.4.c A hierarchical alarm system shall be implemented that has several priorities of alarms. All alarms shall be displayed. Clicking on an alarm on the alarm screen will change the display to the detail of the equipment that is the source of the problem. The system shall have five alarm priorities defined as follows:

Priority Level	Priority Definition	Alarm Definition
Level 1	Critical alarm (Major equipment/unit trip and safety related) and environmental alarms. Alarm will be recorded in the Historian.	– Immediate operator action required to prevent plant shutdown or human health or safety problem – Eminent boiler/HRSG trip condition – Eminent combustion turbine trip condition – Eminent steam turbine trip condition – Primary and back-up device tripped (loss of capacity)
Level 2	Critical process/equipment alarms (alarms on process/equipment relevant to a managed shutdown). Alarm will be recorded in the Historian.	– Immediate operator action required to prevent activation of safety or process critical interlock. Operator action will prevent unit shutdown or escalation of process upset. – Major control loop rejected to manual – Condition resulting in unit runback – Condition resulting in unit rundown

Priority Level	Priority Definition	Alarm Definition
Level 3	Essential and non-essential process/equipment alarms (alarms on equipment necessary for operation but not necessary for a managed shutdown). Alarms will be recorded in the Historian.	– Operator action required in excess of 7 minutes. Fast operator action not required but the operator is required to perform some action as part of his normal task. – Maintenance issues – Minor control loops reject to manual – Device faults, bad quality – Deviation alarms – DCS system alarms
Level 4	Normal operations (no alarm).	– Return to normal alarm – No audible alarm
Level 5	Equipment in lockout or red tag. These points will be recorded in the Historian.	– No audible alarm

- A.13.5.3.4.d The following shall apply to operator process alarms generated from analog input signals only and are distinguished from alarms used for control action. Control logic blocks utilizing alarms for control action shall be kept separate and independent from alarms intended to alert the operator of abnormal process conditions.
- A.13.5.3.4.d.1 The built-in DCS alarm features (high, high-high, low, low-low, etc.) of analog input point database records shall be used for all priority levels for warning operations of “off-normal” operational parameters.
- A.13.5.3.4.d.2 Use of High, Low and High/Low monitor algorithms/function blocks on originated analog points shall be limited to the development of logic schemes or strategies for permissives, start/stops, trips, runbacks, etc. Use of these algorithms solely to generate an alarm from an analog point is not permitted.
- A.13.5.3.4.d.3 The use of the High, Low, and High/Low monitor algorithms/function blocks (identified in the previous section) shall be used to generate the alarm associated with the specific permissive (not met), trip, runback, etc.
- A.13.5.3.4.e Each alarm message shall be logged along with tag number, date and time, alarmed value, unit, set point, area, and status (acknowledged, non-acknowledged, or returned to normal). Alarm formats will be Facility DCS Subcontractor’s standard.
- A.13.5.3.4.f Equipment not in service or tagged out shall have their alarms deactivated.
- A.13.5.3.4.g System failures shall be alarmed and logged on the alarm capture computer.
- A.13.5.3.5 Reporting

- A.13.5.3.5.a All plant operation and plant history (sequence of events etc.) shall be through the Facility DCS with, if necessary, hard copy reports when requested from the Facility DCS printers. All operator functions shall be entered into the Facility DCS such that logs, alarm records and daily reports shall be made available through the Facility DCS displays.
- A.13.5.3.5.b The status of each SOE point shall be time tagged at the source and stored in a database together with other relevant information for a specific time period. Data will be continuously deleted from the database after the specified time period has elapsed. On the occurrence of a nominated event (e.g., turbine trip) or manual initiation via the Facility DCS, all data for the time period before the event shall be retained and continue to be recorded for a period after the event.
- A.13.5.3.5.c The Facility DCS Subcontractor shall develop the SOE program to permit storage of the sequence of events log in the HSR system. The HSR shall be sized large enough to store all SOE logs.
- A.13.5.3.5.d Facility DCS Shall indicate run times for the CTG, STG, and all motors 480 Volt and higher
- A.13.5.3.5.e The HSR shall be capable of building reports which can be either printed or saved electronically. These reports can be set up to run at certain times and days.
- A.13.5.3.6 Plant Performance Monitoring System
- A.13.5.3.6.a Seller shall provide an interface with the Seller supplied HSR for a secondary Performance Monitoring System for the Facility as designated and provided by the Buyer.
- A.13.5.3.6.b The Plant Facility DCS shall be provided with OSIsoft PI System software installed on one of its servers. This server shall be connected to the Plant LAN via a network connection through a security appliance (e.g., data diode) provided by Buyer.
- A.13.5.4 Testing: Factory Acceptance, Start-up, and Commissioning
- A.13.5.4.1 In addition to the manufacturer's production tests, the Seller shall carry out routine tests on completed Equipment. Buyer reserves the right to witness such tests. Routine tests on each piece of Equipment shall be fully documented and include at least the following: visual inspection, performance test, control loop testing, fail over testing (communication and power) and voltage withstand test and insulation test. Where Equipment is intended to operate together, the complete assembly shall be tested to demonstrate that the interconnected pieces are compatible.
- A.13.5.4.2 A factory acceptance test shall be performed by Seller. The Seller shall include all Equipment necessary for full testing to cover both factory and at Project site. All Facility DCS functions, inputs and outputs (over entire range), all information exchanges and paths, all operator interfaces and all spare hardware shall be tested. These tests shall cover individual module tests, systems tests, and complete Facility DCS system testing using simulated signals and all the different types of interfaces that will exist in the plant. The HSR shall be fully configured and functional prior to startup and commissioning.

- A.13.5.4.3 From the various factory equipment/components tests, evidence shall be provided to prove that the Equipment meets the requirements of this specification and are sufficiently reliable to justify delivering to Project site. The factory acceptance tests are intended to prove that the modules and sub-systems are compatible and that the complete system hardware and software conforms to this specification. This can be achieved by simulating the interfaces between the modules and sub-systems, which are not available to the manufacturer at the time of test.
- A.13.5.4.4 The Facility DCS Subcontractor shall provide full test documentation. All spares required for commissioning are to be included. All software shall be checked against all hardware systems.
- A.13.5.4.5 The Facility DCS equipment shall conform to, and tests shall be conducted in accordance with, the latest applicable Standards of the American National Standard Institute, Inc. (ANSI), the Institute of Electrical and Electronics Engineers, Inc. (IEEE), and the National Electrical Manufacturers Association (NEMA).
- A.13.5.4.6 A Facility acceptance test shall be performed. The Facility acceptance tests shall be fully documented and include, but not be limited to, the following:
- A.13.5.4.6.a All workstation or PLC facilities are tested without connection to workstations in the new Control Room.
- A.13.5.4.6.b Data communications to workstations shall be established for each workstation or PLC.
- A.13.5.4.6.c Commissioning tests including, in-situ instrument calibration check to Facility DCS/PLC, control loops, Facility DCS/PLC device drivers, protection and interlock logic, sequences, station master load control, alarms, failover testing (communication and power), power and grounding checks, etc.
- A.13.5.4.6.d Facility Tests - Control and Instrumentation: The Seller shall carry out all necessary calibrations of instruments, control valves and control loops. All the testing and proving of instrumentation shall be carried out per the pre-commissioning and commissioning activities specified. Calibration documentation shall be provided in all cases and be part of the “turnover package” submitted to the Buyer.
- A.13.5.4.6.e The Seller shall designate a Facility DCS workstation solely for Buyer’s use during the commissioning. The workstation shall be available two weeks after Facility DCS power up at the Facility. It shall be kept current with all the latest graphic and logic changes in the Facility DCS.
- A.13.5.4.6.f Data communication and interfaces between Facility DCS and proprietary control equipment as listed in Sections A.13.2.2.2 and A.13.2.2.3 Control System Interfaces shall be demonstrated.
- A.13.5.4.6.g The Seller shall work with the Buyer to establish full working communication between the BOP Facility DCS and all interfaces detailed in this section including but not limited to, CEMS, Fuel Supplier Gas Yard(s), RTU, BOP vibration monitoring and the AGC.

A.13.6 COMBUSTION TURBINE GENERATOR CONTROL SYSTEM (TCS)

Instruments and controls that are supplied as part of the CTG package will be provided in accordance with Seller's standards except that Factory Acceptance Testing of the complete control package shall be performed using Vendor's standard testing procedures. The tests shall be performed prior to shipment.

A.13.6.1 General TCS Requirements

A.13.6.1.1 The Seller shall supply all the control, protection, and instrumentation equipment for the safe, reliable, and efficient operation of the combustion turbine-generator and its auxiliaries. The CTG and HRSG shall operate as an integral unit.

A.13.6.1.2 The control systems supplied for the control of the combustion turbine generator shall be directly interfaced with the BOP Facility DCS to provide coordinated operation with all elements of the combined cycle plant (e.g., limiting the ramp rates to within the HRSG stress limitations, etc.).

A.13.6.1.3 The TCS shall provide for the automatic and semi-automatic starting, synchronizing, loading, and shutting down of the combustion turbine generator. Comprehensive supervisory equipment for monitoring operational status, alarms and automatic protection shall be provided for the safe remote operation of the machine. All the above operational procedures shall be included in the interface to the Facility DCS.

A.13.6.2 CTG Controls

A.13.6.2.1 Consisting of the manufacturer's normal complement of equipment, the control and instrumentation package for the CTG shall include, but not be limited to, the following:

A.13.6.2.1.a Governor controls, droop selection, MW load control, and exhaust temperature limiting. Droop control shall be active in MW mode or AGC mode so that the CTG responds to system frequency changes during these modes. See Section A.5.

A.13.6.2.1.b Emergency tripping and protection system (fail-safe) including over-speed trip equipment and on line trip testing facilities. 2 out of 3 (2oo3) voting shall be implemented to the extent practical, with respect to physical space limitations within the OEM standard design. Buyer shall review and approve all trip systems that do not have 2oo3 voting.

A.13.6.2.1.c Sequence controls and interlocks (e.g., pre-start checks, start-up auto-synchronizing, load run-up, shut-down, etc.).

A.13.6.2.1.d Comprehensive machine condition monitoring and supervisory equipment.

A.13.6.2.1.e Control and instrumentation for auxiliary systems.

A.13.6.2.1.f Local and remote alarms on the operator workstation.

A.13.6.2.1.g Generator control and instrumentation, including electrical protection.

A.13.6.2.1.h Fire and gas detection systems.

A.13.6.2.2 The preferred supervisory instrumentation for the CTG shall be Bently Nevada with provisions for an additional serial card to interface Alta Solutions, including but not limited to the following parameter monitoring: shaft vibration in x and y directions (at 45° and 135° angles of the horizontal plane), phase reference, bearing pad temperatures, thrust bearing to shaft position, thrust bearing temperature.

A.13.6.2.3 The CTG vibration monitoring equipment shall be interfaced with the Facility DCS via TCS, such that all signals and alarms/trips can be monitored in the Control Room.

A.13.6.2.4 The CTG supervisory system shall be fully compatible with the condition monitoring analysis system installed in the Control Room.

A.13.6.2.5 TCS shall be provided with network printer in the Control Room and the local control package.

A.13.6.2.6 Emergency stop push buttons shall be mounted on the trip panel installed in the Control Room.

A.13.6.2.7 Refer to Section A.5 for additional instrumentation and controls requirements for the CTG.

A.13.7 HEAT RECOVERY STEAM GENERATOR (HRSG) CONTROLS

A.13.7.1 General HRSG Control Requirements

A.13.7.1.1 The Contractor shall supply all control, protection, and instrumentation for the safe, reliable, and efficient operation of the HRSG. All of the HRSG control functions will be integrated wired directly into the BOP Facility DCS. The combustion turbine and HRSG shall operate as an integral unit. The HRSG shall be capable of following the inherent rapid start up and shut down of the combustion turbine without undue thermal stress.

A.13.7.1.2 All control devices and instrumentation mounted locally must be suitable for the environmental conditions. Protective instrument enclosures shall be provided to protect against all local weather conditions.

A.13.7.2 HRSG Controls

A.13.7.2.1 The control and instrumentation package shall include, but not be limited to, the following:

A.13.7.2.1.a Drum level control for all three HRSG drums. The drum level control shall be three elements control consisting of level, feedwater (condensate) inlet and steam flow (BFP suction flow) outlet.

- A.13.7.2.1.b Steam temperature control for both SH and RH steam temperature. The Steam temperature control shall be cascaded control with final steam temperature controller output cascaded to spray outlet temperature (Secondary SH inlet temperature). Saturation limits shall be applied to prevent spraying into saturation.
- A.13.7.2.1.c Economizer inlet temperature (economizer recirc) control.
- A.13.7.2.1.d Automatic continuous blowdown monitoring and control.
- A.13.7.2.1.e Emergency tripping and protection systems.
- A.13.7.2.1.f Sequence control and safety interlocks.
- A.13.7.2.1.g Controls and instrumentation for auxiliary systems.
- A.13.7.2.1.h Local and remote alarms.
- A.13.7.2.2 The control and monitoring systems for the HRSG shall be a drop integral within the BOP Facility DCS. Centralized control and monitoring of the HRSG shall be provided at the Control Room via the Facility DCS.
- A.13.7.2.3 Refer to Section A.6 for additional instrumentation and controls requirements for HRSG.
- A.13.8 STEAM TURBINE GENERATOR (STG) CONTROLS
- A.13.8.1 General STG Control Requirements
- A.13.8.1.1 The control and instrumentation systems offered shall provide for the safe, reliable, and efficient operation of the plant as defined by the specification. The systems shall enable the steam turbine to meet the optimum output achievable under steady state and changing load conditions while maintaining safe plant conditions and high levels of efficiency.
- A.13.8.1.2 The systems offered shall provide the automatic, semi-automatic and manual controls for starting, loading and shutting-down of the steam turbine-section of the power train.
- A.13.8.1.3 The control and instrumentation systems shall be interfaced with the Facility DCS to provide coordinated operation of the steam and combustion turbines. Control and monitoring of the steam turbine shall be provided at the Control Room via the Facility DCS and the TCS HMI in the control room.
- A.13.8.2 STG Controls
- A.13.8.2.1 The control system shall include the following features:

- A.13.8.2.1.a The auto run-up and loading system shall be designed to ensure consistent turbine run-up control from startup speed control to full load at maximum rates compatible with the thermal state of the turbine, the steam conditions applied, and the allowable expenditure of turbine life expectancy. The design of the auto run-up system shall take full account of:
 - A.13.8.2.1.a.1 All necessary pre-start checks to ensure minimum conditions for auto run-up initiation are satisfied.
 - A.13.8.2.1.a.2 Selection of run-up rate (cold, warm, and hot).
 - A.13.8.2.1.a.3 Turning after steam turbine shutdown.
- A.13.8.2.2 Governor System
 - A.13.8.2.2.a The turbine governor shall include the following features:
 - A.13.8.2.2.a.1 Electro-hydraulic control system
 - A.13.8.2.2.a.2 Triplex, high-integrity speed monitoring channels for separate turbine control and over-speed protection.
 - A.13.8.2.2.a.3 Comprehensive self-diagnostic fault detection features.
 - A.13.8.2.2.a.4 On-load testing of all turbine steam admission valves shall be provided.
 - A.13.8.2.3 A Bently Nevada turbine supervisory instrumentation (TSI) system.
 - A.13.8.2.3.a A turbine protection system shall be provided. This protection system shall trip the turbine-generator under hazardous operating conditions. Trip circuit supervision and fault detection shall be included to provide a high integrity fail-safe system. Emergency stop push-buttons shall be installed on the trip panel in the Control Room.
 - A.13.8.2.4 Miscellaneous Turbine Auxiliary Systems
 - A.13.8.2.4.a The control of the principal turbine drains after the stop valves shall be included.
 - A.13.8.2.4.b Separate control groups shall provide monitoring, regulating and sequence control of all plant functions associated with the turbine oil systems, vacuum and gland sealing systems, condensate, cooling, and all auxiliary systems.
 - A.13.8.2.4.c The group control sequence shall co-ordinate the operation of pumps and all associated plant functions where required during run-up, shutdown, normal and emergency operations.
 - A.13.8.2.4.d The TCS shall be capable of printing on a networked printer in the Control Room.
 - A.13.8.2.4.e Refer to Section A.7 for additional instrumentation and controls requirements for the STG.

A.13.9 BALANCE OF PLANT (BOP) CONTROLS**A.13.9.1 General BOP Control Requirements**

A.13.9.1.1 Unless otherwise specified, the manufacturers' standard packages of control and instrumentation shall be supplied for all auxiliary plant equipment and BOP systems. Protection systems for major plant equipment, (e.g., Feedwater pump(s), etc.), shall use two-out-of-three majority voting and shall be independent of the control system for that Facility. Equipment shall be supplied to interface all BOP systems and all auxiliary Facility equipment items with the Facility DCS to enable remote monitoring and data logging at the Control Room suitable for one-man operation. This shall also be supplemented with local controls, gauges, and other devices to allow local maintenance and testing activities where required. The control and instrumentation systems for the common BOP systems shall be designed, manufactured, and installed to the same standards as that provided for the main plant process systems.

A.13.9.1.2 Complete control, instrumentation and protection packages shall be provided as applicable for all systems provided under the Agreement. This shall include but not be limited to the following:

A.13.9.1.2.a Steam systems (Steam supply, steam bypass system etc.)

A.13.9.1.2.b Water systems (service and demineralized)

A.13.9.1.2.c Water treatment system

A.13.9.1.2.d Generator cooling systems for combustion turbine generator and steam turbine generator

A.13.9.1.2.e Combustion Turbine inlet evaporative cooler

A.13.9.1.2.f Condensate system

A.13.9.1.2.g Compressed service and instrument air systems

A.13.9.1.2.h Fire protection system (controls and instrumentation are external to the DCS)

A.13.9.1.2.i Gas detection system

A.13.9.1.2.j Hydrogen seal system if supplied.

A.13.9.1.2.k Fuel gas system

A.13.9.1.2.l Condenser systems

- A.13.9.1.2.m Independent coolers to cool plant auxiliaries including the Air Cooled Heat Exchangers (ACHE)
- A.13.9.1.2.n Feedwater system
- A.13.9.1.2.o Chemical feed systems
- A.13.9.1.2.p Waste water systems
- A.13.9.1.3 The steam bypass system shall be fully instrumented showing temperature, pressures and flows at each pressure level (i.e., HP, RH, LP). The spray water control for the de-superheating shall be based on enthalpy control. All temperatures, flows and pressures for the respective steam and water lines involved with this bypass control scheme shall be completely instrumented, monitored, displayed to the operator, and used by the Facility DCS control loop. Protection shall be included in the system to ensure critical conditions are avoided in the various stages of the bypass system. The steam bypass system shall be fully automated to support the transfer of a HRSG from the bypass system to the steam turbine with minimal operator intervention. The steam bypass system shall be capable of automatically returning to steam bypass mode on a steam turbine trip without steam safety relief valve operation or CTG trip or runback. The steam bypass system shall be capable of bypassing excess steam automatically during fast CTG ramping.
- A.13.9.1.3.a Contractor shall design and tune the logic to avoid a quick closure of the bypass valve on high temperature while still protecting downstream equipment from temperature excursions in the event of temporary loss of spray water pressure or control.
- A.13.9.1.4 The condenser controls shall be fully instrumented and automated, using the Facility DCS to ensure the operator is fully aware of all conditions. Any manufacturer's standard package shall interface fully with the Facility DCS.
- A.13.9.1.5 The demineralized water storage tanks shall have level monitoring and inlet flow totalizers reporting in the Facility DCS.
- A.13.9.1.6 Instrument and Service Compressed Air Systems shall each have their own respective PLC based control and monitoring system, but shall interface with the Facility DCS for the supervisory control and status/alarm conditions are available to the operator in the Control Room.
- A.13.9.1.7 The fuel gas systems shall be designed by the Seller for implementation in the plant Facility DCS system.
- A.13.9.1.8 The feedwater system, closed loop cooling water system, chemical treatment system and waste water system shall be fully automated and instrumented. All controls and instrument signals shall interface with the Facility DCS such that the operator shall be able to assess their condition especially under alarm conditions.

- A.13.9.1.9 Local systems such as sump pumps, oil water separator, eye wash stations shall be locally controlled with status alarms wired back to the Facility DCS.
- A.13.9.1.10 Not used
- A.13.9.1.11 The raw water storage tanks (e.g., Service/Fire, Demin, RO permeate) shall have level monitoring reporting in the Facility DCS.
- A.13.10 REQUIREMENTS FOR INSTRUMENTATION
- A.13.10.1 Instrumentation General
- A.13.10.1.1 This section describes the general requirements for the supply and installation of the instrumentation for the Facility. All instrumentation, related devices, and equipment necessary to allow the safe, reliable, and efficient operation of the Facility shall be supplied.
- A.13.10.1.2 The objective shall be to standardize all equipment, wherever possible, throughout the Facility in order to simplify operation, maintenance and reduce spare parts. In general, all Equipment shall be of modern state-of-the-art design, incorporating proven technology. All Equipment shall be subject to the approval of Buyer.
- A.13.10.2 BOP Control and Instrumentation Signal Levels
- A.13.10.2.1 The following signal levels shall be used for instrumentation and control valve actuating; other signals with Buyer's approval:
- a. Analog 4 to 20 mA at 24 VDC
 - b. Digital outputs 120VAC and 125 VDC, with interposing relays as required by the circuits
 - c. Digital inputs 24 VDC, 48 VDC, 125 VDC and 120 VAC wetting voltages
 - d. Solenoids 120 VAC/ 125 VDC
- A.13.10.3 Field Mounted Instruments
- A.13.10.3.1 Unless otherwise specified or approved by Buyer, all parameter (e.g., pressure, flow, level, temperature) for indication on local control panels or control panels remote from the point of measurement or for use in the BOP Facility DCS, Control Room, or other Facility auxiliary control/monitoring system shall utilize state-of-the-art electronic 2-wire transmitters.
- A.13.10.3.2 All field mounted electrical equipment shall be weatherproof to NEMA Type 4 or equivalent and suitable for the local ambient weather conditions.
- A.13.10.3.3 All smart transmitters with HART Protocol shall be provided with both the Facility DCS and field programmable tools. Each transmitter which is used to transmit a signal to the

control system shall be loop powered directly from the Facility DCS I/O cards, compatible with the Facility DCS scheme.

- A.13.10.3.4 All transmitters shall be of the indicating type or equipped with separately mounted local indicator, except transmitters in the CTG enclosure. All transmitters shall be provided with test connections and instrument isolating valve manifolds (i.e., 2-way for single input, 5-way for differential inputs). For high-pressure systems (above 200 psi) manifold blowdown pipework or plugs must be provided.
- A.13.10.3.5 Unless required by code, transmitters shall be used to the greatest extent possible in place of process type switches.
- A.13.10.3.6 Switches for pressure, temperature and level monitoring shall be of the heavy-duty type with double pole changeover contacts double pole-double throw (DPDT). Contacts shall be rated to suit their required duty. Mercury switches shall not be used. All pressure switches shall be provided with isolation valves and two-valve manifolds. Float type level switches shall be provided with isolation valves.
- A.13.10.3.7 Instruments shall be grounded at source end only, not at both ends. The cable shield shall be isolated at the instrument end.
- A.13.10.4 Flow Instruments
 - A.13.10.4.1 Paddle type orifice plates shall generally be used as the primary elements in flow measurement. Orifice plates shall be of the square edge concentric type for clean fluids. Differential pressure instruments shall be close coupled to the orifice taps where practical. Orifice plate sizing, orifice plate construction, and the design of associated meter piping shall conform to the requirements of ASME.
 - A.13.10.4.2 The orifice plate information shall be stamped on the upstream side of the paddle handle, and the tag number shall be stamped on the downstream side.
 - A.13.10.4.3 Orifice plates shall be made of a material suitable for the service application.
 - A.13.10.4.4 The orifice beta ratio (d/D) shall be between 0.4 and 0.75 for flow control measurements.
 - A.13.10.4.5 Orifice meter accuracy shall conform to ASME MFC-3M specifications.
 - A.13.10.4.6 Rotameters shall be used for local indication on low flows. Process rotameters shall have metal tubes. Glass tube rotameters shall only be used for purging or auxiliary service with non-hazardous fluids.
 - A.13.10.4.7 Positive displacement type meters shall be used for measuring oil flow.
 - A.13.10.4.8 Flow meters employing alternative measurement principles may be utilized for appropriate applications subject to the approval of Buyer. For special applications, turbine meters, positive displacement meters, magnetic flow meters, venturi flow tubes, pitot tubes, Annubar tubes, Coriolis mass flowmeters, vortex meters, sonic and ultra-sonic flowmeters,

etc., shall be used. Straight meter runs for all special application flow meters shall conform to industry accepted design standards and/or the meter manufacturer's requirements. Calibrated flow elements shall have accuracy within +/- 1.0 percent or better of calibrated full scale range.

- A.13.10.4.9 Where density, temperature or pressure corrections for metered performance monitoring signals are required, such measurements shall be made close to the flow meter location.
- A.13.10.4.10 Flowmeters for the fuel gas flow measurements for the CTG and duct burners shall meet the requirements of the EPA. Manufacturer's calibration certificate shall be provided that shows that the flow meter meets the accuracy requirements of the EPA.
- A.13.10.4.11 Flowmeters for the feedwater flow measurements for the HRSG shall be a flow nozzle meter and the design of associated meter piping shall conform to the requirements of ASME.
- A.13.10.5 Level Instruments
- A.13.10.5.1 Level measuring devices may be of the direct measurement, differential pressure or electrical/electronic type as appropriate to the application. For local indication of level, direct measuring devices shall be used. Unless otherwise approved by Buyer, each measuring instrument shall be removable without the vessel or other instruments being taken out of service.
- A.13.10.5.2 Level gauges shall be of the reflex type made from stainless steel bar and fitted with toughened borosilicate glass and marked with their safe working pressure and temperature, except on low temperature and pressure application when transparent types may be used.
- A.13.10.5.3 Generally, magnetic float type level gauges with magneto restrictive level transmitters shall be used for clean liquid level measurements. The gauges shall be mounted in external cages with flanged connections, rating same as vessel.
- A.13.10.5.4 Differential pressure type transmitters shall be used for clean liquid level measuring service where it is not practical to use magnetic float type level transmitters. Level transmitters shall have accuracy within +/- 0.1% (+/-0.5% for TCS) or better of calibrated full scale range. Filled capillary system level instruments shall be used where fluids are viscous or contain solids that may plug external devices. Other types of sensing elements may be used such as paddle, capacitance, sonic, etc., may be used when float/displacer type switches are not suitable for the application.
- A.13.10.5.5 Direct measurement of level by means of internally mounted floats etc., shall only be used when the switch-point is either well defined in advance or is adjustable in service, and the vessel can be emptied and/or depressurized for the removal of the switch without effect to the normal operation of the plant, or where choking of extended connections is likely to occur.
- A.13.10.5.6 Float switches shall be glandless with magnetic coupling.

A.13.10.6 Pressure and Differential Pressure Instruments

- A.13.10.6.1 In general, process transmitters shall be 4-20 mA DC, two wire, solid state SMART type with HART protocol. All process transmitters shall have an accuracy within $\pm 0.1\%$ of calibrated range or better, which shall include the combined effects of linearity, hysteresis, and repeatability. Pressure and differential pressure transmitters shall have adjustable zero and span and shall have zero elevation/suppression capability. All transmitters with local indication shall be furnished with a display scale of 0-100% of range. Transmitters for fluid applications that may be corrosive, highly viscous, or contain entrained solids shall be furnished with diaphragm seals and stainless steel capillary tubing (if required). All differential transmitters shall be equipped with 5 valve manifolds. All pressure transmitters shall be equipped with two valve manifolds.
- A.13.10.6.2 Transmitters shall be used whenever possible in place of process type switches (pressure, level, flow, etc.) for all system applications.
- A.13.10.6.3 Locally mounted pressure gauges shall be provided upstream and downstream of each piece of equipment that can affect process pressure, i.e., pumps, filters, heat exchangers, etc., with the exception of CTG and STG packages. Pressure indicators on pump headers shall be provided with snubbers and shall be glycerol filled.
- A.13.10.6.4 Pressure gauges shall have weatherproof cases, solid front with blowout back, an accuracy within $\pm 0.5\%$ ($\pm 2.0\%$ for TCS) of calibrated full scale range (both upscale and downscale) and be furnished with helical type elements with Type 316 stainless steel wetted parts unless a more corrosion resistant material is required. Pressure gauges shall have 4½" dials with black graduations and pointer on a white face, ½" NPT lower bottom connection, and furnished with windows of shatterproof glass or plastic material. Pressure gauge ranges shall be selected such that the maximum operating system pressure does not exceed 75% of the full-scale range. Pressure gauges for fluid applications that may be corrosive, highly viscous, or contain entrained solids shall be furnished with diaphragm seals.
- A.13.10.6.5 Differential pressure indicators shall have bellows, piston, bourdon tube or diaphragm type sensing elements with wetted movement parts of 316 stainless steel, unless a more corrosion resistant material is required. Differential pressure indicators shall be furnished with 4½" minimum diameter indicator dials, ½" NPT process connections, and windows of shatterproof glass or plastic material. Accuracy shall be within $\pm 1.0\%$ ($\pm 2.0\%$ for TCS) full-scale indication (both up and down) or better with no leak-through.
- A.13.10.6.6 Differential pressure instruments shall be capable of taking full line pressure on one side only without damage or loss of calibration.
- A.13.10.6.7 Pressure and differential pressure switches, if used, shall be either of the bellows, piston, or bourdon tube type. The setpoint adjustment shall be internal with some means of tamper proofing provided. Pressure switches shall have repeatability within ± 1.0 percent of operating range or better. Switches used for control shall not be used for other functions such as alarming or tripping.

- A.13.10.6.8 Pressure instruments exposed to possible vacuum shall be protected for full vacuum.
- A.13.10.6.9 Diaphragm seals shall be used for slurries, corrosive fluids, and for very viscous liquids.
- A.13.10.6.10 Pulsation dampeners shall be used for pressure instruments that are directly connected to positive displacement pump and reciprocating compressor suction or discharge lines. Liquid-filled gauges shall be used where extreme vibration of the gauge is expected.
- A.13.10.6.11 Siphons shall be used for pressure instruments on steam service unless a liquid filled sensing line is used.
- A.13.10.6.12 Not Used
- A.13.10.6.13 Pressure gauges shall be 4½ inch minimum local mounted, 3½ inch panel mounted, and 1½ inch to 2½ inch mounted on air operated dampers and control valves.
- A.13.10.7 Temperature Instruments
- A.13.10.7.1 The method of temperature measurement to be employed shall be selected for the particular application bearing in mind requirements for accuracy and reliability.
- A.13.10.7.2 The primary elements for temperature service shall consist of thermocouples or resistance temperature detectors (RTD), depending upon the service applications. The temperature sensors shall have accuracy according to ASTM E230/E230M Special for thermocouples and ASTM E1137 Grade A for RTDs.
- A.13.10.7.3 Thermocouple extension wire will have the same characteristics as the thermocouple. Connections shall be made to avoid cold junctions.
- A.13.10.7.4 Thermocouple temperature detectors shall conform to ANSI MC96.1 and shall be Dual Element type chromel-constantan (ISA Type E) or chromel-alumel type (ISA Type K) for high temperature applications. Thermocouple calibrations shall conform to the latest issue of ANSI-MC96.1 Temperature Measurement Thermocouples, with cold junction reference at 32°F. Thermocouples shall be ungrounded.
- A.13.10.7.5 Resistance temperature detectors (RTD) shall be used for temperatures less than 200°F. Process control applications shall use 100 Ω at 0°C, three-wire platinum type RTDs. All RTD elements shall be duplex.
- A.13.10.7.6 Thermocouples and RTDs elements shall be spring-loaded to provide good thermal contact with its associated thermowell. All connection heads shall be rated NEMA 4 as a minimum with appropriate hazardous area rating as required, made of cast iron, steel, or aluminum with screwed covers and retaining chain, and supported from the well by a nipple-union-nipple extension. Connection heads shall be furnished with insulated brass terminal blocks for extension wiring. Connection head conduit connections shall be ½" NPT.
- A.13.10.7.7 Local temperature indicators shall be provided upstream and downstream of each piece of equipment that can affect process temperature (i.e., large pumps [Boiler Feed Pumps,

Condensate Pumps, Closed Cooling Water Pumps], heat exchangers, coolers, etc.), with the exception of CTG and STG packages. Local temperature indicators shall be bimetal type with adjustable angle head, 5-inch dials with plastic windows, hermetically sealed stainless steel construction with 0.25" O.D. stems.

- A.13.10.7.8 All fluid system temperature sensors shall be equipped with thermowells. Thermowells material shall be the same general type of material as the pipe or vessel. The minimum material for thermowell shall be 316 stainless steel.
- A.13.10.7.9 Thermowells shall be installed in all locations requiring temperature test points. Thermowells shall also be installed at all locations necessary to support the requirements for ASME performance testing where required.
- A.13.10.7.10 Thermowells shall be suitable for the design pressure, flow, and temperature of service. Each thermowell shall be provided with brass plug and chain. Thermowells installed in high velocity streams shall be subjected to frequency ratio calculation to prevent the wells from breaking.
- A.13.10.7.11 Sensing elements for air, inert gas and radiant temperature measurements shall be complete with suitable protective sheath. For steam, water, and hazardous applications, thermowells shall be utilized.
- A.13.10.7.12 No temperature measuring system shall use mercury as its sensing medium.
- A.13.10.7.13 Thermocouples and RTDs shall be wired directly to the Facility DCS and shall not use temperature transmitters.
- A.13.10.8 Analyzers
- A.13.10.8.1 Measuring instruments monitoring chemical or physical properties of process fluids and substances may be installed either directly in the process line or vessel or at a distance and connected by means of sampling systems.
- A.13.10.8.2 Analytical instruments shall be selected to operate continuously, infrequently or on a continuously interrupted cycle as most suited to the measurement and the intended application.
- A.13.10.8.3 If sampling systems are employed then they must be designed such that the sample cannot be contaminated and time lags between the sampling point and the analyzer are insignificant (e.g., on start up where the lines may have been stagnant and steam/water quality is a required release condition for the steam turbine).
- A.13.10.8.4 Sensors shall be of ruggedized construction and shall not require frequent maintenance or recalibration. Where sensors require the use of calibration solutions or gases, then a minimum of one year's supply at normal usage shall be supplied. Where sensors require replacement or removal for recalibration or rejuvenation at regular intervals, then an adequate number of spare sensors shall be supplied for one year's normal usage.

A.13.10.9 All instrument tagging shall agree with the approved project tagging procedure and shall be read in English units. Instrument tags shall be stainless steel, either screwed into instrument or attached to instrument by stainless steel wire.

A.13.11 INSTRUMENT INSTALLATION REQUIREMENTS

A.13.11.1 Installation Responsibility

Seller shall be responsible for installation of all instruments furnished by Seller as well as Seller's sub-vendors.

A.13.11.2 General

A.13.11.2.1 In general, valves shall be located as follows:

- a. Frequently operated manual valves, control valves, non-return valves, high energy safety valves, and interior header fire protection isolation valves shall be located at an accessible location at floor level or fixed platform.
- b. Other valves, including but not limited to, air operated valves, regulators, motor operated valves, and instrument root valves may be located where a ladder, manlift, or scaffolding may be required for access.
- c. Clearance shall be allowed between the top of the control valve actuator and the underside of the nearest obstruction above it for removal of the control valve actuator and trim in one piece.
- d. Threaded control valves shall have flanges or unions in accordance with the Piping Material Specifications immediately adjacent to the control valve for purposes of removing the valve.

A.13.11.2.2 Instrument and control equipment for outdoor usage where the process is subject to freezing (such as steam or water) shall be installed in instrument enclosures to prevent damage from freezing, wind, rain, salines, fumes, and dust. Equipment enclosures shall be appropriately rated for ultraviolet exposure and shall be provided with heaters.

A.13.11.2.3 Instrument enclosures and racks shall be designed to facilitate instrument calibration and maintenance. Local instruments shall be easily read without dismantling equipment.

A.13.11.2.4 If required, analytical detector systems mounted outdoors shall be installed in noncombustible, corrosion resistant, weatherproof enclosures.

A.13.11.2.5 The sensor and analyzer shall, where possible, be mounted near the sample point and shall be properly protected from the environment.

A.13.11.2.6 Analyzers may be installed in analyzer houses near the measuring points in field. The temperature inside the analyzer houses shall be controlled so as to ensure adequate ambient condition.

A.13.11.2.7 pH electrodes shall be designed where the electrode remains wet and shall be installed with provision to allow easy removal for periodic cleaning, inspection and replacement or full

calibration when the process is in service. Electrodes shall include provisions to disconnect cable at the probe.

- A.13.11.2.8 In-line instruments shall be located where they shall be accessible for maintenance and servicing.
- A.13.11.2.9 Instruments not mounted inline shall be located where they shall be accessible from platforms or grade. Indicating instruments shall face forward toward the normal operating area and shall be within reading distance and in the line of sight.
- A.13.11.2.10 Instruments shall be mounted level and plumb, rigidly supported and in such a manner as to provide protection from heat, shock and vibration; accessibility for maintenance; and freedom from interference with piping, conduit, and equipment.
- A.13.11.2.11 Tubing shall be installed in a neat, workmanlike manner, properly sloped, and show no sign of crumpling, bends of too short a radius, flattening, etc. Open tube ends and connections shall be kept plugged to keep out dust, dirt, moisture, oil, etc. Tubing, fittings, and instrument manifolds installations shall be in accordance with ASME B31.1, "Power Piping".
- A.13.11.2.12 Instrument enclosures, if used shall be provided with a low temperature alarm to notify the plant operator when a heater fails or a heat trace circuit trips.
- A.13.11.2.13 Instrument tubing shall not be welded and shall be ½ inch minimum size. See Section A.13.11.10.1 for more detailed requirements.
- A.13.11.3 Classified Areas
 - A.13.11.3.1 Hazardous location classes will be as per NFPA 70.
 - A.13.11.3.2 In general, instruments requiring electrical power shall be located outside of hazardous areas. However, if it is deemed that an instrument requiring electrical power shall be located in a hazardous area, the design shall incorporate appropriate methods of protection.
 - A.13.11.3.3 The preferred methods of protection shall include:
 - a. Locate outside of classified area
 - b. Non Incendive
 - c. Explosion Proof
 - d. Intrinsically Safe
 - e. Purged and Pressurized
 - A.13.11.3.4 Non-incendive design will be permitted for use in Class I, Division 2 areas, but shall be used only in conjunction with equipment certified for use in non-incendive applications.
 - A.13.11.3.5 If intrinsically safe systems are specified, the electronic instruments shall be certified by the appropriate agency when used with approved current limiting device.

- A.13.11.3.6 All instrumentation and control devices shall be suitable for the environment where they will be located.
- A.13.11.4 Personnel Protection
- A.13.11.4.1 Consideration shall be given to personnel protection during the normal operation of field instruments.
- A.13.11.4.2 Process sensing lines that are above 140°F during normal operation and which are readily accessible to personnel shall be provided with means to prevent direct contact in those readily accessible areas.
- A.13.11.5 Process Tap Connections
- A.13.11.5.1 Connection to the process system shall be in accordance with the particular application. Connections shall be in accordance with the applicable Code, piping line specification or manufacturer recommendations as shown on the Piping and Instrumentation Diagram and or manufacturer's equipment drawings. Provide independent taps for all redundant instrument installations.
- A.13.11.6 Process connection Orientation
- A.13.11.6.1 Pressure and flow connections shall be located on the side of the pipe for liquid or steam applications. Gas and non-condensing vapor connections shall be located on the top of the pipe.
- A.13.11.6.2 Temperature connections shall typically be located on the top of the pipe. Temperature connections can also be located on the side or at 45° between the side and top of the pipe.
- A.13.11.6.3 Level connections – varies depending upon type detector.
- A.13.11.7 Pressure connections
- A.13.11.7.1 Connection size shall be ¾" for piping with a design pressure equal to or less than 600 PSIG and a design temperature equal to or less than 750°F. Connection size shall be 1" for other applications.
- A.13.11.8 Flow Connections
- A.13.11.8.1 Transmitters for flow nozzles shall be mounted external to the nozzles. The material and installation shall be in accordance with the pipe class of the process in which the instrument is used.
- A.13.11.8.2 Connections on orifice plate flow elements shall be through orifice-tapped flanges. Two sets of orifice flange tap connections shall be provided. The minimum flange rating for the orifice flanges shall be 300 lbs.

- A.13.11.8.3 Transmitters for flow orifices shall be mounted separate from the flow taps. The root valve material and installation shall be in accordance with the pipe class.
- A.13.11.9 Level connections
- A.13.11.9.1 Tank level transmitters using dP pressure transmitters mounted external to tanks shall be the same as pressure transmitters mounted external to pipe. Tank level transmitters may also be flange mounted to nozzles at the tanks.
- A.13.11.10 Instrument Sensing Lines
- A.13.11.10.1 Instrument Sensing Line Material
- A.13.11.10.1.a 316 stainless steel tubing, compression fittings, weld fittings, and valves shall be used for all instrument sensing lines unless otherwise required by process conditions. Welded fittings shall be utilized for all applications rated 900 PSI or greater or 900°F or greater, Swagelok compression fittings shall be utilized for all other applications.
- A.13.11.10.1.b Tubing wall thickness shall be determined for each installation application in accordance with ASME 931.0 based on average wall thickness.
- A.13.11.10.1.c All tubing for this service shall, in general, have a minimum outside diameter of ½-inch (except as noted for high pressure/temperature applications per ASME B31.1). All tubing shall conform to the following requirements:
1. ASTM A213 Dual Rated Grade TP316/316L, carbon content $\leq 0.0354\%$ average wall, Rockwell Hardness shall not exceed 90Rb for applications of $< 1,000^{\circ}\text{F}$.
 2. ASTM A213 TP316H for applications of $>$ or $= 1,000^{\circ}\text{F}$, Rockwell hardness shall not exceed 95Rb.
 3. Seamless Stainless Steel
 4. Cold Drawn Fully Annealed
 5. 20 ft. Lengths or Longer
 6. All fittings shall be ASTM A213 316/316L for application of $< 1,000^{\circ}\text{F}$ or ASTM A213 316H for applications of $>$ or $= 1,000^{\circ}\text{F}$.
- A.13.11.10.2 The material specification, outside diameter and wall thickness requirements for tubing shall conform to the Instrument Tubing Maximum Design Pressure Calculation approved for the Project. Minimum bending radius of instrument sensing line tubing shall be three times the tube outside diameter.
- A.13.11.11 Instrument Sensing Line Configuration
- A.13.11.11.1 Sensing Line Routing
- A.13.11.11.1.a Instrument sensing lines shall be routed as directly as practical from the process route valve to the instrument.

- A.13.11.11.1.b Routing of instrument primary piping and tubing, including piping from the process connection through the root valve and the instrument primary piping, shall be in accordance with the following criteria:
- A.13.11.11.1.b.1 Special fittings such as reservoirs (condensate pots) and other devices shall be installed at primary flow element connections as required by the design of the instrument, in accordance with the instructions of the instrument manufacturer. Condensate pots to have double isolation vent valves for venting while filling the condensate pot; not welded plugs.
- A.13.11.11.1.b.2 To insure a constant static head, the connection from low pressure steam and low pressure liquid filled lines shall slope downward continuously from the primary element connection to the instrument (for steam flows this downward slope is from the condensate pots). Horizontal runs shall have a slope of not less than $\frac{1}{2}$ inch per foot and must be adequately supported to maintain the constant slope. Vacuum connections to the condenser and low-pressure extractions shall always slope upward to the instrument.
- A.13.11.11.1.b.3 Instrument primary piping for steam or liquid pressure or flow, and manometer level measurement systems shall slope downward (avoiding high points) from the primary element connections to the instrument (for steam flows this downward slope is from the condensate pots). Instrument primary piping for flue gas and airflow measurement systems shall slope upward from the primary element connections to the instrument. If these requirements cannot be met, special venting and drain provisions will be required.
- A.13.11.11.1.b.4 Sensing lines for gas and air applications shall be routed from the process taps to the instrument avoiding low points that can trap condensate.
- A.13.11.11.1.b.5 Primary piping instrument taps shall not be located on the bottom of the pipeline.
- A.13.11.11.1.b.6 Redundant transmitters and switches shall be provided with separate process connections.
- A.13.11.11.1.b.7 All instruments and gauges shall have independent process connections.
- A.13.11.11.2 Sensing Line Support
- A.13.11.11.2.a Support of tubing shall be adequate to assure that the tubing is not overstressed and to prevent sagging.
- A.13.11.11.2.b The preferred method of routing and supporting tubing is in tube tray.
- A.13.11.12 Remotely Mounted Instruments
- A.13.11.12.1 Control devices in high temperature applications or for equipment in inaccessible areas shall be mounted remotely.

A.13.11.13 Freeze Protection

A.13.11.13.1 For steam or water services subject to freezing at the Project defined conditions, the following shall apply:

A.13.11.13.1.a All outdoor instrument sensing lines shall be electrically heat traced and insulated (see Section A.10.32).

A.13.11.13.1.b Instruments located outdoors or in unheated areas indoors, which are subject to freeze damage, shall be mounted in electrically heated instrument enclosures. Enclosure shall be rated as a minimum for NEMA 4 with windows for viewing enclosed gauges or transmitter LCD readouts. Prefabricated instrument boxes or floor stand cabinets may be used, depending on the number of instruments to be mounted. Instrument enclosures shall be provided with a low temperature alarm to notify the operator of heater malfunction.

A.13.11.13.1.c For heat traced sensing lines, heat trace cable to be adequately rated for all process temperature conditions.

A.13.11.13.1.d Refer to Section A.12.32 for additional heat tracing design conditions and requirements.

A.13.11.14 Calibration

A.13.11.14.1 Instruments shall be calibrated or meet specified tolerances as defined below. Calibration and test equipment shall be traceable to National Institute of Standards and Testing (NIST).

Instrument Type	Calibration Requirement
Analyzers - Field mounted	Analyzers shall be factory calibrated to manufacturer's standard.
Continuous Emissions Monitoring Systems (CEMS)	CEMS analyzers shall be factory and field calibrated by the CEMS Subcontractor.
Control Valves	Valve stroke and proper action of accessories (positioners, switches, solenoids, etc.) to be set by manufacturer.
Flow Elements - Orifice plates, Flow nozzles, Venturis and Annubars	Flow elements shall be inspected in the factory by the manufacturer to manufacturer's standards.
Flowmeters - Vortex, Magnetic, Turbine, Ultrasonic	Flowmeters - Vortex, magnetic and turbine shall be calibrated to the specified range in the factory by the manufacturer.
Gauges - Pressure & Temperature	Gauges shall be factory calibrated to manufacturer's standard.
Level Switches - Float & Displacer	For pre-assembled equipment, switches shall be factory set to manufacturers' standard. For field assembled equipment, switches shall be set in the field.
Process Switches - Pressure & Temperature	Switches shall be calibrated to the specified setpoint(s) by the manufacturer.
Position Switches - Valves & Dampers	Switches will be set by manufacturer.
Transmitters - Digital	Digital/smart transmitters (pressure, differential pressure, and temperature) shall be calibrated and set to the specified range in the factory by the manufacturer.
Transmitters Level - any non-differential pressure type. Radar, ultrasonic, displacer, etc.	Factory calibrated by the manufacturer, if possible.
Thermocouples and RTDs	Factory calibrated to be in accordance with ITS-90, IEC-60751 or other standard required by the purchase specification.

A.13.11.14.2 Instruments provided as part of vendor skids shall be calibrated in the factory before shipment/installation. Calibration for these devices shall be checked after installation and recalibrated, as necessary.

A.13.11.15 Pressure Testing

- A.13.11.15.1 Instrument air supply lines shall be pressurized to instrument air system pressure and checked for leaks using a leak detection liquid surfactant.
- A.13.11.15.2 Tubing used for instrument sensing lines shall be pressure tested using either hydrostatic, pneumatic, or initial service test methods as defined in ASME 831.1. Sensing lines, where the design conditions are ≥ 900 psig or ≥ 800 °F, shall be tested before putting the line into service.
- A.13.11.15.3 Sensing lines for hazardous process fluids (i.e., ammonia, fuel oil, natural gas, hydrogen, etc.) shall be tested before putting the line into service. Generally, these lines cannot tolerate traces of water, thus these lines shall be tested pneumatically using nitrogen.
- A.13.11.15.4 Other sensing lines may be tested during initial service.
- A.13.12 CONTINUOUS EMISSIONS MONITORING SYSTEM (CEMS)
- A.13.12.1 General Technical Requirements
- A.13.12.1.1 Required Measurements: Seller shall furnish Continuous Emission Monitoring Systems (CEMS) as specified herein to continuously monitor the flue gases at the sampling point in the HRSG stack. The CEMS shall consist of all instrumentation and auxiliary equipment necessary to continuously measure and record data for: (a) NO_x volumetric concentration; (b) O₂ percent; (c) CO volumetric concentration; and (d) NH₃ slip. The CEMS shall produce all required data logging and reporting as required by the Air Permit.
- A.13.12.1.2 The CEMS shall include sampling probe, heated sample line, calibration gas regulators, calibration gases, sample conditioning equipment, air purge equipment, and other appurtenances necessary to achieve the specified systems accuracy.
- A.13.12.1.3 The CEMS shall utilize microprocessor-based hardware mounted in CEMS cabinets. The complete systems shall be designed to allow unattended operation of the systems between regularly scheduled maintenance.
- A.13.12.1.4 The CEMS shall be installed as an extractive system, if required by the Air Permit.
- A.13.12.1.5 For NO_x, O₂, CO, and NH₃ slip CEMS equipment, conformance with equipment performance specification requirements of current PS 2, 3, and 4A of 40 CFR 60 Appendix B, 40 CFR 75 Appendixes A through G and EPA Performance Specifications set forth in any other proposed or promulgated Applicable Laws as of the date of testing. Calibration, accuracy, and drift shall follow these regulations or the following, whichever are most restrictive:
- A.13.12.1.5.a For a O₂ monitor, the Relative accuracy is to be determined in accordance with P75 requirements where the mean difference between the reference method values from the RATA and the corresponding monitor values is within ± 1.0 percent O₂, determined by relative accuracy test audit (RATA) These requirements shall be included in the Seller's operator manuals and maintenance/instruction books.

- A.13.12.1.5.b The NH₃ concentration in the CTG Stack shall be tested or calculated according to the method and frequency listed below:
- A.13.12.1.5.b.1 Not Used.
- A.13.12.1.5.b.2 Not Used.
- A.13.12.1.5.b.3 Install and operate a dual stream system of NO_x CEMS at the exit of the SCR. One of the exhaust streams would be routed, in an unconverted state, to one NO_x CEMS and the other exhaust stream would be routed through a NH₃ converter to convert NH₃ to NO_x and then to a second NO_x CEMS. The NH₃ slip concentration shall be calculated from the delta between the two NO_x CEMS readings (converted and unconverted).
- A.13.12.1.5.c The NH₃ concentration in the CTG Stack will be tested or calculated using 24-hour zero drift and 24-hour calibration drift less than or equal to 2.5% (0.5% for O₂) of the span value, determined separately for pollutants in units of ppm and %, by calibration gas injection in accordance with Contractor's operator manuals and maintenance/instruction books.
- A.13.12.1.6 Operational and Performance Requirements: The CEMS shall meet all applicable operational and performance specifications promulgated by the United States (U.S.) Environmental Protection Agency (EPA) in Title 40 of the Code of Federal Regulations (CFR) Parts 60 and 75, and its applicable appendices and the Site Regulatory requirements annotated in the site Air Permit.
- A.13.12.1.7 Seller shall prepare the CEMS QA/QC plan and submit them to the Buyer for review and comment to support submission to the USEPA and appropriate state and local agencies.
- A.13.12.1.8 The probe and all other surfaces which come into contact with the flue gas or calibration gas stream shall be glass, or heavy wall 316 stainless steel or other appropriate material.
- A.13.12.1.9 All necessary tubing and hardware required for a complete installation shall be provided by the Seller.
- A.13.12.1.10 Seller shall provide controls, instrumentation, and alarms for maintenance, testing and unattended operation of the CEMS.
- A.13.12.1.10.a CEMS certification shall be provided by Seller.
- A.13.12.1.10.b Each analyzer shall provide 4-20 mA hardwired outputs to the ESC 8864 Data Loggers.
- A.13.12.1.10.c Each ESC 8864 Data Logger shall be provided with individual hardwired inputs and outputs for each monitored parameter, combustion turbine load and percent load, steam turbine load and percent load, fuel flow, ammonia injection flow, flame on, CEMS in calibration, CEMS in maintenance, CEMS general alarms, pounds per hour, startup/shutdown, permitted values, etc.

- A.13.12.1.10.d The Data Logger shall provide one independent output for each of NO_x, CO, O₂, and NH₃ slip analysis. Each of the outputs shall be an isolated 4-20 mA VDC linear, analog signal capable of driving a 600-ohm (minimum) load. Individual output for each channel shall be provided.
- A.13.12.1.10.e The analyzers shall measure in units:
- A.13.12.1.10.e.1 NO_x – ppm
 - A.13.12.1.10.e.2 CO – ppm
 - A.13.12.1.10.e.3 O₂ – %
 - A.13.12.1.10.e.4 NH₃ – ppm
- A.13.12.1.11 Seller shall furnish any other analyzer as called for in the operating permit for this Facility.
- A.13.12.1.12 Analyzers shall be provided in accordance with the following criteria:
- A.13.12.1.12.a Individual analyzers shall be provided to measure the volumetric concentration of each specified gas. The analyzers shall be designed for continuous unattended operation.
 - A.13.12.1.12.b Analyzers shall be scaled per EPA guidelines to measure the range of concentrations specified herein. Dual range selection capability is required.
 - A.13.12.1.12.c Each analyzer shall be designed for ease of manual calibration and adjustment.
 - A.13.12.1.12.d Each analyzer shall include a panel meter for display of monitoring data.
- A.13.12.1.13 Data Acquisition and Handling System (DAHS)
- A.13.12.1.13.a The Buyer will provide the DAHS server to meet corporate build requirements, which will be located in one of the LAN network cabinets in the Administration Building LAN room. Seller shall provide Buyer with the software, configuration, licenses, activation codes, etc. for the ESC Stack Vision software.
 - A.13.12.1.13.b The Data Loggers shall be connected to the Plant LAN to communicate with the DAHS server.
- A.13.12.2 CEMS Enclosure
- A.13.12.2.1 All non-stack-mounted devices except the gas cylinders and the CEMS DAS system shall be enclosed in a pre-engineered steel enclosure. The enclosure roof and siding shall be constructed out of insulated metal siding with interior panels. The enclosure shall be walk-in type constructed in accordance with applicable national, regional, and local building code requirements. Seller shall furnish fully redundant heating, ventilation, and air conditioning equipment for personnel comfort and equipment protection. CEMS enclosure shall have a 6'x 2' table and upper and lower cabinets. Space shall be allocated in the

CEMS enclosure for another CEMS rack and analyzers to be installed for CTGs discharge emissions.

- A.13.12.2.2 Gas cylinders shall be enclosed in a rigid frame rack, with a protective rain hood, convenient for cylinder change out and shall be mounted outside the CEMS enclosure.
- A.13.12.2.3 Analyzers shall be mounted on a rack, completely piped, and wired with all field sample tubing and electrical wiring connections terminating at bulkhead tubing fittings and electrical junction boxes.
- A.13.12.2.4 Seller shall configure the shelter so that all penetrations are on the side of the shelter closest to the stack.
- A.13.12.2.5 CEMS Power Supply:
 - A.13.12.2.5.a The shelter main power entrance shall be configured for side feed. Power distribution panels shall be provided to receive two (2) 480-VAC, 3-phase, 60-Hertz, unregulated power supply feeds and one (1) 120-VAC, 1-phase, 60 Hz UPS for the following services by Seller:
 - A.13.12.2.5.b 480V auto-transfer switch
 - A.13.12.2.5.c 480V to 208/120-volt transformer
 - A.13.12.2.5.d Not Used
 - A.13.12.2.5.e Heating, ventilating and air conditioning equipment
 - A.13.12.2.5.f Lighting and power receptacles
 - A.13.12.2.5.g The power distribution panels shall have an interrupting capacity of 65,000 rms symmetrical
 - A.13.12.2.5.h The Facility UPS electrical power supply shall be used for the CEMS analyzers, controllers, monitors, controls, instrumentation, and other monitoring accessory equipment.
 - A.13.12.2.5.i All electrical protection equipment and accessories, distribution panels, circuit breakers, etc., shall be provided by Seller.
 - A.13.12.2.6 Heating, Ventilation and Air Conditioning (HVAC):
 - A.13.12.2.6.a All HVAC equipment shall be suitable for use in industrial or heavy commercial environments and shall have a three-phase 480V rating. Insulation, air-conditioning/heating shall be provided to maintain interior environment at conditions required for the housed equipment constraints. The insulation shall be adequate for the size of the HVAC system.
 - A.13.12.2.6.b HVAC shall be provided to maintain the shelter's inside temperature between 65°F and 75°F, and 40% - 60% relative humidity the year round, with or without the inside

equipment running (see Section A.9 – Site Requirements and Design Criteria) for ambient weather condition requirements).

A.13.12.3 **FACTORY ACCEPTANCE TESTING**

A.13.12.3.1 Seller shall perform a complete functional acceptance test (FAT) of the CEMS at the factory before shipment of any equipment to the Project site. The CEMS shall be fully interfaced with the Data Loggers and the data acquisition system to demonstrate full integration of the systems' hardware and software. The FAT shall involve the use of NO_x, CO, and O₂ gases which will be sampled through a complete sampling system (where applicable) set up in the same manner as it will be set up in the field. The FAT shall cover and demonstrate all functions to be performed by the CEMS including but not limited to: (1) automatic calibration drift check; (2) manually initiated calibration drift check; (3) all status indicator functions; (4) all alarm condition functions; (5) all programmable logic controller functions, including but not limited to successful data transfer out of the communication ports; (6) all data acquisition system functions; (7) all hardwired signal to Facility DCS; and (8) Linearity and software calculation review.

A.13.12.4 NOT USED

A.13.13 **VIBRATION MONITORING SYSTEM**

A.13.13.1 All medium voltage motors and driven equipment shall be either furnished with vibration monitoring equipment or provided with mounting plates for possible future installation of vibration monitoring equipment.

A.13.13.2 Vibration monitoring shall be provided for select rotating equipment deemed critical to the operational process as listed below:

- Steam Turbine/Generator
- Boiler Feed Pump
- Combustion Turbine/Generator
- ACC Fans (vibration switches)

A.13.13.3 Each piece of BOP critical equipment referenced in the previous paragraph, except ACC Fans, shall be supplied with independent input cards to Bently Nevada Orbit 60 (preferred) or Alta Solutions AS-7000 (acceptable) vibration monitoring system. The CT/G and ST/G shall be provided with manufacturer's standard Bently Nevada 3500. The ACC Fans shall be supplied with vibration sensors/transmitters, which shall be wired to the DCS.

A.13.13.4 Axial displacement shall be monitored if recommended by the Seller with Buyer concurrence. If axial displacement is monitored, two probes shall be provided in accordance with API-670

A.13.13.5 Each bearing shall be monitored in both the x and y directions (at 45° and 135° angles of the horizontal plane) and a Keyphasor will be included for each lineup.

- A.13.13.6 Vibration inputs shall be continuously monitored in the vibration monitoring system and separate alarm and trip points for each lineup shall be available for use in the Facility DCS. An alarm point shall be provided which shall be initiated before the trip point.
- A.13.13.7 Vibration monitoring input tagging shall be descriptive to facilitate operator identification of input equipment identity.
- A.13.13.8 Not used
- A.13.13.9 HRSG Ammonia Dilution (SCR) Fans bearings to be provided with vibration transducers and temperature measurements which shall be connected to Facility DCS.
- A.13.13.10 The vibration monitoring package shall be perpetual, royalty free package.
- A.13.13.11 The computer or server can be located in the Facility DCS network room, but the monitor shall be on the control room engineering console.
- A.13.14 WEATHER STATION
Seller shall furnish and install a weather station to monitor ambient dry bulb temperature, % relative humidity, rain gauge, and wind speed and direction gauge. These measurements shall be fed to Facility DCS and shall be available to plant operator through HMI displays.

END OF SECTION

SECTION A.14

CIVIL/STRUCTURAL/ARCHITECTURAL REQUIREMENTS AND DESIGN CRITERIA

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SECTION A.14

CIVIL/STRUCTURAL/ARCHITECTURAL REQUIREMENTS AND DESIGN CRITERIA

A.14.1 GENERAL

- A.14.1.1 This section defines the minimum requirements for construction materials and design requirements for structures, foundations, buildings and civil sitework. This section indicates specific information for the design of structures, foundations, and site development Work required for services to engineer, procure, and construct the Facility.

A.14.2 SCOPE OF WORK

- A.14.2.1 The scope of Work is summarized in Section A.1 – Project Requirements and elsewhere in the Contract.
- A.14.2.2 Seller shall prepare specifications for material testing requirements, which detail the type, frequency, and verification testing to be performed by a third-party Testing Service. The field and laboratory testing requirements shall be performed at sufficient locations and frequency to ensure that specified placement and material requirements conform to IBC and to the requirements specified herein. The material testing specifications shall be reviewed and approved by the Buyer.
- A.14.2.3 The Seller shall employ an independent, third-party Testing Service, acceptable to and approved by the Buyer, to perform tests and to submit test reports.
- A.14.2.4 The third-party Testing Service shall sample, test and certify that the Work and materials are installed as specified to include but not limited to: earthwork materials and compaction, deep foundation installation (e.g. drill or driven piles), asphalt paving compaction, concrete and grout (slump, concrete strength, concrete air entrainment, concrete temperature and placement as applicable), post-installed concrete anchors, structural steel erection, high strength bolting, field welding and coating applications.
- A.14.2.5 The third-party Testing Service shall submit all reports to the Seller and the Buyer in a timely fashion. Records of third-party Testing Service and all tests and inspections shall be maintained in the Seller's files, available to Buyer on request.
- A.14.2.6 Acceptance of Work by the third-party Testing Service shall not relieve the Seller in any manner from full responsibility for the Work.
- A.14.2.7 The Seller shall perform and require its subcontractors to perform sufficient testing and inspections to ensure that the products supplied satisfy specifications.
- A.14.2.8 Materials and installed Work may require testing and retesting at any time during progress of Work. Retesting of rejected materials for installed Work shall be done at Buyer's direction and at no expense to Buyer.

- A.14.2.9 The Seller shall provide a detailed civil, structural, and architectural design criteria document that elaborates upon and provides implementation of the civil, structural, architectural requirements and design criteria specified herein to be used for Seller's detailed design and engineering. Seller's design criteria document shall include, but not be limited to, specific design requirements for all elements of the Seller's project Work scope (e.g., structural steel, gallery steel, concrete foundations, anchor rods and masonry). Seller's design criteria document shall be submitted to the Buyer for review and approval prior to implementation by the Seller.
- A.14.2.10 Seller is responsible for structural stability of structures and equipment during erection and installation. Design, supply, installation and removal of all temporary bracing, shoring, etc. required to maintain such stability is the Seller's responsibility.
- A.14.2.11 All architectural drawings, civil drawings, structural drawings, architectural/civil/structural procurement specifications and architectural/civil/structural installation specifications shall be sealed by Professional Engineer registered in the state that the Project is located.
- A.14.2.12 Buyer reserves the right to inspect any part of the Work at any time and to perform tests and prepare test reports. If required, Seller shall provide access for Buyer and testing agency to location where Work is being installed so that Buyer's inspection and testing can be accomplished.
- A.14.2.13 Seller shall correct deficiencies in the Work that inspections and laboratory test reports have indicated to be not in compliance with requirements. Seller shall perform additional tests, at no expense to Buyer, as necessary to reconfirm any noncompliance of original Work and to show compliance of corrected Work.
- A.14.3 DESIGN PHILOSOPHY, REFERENCE CODES AND STANDARDS
- A.14.3.1 General
- The overall philosophy for the civil-structural construction activities is to engineer and design structures, foundations and structural components that will be consistent with the scope of Work included herein.
- A.14.3.2 Structural Steel
- Structural steel shall include access platforms, steel stair towers, pipe racks and individual supports. Structural steel and other outdoor structures shall be procured, shop detailed, fabricated, hot-dipped galvanized and delivered to the site and erected by the Seller. Coating touchup shall be performed on site by the Seller.
- Interior structural steel for pre-engineered buildings will be prime coated only.
- A.14.3.3 Foundations

- A.14.3.3.1 Reinforced concrete foundations for equipment, buildings and other structures shall be by the Seller, including, but not necessarily limited to, material procurement, fabrication, delivery, and erection of formwork, reinforcing steel, embedded items, and placement and finishing of concrete.
- A.14.3.3.2 All buildings and various yard structures shall have reinforced concrete foundations with top of concrete elevation set at 6 inches minimum above adjacent final grade elevation. Foundations shall be designed in accordance with the latest design code requirements and geotechnical data.
- A.14.3.3.3 Foundations shall be designed and sized to meet the specific site soil conditions and minimize the potential for differential settlement.
- A.14.3.4 At Seller's discretion, fiber reinforcement can be used in lieu of rebar reinforcement for cable tray support foundations, platform landings, and stair/ladder landings. The Engineer of Record shall specify the fiber reinforcement that is to be used.
- A.14.3.5 Grade Slabs
 - A.14.3.5.1 Concrete slabs in close proximity to one another shall be combined into one slab to the extent practical. Seller shall establish top of concrete at grade to be at the same elevation for the power block for equipment slabs, building foundations, miscellaneous utility support slabs, etc.
 - A.14.3.5.2 Concrete pads or paved areas shall be designed and provided for equipment maintenance. Slab design shall accommodate pipe trenches and continuous trench floor drains as the mechanical systems dictate.
- A.14.3.6 Access Requirements
 - A.14.3.6.1 Not Used.
 - A.14.3.6.2 Access shall be in accordance with Exhibit A-16.4.9 Standard Access, Section A.10 – Mechanical Requirements and Design Criteria, and as otherwise specified herein.
 - A.14.3.6.3 Adequate space shall be provided for pull-space room and space for maintenance of the items being accessed.
 - A.14.3.6.4 Adequate space shall be provided to service control valves including their operators.
 - A.14.3.6.5 Adequate space shall be provided within enclosures, as well as removable enclosure panels, to allow for equipment removal.
 - A.14.3.6.5.a Access platforms, stairs, ladders, and railings shall conform to IBC or OSHA, and local code requirements. Platforms and galleries shall be grating. Platforms, galleries, and stairways shall have a minimum clear width of 3 feet and minimum clear headroom of 7ft- 6in. Major Equipment platforms and enclosures may be designed for a 28" minimum

width, in accordance with IBC Standards. Major Equipment enclosures may have reduced headroom, where limited by standard OEM equipment designs. For commonly accessed areas, stairways shall have a maximum riser height of 7 inches and a minimum tread depth of 11 inches. In other, infrequently accessed areas, tread depths and risers shall be in accordance with referenced codes, standards, and general industry practice. Handrails shall not protrude into the 3 foot clear width. Ladders shall have minimum clearance as specified by OSHA and shall have slip resistant rungs. Railings shall be all welded construction without fittings. Railing bends shall be smooth without miters and welds shall be ground to provide a smooth rail surface. Indoor and outdoor grating shall be serrated. Openings in grating shall be banded. Abrasive nosing shall be fastened to all stair treads and to grating at floors or landings at the top of all stair runs.

- A.14.3.6.6 Walkway gallery platforms shall be located to provide access to normally operated valves, equipment, etc. requiring access as specified herein. Tie-ins to the HRSG stair towers shall be provided.
- A.14.3.6.7 Provide ramps at minor differences in floor elevations to facilitate cart access.
- A.14.3.6.8 All galleries and platforms shall be accessible by stairs. In certain locations, access to particular platforms by ladder will be considered acceptable if the layout does not allow space for a stair system. The Seller shall obtain Buyer's approval for those locations where a ladder is to be used instead of stairs. Access to the top of field erected tanks will be by ladder.
- A.14.3.6.9 Concrete-filled pan treads shall be used in enclosed stairwells provided as required means of egress from enclosed buildings/structures.
- A.14.3.6.10 Clearances shall be reflected in the 3D model to demonstrate that the appropriate clearances have been provided. This is subject to review by Buyer for approval.
- A.14.3.7 Consideration of the Effects of Settlement
 - A.14.3.7.1 The design of foundations, as well as the superstructures and equipment supported by them, shall consider the effects of settlement, both total and differential settlements, and include the resulting effects into the design of these elements.
 - A.14.3.7.2 The settlements to be considered are those occurring within a single foundation or structure and those occurring between multiple foundations or structures that are adjacent to one another. The settlement consideration effects should be consistent with the manner of design for any and all elements that interconnect within or between the foundations and/or structures (e.g., piping, equipment skids, conduit, cable tray).
 - A.14.3.7.3 The settlements, both total and differential, and their effects, shall satisfy the equipment manufacturer's requirements for settlement limits.
- A.14.3.8 Architectural

- A.14.3.8.1 The architectural features and accessibility requirements for this Facility shall be designed in accordance with the adopted version of the International Building Code (IBC), the International Energy Conservation Code (IECC) and OSHA. The facility shall conform to NFPA 850 Recommended Practices for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations. The Administration/Control Building shall also be designed to meet the requirements of the Americans with Disabilities Act (ADA). Architectural features shall be designed to meet the applicable requirements of the local Zoning Ordinance.
- A.14.3.9 Maintenance Crane Requirements
- A.14.3.9.1 The Seller's equipment design and layout shall consider access for future mobile cranes for maintenance activities for all large equipment, including but not limited to the CTs, HRSGs, STs, generators, valves, and pumps. The Seller's Equipment design and layout shall provide adequate space for both the maintenance crane and laydown areas for all Equipment and Systems that comprise the Facility. The plan developed by the Seller for future mobile cranes shall be a deliverable to the Buyer.
- A.14.3.10 Design Codes, Standards, Laws and Ordinances
- A.14.3.10.1 As a minimum, all structures and site improvements shall be designed and constructed in accordance with the requirements or recommendations contained in the following codes, specifications, and standards, except where more stringent requirements are shown or specified. If provisions of these documents conflict, the more stringent requirement shall apply unless otherwise approved by Buyer.
- A.14.3.10.2 When an edition date is not indicated in IBC, the latest edition and addenda in effect as of the date of the Contract shall apply.
- A.14.3.10.3 Federal
- A.14.3.10.3.a Title 29, Code of Federal Regulations (CFR), Part 1910, Occupational Safety and Health Standards.
- A.14.3.10.3.b Title 40, CFR Section 112 et seq., US Environmental Protection Agency (EPA), requires a Spill Prevention Control and Countermeasure (SPCC) plan for facilities storing in excess of 1320 gallons in aggregate tanks aboveground and 42,000 gallons below ground. The permanent SPCC plan will be prepared by Buyer. The Construction SPCC plan shall be prepared and maintained by the Seller. Secondary oil containment shall be provided for all equipment containing 55 gallons of oil or more.
- A.14.3.10.4 State

- A.14.3.10.4.a Department of Transportation of the state in which the Project is located, Standard Specifications and applicable Special Provisions and Reference Specifications, as last revised.
- A.14.3.10.4.b Occupational Safety and Health Act (OSHA)
- A.14.3.10.4.c Department of Environmental Quality of the state in which the Project is located.
- A.14.3.10.4.d Accessibility Code (ADA)
- A.14.3.10.5 Local County Code(s), as required.
- A.14.3.10.6 Industry Codes and Standards
 - A.14.3.10.6.a The following general design requirements and procedures shall be followed in development of Facility specifications regarding the use of Codes and Industry Standards.
 - A.14.3.10.6.a.1 Specifications for materials shall follow the standard specifications of the ASTM International (ASTM) and the American National Standards Institute (ANSI).
 - A.14.3.10.6.a.2 Field and laboratory testing procedures for materials shall follow standard ASTM specifications.
 - A.14.3.10.6.a.3 Design and placement of structural concrete shall follow the recommended practices, of the American Concrete Institute (ACI), IBC, the Concrete Reinforcing Steel Institute (CRSI), and the Precast/Prestressed Concrete Institute (PCI).
 - A.14.3.10.6.a.4 Design, fabrication, and erection of structural steel shall follow the recommended practices of the American Institute of Steel Construction (AISC) and IBC.
 - A.14.3.10.6.a.5 Steel components for metal wall panels and roof decking shall conform to the American Iron and Steel Institute (AISI) “North American Specification for the Design of Cold-Formed Steel Structural Members.”
 - A.14.3.10.6.a.6 Welding procedures and qualifications for welders shall follow the recommended practices and codes of the American Welding Society (AWS).
 - A.14.3.10.6.a.7 Preparation of metal surfaces for coating systems shall follow the specifications and standard practices of the Society for Protective Coatings (SSPC), National Association for Corrosion Engineers (NACE), and the specific instructions of the coatings manufacturer.
 - A.14.3.10.6.a.8 Fabrication and erection of grating shall follow applicable standards of the National Association of Architectural Metals Manufacturers (NAAMM).
 - A.14.3.10.6.a.9 Design and erection of masonry materials shall follow the recommended practices and codes of ACI/ASCE/TMS Masonry Designer’s Guide and IBC.

- A.14.3.10.6.a.10 Plumbing shall conform to the International Plumbing Code IPC.
- A.14.3.10.6.a.11 Design of roof coverings shall conform to the requirements of the National Fire Protection Association (NFPA).
- A.14.3.10.6.a.12 Design of roadways shall conform to the Project state's Department of Transportation Standard and Specifications.
- A.14.3.10.6.a.13 Design, testing, construction and installation for specialty items, proprietary items, and patented items shall follow International Code Council (ICC) report recommendations, and manufacturer recommendations, where applicable.
- A.14.3.10.6.a.14 Product certifications shall be UL listed.
- A.14.3.10.6.b Unless stated otherwise in the Contract documentation, the latest revision of the following Codes and Industry Standards, in effect by the jurisdiction having authority at the time of contract execution, shall be used:
- A.14.3.10.6.b.1 IBC, International Building Code with all Errata.
- A.14.3.10.6.b.2 American Institute of Steel Construction (AISC).
- ANSI/AISC 360 "Specification for Structural Steel Buildings".
 - Code of Standard practice for Steel Buildings and Bridges.
 - Specification for Structural Joints Using High Strength Bolts.
 - Manual of Steel Construction
 - AISC 341 "Seismic Provisions for Structural Steel Buildings"
 - Design Guide 3 - Serviceability Design Considerations for Steel Buildings
- A.14.3.10.6.b.3 American Iron and Steel Institute (AISI) "North American Specification for the Design of Cold-Formed Steel Structural Members"
- A.14.3.10.6.b.4 Association for Iron & Steel Technology (AIST) - Technical Report 13: Guide for the Design and Construction of Mill Buildings
- A.14.3.10.6.b.5 American Welding Society (AWS)
- D1.1 Structural Welding Code – Steel
 - D1.3 Structural Welding Code – Sheet Steel
 - D1.4 Structural Welding Code – Reinforced
 - D1.6 Structural Welding Code – Stainless Steel
- A.14.3.10.6.b.6 American Concrete Institute (ACI)

- ACI 117 “Standard Specification for Tolerances for Concrete Construction Materials”
- ACI 207.1R “Guide to Mass Concrete”
- ACI 211.1 “Recommended Practice for Selecting Proportions for Normal and Heavy Weight Concrete”
- ACI 212.3R “Chemical Admixtures for Concrete”
- ACI 301 “Specification for Structural Concrete for Buildings”
- ACI 302.1R “Guide for Concrete Floor and Slab Construction”
- ACI 305.1 “Specification for Hot Weather Concreting”
- ACI 305R “Guide to Hot Weather Concreting”
- ACI 306.1 “Specification for Cold Weather Concreting”
- ACI 306R “Guide to Cold Weather Concreting”
- ACI 308.1 “Standard Specification for Curing Concrete”
- ACI 309R “Guide for Consolidation of Concrete”
- ACI 315 “Details and Detailing of Concrete Reinforcement”
- ACI 318 “Building Code Requirements for Structural Concrete”
- ACI 350R “Code Requirements for Environmental Engineering Concrete Structures”
- ACI 351.3R “Foundations for Dynamic Equipment”
- ACI 530 “Building Code Requirements for Masonry Structures”
- ACI 530.1 “Specifications for Masonry Structures”
- Other ACI Codes Referenced herein

A.14.3.10.6.b.7 Concrete Reinforced Steel Institute (CRSI), Design Handbook

A.14.3.10.6.b.8 Precast/Prestressed Concrete Institute, PCI Design Handbook Precast and Prestressed Concrete

A.14.3.10.6.b.9 Masonry Designers Guide

A.14.3.10.6.b.10 American Society of Civil Engineers (ASCE)

- ASCE/SEI (ASCE) 7, Minimum Design Loads and Associated Criteria for Buildings and Other Structures

- A.14.3.10.6.b.11 ASTM International (ASTM). The version of the following codes and standards as listed in IBC shall be included as a minimum:
- ASTM A6 “General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use”
 - ASTM A36 “Specification for Carbon Structural Steel”
 - ASTM A53 “Standard Specification for Pipe, Steel Black and Hot-Dipped, Zinc Coated, Welded and Seamless”
 - ASTM A153 “Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware”
 - ASTM A276 “Standard Specification for Stainless Steel Bars and Shapes”
 - ASTM A283 “Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates”
 - ASTM A307 “Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength”
 - ASTM A500 “Standard Specification for Cold-formed Welded and Seamless Carbon Steel Structural Tubing in rounds and Shapes”
 - ASTM A572 “Standard Specification for High Strength, Low Alloy Columbium-Vanadium Structural Steel”
 - ASTM A606 “Standard Specification Steel, Sheet and Strip, High-Strength Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance”
 - ASTM A615 “Standard Specification Deformed and Plain Billet Steel Bars for Concrete Reinforcement”
 - ASTM A653 “Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process”
 - ASTM A695 “Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, for Fluid Power Applications”
 - ASTM A706 “Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement”
 - ASTM A992 “Standard Specification for Steel for Structural Shapes for Use in Building Framing.”
 - ASTM A1011 “Standard Specification for Steel, Sheet and Strip, Hot Rolled Carbon, Structural, High Strength Low-Alloy and High Strength Low-Alloy with improved Formability.”
 - ASTM A1064 “Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

- ASTM C94 “Standard Specification for Ready-Mixed Concrete”
- ASTM D422 “Standard Test Method for Particle-Size Analysis of Soils” (Withdrawn 2016)
- ASTM D1143 “Test Methods for Deep Foundations Under Static Axial Compressive Load”
- ASTM D1556/D1556M “Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method”
- ASTM D1557 “Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³))”
- ASTM D2167 “Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method”
- ASTM D2216 “Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass”
- ASTM D2487 “Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)”
- ASTM D2488 “Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)”
- ASTM D3689 “Standard Test Methods for Deep Foundations Under Static Axial Tensile Load”
- ASTM D3966 “Standard Test Methods for Deep Foundations Under Lateral Load”
- ASTM D4318 “Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils”
- ASTM D4945 “Standard Test Method for High-Strain Dynamic Testing of Deep Foundations”
- ASTM D5882 “Standard Test Method for Low Strain Impact Integrity Testing of Deep Foundations”
- ASTM D6938 “Standard Test Methods for In-Place Density and Water Content of Soil and Soil Aggregate by Nuclear Methods (Shallow Depth)”
- ASTM F1136 “Zinc/Aluminum Protective Coatings for Fasteners”
- ASTM F1554 “Standard Specification for Anchor Bolts, Steel, 36, 55 and 105-ksi Yield Strength”
- Other ASTM Standards Referenced herein

A.14.3.10.6.b.12 NAAMM Manual – Metal Bar Grating Manual

- A.14.3.10.6.b.13 SDI Manual of Construction with Steel Deck
- A.14.3.10.6.b.14 The Society for Protective Coatings (SSPC)
- SSPC-PA1 “Shop, Field and Maintenance Painting of Steel”
 - SSPC-PA2 “Measurement of Dry Coating Thickness with Magnetic Gauges”
 - SSPC-SP6/NACE No. 3 “Commercial Blast Cleaning”
- A.14.3.10.6.b.15 Aluminum Association, “Aluminum Design Manual”
- A.14.3.10.6.b.16 American Water Works Association (AWWA)
- AWWA D100-11 — “Welded Carbon Steel Tanks for Water Storage”
 - AWWA D103-19 — “Factory Coated Bolted Carbon Steel Tanks for Water Storage”
- A.14.3.10.6.b.17 American Association of State Highway and Transportation Officials (AASHTO)
- A Policy on Geometric Design of Highways and Streets
- A.14.3.10.6.b.18 Manual on Uniform Traffic Control Devices (MUTCD), Federal Highway Administration (FHA)
- A.14.3.10.6.b.19 Asphalt Institute - The Asphalt Handbook (MS-4)
- A.14.3.10.6.b.20 Heating, Ventilating, and Air Conditioning Guide by American Society of Heating, Refrigeration, and Air Conditioning engineers (ASHRAE)
- A.14.3.10.6.b.21 International Energy Conservation Code (IECC)
- A.14.3.10.6.b.22 National Fire Protection Association (NFPA) Standards
- A.14.3.10.6.b.23 International Association of Plumbing and Mechanical Officials
- A.14.3.10.6.b.24 American Society of Nondestructive Testing Recommended Practice (ASNT-TC-1A)
- A.14.3.10.6.b.25 International Organization for Standardization (ISO) 10816-1 “Evaluation of Machine Vibration by Measurements on Non-Rotating Parts”
- A.14.3.10.6.b.26 CMAA, Crane Manufacture Association of America
- A.14.4 ARCHITECTURAL REQUIREMENTS
- A.14.4.1.1 General architectural requirements including code references are included in Section A.14.3.

- A.14.4.1.2 See Section A.14.13 (Surface Preparation and Protective Coatings) for protective coatings of structural steel for buildings, enclosures and canopies.
- A.14.4.1.3 All building metal siding, roofing, trim, and accessories with painted finish colors will be selected by Buyer from the manufacturer's standard colors.
- A.14.4.1.4 Accessibility (ADA) Requirements. The design and construction of the Facility including, but not limited to toilet facilities, kitchen and breakroom facilities, clearances, doors, hardware, slopes, stairs, and ramps shall comply with the accessibility requirements of the ADA. The accessibility requirements will apply to only regularly occupied facilities such as the Control/Administration Building.
- A.14.4.1.5 All exterior doors, except the roll-up type, shall have an exterior awning provided above the door. All exterior doors shall have either concrete stoop or concrete ramp for those buildings required to meet the ADA requirements.
- A.14.4.1.6 Interior, exterior and emergency lighting at all buildings, enclosures and canopies shall be LED lighting as specified in Section A.12, Electrical Requirements and Design Criteria.
- A.14.4.1.7 As a minimum, provide buildings and equipment enclosures as indicated in Section A.15, Building and Equipment Enclosure Requirements, with heating, cooling and ventilation systems as indicated.
- A.14.4.2 Pre-Engineered Buildings
- A.14.4.2.1 Pre-Engineered Buildings shall comply with all Applicable Laws and requirements. Building design, fabrication and erection shall be in accordance with the MBMA Metal Building Systems Manual.
- A.14.4.2.2 In general, materials and installation of architectural systems or components shall be as follows:
- A.14.4.2.2.a Exterior Walls: Walls shall be metal wall panel systems of the factory assembled or field erected type and minimum thickness of exterior sheet of 22 gauge, minimum, galvanized steel unless greater thickness is required by the design. Steel panels shall be zinc-coated steel conforming to ASTM A653, G 90 coating designation. Wall panels shall have configurations for overlapping sheets or interlocking ribs for securing adjacent sheets. Exterior wall panels shall be fastened to framework using concealed fasteners. Girt system will remain exposed in unoccupied areas. Refer to A.14.13 for more information.
- A.14.4.2.2.b Installed walls shall be weathertight and shall provide a "U" factor in accordance with the ASHRAE Handbook. Thermal transmittance of insulated assemblies shall be not more than 0.052.
- A.14.4.2.2.c Non-rated interior partitions: Partitions shall be provided for room separations. Partitions shall be of durable construction in all areas. Occupied areas shall have gypsum board partitions with light gauge metal framing. At occupied areas provide single sided gypsum liner wall at inside of building exterior walls and at building structure.

- A.14.4.2.2.d Fire rated Partitions: Partitions shall be provided for area separations, and as required by code. Partitions shall be of durable construction, and all openings and penetrations shall be protected and sealed.
- A.14.4.2.2.e Fire Exits: Fire exits shall be provided at outside walls as required by code. Exit signs shall be provided as required by code. Fire doors shall bear an Underwriters Laboratory (UL) certification level for class of opening and rating for door, frame, and hardware. Doors shall conform to SDI hollow metal door requirements and have fillers adequate to meet the fire rating.
- A.14.4.2.2.f Doors: Doors and frames shall be insulated hollow metal type with weather seals and BHMA Grade 1 hardware. Doors and frames shall have a minimum 16 gauge face thickness and frames shall have a minimum 14 gauge face thickness. Exterior doors and frames shall be formed from galvanized sheet steel. Hardware components shall have a stainless steel, factory finish. Exterior doors shall be insulated to meet energy code requirements and shall be provided with electrified access hardware. Interior and exterior door locations shall be provided with electrified access hardware in accordance with NERC CIP requirements.
- A.14.4.2.2.g Roll-Up Doors: Roll-up doors shall be insulated roll-up steel type with weather seals and windlocks. Components shall be formed from galvanized steel, factory assembled, and factory painted. Doors shall be motor-operated with manual override operation feature. Exterior doors shall be insulated to meet energy code requirements. Doors shall be designed to accommodate the height and width requirements of the equipment within the building and access for maintenance vehicles. Minimum height of warehouse roll-up door shall be 16 feet.
- A.14.4.2.2.h Roofs: Roofs shall be metal roof systems of the factory assembled or field erected type and minimum thickness of exterior sheet 22 gauge sheet steel unless greater thickness is required by the design. Steel panels shall be zinc-coated steel conforming to ASTM A653, G 90 coating designation. Roof panels shall be a minimum 2-inch standing seam with concealed clip. Design provisions shall be made for thermal expansion and contraction consistent (if required) with the type of system to be used. Roof shall not deflect more than 1/240 of span under live load and the roof shall not deflect more under temporary construction load. Roofs shall be sloped to drain into a gutter and downspout system.
- A.14.4.2.2.i Installed roofs shall be weathertight and shall provide a “U” factor in accordance with the ASHRAE Handbook. Thermal transmittance of insulated assemblies shall be not more than 0.035.
- A.14.4.2.2.j Wall and roof panels shall have a factory applied polyvinylidene fluoride finish (70 percent minimum KYNAR) on the exterior side. The finish shall be a minimum of 1 mil thickness consisting of a baked fluoropolymer enamel topcoat factory applied over an appropriate prime coat. Coating shall have a guarantee against fading, chalking, peeling, cracking, checking, chipping, and corrosion for a minimum of 30 years.

- A.14.4.2.2.k Color Schemes: Color schemes shall be selected for overall compatibility, coordinate colors with Buyer standards. All color selections shall be submitted for approval by Buyer.
- A.14.4.2.2.l Signage: Signs and graphic designs for identification and directions shall be incorporated into the interior finishes of each area. Signs shall be placed for safety, ease of operation and direction. The sign system shall provide simple and direct indications using both graphics and text as required. All signage shall comply with ADA requirements.
- A.14.4.2.2.m Pre-engineered metal buildings (packaged to include exterior doors, wall louvers, windows, and related enclosure components) shall be of manufacturers standard modular rigid frame construction with tapered or uniform depth rafters rigidly connected at ends to pinned base tapered or uniform depth columns. Purlins and girts shall be cold-formed “C” or “Z” sections conforming to “North American Specifications for Design of Cold-Formed Steel Structural Members” of American Iron and Steel Institute (AISI). All other members shall be hot rolled shapes conforming to “Specification for Design, Fabrication and Erection of Structural Steel for Buildings” of American Institute of Steel Construction (AISC).

A.14.4.2.3 Architectural Finishes:

A.14.4.2.3.a Architectural finishes in the buildings shall conform to the following table as applicable.

BUILDING	ROOM NAME	FLOOR	WALL	CEILING
Control/Admin Building	Vestibule	WT	GBP*/**	SAT
	Conference Room(s)	CPT	GBP*/**	SAT
	Offices	CPT	GBP*/**	SAT
	Toilets	CT	CWT	SAT
	Lockers	CT	GBP*/**	SAT
	File & Copy	MC	GBP*/**	SAT
	Corridors and Open Office	MC	GBP*/**	SAT
	Reception	CPT	GBP*/**	SAT
	Conference Room/Lunchroom	MC	GBP*/**	SAT
	Control Room	AF**	GBP*/**	SAT
	Simulator Room (if req'd)	CPT	GBP*/**	SAT
	DCS Room	AF**	PFR/MWLP	EX
	Telephone/Communications	MC	GBP */**	EX
	Electrical Equipment Room	MC	GBP/MWLP	EX
	LOTO Room	CPT	GBP*/**	SAT
Warehouse	Warehouse	MC	MWLP/CMUP*	EX
	Warehouse Office (if req'd)	CPT	MWLP/CMUP*	SAT
	Storage Space	MC	MWLP/CMUP*	EX
	Laundry/JC	MC	MWLP/CMUP*	EX
	Climate Controlled Storage	MC	MWLP	EX
	I&C Shop	MC	CMUP*	SAT
	Maintenance Shop*	MC	MWLP/CMUP*	EX
	Warehouse Toilets	MC	CWT	SAT
Water Treatment Building	-			
	Water Treatment	MC*	MWLP	EX
	Electrical	MC	MWLP/CMUP*	EX
	Lab (if req'd)	MC*	MWLP/CMUP*	SAT

Floor Finishes:

AF	Access Flooring System, static dissipative
MC	Cast-in-place concrete with concrete polish system, Retroplate Level 3 Finish
CT	Ceramic tile
CPT	Carpet tile
CHFP	Checkered Floor Plate
WT	Walk-off Tile
*	Specialty coatings will be applied in areas subject to acid or chemical spills
**	Vinyl tile will be static dissipative type

Wall Finishes:

GBP	Painted gypsum board on metal studs
MWLP	Metal wall liner panel at pre-manufactured building exterior walls
CMUP	Filled, painted concrete masonry
CWT	Glazed ceramic tile over masonry or gypsum board
VWC	Vinyl wall covering
PFR	Plywood, fire-rated (Provide as needed for mounting equipment and panels)
*	Provide rubber base throughout finish areas
**	Provide rigid plastic corner guards throughout finish areas

Ceiling Finishes:

SAT	Suspended acoustical tile (water resistant finish for use in toilet rooms)
EX	Exposed to structure

- A.14.4.2.4 Plastic laminate casework, solid surface countertops, toilet room partitions and toilet accessories shall meet IBC and ADA requirements.
- A.14.4.2.5 Unless noted office furniture, appliances, cubical walls, and security hardware required in each building will be furnished and installed by Buyer.
- A.14.4.2.6 Control Room furniture including operator stations shall be furnished and installed by Seller.
- A.14.5 **MATERIALS**
- A.14.5.1 All material for the items listed below shall be new and shall be certified to be in accordance with the applicable specification, or better with Buyer's review and approval. Evidence of certification shall be on file in the Seller's office and furnished to Buyer upon request.
- A.14.5.2 Certified copies of material test reports shall be available in the Seller's file, showing chemical and mechanical properties and the results of each test required by the material specification, for all steel materials furnished under this specification, unless otherwise noted herein.

A.14.5.3 Certificates of Conformance in lieu of material test reports may be accepted as documentation of the above requirements, only upon the written approval of Buyer.

- Structural Steel (Hot-dipped galvanized per ASTM A123)

Wide flange shapes	ASTM A992
Angles, channels, plates	ASTM A36, A992 or A572 Gr 50
Hollow structural sections	ASTM A500 Grade B or C
Structural pipe	ASTM A53 Grade B
Plate Girders (fabricated from plates)	ASTM A572, Gr 50
- Structural Steel Connections
 - High Strength Bolts

	ASTM F3125 Grade A325, Type 1, Zinc-Coated (Mechanically galvanized), ASTM B695, Class 12, 3/4" dia. (min).
	ASTM F3125 Grade F1852, Type 1, Zinc-Coated (Mechanically galvanized), ASTM B695, Class 12, 3/4" dia. (min).
	ASTM F3125 Grade A490, (zinc/aluminum coated), F1136 Grade 3, 1 1/8 inch dia.
 - Nuts

	ASTM A563-DH, Grade C Heavy Hex Zinc Coated (Mechanically galvanized), ASTM A153 Class C
 - Washers

	ASTM F436, Zinc-Coated (Mechanically galvanized), ASTM A153 Class C
- Structural Steel Welding Filler

	AWS D1.1 and Table 3.2 therein, E70XX

- Concrete
 - Conforming to ACI 301
 - Minimum 28 day compressive strengths f'_c
 - 2000 psi (lean concrete)
 - 3000 psi (ductbank)
 - 4000 psi (structural concrete)
 - 5000 psi (water retention structures)
 - Cement
 - ASTM C150, C595, or C1157
 - Fly Ash
 - ASTM C618, Class F or C
 - Aggregates
 - ASTM C33
 - Water
 - ASTM C1602
 - Air-entraining Admixture
 - ASTM C260
 - Water-Reducing Admixture
 - ASTM C494, Type A
 - Accelerating Admixture
 - ASTM C494, Type C or E
 - Retarding Admixture
 - ASTM C494, Type B or D
 - Liquid Membrane-Forming Curing Compound
 - ASTM C309, Type II, Class B
- Non Shrink Grout
 - ASTM C1107
- Masonry
 - Concrete Masonry Units
 - ASTM C90, Type 1, moisture-controlled, medium weight minimum individual unit compressive strength $f'_m = 1,500$ psi
 - Masonry Mortar
 - ASTM C270, Type S or M
 - Masonry Grout
 - ASTM C476, 2000 psi minimum compressive strength
- Reinforcing Steel:
 - Reinforcing Bars
 - ASTM A615 or ASTM A706
- Anchor Rods:
 - Standard:
 - Rods
 - ASTM F1554 Gr 36
 - Nuts
 - ASTM A563 heavy hex, Zinc-Coated, ASTM A153 Class C

Washers	ASTM F436, Zinc-Coated, ASTM A153 Class C
High Strength:	
Rods	ASTM F1554 Gr 55 w/ S1 Supplement or Gr 105
Nuts	ASTM A194, heavy hex
Washers	ASTM F436
Drilled-in Anchors	Hilti Post-Installed anchors or approved equal
Plastic Anchor Bolt Sleeves	Wilson Anchor Bolt Sleeves or approved equal
Headed Concrete Anchors	ASTM A108
• Guardrail/Handrail	ASTM A500, 1-1/2" nominal diameter schedule 40 pipe. Hot-dipped galvanized.
• Toe (Guard) Plate	ASTM A36 1/4" thick, (projecting 4" above platform surface), Hot-dipped galvanized
• Visible Abrasive Nosings:	
Exterior	Alumalun, Type B as distributed by American Abrasive Metals Co., or approved equal
• Floor Grating and Stair Treads	ASTM A569 steel, Hot-dipped galvanized per ASTM A123
• Checkered Floor Plate	ASTM A36 with a symmetrical raised diamond pattern, 1/4" minimum thickness, Hot-dipped galvanized

A.14.6 STRUCTURAL LOADS AND LOAD COMBINATIONS

A.14.6.1 General:

A.14.6.1.1 For the purpose of determining design loads, the Facility shall be considered as an essential facility. Design loads to be applied to the structure and foundations consist of the following:

- Dead load
- Live load
- Snow and Ice load (refer to Section A.9 – Site Requirements and Design Criteria)
- Wind loads
- Seismic loads
- Erection loads, including crane loads, shall be temporary loads imposed on structures, foundations, underground piping and utilities, culverts, and manholes during the erection of structures, installation, and maintenance of equipment.

- Operating load shall be dead load plus weight of any fluid or solid present during operating conditions and/or permanently stored materials. Operating load shall have the same load factor as dead load. For load combinations, consideration for both full and empty conditions shall be made. Seller shall determine and use appropriate minimum uniform operating load values for pipe rack, and other structures.
- Maintenance loads shall be temporary loads resulting from repairs or dismantling of equipment. Maintenance loads shall be considered as a live load.
- Vehicle load shall be that load caused by vehicles (forklifts, cranes, trucks; special trucks for heavy hauling) during construction and plant operation.
- Test load shall be dead load plus weight of any fluid or solid necessary to test equipment or piping.
- Rain loads shall be in accordance with ASCE 7, Chapter 8.
- Torsional loads shall be loads creating torsion or loads not passing through the shear center of a structure.
- Settlement load shall be the load due to differential settlements of equipment and structure foundations.

Detailed descriptions of design loads being applied to the structure and foundations consist of the following:

A.14.6.2 Dead Load:

A.14.6.2.1 Dead load shall be considered as the weight of all permanent construction, including, but not limited to, framing, walls, floors, platforms, roofs, partitions, stairways, handrails, insulation, lagging and the operating weight of all fixed equipment. Operating weight includes the deadweight of the equipment plus any additional weight of removable portions and any constant horizontal or vertical forces resulting from machine operation. Actual equipment operating loads shall be used whenever they exceed the live load allowance for the area occupied by the equipment.

A.14.6.3 Live Load:

A.14.6.3.1 General:

A.14.6.3.1.a Live load includes any movable load or other load that can vary with intensity or occurrence, such as crane loads and uniform floor live load.

A.14.6.3.1.b The live load to be used is the greater of that specified in ASCE 7, given by equipment vendor, or that shown in the Table, Minimum Uniform Live Loads, below. In addition to these loads, other live loads, including erection loads, turbine rotor emergency loads, generator emergency loads, equipment thermal loads, crane loads, and horizontal skidding loads shall be considered where appropriate.

Minimum Uniform Live Loads

<u>Location</u>	<u>Live Load</u>	<u>Remarks</u>
Steam Turbine Ground Floor Slabs	500 psf	Note a
Steam Turbine Mezzanine Floor	200 psf	If applicable
Steam Turbine Operating Floor Deck Slab	300 psf	If applicable
Other Building Ground Floor Slabs	350 psf	Note a
Above Grade Concrete Slabs	200 psf	
Grating floors, access platforms	100 psf	
Stairs, stair landings	100 psf	Note b
Walkways	100 psf	
Roof Live Load	20 psf	Or snow, including drifts, if greater. Also Note e.
Concrete sidewalks, driveways, slabs, or pavement subject to trucks or fire equipment	HS20-44 or HL-93	AASHTO Loading; whichever is more severe
Underground piping, utilities, culverts, manholes	HS20-44 or HL-93	AASHTO Loading and erection loading (including cranes) whichever is more severe
Control/Admin Bldg false floor	200 psf	Or actual equipment load, whichever is greater

Notes Applying to Design Live Loads:

- A truck may operate over accessible areas. The ground floor slabs and grade slabs including truck aisles and entrances shall be designed to carry an AASHTO truck load plus impact. This load will not be combined with any other live load and should not reduce the strength required by other design parameters.
- Members will be designed to support safely the uniformly distributed live load or a concentrated load of 1000 pounds applied at any point on the stairs.
- Equipment loads shall be used when they exceed the live load stated. Equipment and minimum uniform live loads will not be applied simultaneously.
- Equipment removal loads shall be considered.
- Where access to and service of roof-top equipment is required, a minimum live load of 40 psf shall be used over the required roof area.

A.14.6.3.2 Live Load Reduction

- A.14.6.3.2.a No reduction of live load is allowed for roofs and storage areas. Likewise, no reduction of live load shall be made in the design of slabs.

A.14.6.3.3 Live Load Posting and Drawing Notation

- A.14.6.3.3.a The live load used for design shall be shown on the design drawings. If a special live load applies to a partial area, the limits of the special loading shall be shown on the drawings and the building posted accordingly.
- A.14.6.4 Wind Load
 - A.14.6.4.1 General
 - A.14.6.4.1.a Design wind pressures shall be determined in accordance with the provisions and design parameters indicated in Section A.9 – Site Requirements and Design Criteria of this document.
 - A.14.6.5 Seismic Load
 - A.14.6.5.1 General
 - A.14.6.5.1.a Seismic loads shall be determined in accordance with the provisions and design parameters indicated in Section A.9 – Site Requirements and Design Criteria of this document.
 - A.14.6.5.1.b Every building, structure, equipment, and facility, as a minimum requirement, shall be designed and constructed to resist seismic forces determined in accordance with ASCE 7.
 - A.14.6.5.1.c In addition, Architectural, Mechanical, and Electrical components shall be designed and constructed to resist seismic forces determined in accordance with ASCE 7.
 - A.14.6.6 Soil and Hydrostatic Pressure Loads
 - A.14.6.6.1 All below grade and soil retaining structures shall be designed for the applicable soil and hydrostatic pressures. The lateral design pressure shall be determined from the buoyant weight of the soil plus full hydrostatic pressure if/when the adjacent soil is below the water table.
 - A.14.6.6.2 Appropriate surcharge loading, resulting from adjoining structures and concentrated loads from heavy equipment (e.g., nearby tanks, trucks, concrete trucks, construction cranes, etc.) shall be considered in the lateral design pressures. A minimum uniform surcharge load of 500 psf (at the grade surface) shall be used for the design of all below grade structures and foundations.
 - A.14.6.7 Excursion Loads
 - A.14.6.7.1 Excursion conditions (i.e., unusual or infrequent loadings) shall be considered as a separate loading condition beyond the normal operating load(s).
 - A.14.6.8 Temporary Load
 - A.14.6.8.1 Provision shall be made for temporary loads arising from the installation of the heavy machinery and equipment.

- A.14.6.9 Equipment Load
- A.14.6.9.1 Static and dynamic equipment loads shall be as specified on the Manufacturer's drawings.
- A.14.6.10 Impact Load
- A.14.6.10.1 Impact loads shall be those loads caused by impact, i.e., crane loads, moving vehicles, water hammer, etc. Where live loads induce impact on the structure, the assumed live load shall be increased to account for the impact as required. Unless specified otherwise, the increase shall be consistent with IBC and ASCE 7.
- A.14.6.11 Vibratory, Thermal and Friction Loads
- A.14.6.11.1 These loads shall be included in the design and shall include loads as specified by the equipment manufacturers.
- A.14.6.12 Load Combinations
- A.14.6.12.1 Loads shall be applied and combined in accordance with load combinations given in ASCE 7, and as described herein.
- A.14.6.12.2 Load combinations include normal operating, test, excursion, and severe environmental loading conditions, with separate combinations for extraordinary events as given by ASCE 7.
- A.14.7 CIVIL DESIGN
- A.14.7.1 Nominal Site Grade: By Seller
- A.14.7.1.1 Top of Concrete: Elevation 6" higher than the Nominal Finish Grade Elevation"
- A.14.7.1.2 Nominal Finish Site Grade: Elevation to be higher than a 100-year Flood Site Elevation (high point)
- A.14.7.1.2.a Not Used.
- A.14.7.1.2.b Not Used.
- A.14.7.1.3 Plant Coordinate System:
- A.14.7.1.3.a All horizontal survey control shall be established to the state Plane Coordinate System. Vertical control shall be set to North American Vertical Datum of 1988 (NAVD 1988).
- A.14.7.1.3.b A local grid system may be established if Plant North is rotated from State Plane North, and/or out of convenience relative to coordinate size.
- A.14.7.2 Description of Civil Site Development Scope

- A.14.7.2.1 This Civil scope shall include, but not be limited to the following:
- Temporary and Permanent Soil Erosion and Sediment Control
 - Dewatering
 - Clearing and Grubbing
 - Debris and Offsite Disposal in a Licensed Landfill
 - Stripping and Stockpiling of Topsoil
 - Subgrade Preparation
 - On-site Laydown and Construction Craft Parking Areas
 - Onsite Heavy Haul Transport Path
 - Excavation, Fill and Backfill
 - Grading and Drainage
 - Storm Water Drain System and Detention Pond(s), if applicable
 - CDS Hydrodynamic Separators for storm water effluent
 - Sanitary Sewer System, with Lift Station
 - Oily Water Sewer System with Below Grade, Double Wall Oil/Water Separator
 - Paving
 - Chain Link Security Fencing and Gates
 - Truck Containment Pad for Ammonia Deliveries
 - Construction Storm Water Pollution Prevention Plan
- A.14.7.3 Reference Documents
- A.14.7.3.1 The design and construction of this Facility shall be in accordance with all Applicable Laws.
- A.14.7.3.2 All civil design and construction shall be in accordance with the applicable codes, specifications, and standards, except where more stringent requirements are shown or specified. Where provisions of these conflict, the more stringent shall apply unless otherwise approved by Buyer.
- A.14.7.4 Excavation and Backfill
- A.14.7.4.1 Quality Assurance
- A.14.7.4.1.a During the course of the Work, a third-party Testing Service shall perform inspections and tests to identify materials and to determine characteristics, moisture content, and density of compacted fill. These tests will be used to verify that the fill conforms to the minimum requirements of this Specification.
- A.14.7.4.1.b Seller shall perform existing utility identification using geophysical and hydrovac techniques for all excavations within and outside power block area.
- A.14.7.4.2 Project Conditions
- A.14.7.4.2.a See Section A.1 – Project Requirements, for general project conditions.
- A.14.7.4.3 Soil Materials

- A.14.7.4.3.a Soil materials that are suitable for use as fill and backfill shall be GW, GP, SW, SP, SM (with less than 20 percent passing the No. 200 sieve) or CL (with Liquid Limit less than 40). These soil classifications noted are in accordance with Unified Soil Classification System (USCS), ASTM D2487. Soils meeting the definitions which require dual-symbols composed of the approved list of materials above are also acceptable for use as fill and backfill.
- A.14.7.4.3.b Unless otherwise specified by Project geotechnical report and recommendations, unsuitable material for use in construction for fill and backfill are highly plastic material, silts and organic soils classified in accordance with the USCS, ASTM D2487, as ML, MH, PT, OL and OH. Unsuitable backfill and fill also consists of loose, soft, disturbed, frozen, excessively wet, debris and rubbish materials.
- A.14.7.4.3.c Unless otherwise specified by Project geotechnical report and recommendations, unsuitable subgrade materials are highly plastic soils, silts and organic soils classified in accordance with the USCS, ASTM D2487, as MH, PT, OL, OH and uncontrolled fill or debris. Unsuitable subgrade also consists of loose, soft, disturbed, frozen, excessively wet, non-compacted (minimum required is 95% percent of maximum dry density as determined by the modified Proctor test ASTM D1557) materials consisting of ML, CL, GW, GP, GM, GC, SW, SP, SM, and SC.
- A.14.7.4.3.d Utility Bedding and Trench Backfill material shall consist of manufactured angular material including crushed stone, stone screenings, and crushed stone-sand mixtures or sand with little or no fines (material passing the No. 200 sieve) with material quality and placement requirements meeting the more stringent of standard industry practices and the requirements for backfill described herein.
- A.14.7.4.4 Storage of Soil Materials
- A.14.7.4.4.a Stockpile borrow materials and suitable excavated soil materials in an onsite area acceptable to Buyer and protected with sediment and erosion control devices. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover as necessary to prevent fugitive dust.
- A.14.7.4.4.b Stockpile soil materials away from edge of wetlands and excavations per OSHA regulations.
- A.14.7.4.5 Excavation
- A.14.7.4.5.a Areas designated for excavation or fill shall be stripped of all topsoil and all other organic material. Weeds, small roots, heavy grass, and other vegetation remaining after clearing and grubbing operations shall be removed with the topsoil. Stripped topsoil shall be placed in an onsite topsoil stockpile. Topsoil shall be removed from the stockpile and used to cover finished ditches, slopes, and other designated areas. Tree and shrub landscaping will not be included in the scope of work.

- A.14.7.4.5.b Excavations for structures shall meet the applicable safety requirements. Excavate to the required elevations and dimensions within a tolerance of plus or minus 0.1 feet. Extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for tests and inspections.
- A.14.7.4.5.c The bottom of the excavation shall be graded uniformly and free from bumps and hollows, and the sides of the excavation properly sloped per OSHA requirements. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work. All slopes shall be properly maintained during the Work, and slopes shall be inspected and documented per OSHA by Seller's trained, competent personnel. Excavations shall not compromise any existing structures, foundations, or other construction activities.
- A.14.7.4.5.d Excavations shall be kept dry by means of preventing surface water runoff from entering and removing any accumulated groundwater or surface water from the excavation.
- A.14.7.4.5.e If unsatisfactory material is encountered at the bottom of an excavation, this material shall be removed or mitigated to a depth up to two feet and backfilled to the proper grade with compacted satisfactory fill material at no additional cost to Buyer.
- A.14.7.4.6 Subgrade Preparation
- A.14.7.4.6.a The subgrade beneath areas to receive fill, foundations or roadways shall be compacted and proofrolled and be visually inspected/approved by the Testing Service prior to proceeding with the Work.
- A.14.7.4.6.b Proofrolling shall consist of furnishing and operating heavy equipment for testing the stability of subgrade prior to receiving the fill. The intent is to locate any unstable or soft areas. Proofrolling shall be performed in the presence of the Testing Service to allow for observation of unstable and soft areas.
- A.14.7.4.6.c Areas identified as unstable or soft during the proofrolling process shall be mitigated to a depth of up to two feet at no additional cost to the Buyer. Soft or unstable material is defined as obvious pumping action of the subgrade or excessive rutting (greater than 1 inch) during proofrolling.
- A.14.7.4.6.d Visual inspection for approval of subgrade consists of an experienced representative from the Testing Service visually verifying that no unsuitable material is present in the subgrade.
- A.14.7.4.6.e After reaching the plan subgrade level, the subgrade density will be tested by Seller's third-party Testing Service. The natural subgrade material shall be properly compacted to a minimum of 95 percent of the maximum dry density as determined by ASTM D1557 to a depth of at least 10 inches below the final subgrade level.
- A.14.7.4.7 Fill and Backfill General Placement Requirements

- A.14.7.4.7.a After placing mats, spread footings and other foundations the Seller shall place backfill to fill all voids between concrete members and bring the excavated area to approved plant grade. Likewise, the backfill material itself shall be clean, without rubbish or debris, and consist of suitable material.
- A.14.7.4.7.b Place and compact material in excavations and on subgrade promptly, but not before completing the following:
- Construction of below finish grade structures.
 - Surveying locations of underground utilities for record documents.
 - Inspecting and testing underground utilities.
 - Inspection and testing of subgrade.
 - Removing concrete formwork.
 - Removing trash and debris.
- A.14.7.4.7.c Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 3 horizontal such that the placed materials will bond with existing material.
- A.14.7.4.7.d Material shall not be placed upon a porous, wet, spongy, or frozen surfaces, nor shall frozen material be incorporated into the materials.
- A.14.7.4.7.e Materials placed by dumping in piles or windrows shall be spread uniformly before being compacted.
- A.14.7.4.7.f Adjacent to structures, material shall be placed in a manner which will prevent damage to the structures and will allow the structures to assume the loads from the fill gradually and uniformly, if designed for such condition.
- A.14.7.4.7.g Material placed against concrete shall not be done until concrete has attained sufficient strength that backfilling will not cause damage.
- A.14.7.4.7.h Height of material placed adjacent to a structure shall be increased at approximately the same rate on all sides of the structure simultaneously.
- A.14.7.4.7.i Each lift of material placed shall extend the entire length and width of the area being filled when practicable.
- A.14.7.4.7.j Compaction methods, equipment, and loose lift thickness shall be included in the detailed specifications.
- A.14.7.4.8 Moisture Control of Soil Materials
- A.14.7.4.8.a Uniformly moisten, scarify, air-dry, or aerate subgrade and each subsequent fill or backfill layer before compaction to within 2 percent of optimum moisture content.
- A.14.7.4.8.b Subgrade shall be within 2 percent of the optimum moisture content to a depth of at least 10 inches below the final subgrade level.

- A.14.7.4.8.c Moisture content shall not be an acceptance criterion for purely granular, non-plastic, non-cohesive soil materials – these materials shall be evaluated for acceptance based on the in-place dry density and their constituents. Moisture content shall be an acceptance criterion for cohesive materials in addition to dry density and constituents.
- A.14.7.4.9 Compaction of Soil Materials
- A.14.7.4.9.a Compaction of all backfill and fill shall achieve a minimum of 95 percent of the maximum dry density as determined by ASTM D1557.
- A.14.7.4.10 Grading
- A.14.7.4.10.a Areas to be graded shall be cleared of all vegetation. Prior to clearing and grubbing, trees designated for removal shall be identified using plastic tape for Buyer review and acceptance. Trees shall not be removed unless written authorization to proceed is received from Buyer. All stumps and roots larger than 2 inches shall be removed. Debris from clearing and grubbing shall be disposed of in an Buyer-approved landfill.
- A.14.7.4.10.b All topsoil and organic materials shall be stripped from areas to be graded prior to starting earthwork. Topsoil shall be placed in a stockpile for later recovery.
- A.14.7.4.10.c Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations as required.
- A.14.7.4.10.d Provide a smooth transition between adjacent existing grades and new grades. Remove soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- A.14.7.4.10.e The high point of finished grade shall be set at 6 inches below the top of concrete foundation elevations.
- A.14.7.4.10.f Slope grades to direct water away from buildings and to prevent ponding.
- A.14.7.4.10.g The maximum permanent slope, without supplemental stabilization through mechanical means, to be provided shall be 3H:1V, unless otherwise approved by Buyer.
- A.14.7.4.10.h Where approved by Buyer, permanent slopes steeper than 3H:1V and higher than 4 feet shall be numerically evaluated for stability.
- A.14.7.4.10.i Permanent slopes cut into natural or existing soils shall be numerically evaluated for stability.
- A.14.7.4.10.j Slope stability analyses shall consider all appropriate loading conditions such as, but not limited to surcharge traffic, structures, and seismic acceleration.
- A.14.7.4.10.k The minimum safety factor for slopes immediately after construction is 1.3.

- A.14.7.4.10.l The minimum safety factor for slopes for long term stability is 1.5.
- A.14.7.4.10.m The minimum safety factor for slopes subjected to seismic acceleration is 1.1.
- A.14.7.4.10.n Laydown areas may be improved using geotextile and aggregate surfacing as necessary to support temporary equipment storage and parking. Seller may add aggregate surfacing for vehicle corridors as required for support.
- A.14.7.4.10.o Finished area surfacing material shall be approved by Buyer.
- A.14.7.4.11 Field Quality Control
 - A.14.7.4.11.a The density of in-place soils shall be tested by ASTM D6938, ASTM D1556, or ASTM D2167.
 - A.14.7.4.11.b The moisture content of in-place soils shall be determined in accordance with ASTM D6938 or ASTM D2216.
 - A.14.7.4.11.c Loose lift thicknesses shall be measured and monitored by the third-party Testing Service.
 - A.14.7.4.11.d Laboratory testing ASTM D2487, D2488, D4318, D422, and D1557 shall be used to classify, evaluate, and establish field testing datums for soil materials.
 - A.14.7.4.11.e When subgrades, fills, or backfills are not in conformance with the specification requirements, the Seller shall scarify and moisten or aerate or remove and replace soil to depth required; recompact; and retest until specified compaction is obtained.
- A.14.7.4.12 Clean-Up
 - A.14.7.4.12.a At the conclusion of all fill and backfill operations, the Seller shall clear away from the Project site as well as from private and public roads, ditches and surrounding areas, all rubbish and construction materials and all subcontractors' tools, equipment, and other property. Material shall be disposed in an Buyer-approved landfill.
- A.14.7.4.13 Disposal of Excavated Material
 - A.14.7.4.13.a The Seller shall stockpile all excess soil material and unused spoil material excavated from the site. All materials shall be handled in accordance with the terms of all Applicable Laws and Buyer's requirements.
- A.14.7.5 Dewatering
 - A.14.7.5.1 Performance Requirements
 - A.14.7.5.1.a Seller shall review the geotechnical information and determine the appropriate dewatering system for the Work to meet the performance requirements.

- A.14.7.5.1.b Seller shall maintain all excavations in a dry condition to facilitate quality construction and backfill activities.
- A.14.7.5.1.c Design, provide, test, operate, monitor, and maintain a dewatering system of sufficient scope, size, and capacity to control ground-water flow into excavations and to allow construction to proceed on dry, stable subgrades. Maintain dewatering operations to ensure erosion is controlled, stability of excavations and constructed slopes is maintained, and flooding of excavation and damage to foundation Work, utilities, yard piping and/or other Work improvements are prevented.
- A.14.7.5.1.d Prevent surface water from entering the Work area by maintaining grading, dikes, ditches, berms, or other means. Furthermore, prevent surface water and subsurface or groundwater from ponding on prepared subgrades, and from flooding the site and the surrounding area.
- A.14.7.5.1.e Accomplish dewatering without damaging structures and improvements adjacent to excavation.
- A.14.7.5.1.f If the dewatering requirements and the flooding requirements are not satisfied due to failure or inadequacy of the system, then loosening of the foundation soils, instability of the walls or damage to the structure may occur. The supply of all labor and materials, and the performance of all Work necessary to carry out additional Work for repair of the foundation or structure resulting from such inadequacy or failure shall be undertaken by the Seller to the acceptance of Buyer, at no additional cost to Buyer.
- A.14.7.5.1.g Handle and treat the effluent generated by the dewatering process prior to discharge in a manner which meets the requirements of the state regulatory agencies. All water collected from the dewatering process must be treated with applicable BMPs. When possible, treatment of dewatering discharge can be reduced by using the water for dust control or allow water to infiltrate and evaporate.
- A.14.7.5.1.h Provide, take measurements, and maintain observation wells and/or piezometers to monitor groundwater levels at nearby critical structures or near the excavation when the excavation extends more than 5 feet below the groundwater table level.
- A.14.7.5.1.i The Seller shall obtain permits from the appropriate regulatory agencies for the installation and destruction of all monitoring, observation, and dewatering wells. The Seller shall also obtain all pertinent permits from any other Agency with jurisdictional control over a particular activity involved in the dewatering.
- A.14.7.5.1.j The Seller shall prepare a detailed dewatering construction plan and shall submit it to Buyer for review and acceptance one month before the dewatering activity.
- A.14.7.5.1.k During the installation and operation of the dewatering system, the Seller shall monitor the operation to ensure that excessive amounts of sand or fines are not removed which could result in voids or undermining the subsurface conditions below concrete structures.

- A.14.7.5.1.1 The Seller shall establish and perform a movement and settlement survey. The Seller shall employ a Land Surveyor registered in the state the project is located in to establish the exact elevations at fixed points that act as benchmarks. Clearly identify benchmarks and record existing elevations. When the excavation extends greater than 5 feet below the groundwater table, during dewatering, resurvey benchmarks weekly, maintaining an accurate log of surveyed elevations for comparison with original elevations. Seller shall promptly notify Buyer if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction or existing improvements.
- A.14.7.5.2 Dewatering System
- A.14.7.5.2.a Install dewatering system utilizing ditches to sumps, wells, well points, or other methods as appropriate, complete with pump equipment, standby power and pumps, filter material gradation, valves, vacuum gauges, appurtenances, water disposal, and surface-water controls to meet the performance requirements of this specification.
- A.14.7.5.2.b Continuously operate system until foundation work, utilities, yard piping and/or other improvement work is completed and fill materials have been placed, or until dewatering is no longer required.
- A.14.7.5.2.c Provide an adequate system to lower and control groundwater as necessary to permit excavation, construction of foundation work, utilities installation, yard piping installation, placement of backfill or fill materials and/or other improvement Work. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
- A.14.7.5.2.d Dispose of water removed from excavations in a manner which meets state and local regulations. Provide sumps, sedimentation tanks, and other flow-control devices as needed to fulfill these requirements.
- A.14.7.5.2.e Remove dewatering system from Project site on completion of dewatering. Remove piezometers and other monitoring equipment with Buyer's approval. Before abandonment, observation wells, dewatering wells, and test wells shall be filled with bentonite-cement slurry and capped with a 5-foot deep concrete plug. All other requirements for well destruction shall be per guidelines and requirements of the Department of Environmental Quality of the state in which the Project is located.
- A.14.7.5.2.f Notify Buyer immediately of and promptly repair damages to adjacent structures, facilities and/or improvements caused by dewatering operations.
- A.14.7.5.3 Control of Water
- A.14.7.5.3.a Seller shall provide, operate, and maintain all ditches, basins, site grading, and pumping facilities to divert, collect, and remove all water from the work area in compliance with Applicable Laws.

- A.14.7.5.3.b All water shall be removed from the immediate site and discharged at approved locations. The Seller shall comply with all Federal, State, and local stormwater laws, regulations, ordinances, and other Applicable Laws. The Seller shall prepare, certify, obtain approval, and implement a National Pollutant Discharge Elimination System (NPDES) Large Construction Storm Water General Permit for storm water discharges from construction and land disturbance activities and shall not begin earth disturbance activities until the NPDES Permit is obtained from the Department of Environmental Quality of the state in which the Project is located.
- A.14.7.5.3.c The Seller shall be responsible for all costs incurred for compliance with the provisions of the NPDES General Permit. Provisions of the NPDES General Permit will include but is not limited to, monitoring, treatment (when necessary), and compliance resolution. The Seller shall conduct all permit required sampling, analysis, and reporting prior to the discharge of any wastewater.
- A.14.7.6 Protection of Structures and Utilities
- A.14.7.6.1 The existing structures and utilities which are adjacent to and within the limits of the excavation shall be protected against damage. The Seller shall be fully responsible to Buyer in the event of removal or damage of any existing objects which are intended by Buyer to remain in place. In the event the Seller uncovers any unmarked or unknown plant facility during excavation, he shall report his findings to Buyer, and he shall receive instructions from him before proceeding further.
- A.14.7.6.2 Protect structures, utilities, sidewalks, pavements, other facilities and/or improvements from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations and construction traffic.
- A.14.7.6.3 Compact fill adjacent to structures to a density equivalent to that of the surrounding fill by hand-tamping or hand-power tampers.
- A.14.7.6.4 Do not operate heavy equipment within 2 feet of any structure.
- A.14.7.6.5 Do not operate heavy vibratory compactors within 5 feet of any structure.
- A.14.7.6.6 Do not permit passage of heavy compaction equipment over completed facilities within the following periods: (1) over cast-in-place concrete conduits prior to 14 days after placement of the concrete or until concrete sufficient strength is shown by testing
- A.14.7.7 Grading and Drainage
- A.14.7.7.1 General
- A.14.7.7.1.a The working areas of the site shall be well drained during and after construction. No low-lying areas shall be left where water accumulation could occur. The site drainage plan and discharge from the site shall conform to federal, state, and local laws and

regulations. Seller shall obtain all necessary permit approvals, prior to the start of site grading work.

- A.14.7.7.1.b Drainage shall be designed to discharge non-contact stormwater to the appropriate, regulated outfalls as specified in the approved TPDES General Permit. Structural pad elevations and site grades shall be established to allow for proper drainage away from foundations and structures, and to prevent ponding anywhere in the Project site.
- A.14.7.7.1.c Grading and earthwork performed by the Seller for construction parking areas and laydown yards site shall be as required to support construction operations.
- A.14.7.7.1.d Finish site grading shall consist of establishing finished grades and placing surface materials (soil, aggregate, asphalt, concrete, etc.) to the design grades and to facilitate site access and drainage. The targeted minimum slope for unpaved surfaces shall be 0.5 percent. The targeted minimum slope for paved surfaces shall be 0.5 percent. Actual drainage slopes may vary, based on design limitations of a flat site, and will be reviewed with Buyer during detailed design. The maximum slope for seeded areas shall be 3H:1V. Permanent erosion and sedimentation control measures shall be included in the design, as required, to facilitate the overall site drainage plan.
- A.14.7.7.2 Erosion Control
 - A.14.7.7.2.a Proper temporary erosion control measures including but not limited to the use of silt fences, sand bags and seeding shall be employed during construction to control erosion of embankments, temporary material stockpile(s), and to limit sediment runoff.
 - A.14.7.7.2.b Permanent erosion control for ditches and slopes, such as seeding, riprap, headwalls, rock surfacing, slope pavement, drainage terrace pavement, paved downcomers, etc., shall be installed within 30 days of completion of the ditch or slope.
 - A.14.7.7.2.c All necessary permitting for pre- and post-construction stormwater management must be obtained by Seller before start of construction activities.
- A.14.7.7.3 Stormwater Drainage System
 - A.14.7.7.3.a A stormwater drainage system consisting of catch basins and underground piping shall collect stormwater runoff in the power block area. The system design shall comply with the Department of Environmental Quality of the state in which the Project is located. All storm water discharge from the power block area shall meet the requirements of the applicable state and local ordinances and shall be acceptable by the Buyer.
 - A.14.7.7.3.b Stormwater runoff from the construction laydown and parking areas shall follow applicable state and local stormwater management criteria. A construction sediment basin shall be provided to serve a disturbed area of 10 acres at a time. As a minimum, construction sediment basins shall provide at least 3,600 cubic feet of storage per acre drained until final stabilization of the site. Discharge elevations for the sediment basins

will be determined based on disturbed areas, topographic survey, and United States Geological Survey.

A.14.7.7.3.c Materials

A.14.7.7.3.c.1 Storm drainage collection system piping shall generally be constructed of corrugated high-density polyethylene pipe, having a corrugated outer wall and a smooth inner wall and rated for gravity service. Joints shall be classified as watertight.

A.14.7.7.3.c.2 Storm sewer manholes and catch basins shall be precast reinforced concrete structures, designed for HS-20 or HL-93 traffic load with a minimum of 10% impact factor. Precast manholes and catch basins shall have a cast iron frame and removable solid or grate cover.

A.14.7.7.4 Roof Drains

A.14.7.7.4.a Roof drain downspouts may discharge directly to the ground in areas that are not paved and intended for personnel access/walkways or planned for vehicle access. Personnel safety will be considered in determining which downspouts can discharge directly to the ground. Splash blocks will be used in seeded or graveled areas where downspouts do discharge to grade.

A.14.7.8 Oil Containment Requirements

A.14.7.8.1 Oil Containment

A.14.7.8.1.a As a minimum requirement, oil containment structures shall be designed in accordance with the federal requirements of Title 40 CFR 112 and this Specification for all transformers and lube oil tanks. The Seller shall provide oil containment for all equipment containing 55 gallons or more of oil. Oil containment shall include sufficient freeboard for precipitation. The Seller shall comply with the requirements of NFPA 850 for the layout (e.g., sizing) and design of drainage and firewalls as required to protect equipment and other transformers adjacent to transformers.

A.14.7.8.2 Oily Water System

A.14.7.8.2.a An oily water system shall be provided to collect discharges from all areas which have potential for oil contamination.

A.14.7.8.2.b All gravity piping used in the oily water system shall be either Cast Iron Soil pipe (CISP) or Ductile Iron Water pipe (DIWP) and have a minimum diameter of 4 inches. Piping shall be suitably protected against corrosion and able to withstand higher anticipated temperatures of oily wastewater streams. Pipes used to discharge separated wastewater shall be HDPE.

A.14.7.8.2.c Oil contaminated runoff shall be directed by gravity to a buried oil/water separator. Requirements for the oil separator include the following:

- A dual wall steel tank design, below grade per UL 58 and UL 2215
- Maximum flow rate of 500 gpm
- Monitoring system between tank walls
- Packaged coalescing plate separator providing 15 mg/l effluent quality
- Integral lift station with 2-50% submersible pumps
- HDPE pressure rated piping to discharge treated effluent to the plant wastewater sump
- Reinforced concrete hold-down slab and at-grade maintenance slab

- A.14.7.8.2.d The oil separator shall be furnished with an electric control panel housed in a single enclosure type NEMA 4X rated enclosure with mounting post. The control panel shall be equipped with power and sensor cables for each pump, and a set of non-mercury float switches for monitoring the liquid level in the wet well sump.
- A.14.7.8.2.e Each oil separator pump shall be furnished with a power disconnect switch, a circuit breaker, a NEMA-rated magnetic motor starter with overload protection, and a heavy duty end-of-cycle alternator relay to alternate pumps and allow automatic operation of the second pump on failure of the first pump to operate.
- A.14.7.8.2.f The oil separator enclosure shall include pump motor running lights and for each pump and local alarm lights for pump failure and high water.
- A.14.7.8.2.g Every oil containment area shall have a manual, lockable, isolation post indicator gate valve painted to the Buyer's color choice. Post indicators are only required for valves located underground. The manual valve shall not restrict the flow in its fully opened condition. The function of the manual valve is to stop the flow of oil during catastrophic events. The manual valve shall be located in an area accessible under fire-fighting conditions and outside the containment area.
- A.14.7.8.2.h Not Used.
- A.14.7.9 Truck Unloading Containment
- A.14.7.9.1 Provide truck unloading containment for aqueous ammonia, with a drain system directed to the storm drain system with a lockable isolation post-indicator valve painted to the Buyer's color choice.
- A.14.7.9.2 Provide truck unloading containment for sulfuric acid, with a drain system directed to the storm drain system with a lockable isolation post-indicator valve painted to the Buyer's color choice.
- A.14.7.10 Post indicator valves may be painted with a system-unique color code as directed by Buyer.

- A.14.7.11 Sanitary Sewage System
- A.14.7.11.1 Sanitary sewage discharge from new facilities shall be routed to a lift station and pumped to the local municipal sewer system.
- A.14.7.11.2 Seller shall tie into the Municipal Sanitary Sewer line at a manhole outside the Facility boundary, based on Terminal Point TP-2 listed in Section A.3 – Terminal and Interface Points List.
- A.14.7.11.3 Sanitary sewage lift station is required to route new line to the local municipal sanitary sewer. The lift station shall have the following features and components:
- A.14.7.11.3.a The wet well sump and valve box shall be pre-cast concrete with hinged aluminum access door frame and covers, and vents. Each cover shall be sized to provide convenient means of equipment removal, rated for 300 pound loading, and be equipped with weather-proof recessed handles, full-length hinges, a locking latch with a release handle to hold the cover in the open position, and a torsion spring assist for opening and hasp for locking.
- A.14.7.11.3.b Two 100 percent submersible pumps rated for sewage duty with hydraulic sealing flanges, each connected to a discharge elbow mounted in the bottom of the wet well.
- A.14.7.11.3.c Each pump shall be furnished with two stainless steel guide rails with support brackets and a stainless steel lifting chain.
- A.14.7.11.3.d One set of discharge piping from each pump shall be routed to an external valve box containing a plug valve and a swing check valve per AWWA C508 for each pump.
- A.14.7.11.3.e The lift station shall be furnished with an electric control panel housed in a single enclosure type NEMA 4X rated enclosure with mounting post. The control panel shall be equipped with power and sensor cables for each pump, and a set of non-mercury float switches for monitoring the liquid level in the wet well sump.
- A.14.7.11.3.f Each pump shall be furnished with a power disconnect switch, a circuit breaker, a NEMA-rated magnetic motor starter with overload protection, and a heavy duty end-of-cycle alternator relay to alternate pumps and allow automatic operation of the second pump on failure of the first pump to operate.
- A.14.7.11.3.g The enclosure shall include pump motor running lights and for each pump and local alarm lights for pump failure and high water.
- A.14.7.11.3.h An elapsed run time meter shall be supplied for each pump, capable of six-digit reading in hours and tenths of an hour.
- A.14.7.11.4 Force main piping, if required, shall be pressure rated high density polyethylene with fusion welded joints.

A.14.7.11.5 The maximum velocity through sanitary force main piping is 8 ft/s. Maximum allowable pressure at the connection point to the city sanitary sewer system shall be verified with local authorities and adhered to.

A.14.7.12 Sanitary Sewage Flows

A.14.7.12.1 The system shall be designed for average flows of 35 gallons per person per day. The daily peak flow will be determined using the fixture units and the equivalent water demand obtained from the plumbing codes.

A.14.7.12.2 The system shall consider 21 full time employees per day to support operation of the combined cycle site.

A.14.7.13 Parking and Paving

A.14.7.13.1 Permanent Parking

A.14.7.13.1.a The permanent parking areas as shown on the General Arrangement Drawing in Section A.16.3.1 shall be paved with asphalt. All parking stalls shall be laid out in a 90-degree pattern with painted striping and concrete wheel stops.

A.14.7.13.1.b The total number of parking stalls shall be a minimum of 24 stalls, including two ADA stalls. The parking stall criteria are as follows:

Parking Stall Criteria:

Standard stall:	10 feet by 20 feet
Handicap stall:	As dictated by ADA
Aisle width:	24 feet

A.14.7.13.2 Paving

A.14.7.13.2.a All site roads and parking areas shall be paved with asphalt. Roads to chemical totes areas which require forklift access shall be paved with asphalt, including forklift access to each major piece of equipment. Any unimproved areas within the power block area bounded by the perimeter roads shall be compacted crushed stone surfacing or concrete paving.

A.14.7.13.2.b The crushed stone surfacing cross-section shall consist of 6 inches of crushed stone (material no larger than 1 ½ inches in size and no more than 10% passing the No. 200 sieve) on a 12 inch minimum compacted subgrade. The crushed stone surfacing for unpaved areas shall facilitate drainage, prevent ponding, and provide a suitable walking surface. Seller shall provide samples of crushed stone surfacing for Buyer's approval.

A.14.7.13.2.c Concrete paving shall be of sufficient thickness to fully support anticipated traffic loads (trucks, forklifts, cranes) and shall not be less than 4 inches in thickness. Concrete paving shall be supported on 4 inches of crushed aggregate base, on a 12 inch minimum compacted subgrade. Concrete paving shall be thickened at all free edges adjacent to

roads or vehicle access doors into buildings. The thickened portion of the concrete paving shall be 125 percent of the concrete paving thickness, but not less than the paving thickness plus two (2) inches. Seller shall install contraction joints in the paving at no more than 15 feet on center and at all other areas susceptible to cracking. Isolation joints consisting of ½ inch preformed joint material shall be installed around all foundations, manholes, catch basins or other protrusions through the concrete paving. All contraction and isolation joints shall be sealed with a suitable joint sealant.

- A.14.7.13.2.d The road pavement cross-section shall be a minimum of 4 inches of asphalt (consisting of two layers: a wearing course mixture and a base course mixture) on 8 inches of crushed aggregate base, on a 12 inch minimum compacted subgrade. Roads shall be designed for a 20-year service life and account for anticipated HS-20 wheel loads and consider plant operated forklifts and wheel-mounted maintenance cranes. All paving and sidewalks shall be in accordance with applicable state and local specifications.
- A.14.7.13.2.e Roads shall be designed to accommodate an AASHTO WB-50 design vehicle, and a height clearance of 20 feet, and a width of 8 feet 6 inches as specified by AASHTO (Policy on Geometric Design of Highways and Streets). Minimum intersection radius and minimum curb return radius shall be 50 feet unless Seller obtained Buyer's approval for areas where the minimum value cannot be met. Minimum paved road width is 20 feet.
- A.14.7.13.2.f Driveways at the rolling doors of all buildings shall be a minimum 8-inch-thick reinforced concrete pavement to accommodate HS-20/HL-93 trucks and forklifts.
- A.14.7.13.2.g Sidewalks shall be concrete with a minimum width of 5 feet and a minimum thickness of 4 inches. Sidewalks will have a maximum cross slope of 2 percent.
- A.14.7.13.2.h The parking lot and access roads will be provided with the appropriate signs in accordance with OSHA guidelines and striping and the FHWA's Manual on Uniform Traffic Control Devices.
- A.14.7.13.2.i Not Used.
- A.14.7.13.2.j Seller shall provide information to support detailed traffic impact study to be performed by Buyer.
- A.14.7.14 Fences and Gates
 - A.14.7.14.1 Open construction areas and laydown yards shall be temporarily enclosed around the perimeter with an eight-foot-high chain link security fence throughout construction. Fences shall be equipped with gates (sizes and locations as required and determined by the Seller). Fence and gate material shall be galvanized steel.
 - A.14.7.14.2 Work shall also include installation of permanent security fencing. Permanent security fencing shall be seven foot high chain link topped by a 45-degree, one piece, and three wire extension arms for barb wire. Barbed wire shall be 2 strand, 12.5 minimum W&M

gauge wire with 4-point barbs of 14-gauge wire at 5 inch maximum spacing. Chain link fence shall be zinc coated, class 2, chain link fence fabric, No. 9 gauge wire, 2-inch mesh.

- A.14.7.14.3 Where possible, permanent fencing shall be installed in lieu of providing temporary fencing.
- A.14.7.14.4 Sliding motorized gate (24 foot wide) with manual override, conduit and cabling for badge access, intercom, and video cameras are required at the new station entrance. The camera and intercom should be received at both the control room and the main reception desk. The Drive gate shall be located such that no access to any part of the facility is allowed prior to the driveway gate. See Section A.13.3.1 for additional physical security requirements.
- A.14.7.14.5 Fence shall have a top rail and bottom tension wire. Top rails shall be 1.63 inches outside diameter (O.D.) pipe minimum. Wire shall be No. 7 gauge zinc coated coil spring wire.
- A.14.7.14.6 Line posts shall be as a minimum 2 1/2 inches O.D. schedule 40 hot-dipped galvanized steel pipe. End and corner posts shall be a minimum 3 inches O.D. Schedule 40 hot-dipped galvanized steel pipe. Terminal posts shall be braced. Maximum spacing of pipe line posts shall be 10'-0" center to center.
- A.14.7.14.7 Swing gates shall be internally braced against sagging and furnished with hinges, latches, stops, keepers, etc.
- A.14.7.14.8 All posts shall be set in concrete footings having a diameter at least 3 times the post diameter and a depth of 3 feet minimum below grade.
- A.14.7.14.9 Fence Grounding Requirements
 - A.14.7.14.9.a The frame and fabric for fences shall be fully grounded at the time of installation in accordance with the recommendations identified in IEEE 80.
 - A.14.7.14.9.b Fences shall be isolated per Buyer's isolation criteria.
- A.14.7.15 Not Used.
- A.14.7.15.1 Not Used.
- A.14.7.15.2 Not Used.
- A.14.7.15.3 Not Used.
- A.14.7.16 Equipment Delivery Plan
 - A.14.7.16.1 Seller shall be responsible for all equipment and materials delivery to Project Site. Seller shall develop and submit delivery plan to Buyer for review, comment, and approval. Seller shall supply basis and cost details of their heavy haul transport plan.

A.14.7.17 Construction Laydown

A.14.7.17.1 Laydown areas may be left with the improved stone surfacing.

A.14.8 STEEL DESIGN

A.14.8.1 General

A.14.8.1.1 This section covers the design of structural steel for buildings and other structures.

A.14.8.1.2 All structural steel framing elements and connections shall be designed in accordance with either the Allowable Strength Design (ASD) method or the Load and Resistance Factor Design (LRFD) method in accordance with the ANSI/AISC 360.

A.14.8.1.3 Cold-formed steel components shall conform to the American Iron and Steel Institute specifications for structural members.

A.14.8.2 Deflections

A.14.8.2.1 The maximum lateral deflection of a structure at height H (above the base) shall not exceed $0.005 \times H$.

A.14.9 FOUNDATION DESIGN

A.14.9.1 General

A.14.9.1.1 This specification covers the design of all reinforced concrete structures, foundations, ground floor slabs, and yard structures.

A.14.9.1.2 Reinforced concrete structures, foundations and ground floor slabs shall be designed by the ultimate strength method in accordance with ACI 318.

A.14.9.1.3 Foundation depth and other foundation design considerations shall be in accordance with the requirements in IBC and take into account the subsurface conditions at the site.

A.14.9.1.4 Foundations for settlement sensitive equipment and structures, including the cooling tower (if utilized), and major vibratory equipment, including the steam turbine, combustion turbine, and boiler feed pumps, shall be designed to meet equipment supplier settlement/deflection criteria. Soil improvements or deep foundation shall be used if determined to be required by analysis.

A.14.9.1.5 All foundations for structures and major equipment shall be designed using a foundation depth to the frost depth and any applicable code requirements with a minimum of 12 inches below the final grade elevation.

A.14.9.1.6 Concrete elements with a thickness of 4 feet or more shall be considered as mass concrete. Design of mass concrete foundations shall be in accordance with ACI 207-1R.

- A.14.9.1.7 For uplift load combinations, only that portion of the dead load permanently present to counteract the uplift condition shall be considered. Consequently, laydown load, contingency load, and other such loads of temporary nature shall not be considered in this equation.
- A.14.9.1.8 Equipment or buildings supported on shallow foundations shall be separated by pre-molded joint filler from any deep foundations (foundations supported on piles, caissons, etc.)
- A.14.9.1.9 All concrete flat work that is not used for structural purposes shall have its top surfaces sloped a minimum of 1 inch in 20 feet to enable runoff and eliminate ponding. This does not apply to foundation concrete.
- A.14.9.1.10 Structural concrete shall be designed to minimize ponding on structural foundations.
- A.14.9.2 Rotating Equipment Foundations
- A.14.9.2.1 Foundations for rotating equipment shall be designed in accordance with the specific requirements of the equipment manufacturer. In the absence of such specific requirements, these foundations shall be designed in accordance with ACI 351.3R, ASCE guidelines for design of large steam turbine generator foundations, other applicable industry standards and this section.
- A.14.9.2.2 For soil supported foundations the ratio of machine concrete foundation mass to equipment mass shall be at least 3:1.
- A.14.9.2.3 Equipment foundations shall extend a minimum of 6 in. all around beyond the edge of the equipment.
- A.14.9.2.4 The CT(s), ST(s) and associated generators shall be on a single combined foundation for each unit. The foundation shall be isolated from all other adjacent foundations, pipe rack steel foundations.
- A.14.9.3 Factors of Stability
- A.14.9.3.1 The overturning moment due to the wind load or seismic load shall not exceed 2/3 of the stabilizing moment of the building or other structure due to dead load only unless the building or other structure is anchored so as to resist the excess overturning moment.
- A.14.9.3.2 During construction (empty building enclosed with siding) the above ratio may be increased to 90 percent. The weight of earth superimposed over footings may be used to calculate the dead load resisting moment.
- A.14.9.3.3 Other minimum factors of safety for foundations shall be as follows:
- A.14.9.3.3.a Sliding, Uplift, and Buoyancy (normal groundwater) shall be 1.5

- A.14.9.3.3.b Buoyancy (flood groundwater) shall be 1.1
- A.14.9.3.4 The minimum factor of safety for retaining structures during service conditions for overturning and sliding shall be 2.0 and 1.5, respectively.
- A.14.9.3.5 Passive bearing pressure shall not be considered in the calculation of the stabilizing moment for factor of stability against overturning.
- A.14.9.4 Miscellaneous Requirements
- A.14.9.4.1 All equipment on ground floor area slabs or building foundations shall be supported on reinforced concrete pads. The pads shall be a minimum of 6 inches high. Equipment supported on the concrete pads shall be grouted as required or recommended by the equipment manufacturers to provide necessary support along the equipment skid and for smooth operation.
- A.14.9.4.2 Tank foundations shall be designed in accordance with all tank vendor requirements.
- A.14.9.4.3 Pipe supports, platform posts, ladders, etc., may be supported directly on the ground floor slab or building foundation without concrete pads using a minimum of 1 inch of grout.
- A.14.9.5 Additional Requirements for Foundations of Vibratory Equipment
- A.14.9.5.1 Foundations for vibrating equipment shall meet design requirements specified by the equipment manufacturer and industry standards and be designed to limit vibrations.
- A.14.9.5.2 In order to avoid resonant conditions, foundations supporting vibratory equipment shall be designed with natural frequencies removed by at least +/-20% from the operating speed of equipment, unless otherwise specified by the equipment manufacturer.
- A.14.9.5.3 Seller shall perform a dynamic analysis of the combustion turbine generator (CTG) and steam turbine generator (STG) foundations to ensure that the natural frequencies and response of the system are within acceptable limits.
- A.14.10 GEOTECHNICAL DESIGN
- A.14.10.1 General
- A.14.10.1.1 Allowable geotechnical loading for foundations shall be determined by taking into account the ultimate limit state (soil bearing capacity) and serviceability limit state (settlement).
- A.14.10.1.2 Shallow foundation designs shall limit the total settlement to 1 inch or less unless a more restrictive settlement limit is required by the Equipment Manufacturer.

- A.14.10.1.3 Shallow foundation designs shall limit the differential settlement to 0.5 inch or less over 50 feet unless a more restrictive settlement limit is required by the Equipment Manufacturer.
- A.14.10.1.4 Shallow foundation designs shall limit the differential settlement between adjacent foundations with shared piping or otherwise connected superstructure elements to within the tolerable limits for the connected elements.
- A.14.10.1.5 Allowable capacities for deep foundation elements shall be determined using approved methods in accordance with IBC and industry standards.
- A.14.10.1.6 Allowable capacities for deep foundation elements shall take into account effects of pile groups, where appropriate.
- A.14.10.1.7 Deep foundation elements designs shall limit the total settlement to 1 inch or less unless a more restrictive settlement limit is required by the equipment manufacturer.
- A.14.10.1.8 If applicable, installation of deep foundation elements shall not impact the continued operation of the existing plant facilities.
- A.14.10.1.9 Pile foundations, if used, shall be tested in accordance with ASTM Standards D1143, D3689, D3966, D4945 and D5882 and IBC requirements.
- A.14.10.1.10 Not Used.
- A.14.10.2 Groundwater
 - A.14.10.2.1 The groundwater conditions used in the design shall be determined by the Seller from the geotechnical exploration for the site. The Geotechnical Report shall be included in Section A.16.4.4 – Geotechnical Report.
 - A.14.10.2.2 Seller shall evaluate the observed groundwater conditions at the time of the geotechnical exploration and establish an appropriate design long term groundwater level, which accounts for all seasonal fluctuations of the groundwater table due to the precipitation, runoff, or other factors affecting the level.
- A.14.10.3 Subsurface Data and Geotechnical Design
 - A.14.10.3.1 Geotechnical input and parameters for use in design shall be determined by the Seller and included in Section A.16.4.4 – Geotechnical Report.
- A.14.11 DESIGN AND WORKMANSHIP
 - A.14.11.1 Structural Steel – Fabrication
 - A.14.11.1.1 General

- A.14.11.1.1.a The AISC Specification and Code are hereby incorporated into this specification and shall apply except as otherwise specified herein or in related documents, or approved in writing by Buyer.
- A.14.11.1.2 Design of Connections
 - A.14.11.1.2.a All connections shall be developed in accordance with ANSI/AISC 360 and the AISC Manual except as otherwise indicated herein.
 - A.14.11.1.2.b Connection angles, connection plates and gusset plates shall be 3/8 in. thick, minimum.
 - A.14.11.1.2.c When beams are coped, all re-entrant corners will be shaped, notch-free, to a radius of approximately ½ in.
- A.14.11.1.3 Fabrication Quality
 - A.14.11.1.3.a Abutting joints shall be cut and finished true and straight. Joints designed for contact bearing shall have the surfaces faced to have even bearing when bolted and aligned.
- A.14.11.1.4 High-Strength Bolts
 - A.14.11.1.4.a General
 - A.14.11.1.4.a.1 The use of high-strength bolts shall conform to the RCSC Specification.
 - A.14.11.1.4.a.2 Welding of or to high-strength bolts is prohibited.
- A.14.11.1.5 Structural Steel Stair Stringers
 - A.14.11.1.5.a Stairs shall be constructed of channel stringers.
 - A.14.11.1.5.b When stringers project above the floor and do not butt against plate curbs, the ends shall be closed with a plate neatly welded and the welds ground smooth.
 - A.14.11.1.5.c All stair stringers shall be hot-dipped galvanized in accordance with ASTM A123.
- A.14.11.1.6 Guardrail/Handrail
 - A.14.11.1.6.a Guardrail/handrail and posts shall be new steel pipe. Posts shall be spaced a maximum of 8 ft-0 in. on center, unless a smaller spacing is required per OSHA.
 - A.14.11.1.6.b Pipe rails shall be made with complete penetration groove welded connections, without fittings. Bends shall be smooth without miters, kinks, or collapsed wall sections, and all welds shall be ground where necessary to provide a smooth handrail surface. Welds shall not have rough surfaces even where all weld reinforcement is not removed. All shop cuts made to facilitate bending shall be seal welded closed and ground smooth. All pipe rails shall have a weep hole on its underside.

- A.14.11.1.6.c All guardrails/handrails and accessories shall be hot-dipped galvanized in accordance with ASTM A123.
- A.14.11.1.6.d Handrails shall conform to the requirement of OSHA, including requirement for guardrail in addition to graspable handrail at stairs.
- A.14.11.1.7 Ladders and Ladder Cages
- A.14.11.1.7.a Ladders shall conform to the provisions of OSHA 29 CFR 1910. Ladder rungs shall be non-slip per OSHA 29 CFR 1926. Rungs shall be corrugated, knurled, dimpled, coated with skid-resistant material, or otherwise treated to minimize slipping.
- A.14.11.1.7.b Unless specifically designed for longer unbraced lengths, ladders shall have intermediate supports with maximum spacing of 8 ft-0 in and shall be connected at the top and bottom of the ladder.
- A.14.11.1.7.c All ladders greater than 24 feet between landings shall be equipped with a personal fall arrest system or ladder safety system per the requirements of OSHA 29 CFR 1910. If ladder cages are provided, they shall be compatible with the fall arrest system or ladder safety system.
- A.14.11.1.7.d All ladders and accessories shall be coated per the requirements specified herein.
- A.14.11.1.8 Swing Gates
- A.14.11.1.8.a Self-closing gates shall be provided at the top of all ladders.
- A.14.11.1.8.b Swing gates for ladders, platforms and similar uses shall be manufactured, prefabricated, self-closing gates.
- A.14.11.1.8.c Swing gates shall be coated per the requirements specified herein.
- A.14.11.1.9 Grating and Stair Treads
- A.14.11.1.9.a General
- All grating shall conform to the requirements of NAAMM MBG 531.
 - All grating shall be a minimum of 1 1/4 in. deep. Stair treads shall 1 in. deep minimum. Indoor and outdoor grating shall be serrated.
- A.14.11.1.9.b Floor Grating
- Floor grating shall be welded construction, rectilinear in pattern, with 3/16 in. thick longitudinal bearing bars 1 3/16 in. on centers and cross members 3/16 in. thick with minimum cross-sectional area of 1/16 sq in., 4 in. on centers. Maximum span of grating is based on limiting the deflection to ¼ inch due to a uniform live load of 100 psf.

- The weight of removable grating sections shall be less than 75 pounds.
- All pieces cut for piping or equipment shall be banded. Grating abutting ductwork or siding shall be banded without regard to opening size. Banding strips shall project 4 in. above the top of the grating to form a curb and be at least the same thickness as the bearing bars to which they are welded.
- Grating shall be fastened to each support beam at two locations. Minimum of 4 attachments for each grating panel.
- Stair treads shall be the same construction as the floor grating. The Seller shall provide special sized treads where they may occur, or otherwise be necessary due to interfaces, notably at the top tread of certain runs.
- 1 1/4 in. abrasive nosing shall be fastened to all stair treads and to grating at floors or landings at the top of all stair runs.

A.14.11.1.10 Checkered Floor Plate

A.14.11.1.10.a Checkered floor plate shall be smooth-cut or finished to provide smooth straight edges. Floor plates shall be bolted to the supporting steel and shall be removable. Holes in the supporting steel shall be drilled in the field after erection, using the shop-drilled countersunk holes in the checkered plate as a template to ensure proper fit. Holes in the supporting steel may be tapped or nuts may be welded under the beam flanges to receive the flathead bolts. An alternate, mechanical, securing system may be used as approved by Buyer. Checkered floor plate shall be stiffened wherever required for the span and loading.

A.14.11.2 Structural Steel - Erection

A.14.11.2.1 General

A.14.11.2.1.a This section covers the erection of structural steel for buildings and other structures.

A.14.11.2.1.b The fabrication and erection tolerances shall conform to those specified in the AISC Steel Construction Manual.

A.14.11.2.1.c Erection shall comply with the provisions of the codes, specifications, and standards listed in Section A.14.3, except where more stringent requirements are shown or specified.

A.14.11.2.1.d All base plates shall be grouted with non-shrink grout as noted in Section A.14.11.2.4.

A.14.11.2.2 Delivery, Storage, and Handling

- A.14.11.2.2.a Unload and store materials to permit easy access for inspection and identification. Keep steel members off ground by using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration.
- A.14.11.2.2.b Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed.
- A.14.11.2.3 Materials
- A.14.11.2.3.a Materials shall conform to the requirements specified herein.
- A.14.11.2.4 Erection
- A.14.11.2.4.a Surveys: Check elevations of concrete bearing surfaces, and locations of anchor rods and similar devices, before erection Work proceeds, for conformance to the design drawings. Do not proceed with erection until corrections have been made or until compensating adjustments to structural steel Work have been agreed upon with Buyer.
- A.14.11.2.4.b Protection of Existing Structures: The existing structures and utilities which are adjacent to and within the limits of the Seller's Work shall be protected against damage. The Seller shall be fully responsible to Buyer in the event of removal or damage of any existing objects which are intended by Buyer to remain in place.
- A.14.11.2.4.c Setting Bases and Bearing Plates: Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surface of base and bearing plates.
- Set base plates and bearing plates for structural members on plate or sheet shims using wedges or other adjusting devices as necessary.
 - Tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with edge of base or bearing plate prior to packing with grout.
 - Grout solidly between bearing surfaces and bases or plates to ensure that no voids remain. Finish exposed surfaces, protect installed materials, and allow to cure.
 - Minimum grout thickness shall be 1 inch.
 - For proprietary grout materials, comply with manufacturer's instructions and recommendations.
- A.14.11.2.4.d Field Assembly: Set structural frames accurately to lines and elevations indicated. Align and adjust various members forming part of complete frame or structure before permanently fastening. Clean bearing surfaces and other surfaces that will be in permanent contact before assembly. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

- A.14.11.2.4.e Level and plumb individual members of structure within specified AISC tolerances.
- A.14.11.2.4.f Field Assembly and Erection: Field bolting shall be done to ensure safety and proper alignment during erection. If the erection bolts are not sufficient, the Seller shall add field bolts to the connection.
- A.14.11.2.4.g Gas Cutting: Do not use gas cutting torches in field for correcting fabrication errors unless specifically authorized by Buyer. Do not use torches to create holes or to cut members carrying stresses unless specifically authorized by Buyer.
- A.14.11.2.4.h Straightening and Cleaning: All material shall be straight, clean, and free from rust and mill scale. If straightening is necessary, such material shall be straightened or flattened as necessary by some process which will not injure the material and approved by Buyer. All material with sharp kinks or bends will be rejected.
- A.14.11.2.4.i Installation of Metal Bar Grating: Install grating to comply with recommendations of NAAMM grating standard that applies to the grating types and bar sizes indicated, including installation clearances and standard anchoring details.
- A.14.11.2.5 Quality Control
 - A.14.11.2.5.a Field-Bolted Connections: Inspect in accordance with AISC and RCSC specifications.
 - A.14.11.2.5.b Field Welding: Inspect and test during erection of structural steel as specified herein.
- A.14.11.3 Steel Floor Deck
 - A.14.11.3.1 Deck General
 - A.14.11.3.1.a All steel floor deck and accessories shall be hot-dipped galvanized steel and conform to ASTM A653, Structural Grade 33 and ASTM A924. Hot-dip galvanizing shall conform to ASTM A924 with a minimum coating class of G60 as defined in ASTM A653.
 - A.14.11.3.2 Steel Deck Design
 - A.14.11.3.2.a Units shall be fabricated from steel conforming to Section A3 of the AISI Specifications for the Design of Cold- Formed Steel Structural Members with not less than 0.034 in. min. (20 gage) sheet steel.
 - A.14.11.3.2.b Floor decking can be designed as floor formwork but the composite deck properties shall not be utilized for design.
 - A.14.11.3.3 Deck Fabrication
 - A.14.11.3.3.a Form deck units in lengths to span three or more supports, with flush, telescoped, or nested laps at ends centered over supports and interlocking or nested side laps. Provide

necessary materials for steel deck that comply with recommendations of the steel deck manufacturer.

- A.14.11.3.3.b Deck Openings: Unframed openings and all skew cutting shall be cut and reinforced, if necessary, in the field.
- A.14.11.3.4 Deck Welding
 - A.14.11.3.4.a All field welding, shop welding, weld procedures and weld qualification shall be in accordance with AWS D1 .3.
 - A.14.11.3.4.b Continuous visual inspection shall be made to ensure that welds are of the correct size, free from cracks, with proper fusion and penetration of the support steel. The acceptance criteria for field weld inspection shall be in accordance with AWS D1.1.
 - A.14.11.3.4.c Comply with applicable provisions of AWS D1.1 “Structural Welding Code-Steel” and AWS D1.3 “Structural Welding Code-Sheet Steel.” Use qualified welding processes and welding operations in accordance with AWS D1 .3.
- A.14.11.3.5 Install deck units and accessories in accordance with SDI Manual of Construction with Steel Deck, manufacturer’s recommendations, and shop drawings. Seller’s procedures shall comply with 29 CFR 1910.
- A.14.11.4 Reinforced Concrete
 - A.14.11.4.1 General
 - A.14.11.4.1.a Comply with provisions of the following codes, specifications, and standards listed herein. If provisions of these documents conflict, the more stringent shall apply.
 - A.14.11.4.1.b Where required by the IBC Code, install plastic vapor retarder beneath slabs in contact with the ground, in accordance with the requirements of ASTM E1643. As a minimum, vapor retarder shall be provided beneath the Control/Administration Building foundation and other areas where concrete moisture sensitive coatings are to be installed. Seller shall protect vapor retardant material during erection of forms, reinforcing steel and embedded items.
 - A.14.11.4.2 Materials
 - A.14.11.4.2.a Materials shall conform to the requirements specified herein and shall conform to the additional requirements indicated below. Ready-Mix Concrete shall comply with ASTM C94.
 - A.14.11.4.2.b Cement type shall be in accordance with ACI requirements and appropriate for soil conditions as documented in the geotechnical report.

- A.14.11.4.2.c Provide aggregates from a single source. Provide evidence that aggregates are non-reactive with alkalies when tested in accordance with ASTM C289, C227, C1260 or C1567.
- A.14.11.4.2.d Changes in cement, flyash, aggregates, etc., will require submittal of trial batch or field experience data for review prior to the changes being made.
- A.14.11.4.2.e Admixtures: Non-Chloride type only. The use of calcium chloride is not permitted.
- A.14.11.4.2.f Waterstops: Waterstops shall be 6" rubber or PVC, ribbed type with center bulb, capable of resisting 100 ft of head. Waterstops shall be designed and tested in conformance to the requirements of the Army Corps of Engineers CRD-C572.
- A.14.11.4.2.g Vapor Retarders: Plastic water vapor retarders used beneath slab in contact with ground shall be per ASTM E1745, Class A, with a minimum thickness of 6 mils.
- A.14.11.4.2.h Bonding Agent: Polyvinyl acetate or acrylic base.
- A.14.11.4.2.i Joint Sealant: Provide elastomeric joint sealants and backings that have been produced and installed to establish and to maintain watertight and airtight continuous seals without causing staining or deterioration of joint substrates or other as approved by Buyer. Joint sealant and associated materials shall be nonstaining. Joint sealant shall be installed flush with the top of concrete.
- A.14.11.4.3 Proportioning and Designing Mixes
 - A.14.11.4.3.a Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. For the trial batch method, use an independent testing agency for preparing and reporting proposed mix designs. The testing agency shall not be the same as used for field quality control testing.
 - A.14.11.4.3.b Submit written reports including 7- and 28-day compressive strength data to Buyer of each proposed mix for each class of concrete at least 30 days prior to start of Work.
 - A.14.11.4.3.c Adjustment to Concrete Mixes: Mix design adjustments may be requested by Seller when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, and as accepted by Buyer. Laboratory test data for revised mix and design and strength results must be submitted to and accepted by Buyer before using in Work. However, no water shall be added to the concrete after the trucks leave the batching facility.
- A.14.11.4.4 Admixtures
 - A.14.11.4.4.a Use admixtures as required for placement, workability, and durability. Admixtures shall be used in strict compliance with manufacturer's directions.

- A.14.11.4.4.b Admixtures shall be submitted for Buyer approval as part of the concrete mix design submittal.
- A.14.11.4.4.c The use of calcium chloride admixtures is prohibited.
- A.14.11.4.5 Concrete Mixing
- A.14.11.4.5.a Ready-Mixed Concrete: Comply with requirements of ASTM C 94, and as specified.
- A.14.11.4.6 Formwork
- A.14.11.4.6.a Design, erect, support, brace, and maintain formwork to support vertical, lateral, static, and dynamic loads that might be applied until concrete structure can support such loads. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position. Maintain formwork construction tolerances and surface irregularities complying with the ACI 347 limit applicable to Class A tolerances for concrete surfaces.
- A.14.11.4.7 Fabricating and Placing Reinforcement
- A.14.11.4.7.a Fabricate reinforcement in accordance with ACI 315.
- A.14.11.4.7.b Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars," for details and methods of reinforcement placement and supports and as specified.
- A.14.11.4.8 Joints
- A.14.11.4.8.a Construction Joints
- Locate and install construction joints so they do not impair strength or appearance of the structure. Major construction joints shall be indicated on the Seller's design drawings.
 - Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints except as indicated otherwise.
- A.14.11.4.8.b Control Joints
- Control joints shall be saw cut as soon as possible, but no later than 12 hours after completion of concrete finishing.
 - Control joints saw cut in concrete shall be filled with a pourable, flowable, self-leveling, flexible, non-shrinking and durable joint sealant. Seller shall submit the proposed product for Buyer's approval. Joints shall be filled after a minimum of 60 days after concrete placement. Seller shall vacuum joints prior to sealant installation and follow the sealant manufacturer's requirements.
- A.14.11.4.9 Installing Embedded Items

A.14.11.4.9.a The Seller shall properly locate and secure in position before concrete is placed all embedded conduit and piping, anchors, sleeves, inserts, hangers, dowels, sleeves, blocking grounds and other fastening devices required for attachment of other Work. Embedded items shall be sufficiently anchored to maintain their position during concrete placement and prevent their flotation. Maintain items plumb, in alignment and in proper position.

A.14.11.4.10 Concrete Placement

A.14.11.4.10.a Pre-Pour/Placement Meeting and Inspection

- Seller shall have a Pre-Pour/Placement meeting on-site prior to concrete pours for every major foundation, including but not limited to the CTG, STG, HRSG, and Control/Administration/Warehouse/Maintenance Shop Building. Buyer or its designated representative shall be in attendance.
- The Seller shall perform an independent inspection/review prior to concrete placement. Before placing concrete, inspect and complete metal form deck installation, reinforcing steel, and items to be embedded or cast in.

A.14.11.4.10.b General Requirements

- Comply with ACI 304, "Guide for Measuring, Mixing, Transporting, and Placing Concrete," and as specified.
- Deposit and consolidate concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened sufficiently to cause seams, planes of weakness or voids. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation at its final location.

A.14.11.4.10.c Cold-Weather Placement

Comply with provisions of ACI 306.1 and as follows. Protect concrete Work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures. Place no concrete during rain.

- All methods and materials used for concreting in cold or freezing weather shall be subject to the prior approval of Buyer. Cold weather shall be as defined in ACI 306.1. Chill factor shall be taken into consideration in determining proper protection of the concreting operations.
- Do not use frozen materials or place concrete on frozen subgrade or on subgrade containing frozen materials.
 - The Seller shall be responsible for removing ice and frost from foundations, previously placed concrete, forms, form materials and reinforcing steel; providing heating for water and aggregates, and for protecting the newly placed concrete.

- Concrete shall have a temperature conforming to Table 2.3.2.1 of ACI 306.1, when placed in the forms and shall be maintained at a temperature conforming to Table 2.3.2.1 of ACI 306.1 for not less than 72 hours after placing.
- Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.

A.14.11.4.10.d Hot-Weather Placement

When hot weather conditions exist that would impair quality and strength of concrete, place concrete complying with ACI 305 and as specified.

- Cool ingredients before mixing to maintain required concrete temperature at time of placement. Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water.
- Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions.

A.14.11.4.10.e Mass Concrete Placement

The provisions for placing, curing, and protection of mass concrete shall be in compliance with ACI 301, ACI 207 and as herein specified.

- All concrete structures or foundations larger than 4 feet in thickness shall be treated as mass concrete.
- Foundations for steam and combustion turbines and generators shall be treated as mass concrete.
- Mass concrete center temperature shall not exceed 160°F unless otherwise noted by Seller's thermal control plan.
- The maximum allowable difference between the center and surface temperature of mass concrete section shall be 35°F unless otherwise noted by Seller's thermal control plan.
- Seller shall supply insulation blankets of sufficient thickness, thermocouples, etc., as required to maintain the surface temperature of the concrete in accordance with ACI 301 provisions for mass concrete and as required in this section.
- Forms shall be left in place for a minimum of 7 days.
- Seller to provide thermal control plan for Buyer's review as stated above.

A.14.11.4.11 Finishing Concrete

A.14.11.4.11.a Formed Surfaces

- Smooth-Formed Finish: Provide a smooth-formed finish on formed concrete surfaces exposed to view or to be covered with a coating or covering material applied directly to concrete.

A.14.11.4.11.b Concrete Slab Finishes

- Provide a trowel finish for interior slab surfaces exposed to view, slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or other thin film finish coating system.
- Provide a broom finish for exterior slab surfaces that will have foot traffic during operations. Provide a floated finish for exterior slab surfaces that will not be subject to foot traffic.

A.14.11.4.11.c Concrete Curing and Protection

- Curing of concrete shall be in accordance with the requirements of ACI 301.
- Apply curing compound in accordance with manufacturer's recommendations on concrete surfaces.

A.14.11.4.12 Quality Control Testing During Construction

A.14.11.4.12.a A Compressive Strength Test Report Form shall be provided by the Seller for all test specimens. This form shall accompany all test specimens sent to the laboratory.

A.14.11.4.12.b Test results will be reported in writing to Buyer 24 hours after tests. Reports of compressive strength tests shall contain the Facility identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials, slump, air content, concrete temperature, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.

A.14.11.4.12.c Concrete testing will be performed by the Seller only for structural concrete as it is defined in ACI 301 Section 1.2. Structural concrete for this project shall have a minimum compressive strength as required per section A.14.5.3. Testing shall be performed in accordance with ACI 318 and ACI 350 as applicable. Concrete for ductbank, mudmat and flowable fill will not be tested for strength or other testing required by ACI.

A.14.11.5 Anchorage to Concrete

A.14.11.5.1 Cast-in-Place Anchorage

A.14.11.5.1.a Anchor rods, headed bolts, headed studs, and other steel materials cast in concrete shall be designed in accordance with the provisions of IBC and ACI 318.

A.14.11.5.1.b Column anchor rods shall not be used to resist lateral shear forces greater than 10 kips. When lateral shear force is greater than 10 kips, the shear force shall be transferred to the foundation using shear bars and grouted pockets in the foundation.

A.14.11.5.1.c Vertical uplift forces may be transferred to the foundation by means of column chairs and anchor rods or by welding the column directly to the baseplate

- A.14.11.5.1.d All embedded structural shapes and anchor rod assemblies shall be hot-dipped galvanized, unless directed otherwise by the Buyer. Steel elements that are not hot-dipped galvanized and are exposed to soil or atmosphere shall be painted.
- A.14.11.5.2 Post-Installed Anchorage
 - A.14.11.5.2.a All post-installed concrete anchors (e.g., expansion anchors, adhesive anchors, undercut anchors) shall be designed in accordance with the requirements of ACI 318 and the anchor manufacturer.
 - A.14.11.5.2.b Installation of post-installed anchorage shall conform to anchor manufacturer's instructions and requirements.
- A.14.11.6 Concrete Masonry Unit
 - A.14.11.6.1 General
 - A.14.11.6.1.a Comply with the provisions of the following codes, specifications and standards listed in Section A.14.3, except where more stringent requirements are shown or specified. Where provisions of these conflict, the more stringent shall apply, unless otherwise approved by Buyer.
 - A.14.11.6.2 Materials
 - A.14.11.6.2.a Materials shall conform to the requirements specified in Section A.14.5 herein and shall conform to the additional requirements indicated below.
 - A.14.11.6.2.b Joint Reinforcement: Steel, heavy duty, or extra heavy continuous truss type, hot-dipped galvanized after fabrication, conforming to ASTM A951, A82 and A153.
 - A.14.11.6.2.c Tie Bar Anchors: Steel, ASTM A82, hot-dipped galvanized after fabrication with minimum size of 3/16 in. diameter.
 - A.14.11.6.2.d Corrugated Metal Ties: Steel, 16 gauge, 7/8 in. wide, ASTM A36, A1008 or A109, hot-dipped galvanized per ASTM A153.
 - A.14.11.6.2.e Dovetail Anchors: Steel, ASTM A1008 or A109, hot-dipped galvanized per ASTM A153.
 - A.14.11.6.3 Construction:
 - A.14.11.6.3.a CMU shall be laid in standard running bond. Provide special and solid units as required to form corners, returns, offsets, lintels, control joints, etc., and to maintain proper bond.
 - A.14.11.6.3.b Provide dry course flashing under exterior masonry walls for enclosed buildings resting on concrete foundations, floors, beams, curbs, etc. Extend flashing full thickness of wall in all cases. Use care not to injure or pierce felt during installation or in subsequent

laying of masonry. For flashing at grade floors, cement plies together with cold applied adhesive.

A.14.11.6.3.c Truss-type masonry joint reinforcing shall lap a minimum of six inches at splices. Masonry joint reinforcement shall not pass through vertical pre-molded control joints.

A.14.11.6.3.d Bar reinforcing shall be used as reinforcing in reinforced concrete block walls, with size and spacing as indicated on the design drawings. Fill cores containing reinforcing with grout.

A.14.11.6.4 Cold Weather Construction

A.14.11.6.4.a When the ambient temperature is below 40°F, implement cold weather procedures of ACI 530.1 and as required herein.

- Use of antifreeze liquids, salts or similar materials in mortar is NOT PERMITTED.
- Cold weather construction procedures shall be subject to approval of Buyer.

A.14.11.6.5 Hot Weather Construction:

A.14.11.6.5.a When the ambient air temperature exceeds 90°F, implement the hot weather procedures of ACI 530.1 and as required herein.

- Mortar bed surfaces of CMU shall be lightly wetted with cool water to deter the mortar from moisture loss and from drying too rapidly.
- The mortar shall be kept moist and shall not be strung out more than two lengths ahead of the CMU being placed.
- Mortar joints shall be fog sprayed until damp at least three times per day until the masonry is at least three days old.

A.14.12 STRUCTURAL WELDING

A.14.12.1 General

A.14.12.1.1 All welding, welding procedures, welding qualifications, and welder qualifications shall be in accordance with AWS D1.1 Structural Welding Code - Steel and AWS D1.3 Structural Welding Code - Sheet Steel and the additional requirements herein. Provide certification that welders and welding operators to be employed in Work have satisfactorily passed AWS qualification tests.

A.14.12.1.2 Welding procedures (WPS) and Procedure Qualification Records (PQR) shall be submitted for approval prior to the start of production welding and shall be maintained in the Seller's file. The Seller shall use AWS pre-qualified weld procedures whenever possible.

- A.14.12.1.3 Welders, welding operators and NDT personnel shall be certified by independent testing agencies, of recognized standing, in accordance with the most current SNT-TC-1A, as minimum Level 2. Such certifications shall have been validated within the previous 6 months per AWS D1.1, AWS D1.3 or AWS D1.6 prior to performing the Work.
- A.14.12.1.4 Only low hydrogen type covered electrodes shall be used as weld filler metal if shielded metal arc welding (SMAW) is the welding process selected for production welding of carbon steel.
- A.14.12.1.5 Weld filler metals shall meet the requirements of the applicable AWS Filler Metal Specification. A Certificate of Compliance shall be available in the Seller's file for each heat, lot, or batch of filler metal.
- A.14.12.2 Weld Filler Metal Control
- A.14.12.2.1 In addition to the requirements of AWS D1.1, all welding materials shall be stored in a controlled access, clean, dry area that is weathertight and is maintained at a temperature between 40°F and 140°F. The material shall not be in contact with the floor and shall be stored on wooden pallets or cribbing. The materials shall be identifiable at all times during storage, handling, and issuance.
- A.14.12.3 Inspection and Repair of Welds
- A.14.12.3.1 As a minimum, all welds shall be 100 percent visually inspected by the Seller's third-party Testing Service. Inspection and quality of welds shall conform to the requirements of Sections 6, 8 and 9 of AWS D1.1, AWS D1.3 and AWS D1.6.
- A.14.12.3.2 All welds found deficient shall be repaired in accordance with AWS D1.1. Seller shall record types and locations of defects and Work required and performed to correct weld defects and deficiencies.
- A.14.12.3.3 The weld inspection shall be by Seller's AWS Certified Inspector, or Assistant Welding Inspector(s), under the supervision of the AWS Certified Inspector. Alternatively, the Seller may implement a program for self-certification of welding inspectors, provided the program is written and is supervised by an AWS Certified Inspector in compliance with the requirements of AWS D1.1, Sections 6 and 8. The Seller's Weld Inspection Program, including the Inspector's certification records, shall be made available to Buyer.
- A.14.13 SURFACE PREPARATION AND PROTECTIVE COATINGS
- A.14.13.1 General
- A.14.13.1.1.a Coatings shall have a minimum design life of 20 years without recoating.
- A.14.13.1.1.b Coatings shall comply with the locally adopted EPA Volatile Organic Compound (V.O.C.) limits.

- A.14.13.1.1.c All steel material furnished under this Specification, except machined surfaces or as otherwise specified herein, shall be cleaned, primed and top coated and/or hot-dipped galvanized as required herein.
- A.14.13.1.1.d A standard coating system is incorporated herein, which includes surface preparation, prime, intermediate (if required) and top coating material, required application procedure, and corrective procedure.
- A.14.13.1.1.e Any conflict between this specification and the requirements or instructions of the SSPC, or the coating manufacturers, shall be brought to Buyer's attention in writing.
- A.14.13.1.1.f The Seller shall submit the coating manufacturer's standard color charts, chips, or samples for selection of final finish colors by Buyer. Major Equipment supplier shall utilize their standard colors.
- A.14.13.2 Coating Application
 - A.14.13.2.1.a Coatings shall be applied in accordance with the requirements of SSPC PA1, supplemented by requirements of the coating manufacturer and application requirements of this specification.
 - A.14.13.2.1.b Where abrasive blast cleaning is required, abrasives shall be used that develop a substrate profile per the manufacturer's recommendation, but no less than 1.0 mil.
 - A.14.13.2.1.c Prevent fallout from cleaning operations from being deposited on adjacent surfaces which are ready for coating and freshly coated surfaces. Where deleterious material may be deposited as a result of normal construction activities, a prepared surface shall either be protected or coated immediately.
 - A.14.13.2.1.d All coating material containers shall be examined upon delivery. Any evidence of leaks, broken seals, freezing or other damage which may have resulted in any loss of the constituents by volatilization or otherwise shall be cause for rejection. Coating material containers shall be labeled to show the name of the manufacturer, the product trade name or designation, color, and the expiration date. Containers shall have their labels intact and completely legible.
 - A.14.13.2.1.e Mixing shall conform to the requirements of SSPC PA1 except as otherwise required below. Paint, which has skinned, gelled, separated, or otherwise deteriorated during storage to the extent that normal thinning will not restore the paint to its intended viscosity, uniformity, and consistency, shall not be used. All paint shall be strained after mixing.
 - A.14.13.2.1.f Only those types and brands of thinner recommended by the coating manufacturer shall be used for thinning. The amount of thinning shall be limited to the amount necessary to facilitate application. Surfaces which have been prepared, as required, and are ready for painting shall be painted as soon as practical.

- A.14.13.2.1.g Coatings shall be applied to dry, frost free surfaces and within the ambient condition parameters established in SSPC PA1, except as otherwise required or permitted herein. Application at temperatures (surface or ambient) in excess of 100°F or per the manufacturer's recommendation shall not be permitted if the resultant film is found to be prone toward bubbling, cratering, or pin holing.
- A.14.13.2.1.h Low speed pot agitators shall be used to keep zinc in suspension when applying primers containing zinc dust. Zinc primers shall be properly cured and free from dry spray and mud cracking. Where present, these shall be removed and the coating repaired.
- A.14.13.2.1.i Spot touch up priming shall be accomplished before rust has formed on the cleaned surface. The prepared spot or area shall be cleaned with a cleaning solvent and allowed to dry completely before applying topcoat materials. Touch up materials for spot priming shall be brushed applied.
- A.14.13.2.1.j Surfaces which have been prepared and touched up as required and are ready for coating shall be coated as soon as practicable after the spot priming or touch up coating material has thoroughly dried, so as to minimize the chance of recontaminating the prepared surface.
- A.14.13.2.1.k The minimum drying time before handling the coated material shall be in accordance with the manufacturer's recommendations. Subsequent finish coats, if required, shall be applied only after the previously applied coat has been allowed to dry for the necessary dry-to-recoat interval as specified by the manufacturer.
- A.14.13.2.1.l Where more than one topcoat is applied, the underlying coat(s) shall be tinted a different shade than the required final coat color to facilitate proper coverage and to allow for clear differentiation between coats. Only the specific tinting agents recommended by the coating manufacturer shall be used. Specifically, with urethane coatings, only solvent base universal tints shall be used.
- A.14.13.2.1.m Shop welded contact surfaces, such as the faying surfaces between connection angles and beam webs shall be coated with an acceptable product before assembly or completely seal welded prior to coating to prevent rust formation. Inaccessible surfaces, the perimeters of which are continuously seal welded, need not be primed. An acceptable product for shop welded contact surfaces is Carbo-Weld 11 as manufactured by the Carboline Company, St. Louis, Missouri or equal.
- A.14.13.2.1.n Milled surfaces shall be coated with a rust-preventative material. Coating shall be applied after the Seller's inspection and prior to being placed outdoors.
- A.14.13.3 Standard Coating System
 - A.14.13.3.1 General
 - A.14.13.3.1.a Seller shall provide Buyer with a recommended manufacturer's coating system for all supplied equipment (e.g., pumps, valves, etc.) for the environment and intended service

of that equipment. The coating system shall include identification of surface preparation, shop prime coating, shop finish coating, shop touch-up coating and coating materials required for the Work. Unless otherwise specified, all external surfaces of machinery and equipment shall be coated as follows:

- Machined surfaces shall not be coated prior to mating.
- Coating the external surfaces of non-ferrous metal castings, piping or other parts is not required unless otherwise specified.
- Galvanized surfaces, stainless steel, nameplates, and smooth aluminum sheet shall not be coated. Perforated and cast aluminum shall be coated. Junction boxes, etc., shall be coated.
- All surfaces that are inaccessible after fabrication shall be completely painted in the manufacturer's factory prior to fabrication.

A.14.13.3.1.b Coating systems shall comply with Table 1.

A.14.13.3.1.c This painting system involves zinc-rich paint, gray in color, with material requirements meeting SSPC PS12, surface preparation meeting SSPC SP6 without appendix.

A.14.13.3.1.d All coating products except zinc rich primers used for this Work shall be certified 100% lead free. Zinc rich primers shall be restricted to ASTM D520 Type 11.

A.14.13.3.2 Coating Schedule

The coating schedule shown in Table 1 summarizes the coating Work anticipated for the Work. Finish colors are to be determined by Buyer.

A.14.13.4 Film Thickness Test

A.14.13.4.1 For film thickness measurement, the requirements, and recommended practices of SSPC-PA2 shall be followed. Testing shall be performed for all of the Work processed during any coating shift for one full day per coating work week for all steel.

A.14.13.5 Hot-Dip Galvanizing

A.14.13.5.1 After fabrication and before assembly, all structural steel framing, grating and stair treads, guardrails, handrails, ladders, and cages shall be degreased, cleaned of rust and scale, prefluxed, and hot-dipped galvanized. The zinc (hot-dipped galvanized) coatings applied to the fabricated products shall be in accordance with ASTM A123 and all of the incorporated specifications and recommended practices of the ASTM referenced therein, except as otherwise required or permitted herein. Additionally, hot-dip galvanizing and fabrication of items for hot-dip galvanizing should conform to the standards and guidelines set forth in AHDGA/ZI Manual.

A.14.13.5.2 Precautions shall be taken to avoid distortion or warpage of members during hot-dip galvanizing. The procedure suggested in ASTM A384 and on pages 26 and 27 of

AHDGA/ZI Manual shall be observed. Material failing to meet the required criteria for straightness and length shall be subject to rejection.

- A.14.13.5.3 Seller's fabricator shall determine the size, location, and shape of fill, drain, and vent openings in the product in accordance with the recommendations of ASTM A385 for closed sections such as pipe and structural tubing and open sections such as rolled shapes, plates, and built-up members. Such openings shall be documented on the detailed shop drawings by specifying the size, location, and shape as required on each member.
- A.14.13.5.4 Seller's Fabricator shall completely seal the perimeter of overlapped member surfaces that are in contact with continuous welds prior to hot-dip galvanizing. Where design welds are required for overlapped members, then only the balance of the overlapped perimeter shall be sealed. Unsealed overlapping areas may trap hot-dip galvanizing process acids which can escape to discolor or damage the hot-dipped galvanized coating. Seller's fabricator shall determine the venting requirements for sealed overlapping surfaces. Vent holes for such cases shall be provided, if necessary, in only one member of the overlapped area.
- A.14.13.5.5 All grating, stair treads, ladders, floor plates, banding bars, and other members shall only be hot-dipped galvanized after all shop fabricator processes have been completed.
- A.14.13.5.6 Hot-dipped galvanized faying surfaces of bolted connections using ASTM A325 or A490 bolts slip critical connections shall be roughened by means of hand wire brushing. Hand wired brushing shall achieve visible roughening of the faying surfaces. Hand wire brushing shall be controlled to avoid polished faying surfaces. Polished faying surfaces and power wire brushing of faying surfaces is unacceptable. Faying surfaces are defined in the "Specification for Structural Joints Using ASTM A325 or A490 Bolts."
- A.14.13.5.7 Seller shall ensure that there are no cracks at re-entrant corners of coped W shapes. If cracks are found, they shall be repaired prior to shipment to the Project Site. Seller's repair procedure shall be submitted to Buyer for review prior to installation. Hot-dipped galvanized material with metal cracks is unacceptable. Seller shall repair or replace unacceptable material at no cost to Buyer.
- A.14.13.5.8 Seller shall coat materials with safety colors as specified in Section A.14.13.
- A.14.13.6 Hot-Dip Galvanizing Touch-Up and Repair:
- A.14.13.6.1 Uncoated areas of steel after initial hot-dip galvanizing and/or mechanical damage during handling and erection shall be repaired in accordance with the requirements of ASTM A780 and Annex A2 of ASTM A 780 with the following exceptions:
- Areas to be repaired shall be power disk sanded to bright metal. To ensure that a smooth reconditioned coating can be affected, surface preparation shall extend into the undamaged or acceptable hot-dipped galvanized area by not less than one inch all around to ensure continuity of coating.

- Touch-up paint shall be an organic cold galvanizing compound having a minimum of 93% zinc dust by weight in the dry film. Touch-up on hot-dipped galvanized surfaces where hot-dip galvanizing has been removed or otherwise damaged shall be coated per CS-107.
- The paint shall be spray or brush applied until a total dry film thickness of 4 mils minimum has been achieved. Two separate coating applications shall be made with each application achieving a minimum dry film thickness of 2 mils. A finish coat of aluminum paint shall be applied to provide a color blend with the surrounding hot-dip galvanizing.
- Coating thickness exclusive of the finish coat shall be verified by measurements with a magnetic or electromagnetic gauge.

A.14.13.6.2 The use of zinc-based solders or metallizing by zinc spray for touch-up and repairs is not permitted.

A.14.13.6.3 Any wet storage stain shall be removed by the Seller if formed and discovered prior to leaving the hot-dip galvanizing plant. Wet storage stain shall be removed to prevent premature failure of the coating. Wet storage stain shall be removed as follows:

- The objects shall be arranged so that their surfaces dry rapidly.
- Remove light deposits with a stiff bristle (not wire) brush. Heavier deposits are to be removed by brushing with an acidic based metal cleaner. The surfaces cleaned shall be thoroughly rinsed with water.
- A coating thickness check must be made in the affected areas to ensure that the zinc coat remaining after the removal of wet storage stain is sufficient to meet or exceed the requirements of the Specification. Coating thickness shall be verified by measurements with a magnetic or electromagnetic gauge.
- Failure to meet Specifications requirements after removal of wet storage stains shall require that the affected materials be stripped and regalvanized. These same materials are subject to re-inspection and retest.

A.14.13.7 Safety Color Code Coating

A.14.13.7.1 Items indicated below shall be coated with safety colors complying with ANSI/NEMA Z535.1 ISCC-NBS color designations and block numbers and as specified and approved by Buyer. Color coating for safety colors is in addition to hot-dipped galvanized coating. Colors should be non-fading and non-chalking.

A.14.13.7.2 Trolley Beams: Safety Yellow. The design capacity of the trolley beam shall be stenciled on both sides of the web at the approximate midspan of each beam, using the notation "CAPACITY __ TONS" lettered in 3 inch high block letters with black paint

A.14.13.8 Coating and Finish Systems



A.14.13.8.1 Surface preparation and painting system shall be in accordance with Table 1.

TABLE 1
EXTENT OF COATING AND FINISH SYSTEMS

ITEM	SURFACE PREPARATION	COATING SYSTEM
1. Structural and miscellaneous ferrous steel members, including columns, beams, girders, bracings, girts, hangers, struts, tie rods, plates, anchor bolts, handrail posts, gratings, nosings, etc.:		
a. All surfaces of indoor metals unless otherwise indicated	Per coating manufacturer's requirements.	Hot-dipped galvanized per ASTM A123.
b. All pre-engineered building steel	Per coating manufacturer's requirements.	Prime coat only; Pre-engineered building supplier's standard.
c. PDC buildings	Per coating manufacturer's requirements.	PDC supplier's standard.
d. All surfaces of exterior (outdoor) metals	Per coating manufacturer's requirements.	Hot-dipped galvanized per ASTM A123.
e. Milled, embedded, contact and welded surfaces, etc.	None (unless otherwise indicated).	No painting – milled surfaces protected with lacquer.
f. Safety color coat on surfaces of indoor metals	Per coating manufacturer's recommendations.	1 or 2 - coat epoxy system.
g. Touch-up marred painted areas, bolt heads, nuts, washers, unprotected fasteners, field welds, and adjacent unpainted areas and strips, unless otherwise indicated.	SSPC-SP1, SP2, SP3 unless otherwise specified by coating manufacturer.	Same as previously applied coating.
h. Marred hot-dipped galvanized areas and field welds on hot-dipped galvanized surfaces.	Per coating manufacturer.	CS-107.
2. Stainless Steel, unless otherwise indicated	None.	No painting.
3. Surfaces to be in contact with aluminum; or aluminum surfaces	Per coating manufacturer's requirements.	Per manufacturer's standard coating.
4. Supplementary steel and associated hardware for pipe supports, cable tray supports, conduit support, and HVAC supports (indoor)	Per coating manufacturer's requirements.	Hot-dipped galvanized per ASTM A123.
5. Exposed (without lagging) steel piping	Per coating manufacturer's requirements.	Per manufacturer's standard coating system.
6. All other equipment (e.g., OEM Major Equipment, etc.)	Per coating manufacturer's requirements.	Per manufacturer's standard coating system.
7. Concrete masonry unit walls	Per coating manufacturer's requirements.	CS-123.
8. Indoor concrete floors	Per coating manufacturer's requirements.	CS-209.



ITEM	SURFACE PREPARATION	COATING SYSTEM
9. Plaster and gypsum board	Per coating manufacturer's requirements.	CS-313.
10. Chemical Feed area foundation and sump	Per coating manufacturer's requirements.	CS-316.
11. Battery Room concrete floor	Per coating manufacturer's requirements.	CS-238.
12. Hollow Metal Doors and Frames	Per coating manufacturer's requirements.	Pre-finished or 2 coat acrylic enamel system.

COATING SYSTEM CS-105
1-COAT EPOXY PRIMER FOR PROPERLY PREPARED GALVANIZED STEEL SUBSTRATES

Description	:	1-coat epoxy primer for properly prepared galvanized steel substrates
Uses	:	Primer over galvanized steel
Criteria	:	Application temperature > 50°F; above ground; underground; underwater; embedded; indoors, outdoors; operating temperature ≤ 1;70°F; abrasive; non-abrasive; corrosive, non-corrosive; uninsulated
Surface Preparation	:	SSPC-SP1, SP2, and/or SP3 as required and phosphoric acid etch as recommended by coating manufacturer
Surface Profile	:	Per coating manufacturer
Generic Type Primer	:	Epoxy

<u>Acceptable Manufacturers</u>	<u>Primer</u>	<u>DFT</u>
Carboline	Carboguard 893	1-2
Keeler & Long PPG	Kolor-Poxy Primer KL3200 Series	2-4
International	Intergard 345	4-6
Sherwin Williams	B67 Series Recoatable Epoxy	3-5
PPG	Pittguard 97-145	2-4
Devoe-International	Devran 205	2-4
Ameron-PPG	Amercoat 385	2-4
Hempel	Hempadur 17630	5-8

Note: Apply mist cost as recommended by coating manufacturer.

COATING SYSTEM CS-107
TOUCH-UP SPRAY APPLIED COATING FOR HOT-DIPPED GALVANIZED STEEL

Description	: Touch-up spray applied coating for hot-dipped galvanized steel
Uses	: Surfaces which have been abraded or burned off by welding
Criteria	: Application temperature > 50°F; above ground; underground; underwater; embedded; indoors, outdoors; operating temperature ≤ 750°F; abrasive; non-abrasive; corrosive; non-corrosive; un-insulated
Surface Preparation	: Per coating manufacturer
Surface Profile	: Per coating manufacturer
Generic Type Touch-Up	: Zinc rich

<u>Acceptable Manufacturers</u>	<u>Touch-up</u>	<u>DFT</u>
Keeler & Long PPG	Galvanode Primer #6500	2-3
Carboline	carbozinc 859	3-5
Sherwin Williams	Zinc Clad 5	3-4
PPG	UC65383/65384	3
Hempel	Organic Zinc Rich 17360	2-4

COATING SYSTEM CS-123
1-COAT EPOXY SEALER FOR INTERIOR AND EXTERIOR PROPERLY PREPARED CONCRETE
SUBSTRATES

Description	: 1-coat, Epoxy sealer for interior and exterior properly prepared concrete substrates
Uses	: Interior or exterior surfaces of concrete
Criteria	: Application temperature > 50°F; above ground; indoors, outdoors; temperature below 175°F; non-abrasive; non-corrosive; un-insulated
Surface Preparation	: Per coating manufacturer
Surface Profile	: Per coating manufacturer
Generic Type Sealer	: Epoxy

<u>Acceptable Manufacturers</u>	<u>Touch-up</u>	<u>DFT</u>
Carboline	Carboguard 1340	5 mils
International	Enviroline 57x	1.5-2 mils
Sherwin Williams	Sher-Crete Concrete Hardner	10 mils

COATING SYSTEM CS-209
2-COAT EPOXY-POLYAMINE OR POLYAMIDE SEALER
FOR CONCRETE SURFACES

Description	: 2-coat epoxy-polyamine or polyamide sealer for concrete surfaces
Uses	: Anti-slip high wear application for floors and bases
Criteria	: Application temperature > 50°F; above ground; embedded; indoors, operating temperature ≤ 170°F; abrasive; non-abrasive; corrosive, non-corrosive
Surface Preparation	: Mechanically clean
Surface Profile	: Obtain a surface resembling 80-120 grit sandpaper
Generic Type Sealer	: Epoxy
Generic Type Finish	: Epoxy

<u>Acceptable Manufacturers</u>	<u>Sealer</u>	<u>DFT</u>
Carboline	Carboguard 1340 HS	2.3
Keeler & Long PPG	Kolor-Poxy Primer/Sealer Coat 5129	2-4
International	Intergard 345 (concrete)	2-4
Sherwin Williams	Amorseal 33	8
Ameron-PPG	Amerlock 400	4-6
PPG	Megaseal WBPG W/30-50 MES H	5-7
Devoe-International	167 Preprime	1.5
Hempel	Sealer Epoxy 553 US	1-2

<u>Acceptable Manufacturers</u>	<u>Finish</u>	<u>DFT</u>
Carboline	Santile 945 SL	20-25
Keeler & Long PPG	Hi-Solids Epoxy KLN9600N with KL grit	10-16
International	Interzone 954	20-25
Sherwin Williams	Amorseal 650 SL/RC	20-25
Ameron-PPG	Amerlock 400 w/887 Additive	25
PPG	Megaseal SL	10-30
Devoe-International	Devran 124	20-25
Hempel	Hempadur Multi-Strength 35530	8-12

COATING SYSTEM CS-220

**2-COAT EPOXY FIELD APPLIED SYSTEM FOR PREVIOUSLY COATED
CARBON STEEL EXTERNAL**

Description	:	2-coat epoxy field applied system for previously coated carbon steel external surfaces
Uses	:	General purpose
Criteria	:	Application temperature > 50°F; above ground; indoors or outdoors; operating temperature ≤ 170°F; non-abrasive; corrosive and insulated OR non-corrosive and uninsulated
Surface Preparation	:	SSPC-SP2 and SP3 as required
Surface Profile	:	Per coating manufacturer
Generic Type Primer	:	Tie
Generic Type Finish	:	Epoxy

<u>Acceptable Manufacturers</u>	<u>Primer</u>	<u>DFT</u>
Carboline	Rustbond Penetrating Sealer	1-2
Keeler & Long PPG	3200	3-5
International	Interseal 600	2-3
Sherwin Williams	Macropoxy 920 Preprime	2-3
Ameron-PPG	Amerlock 400	2-3
PPG	UC65357/UC65358	1-1.5
Sigma-PPG	Sigmacover TCP	3-8
Devoe-International	Preprime 167	1.5
Hempel	Hempadur Epoxy 17630	5-8

<u>Acceptable Manufacturers</u>	<u>Finish</u>	<u>DFT</u>
Carboline	Carboguard 890	3-4
Keeler & Long PPG	9600	4-6
International	Interseal 670 HS	3-4
Sherwin Williams	Macropoxy 646	3-4
Ameron-PPG	Amerlock 400	3-4
PPG	97-145/97-149 Series	3-4
Sigma-PPG	Sigmacover TCP	3-8
Devoe-International	224 HS	3-4
Hempel	Hempadur Epoxy 17630	5-8

COATING SYSTEM CS-238
CHEMICAL RESISTANT COATING SYSTEM FOR SECONDARY
CONTAINMENT SURFACES

- Description : Chemical resistant coating system for secondary containment surfaces.
- Uses : For interior walls and floors, and concrete supports in acid containment areas. Use also for caustic areas if specifically indicated.
- Surface Preparation : Concrete Surfaces: Refer to Article 305.3b. Brush blast to remove all dirt, spalled concrete, loose concrete and other foreign matter. Obtain a surface resembling 80 to 120 grit sandpaper.
- : Carbon Steel: Conform to SSPC-SP5.
- : Systems and Normal Thickness: As follows:

<u>Location</u>	<u>Coating System</u>
Acid Containment Area Interior Walls and concrete supports-1/8 inch	- Protecto-Line 100 by Dudick - Ceilcrete 695 by Ceilcoat
Containment Area Floor and pump area floor - 1/4 inch	- Protecto-Crete 140 by Dudick - Ceilcrete 695 by Ceilcrete
Containment Area Outside Surfaces of Walls-40 mils DFT	- Protecto Coat 800 by Dudick - Flakeline 232 by Ceilcrete

Notes:

- (1) Furnish the services of the manufacturer's technical representative to oversee the installation of the coating system.
- (2) Expansion joints and grout: Manufacturer's standards as approved by Purchaser.
- (3) Cleaning and Curing: In accordance with printed requirements of manufacturer.

COATING SYSTEM CS-313
3-COAT LATEX SEALER AND LATEX FLAT INTERMEDIATE AND FINISH SYSTEM

Description	:	3-coat latex sealer and latex flat intermediate and finish system
Uses	:	Interior surfaces of gypsum board, dry wall, sheetrock, etc.
Criteria	:	Application temperature > 50°F; above ground; underground; underwater; embedded; indoors; outdoors; operating temperature ≤ 150°F; non-abrasive; non-corrosive; uninsulated
Surface Preparation	:	Per coating manufacturer
Surface Profile	:	Per coating manufacturer
Generic Type Sealer	:	Latex
General Type Intermediate	:	Latex Flat
Generic Type Finish	:	Latex Flat

<u>Acceptable Manufacturers</u>	<u>Sealer</u>	<u>DFT</u>
Keeler & Long PPG	Kolor-Tex KLC 4100	1-2
International	Intercryl 530	1-2
Sherwin Williams	ProMar 200 Primer	1-2
PPG	Speedhide 6-2	1-1.5
Devoe-International	Glidden Pro 1000	1.5-2
Sigma-PPG	Sigmatex	1.5-2

<u>Acceptable Manufacturers</u>	<u>Intermediate</u>	<u>DFT</u>
Keeler & Long PPG	Kolor-Tex KLKC310 Series	1-2
International	Intercryl 530	1-2
Sherwin Williams	ProMar 200 Flat	1-2
PPG	Speedhide 6-70	1-2
Devoe-International	Glidden Pro 1210	1-2
Sigma-PPG	Sigmatex	1.5-2

<u>Acceptable Manufacturers</u>	<u>Finish</u>	<u>DFT</u>
Keeler & Long PPG	Kolor-Tex KLKC310 Series	1-2
International	Intercryl 530	1-2
Sherwin Williams	ProMar 200 Flat	1-2
PPG	Speedhide 6-70	1-2
Devoe-International	Glidden Pro 1210	1-2
Sigma-PPG	Sigmatex	1.5-2

COATING SYSTEM CS-316

3-COAT POLYAMINE EPOXY SYSTEM FOR CONCRETE FLOORS AND BASES

Description	:	3-coat polyamine epoxy system for concrete floors and bases
Uses	:	High wear surfaces
Criteria	:	Application temperature > 50°F; above ground; underground; underwater; embedded; indoors; outdoors; operating temperature ≤ 170°F; abrasive; non-abrasive; corrosive; non-corrosive; insulated; uninsulated
Surface Preparation	:	Clean area using vacuum cleaner, etch surface as recommended by coating manufacturer, and thoroughly flush surface clean using water prior to application of surfacer
Surface Profile	:	Per coating manufacturer
Generic Type Surfacer	:	Epoxy
Generic Type Intermediate	:	Epoxy
Generic Type Finish	:	Epoxy

<u>Acceptable Manufacturers</u>	<u>Surfacer</u>	<u>DFT</u>
Carboline	Semstone 140-SL	10-15
Keeler & Long PPG	3400	10-15
Sherwin Williams	Corobond	4-6
Ameron - PPG	Nu-Klad 114A	15-20
PPG	Megaseal WBPC	2-3
Devroe-International	Devran 126	10-15
Sigma-PPG	Novoguard Caulk	15-20

<u>Acceptable Manufacturers</u>	<u>Intermediate</u>	<u>DFT</u>
Carboline	Carboguard 890	5-7
Keeler & Long PPG	3500	5-8
Sherwin Williams	Core-Cote HD	8-10
Ameron-PPG	Amerlock 400	5-7
PPG	Megaseal SL	8-10
Devroe-International	Devran 224HS	4-8
Sigma-PPG	Sigmacover TCP	5-7
Ameron-PPG	395 FD	4-5



END OF SECTION



SECTION A.15

BUILDING AND ENCLOSURE REQUIREMENTS AND DESIGN CRITERIA

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SECTION A.15
BUILDING REQUIREMENTS

A.15.1 GENERAL

This section defines the minimum design requirements for buildings, equipment enclosures and structures. The Seller is responsible for the design of all building and equipment enclosures which shall include all building support systems including, but not limited to, lighting, fire detection, fire protection and HVAC systems as required.

- A.15.1.1 The final size determination of buildings, equipment enclosures and structures shall be based on the Seller's layout of all equipment and equipment foundations that may be housed within the building. This layout shall also account for adequate clearance requirements for the removal and/or normal maintenance of all equipment contained within the buildings or enclosures.
- A.15.1.2 Structural requirements for buildings and equipment enclosures including code references, materials, loads, and finishes are included in Section A.14 – Civil/Structural/Architectural Requirements and Design Criteria.
- A.15.1.3 Architectural requirements including code references, materials, finishes, and performance ratings are included in Section A.14 – Civil/Structural/Architectural Requirements and Design Criteria.
- A.15.1.4 Pre-fabricated structures, where used, shall comply with state building code requirements, including industrialized building requirements, where applicable.
- A.15.1.5 Pre-engineered building, pre-fabricated building, custom designed buildings, and equipment enclosures shall be provided with auxiliary framing at roof level capable of supporting the mechanical and electrical components within the building including, but not limited to, piping, conduit, and cable tray.
- A.15.1.6 Mechanical and electrical equipment enclosures shall be provided for weather protection and/or for noise abatement.
- A.15.1.7 Provide exterior insulated window assemblies for all occupied rooms with exterior walls.
- A.15.1.8 All exterior doors to any building which houses personnel, information technology (IT) infrastructure (wireless access points (WAP), switches, servers, etc.), DCS infrastructure (PLCs, servers, etc.), relays, battery banks and electrical equipment shall have controlled access via electronically controlled locks, badge readers, door sounders and security cameras. Typical buildings and spaces include but are not limited to, administration building, control room, turbine control systems, distributed control system network room, local area network room, electrical power distribution centers (PDCs), continuous emissions monitoring buildings (CEMs), exciters, thyristors, steam sampling labs and

water treatment buildings. Typical buildings that do not meet this requirement are equipment enclosures and fire pump houses however all buildings shall be screened to be determined if security is required. See Section A.13.3.1 for additional physical security requirements.

- A.15.1.9 All control room doors must have security measures including badge readers, electronic lock, intercom, door sounders, and cameras. Entry doors to DCS server, telecommunication and electrical room shall also be equipped with badge reader, door sounders, and electronic locks. The interior vestibule door shall be equipped with a badge reader, intercom and camera stationed at the reception desk and lock out tagout entry desk to control entry. See Section A.13.3.1 for additional physical security requirements.
- A.15.1.10 Building and equipment enclosure HVAC system design requirements are included in Section A.9 – Site Requirements and Design Criteria.
- A.15.1.11 Seller to Provide Building Arrangement Drawings of all Buildings and Enclosures listed in Section A 15.2. Drawings will include but are not limited to Architectural, General Notes, Code Analysis, Partial Floor Plans, Roof Plans, Building Elevations, Room Finish Schedules Door Schedule, Window Schedules, Structural Building Plans & Sections.

A.15.2 BUILDING AND EQUIPMENT ENCLOSURES

A.15.2.1 Control/Administration Building:

The building shall be a pre-engineered building with HVAC system. The building area shall be as specified per Table A.15.2-1. The building will have an eave height of 16'-6" minimum. All rooms with suspended acoustical tile ceiling shall have a ceiling height of 11 feet. Ceiling height shall be measured from finish floor level to the bottom of the suspended ceiling.

Raised access floor systems will be provided as indicated in the Architectural Finishes schedule in Section A.14 - Civil/Structural/Architectural Requirements and Design Criteria. Loading criteria for the access flooring is included in A.14. Wiring shall be concealed within the raised floors and/or walls. No wiring drops are allowed from the ceiling. Provide floor data and power receptacles for all rooms with access flooring and conference rooms. See Section A.12 - Electrical Design Criteria for cable requirements. Coordinate locations of network, power, and communication receptacles with Buyer for projectors, screens, and additional furniture. Provide additional blocking and support for wall mounted screens and panels. Buyer shall review and approve layout of building.

The building shall be designed to meet ADA requirements. Provide shower/floor drain in each toilet/ shower room.

The control room shall have at least one window of approximately 16 square feet preferably looking toward the power block area. Workstations shall not be located in DCS Network Rooms.

Building shall have fire protection and fire detection. See Section A.11 - Fire Protection Requirements and Design Criteria for project requirements.

Table A.15.2-1: Control Administration Building

Control Administration Building					
Room	Exterior Access	Sq. Ft. Per	Count	Total Area (SF)	Notes
Control Administration	-	-	-	-	-
Overall: 80' x 100'					
Offices	-	160	5	800	-
File and Copy Room	-	300	1	300	-
Open Office Area (cubicles)	-	400	1	400	-
Telecom	-	350	1	350	-
Electrical Equip	Yes	640	1	640	Access from Corridor and Exterior 9' high exterior door.
Bathroom; 2 showers, 2 stalls, 2 urinals or 1 additional stall, 12 lockers	-	432	2	864	2 urinals in only 1; replace with 1 stall in the other. Provide min. ADA compliant fixtures req'd.
Conference Room/ Lunchroom/ Kitchenet/ Toilet room (ICC 500)	Yes	1000	1	1000	ICC500 rooms must be adjoining for egress between Includes kitchenette and restroom. Upper & lower casework with sink, space for two (2) 36" wide refrigerators, (1) undercounter dishwasher, & (1) 30" wide stove. (1) ADA toilet with secure vest. between control room & lunchroom.
Control Room (ICC 500)	-	1400	1	1400	Access Flooring System, designed as ICC-500 storm shelter (storm-hardened) but no public access provided.

Control Administration Building					
DCS Room (ICC 500)	Yes	630	1	630	Access Flooring System, sized to allow for cabinet access front and rear, designed as ICC-500 storm shelter (storm-hardened) but no public access provided. Exterior door to be 4' wide by 9' high for equipment access.
LOTO Room	Yes	250	1	250	Locking transfer window to Vest. & Door to Control Room
Hallways/Walls	-	-	-	1366	Approximately 17%
Total Admin Building				<u>8000</u>	

A.15.2.2 Warehouse/Maintenance Building:

Warehouse/Maintenance Building shall be a pre-engineered building with heating and ventilation system adjacent to the Control/Admin area. Provide area conditioning at areas noted to be climate controlled. The building area shall be as specified per Table A.15.2-2. The building will have an eave height of 25'-0" minimum.

The warehouse design shall accommodate an Buyer procured storage rack system, with access aisles and motor operated rollup doors for forklift and vehicular access. Detailed list of rooms is provided below. Buyer shall review and approve layout of building. Building shall have fire protection and fire detection per Section A.11 - Fire Protection Requirements and Design Criteria.

Table A.15.2-2 Warehouse/Maintenance Building

Warehouse/Maintenance Building					
Room	Exterior Access	Sq. Ft. Per	Count	Total Area (SF)	Notes
Warehouse/Maintenance Overall: 80' x 115'	-	-	-	-	Layout to combine the location of as many of the single-story rooms together and use space above for a storage mezzanine.
Climate Controlled Storage	-	250	1	250	
Laundry/JC	-	120	1	120	1 Floor drain to sanitary system
Warehouse Bathroom	-	120	1	120	1 toilet, 1 urinal, 1 sink

I&C Shop	-	400	1	400	
Maintenance Shop (w/Crane)	Yes	2400	1	2400	5-ton manual hoist and trolley
Storage Space	Yes	5910	1	5910	
Total Warehouse/Maintenance				<u>9200</u>	

A.15.2.3 Water Treatment Building:

Water Treatment Building shall be a pre-engineered building provided with heating and ventilation system. Separate enclosed electrical and DCS rooms shall have an independent heating, cooling, and ventilation system.

Table A.15.2-3 Water Treatment Building

Water Treatment Building			
Room	Exterior Access	Total Area (SF)	Notes
Water Treatment	Yes	By Seller	-
DCS Room	Yes	By Seller	Minimum 2 egress doors, one door sized for equipment access (may be combined with electrical room)
Electrical Room	Yes	By Seller	Minimum 2 egress doors, one door sized for equipment access (may be combined with DCS room)
Total Water Treatment Building		By Seller	

A.15.2.4 HIP Steam Turbine enclosure and enclosure between LP Steam Turbine and Generator (See Section A.7.4.25)

Pre-engineered enclosure. Provide ventilation system.

A.15.2.5 Steam Turbine/Generator Excitation Equipment Enclosure:

Pre-engineered or pre-fabricated enclosures. Vendor supplied enclosure. Provide heating, cooling, and ventilation system.

A.15.2.6 Combustion Turbine/Generator Enclosure with noise walls (for nearfield noise compliance)

Pre-engineered enclosure. Provide ventilation system.

A.15.2.7 Combustion Turbine/Generator Auxiliary Equipment Enclosure

Pre-engineered or pre-fabricated enclosures. Provide heating and ventilation system.

A.15.2.8 Boiler Feedwater Pump Enclosure:

Not provided.

A.15.2.9 Steam Water Sample Enclosures

- Pre-engineered or pre-fabricated enclosure. Provide heating, cooling, and ventilation system. Provide one enclosure at the STG area.
- A.15.2.10 CEMS Enclosure:
Pre-engineered or pre-fabricated enclosure. Provide heating, cooling, and ventilation system.
- A.15.2.11 Fire Pump House Enclosure:
Pre-engineered or pre-fabricated enclosure. Provide heating and ventilation system.
- A.15.2.12 Diesel Generator Enclosure:
Pre-manufactured enclosure. Provide heating and ventilation system.
- A.15.2.13 Combustion Turbine/ Generator Excitation Enclosure:
Pre-engineered or pre-fabricated enclosures. Vendor supplied enclosure. Provide heating, cooling, and ventilation system.
- A.15.2.14 Combustion Turbine Control Package Enclosure:
Pre-engineered or pre-fabricated enclosures. Vendor supplied enclosure. Provide heating, cooling, and ventilation system.
- A.15.2.15 PDC Buildings:
Pre-engineered or pre-fabricated enclosures. Provide heating, cooling, and ventilation system. Provide one main PDC and additional PDCs as required, including but not limited to HRSG, CCW, and cooling tower or ACC.
- A.15.2.16 Cooling Tower (if utilized) Chemical Treatment Shelter
Roof canopy only above equipment storage area. Shelter can be pre-engineered or custom designed.
- A.15.2.17 Closed Cooling Water Pump Shelter:
Roof canopy only above pump area, shelter can be pre-engineered or custom designed.
- A.15.2.18 ST Lube Oil Unit Shelter:
Roof canopy only above equipment area, shelter can be pre-engineered or custom designed.
- A.15.2.19 Guard Shack:
Pre-fabricated enclosure. Provide heating, cooling, and ventilation system.
- A.15.2.20 Ammonia Tank and Pump Sunshades
None Provided
- A.15.3 CRANES AND HOISTS
At a minimum cranes and hoists shall be provided as indicated:

- a. Compacted gravel road base will be provided for mobile crane pads at each of the combustion turbines and the steam turbine. Gantry cranes are not required for the steam turbine and combustion turbines.
- b. Monorails with motor-operated trolley hoists are required for each of the boiler feedwater pumps and motors. The monorails shall extend beyond the equipment equipment/foundation to facilitate direct transfer from hoist to flatbed truck. Provide stops at ends of hoist beam.
- c. Monorails required for HRSG, combustion turbines and other equipment shall be as indicated in the respective equipment procurement specification Sections A.5 – Combustion Turbine-Generator, A.6 – Heat Recovery Steam Generator, and A.7 – Steam Turbine-Generator.

END OF SECTION



Entergy Texas, Inc.
Combined Cycle Plant RFP

Technical Specification: ETI-CCCT
Issue: Rev. 0
February 11, 2026

A.16.1 – Division of Responsibility (DOR) Matrix



Entergy Texas, Inc.
Combined Cycle Plant RFP

Technical Specification: ETI-CCCT
Issue: Rev. 0
February 11, 2025

Item	Description	Engineering	Procurement	Constr / Implement	Comments
1	General Requirements and Services				
a.	General				
a.1	Project labor agreement	Seller	Seller	Seller	If applicable.
b.	General Construction				
b.1	Hazardous Material Survey (If required)	Seller	Seller	Seller	
b.2	Removal, Transport and Disposal of Hazardous Materials	Seller	Seller	Seller	
b.3	Lead and Asbestos Testing and Abatement	Seller	Seller	Seller	
b.4	Demolition of Existing Facilities	Seller	Seller	Seller	If required.
c.	Project Management and Engineering				
c.1	Baseline Noise Study	Seller	Seller	Seller	Far Field noise study as required.
d.	Construction Utilities and Services				
d.1	Buyer Site Trailers	Buyer	Buyer	Seller	Seller connects power, potable water, and sanitary connections only.
d.2	Buyer Site Trailers Phone/Fax/ Hookup, Hi-Speed Lines	Buyer	Buyer	Buyer	
d.3	Temporary Construction Power and Consumption	Seller	Seller	Seller	See Section A.1.1.3.19 and Section A.4.8.
d.4	Construction Water Supply	Seller	Seller	Seller	See Section A.4.8 and A.4.1.7.
d.5	Seller Construction Internet Service	Seller	Seller	Seller	
2	Civil/Sitework				
a.	Site Topographic Survey	Seller	Seller	Seller	
b.	Property limits survey	Seller	Seller	Seller	
c.	Permanent Site Benchmarks	Seller	Seller	Seller	
d.	Geotechnical soil Exploration, including borings and soil resistivity testing	Seller	Seller	Seller	
3	Architectural				
a.	Control/Administration Building – Control Room operators stations and furniture within the Control Room	Seller	Seller	Seller	
b.	Control/Administration Building – Other Office Furniture & Furnishings (Tables, Desks, Chairs, etc.)	Seller	Seller	Seller	
c.	Control/Administration Building – Permanent Office Equipment (Computer, Fax, Projectors, etc.)	Seller	Seller	Seller	
d.	Sample Laboratory Furniture (Cabinets, Tables, Desks, Chairs, etc.)	Seller	Seller	Seller	



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Item	Description	Engineering	Procurement	Constr / Implement	Comments
e.	Sample Laboratory Equipment (Analyzers, Apparatus, etc.)	Seller	Seller	Seller	
f.	Control/Administration Building – Kitchen Appliances	Seller	Seller	Seller	
4	Mechanical/Process Equipment				
a.	Chemical Feed System				
a.1	Supply of liquid polymer in totes	Seller	Seller	Seller	
b.	Demineralized Water Treatment System				
b.1	Chemical totes for all chemicals used within water treatment system	Seller	Seller	Seller	
c.	Potable Water System				
c.1	Eyewash / Showers	Seller	Seller	Seller	
d.	Bulk Gas Systems				
d.1	Nitrogen Bottles	Seller	Seller	Seller	
d.2	Carbon Dioxide Storage	Seller	Seller	Seller	
d.3	Hydrogen Storage	Seller	Seller	Seller	
e.	Fuel Gas System				
e.1	Natural Gas Custody Transfer Flange Terminal Point	Seller	Seller	Seller	
5	Electrical & Instrumentation				
a.	Electrical				
a.1	High Voltage Transmission Towers	Seller	Seller	Seller	
a.2	High Voltage transmission lines including OPGW (or other supplied communication cable and/or ground wire) to each Dead End Structure	Seller	Seller	Seller	Refer to Section A.3 and A.12 for detailed interface requirements.
a.3	Modification Within the Existing Switchyard	Transmission Owner	Transmission Owner	Transmission Owner	
a.4	High Voltage Breakers	Seller	Seller	Seller	Seller to provide breakers consistent with Buyer's Approved Vendor List
b.	Security and In-Facility Communications Systems				
b.1	Security Cameras	Buyer	Buyer	Seller	Buyer will provide Operating Facility security system design, electronic equipment, and installation. Seller shall design and provide cabling and raceways between buildings/enclosures/doors for the security system in the Operating Facility.
b.2	Gate Opener and Card Reader System	Buyer	Buyer	Seller	Buyer will provide Operating Facility security system design, electronic equipment, and installation. Seller shall design and provide cabling and raceways between buildings/enclosures/doors for the security system in the Operating Facility.



Item	Description	Engineering	Procurement	Constr / Implement	Comments
b.3	Communications – Telephone, LAN & WAN	Buyer/Seller	Buyer/Seller	Buyer/Seller	Seller shall design, supply and install the fiber infrastructure for Buyer supplied project Local Area Network (LAN), Wide Area Network (WAN) w/ Voice Over Internet Protocol (VOIP) telephone system in every building. Seller shall provide network cabinets, fiber patch panels, Ethernet patch panels, cabling, raceways, etc. to accommodate the Buyers supplied electronic equipment. See A.16.4.12 Seller shall supply and install a minimum of a 24 strand (12 pair) single mode fiber cable to each building with the main fiber feeds into the facility being a minimum of 96 strand (48 pair) single mode fiber cable. Buyer shall provide and install telecom racks, telecom electronic equipment, telephones, servers, switches, routers, and Ethernet and fiber patch cables within the network cabinets from the electronic equipment to the Ethernet and fiber patch panels provided by Seller.
6	Construction & Start-up				
a.	Commissioning & Start-up				Seller's startup shall use typical startup procedures, practices, and forms. This includes Lock Out Tag Out system, hot work permit system, etc. until Substantial Completion
a.1	Start-up and Operations Operators	N/A	Buyer	Buyer	Care and Control of Project by Seller until Substantial Completion
a.2	All Operating spares	Buyer	Buyer	Buyer	List to be provided by Seller
b.	Start-up Consumables through Substantial Completion, including;				
b.1	Water treatment chemicals	Seller	Seller	Seller	
b.2	Nitrogen	Seller	Seller	Seller	
b.3	Hydrogen	Seller	Seller	Seller	
b.4	Carbon Dioxide	Seller	Seller	Seller	
b.5	Natural gas	Seller	Seller	Seller	
b.6	SF6 gas	Seller	Seller	Seller	
c.	Operation Consumables, including;				
c.1	Water treatment chemicals	N/A	Buyer	N/A	
c.2	Lubricating Oil	N/A	Buyer	N/A	
c.3	Ammonia	N/A	Buyer	N/A	
c.4	Nitrogen	N/A	Buyer	N/A	



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Item	Description	Engineering	Procurement	Constr / Implement	Comments
c.5	Hydrogen	N/A	Buyer	N/A	
c.6	Carbon Dioxide	N/A	Buyer	N/A	
c.7	Natural gas	N/A	Buyer	N/A	
7	Project Testing				
a.	Performance Testing Operators	N/A	Buyer/Seller	Buyer/Seller	See Section A.4.15.1.4.



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Combined Cycle Plant RFP

Technical Specification: ETI-CCCT
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February 11, 2026

A.16.2.1 – Entergy Electrical Standards and Procedures



ENTERGY TRANSMISSION STANDARDS
PROTECTION & CONTROL
PURCHASE SPECIFICATION

Title Current Transformers - Specification	No. & Rev: PN0301 R05	Effective: Oct 2022
Prepared By: Devki Sharma	Approved By: Michael Walcott, Manager, Transmission Design Basis	

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Rev. No	Revisions	Date	Rev. by	App. by
01	Updated to new format, extensive revision	Aug 2009	DS	MB
02	6.1.3 revised	Dec 2011	DS	MB
03	Reformatted, added MV CTs	Aug 2016	DS	MB
04	Added bushing & slipover CTs, polymeric only housing	June 2021	DS	KB
05	Revised 6.2.10	Sept 2022	DS	MW

PROPRIETARY AND CONFIDENTIAL INFORMATION

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PN0301	Current Transformers - Specification	R05

1.0 INTRODUCTION

1.1 Purpose

The intent of this specification is to specify the requirements for current transformers (CT) for use in high voltage and extra high voltage substations.

1.2 Scope

This specification applies to all free-standing current transformers used for metering and protection applications in 15 kV through 500 kV Substations. This specification also applies to external slip-over CTs and internal bushing type CTs that are supplied as a component of dead-tank circuit breakers, metal-clad switchgear and gas-insulated switchgear. Entergy standard AL1203 specifies standard common requirements applicable to the substation equipment and shall be considered a part of this specification.

This is a functional specification. It is not intended to describe in complete details all technical requirements, nor to set forth those requirements that are covered by the applicable standards and codes. The intent of this specification is to ensure that the product to be supplied meets the requirements of this specification & applicable industry standards for its intended function. Any and all material & accessories that are normally required and supplied with the equipment for its proper functioning shall be supplied by the Vendor even if they are not specifically mentioned in the specification.

1.3 Changes for this revision

Section 6.2.10 revised to specify three conduit knockouts in the terminal box. Standard for enclosure integrity changed from IEEE C57.12.31 to IEEE C57.12 30. There were some editorial type changes

1.4 Effective Date

Changes in this standard are effective immediately. Orders placed, but not filled, or ready to be placed should be reviewed and consider using the revised specification.

1.5 Training and Awareness

This document principally impacts Relay Design, Substation Design, Project Management, and Asset Management. Management in those groups should make sure that their personnel are aware of the changes in this document.

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2.0 DEFINITIONS, TERMINOLOGY

See section 2.0 of AL1203, Standard Requirements, Substation Purchase Specification for definitions of standard and common contract related terms.

Continuous thermal current rating factor (RF): The factor by which the rated primary current of a current transformer is multiplied to obtain the maximum primary current that can be carried continuously without exceeding the limiting temperature rise from 30°C average ambient air temperature. The RF of tapped-secondary or multi-ratio current transformers applies to the highest ratio, unless otherwise stated. (*IEEE C57.12.80*)

3.0 REFERENCE STANDARDS & DOCUMENTS

See section 3.0 of AL1203, Standard Requirements, Substation Purchase Specification.

- 3.1. Entergy AL1203: Standard Requirements, Substation Purchase Specifications
- 3.2. Entergy AZ0202: Product Qualification Procedure
- 3.3. IEEE Std C57.13: Standard Requirements for Instrument Transformers
- 3.4. IEEE Std C57.12.30; Standard for Pole-Mounted Equipment – Enclosure Integrity for Coastal Environments
- 3.5. IEEE Std C57.13.5; Standard for Performance and Test Requirements for Instrument Transformers of a Nominal System Voltage of 115 kV and Above

4.0 QUALIFICATION & QUALITY ASSURANCE

4.1 Qualification

See section 4.1 of AL1203 for procedure to be qualified as an approved Entergy contractor. In addition, the manufacturer shall provide the data required in Attachments PN0301-A2 and PN0301-A3 for each rating of CT to be considered for qualification.

4.2 Quality Assurance

See section 4.2 of AL1203 for the manufacturer's QA programs, inspection & test, and schedule requirements.

4.3 Bid Requirements

The CT, complete with all the accessories, shall be supplied to the destination specified in the Attachment PN0301-A1 or the Purchase Order. The Supplier's proposal shall include the cost, insurance, duty if applicable, and freight for shipping and delivery of the equipment to the destination.

5.0 SERVICE CONDITIONS

Service conditions specified in section 5.0 of AL1203 apply. For quick reference the following temperature range and wind withstand capability applies to outdoor equipment:

The operating temperature range of the CT shall be -30 °C to + 40 °C, and at an average ambient temperature not exceeding 30 °C. The CT shall withstand hurricane force wind velocity of 150 mph or a one-inch-thick coating of ice with winds up to 40 mph

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6.0 DESIGN AND CONSTRUCTION

6.1 Design

6.1.1 The CT shall be designed and tested in accordance with IEEE Std C57.13. Current transformers 115 kV and above shall be tested in accordance with IEEE Std C57.13.5.

Bushing CTs and slip-on CTs shall comply with Annex B of IEEE Std C57.13.

6.1.2 The CT shall be a single phase 60 hertz, outdoor unit to supply a low current for metering, control, and protective relay functions. Specific requirement such as application, primary voltage, primary and secondary winding rated current, number of secondary windings, ratio, accuracy, burden and accessories will be specified by Entergy in Attachment PN0301-A1, or the Purchase requisition.

6.1.3 The free-standing CT shall have the following rated voltage, and insulation ratings.

Maximum System Voltage	BIL
15.5 kV	110 kV
25.5 kV	150 kV
36.5 kV	200 kV
72.5 kV	350 kV
123 kV, 145 kV	650 kV
170 kV	750 kV
245 kV	1050 kV
362 kV	1300 kV
550 kV	1800 kV

Bushing CTs and external Slip-over CTs shall be rated 600 volts 10 kV BIL.

6.1.4 All free-standing CTs shall be multi-ratio, with taps in accordance with IEEE Std C57.13 unless specified otherwise as single or dual ratio in the Attachment PN0301-A1 or the purchase order.

Bushing CTs and external Slip-over CTs shall be single or multi ratio as specified in the Attachment PN0301-A1.

Note: Extended range CTs will typically be specified as single or dual ratio CTs.

6.1.5 All free-standing post type CTs shall have number of cores as specified in the Attachment PN0301-A1. The secondary windings shall be fully distributed. Rated secondary winding current shall be 5 amps.

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6.1.6 Unless specified otherwise in the Attachment PN0301-A1, primary current and minimum short-time thermal current rating rms for one second shall be selected from the following table.

For bushing and slip-over CTs the short-time thermal current ratings apply to the secondary winding only.

Maximum System Voltage	Primary Current	Short – time Thermal Current
15.5 kV	1200 A	25 kA
	2000 A	31.5 kA
	3000 A	40 kA
25.5 kV	1200 A	25 kA
	2000 A	31.5 kA
36.5 kV	1200 A	25 kA
	2000 A	31.5 kA
	3000 A	40 kA
72.5 kV	2000 A	40 kA
	3000 A	63 kA
123 kV	2000 A	40 kA
	3000 A	63 kA
145 kV	2000 A	40 kA
	3000 A	63 kA
170 kV	2000 A, 3000 A	40 kA
245 kV	2000 A	40 kA
	3000 A	63 kA, 80 kA
362 kV	2000 A	40 kA
550 kV	3000 A	40 kA

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6.1.7 Accuracy of windings for metering shall be 0.3B1.8, accuracy class 0.3 (0.3% accuracy at all metering burdens up to B1.8). Other accuracy classes such as 0.15B1.8 for high accuracy extended range CTs, as tabulated below, may be specified by Entergy using Attachment PM0301-A1.

Metering Accuracy Class	Accuracy			
	At RF *100% Rated Current	At 10% Rated Current	At 5% Rated Current	At ≤ 1% Rated Current (Note)
0.3	0.3%	0.6%		
0.3S	0.3%		0.3%	
0.15	0.15%	0.3%		
0.15S	0.15%		0.15%	0.15%

Note: This is a non-IEEE standard requirement for extended range CTs.

Accuracy of the winding for Relaying shall be C800, or C400 if specified in Attachment PN0301-A1. All relaying cores of the CT shall have same accuracy.

6.1.8 The continuous thermal current rating factor (RF) shall be 2.0 for CTs rated up to 2000 Amps, and 1.5 for CTs rated 3000 Amps. The CT shall maintain its accuracy through its Rating Factor and able to be used continuously to this level.

6.1.9 The short-time mechanical current rating shall be 2.7 times the short-time thermal current rating of the CT per IEEE Std C57.13.

6.2 Construction

6.2.1 Current transformers up to 35 kV may be either oil-filled or dry-type with molded cycloaliphatic epoxy insulation. CTs 69 kV and above shall be oil-filled in a high voltage hollow insulator. The oil shall not contain polychlorinated biphenyls (PCB).

6.2.2 CTs with molded cycloaliphatic epoxy insulation may be window type, bar-type or wound primary type. Window type current transformers shall include high strength porcelain bushing tube for primary conductor. When specified, bus bars with NEMA standard four-hole pads, complete with guards to prevent entry of foreign objects into the primary tube, shall be supplied with the window-type current transformer.

Inside diameter of the slip-over or window type CT shall be 6.5 inches unless specified otherwise in the attachment.

6.2.3 The high voltage external insulator of the oil-filled current transformer shall be hermetically sealed composite polymeric silicone rubber hollow insulator. Porcelain will not be accepted unless specifically approved by Entergy for the particular project.

6.2.4 The minimum leakage distance of the housing shall be as follows:

Nominal System Voltage	Minimum Leakage Distance
15 kV	15 inches
25 kV	25 inches
34.5 kV	35 inches
69 kV	69 inches
115 kV, 138 kV	138 inches
161 kV	161 inches
230 kV	230 inches
345 kV	345 inches
500 kV	500 inches

6.2.5 High voltage CTs, 69 kV and above, shall be, as an option, provided with a normally grounded capacitance tap for tan delta test purposes.

6.2.6 Oil filled CT shall have a visible oil level indication. The CT shall have provisions for draining or adding oil for maintenance.

6.2.7 Finish color of the insulator shall be ANSI 70 light gray or equivalent. The insulator shall be free from cavities, blisters, burns or other defects and shall be uniform in color.

6.2.8 The top and the bottom metal housings, if made of steel, shall have a minimum of 3 mils of ANSI 70 sky gray paint. The paint finish shall comply with the requirements of IEEE Std C57.12.30 and be compatible with a seacoast marine environment containing corrosive sulfur and salt elements. Aluminum or non-corrosive metal parts do not need to be painted. Hot dipped galvanized surfaces shall not be painted.

6.2.9 The base shall be provided with four 1-1.5-inch lifting holes for 4-point sling for attachment to mounting structures.

6.2.10. The base unit or the low voltage terminal box shall have three 1.5-inch knockouts, one on each side and one at the bottom, to allow conduit entry from either side and or the bottom.

6.2.11. All external hardware of the base unit or terminal box shall be series 300 stainless steel, corrosion-resistant aluminum, or hot dipped galvanized.

6.2.12. The high voltage terminal shall be tin-plated or bare aluminum 4-hole NEMA standard pad accommodating copper or aluminum conductors.

6.2.13 The CT shall have one ground pad with two NEMA standard spacing holes for ground connection with copper or copper-clad steel conductor.

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6.2.14. The head of the current transformer shall be constructed of corrosion-resistant marine guard aluminum or stainless steel.

6.2.15. The polarity of the leads or terminals shall be clearly marked by permanent markings.

6.2.16 Application and mounting dimensions of the slip-over CTs will be specified by Entergy in the attachment PN0301-A1.

6.3 Nameplate

A stainless steel nameplate shall be permanently attached to the CT. The information on this nameplate shall include all data for the CT according to IEEE Std C57.13. In addition, the nameplate shall include the following:

- a) Thermal Burden
- b) Winding schematic showing all windings, terminal markings and polarity indication
- c) Entergy purchase order number
- d) Type and Volume of Oil
- e) A statement that the oil is free from PCBs
- f) Warranty period

Note: The additional information may be provided on a supplementary nameplate.

7.0 TESTS

Each current transformer shall undergo all routine tests as specified in IEEE Std C57.13 and IEEE Std C57.13.5.

Four copies of the certified test reports shall be sent to the Purchaser no later than 15 days after shipment.

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8.0 DRAWINGS & INSTRUCTION MANUALS

See 8.0 of Entergy Std AL1203 for drawings for approval, final drawings and instruction manuals required by Entergy. Drawings, test reports and Instruction manuals shall be in electronic form as specified in AL1203.

All drawings and instruction manuals shall be sent under a cover letter which lists drawing numbers and title of all drawings forwarded, destination of the transformer, purchase order number, and the quantity to the person specified in the Attachment PN0301-A1, or as specified on the purchase order.

The instruction manual shall include final data required by attachments PN0301-A2 and PN0301-A3. In addition, the following application data as applicable and as described in IEEE Std C57.13 shall be provided:

- a) Ratio correction factor and phase angle curves
- b) Short-time mechanical and short-time thermal current ratings
- c) Resistance of the secondary winding
- d) Excitation curves showing knee of the curves

9.0 WARRANTY

Manufacturer shall warrant the current transformer, complete with all accessories, to be free from defects in material and workmanship, including material, parts and components of other suppliers which are an integral part of the current transformer, for a period of not less than five (5) years after the in-service date or a period of not less than five (5) years and six (6) months after delivery, whichever occurs first.

10.0 SHIPMENT

See section 10.0 of AL1203 for additional and standard shipping requirements.

10.1 Each unit shall be delivered in wood crates containing the complete assembly unit. The assembly fittings, high voltage terminal, electrical shield, screws, bolts, nuts, etc. shall be in a small box or cloth bag and shipped with the capacitor voltage transformer inside the crate.

10.2. The correct position shall be identified on the crates by an "UP" indicator for transporting and storage. The unit shipped vertically shall not be tilted by more than 30° from the vertical position.

10.3. The crates, boxes, etc. shall show the Vendor's order number, the Entergy order number, and the number of crates shipped.

PN0301	Current Transformers - Specification	R05

11.0 RESPONSIBILITIES

The Manager of Relay Design is responsible for assuring that all equipment is purchased and manufactured in accordance with this standard.

11.1 Interpretation

Interpretation of this standard is the responsibility of the Design Managers and Design Supervisors. Questions should be directed to Transmission Design Basis.

11.2 Deviation

Deviations from this standard may be made only with the consent of the Manager of Relay Design or an approved agent thereof. Any deviations granted shall be reported to the Manager of Transmission Design Basis for consideration for inclusion in the standard. No other person is granted independent authority to grant deviations.

11.3 Regulatory Requirements

None

12.0 ACKNOWLEDGEMENTS

None

13.0 ATTACHMENTS

13.1 PN0301-A1 - Specific Requirements (Data to be supplied by Entergy)

13.2 PN0301-A2 - CT Details (Data to be supplied by Manufacturer with bid)

13.3 PN0301-A3 - CT Details (Data to be supplied by Manufacturer for Units not previously supplied to Entergy)

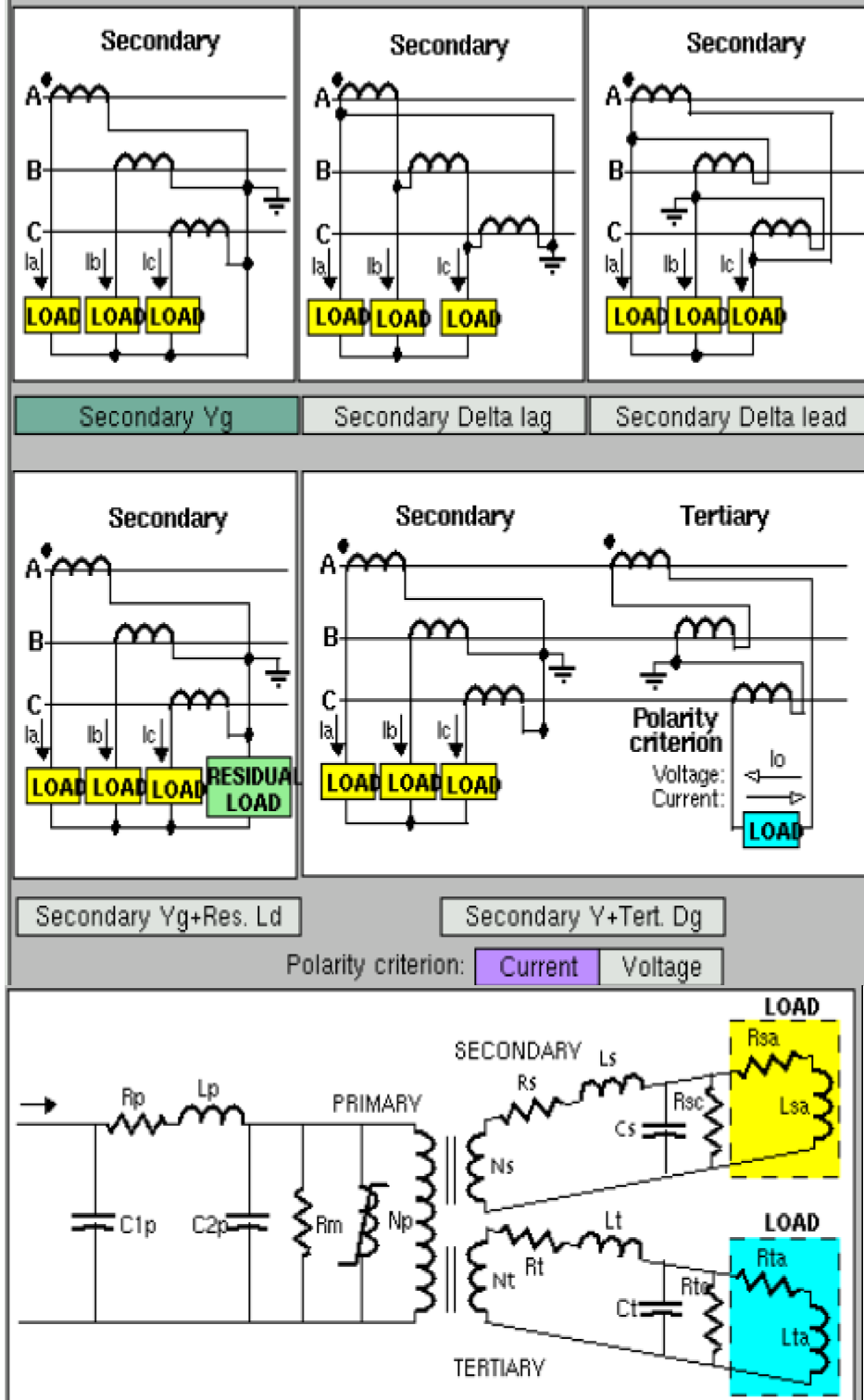
PN0301-A1	Current Transformers - Specification Specific Requirements (Data to be Supplied by Entergy)	R05

1	Substation	
2	Quantity required	
3	Date required	
4	Type of current transformer	Oil filled / window / bar / bushing / slip-on
5	Maximum System Voltage (See 6.1.3)	
6	System BIL (see 6.1.3)	Per spec. / _____
7	Secondary winding taps (see 6.1.4)	Single /dual / multi ratio
8	Secondary current (see 6.1.5)	5 Amps
9	Number of Secondary Windings (see 6.1.5)	1/2 /3 /4 /5
1	Primary Current (see 6.1.6)	
11	Rated Short-time thermal current (see 6.1.6)	
12	Accuracy of Metering winding (see 6.1.7)	
13	Accuracy of Relaying winding(s) (see 6.1.7)	
14	Continuous thermal current rating factor RF (see 6.1.8)	Per spec or _____
15	Primary bus-bar for window type CT (see 6.2.2)	Required / not required
16	Insulator Leakage distance (see 6.2.4)	Per spec./ _____
17	Inside window diameter (See 6.2.2)	6.5 " / Other _____
18	Slip-over CT mounting (See 6.2.2)	
19	Point of Delivery	
20	Person(s) to notify 48 hours in advance of shipment	
21		

PN0301-A2	Current Transformers - Specification Data to be supplied by Manufacturer with Bid	R05

1	Manufacturer	
2	Manufacturing Location	
3	Style / Catalog number	
4	Primary Voltage	
5	Rated BIL	
6	Rated short-time thermal current	
7	Rated short-time mechanical current	
8	Rated Primary Current	
9	Rated secondary current	
10	Number of Secondary Windings	
11	Accuracy of Metering winding	
12	Accuracy of Relaying Winding	
13	Partial Discharge Extinction Voltage	
14	Partial Discharge Value	
15	Insulator Leakage Distance (Mfr standard)	
16	Insulator Leakage Distance (offered)	
17	Terminal Pad material	
18	Insulator Material (Ceramic / non-ceramic)	
19	Capacitance test tap (Provided / not provided)	

Transformer windings connections:



PN0301-A3	Current Transformers - Specification Data to be supplied by Manufacturer with Bid (For units not previously supplied to Entergy)	R05

R_{ss} – connection resistance

R_p , L_p – primary leakage resistance (ohm) and inductance (henry)

R_m – resistance (ohm) representing magnetization losses

C_{1p} , C_{2p} – Stray Capacitance (farad)

N_p , N_s , N_t – number of turns

R_s , L_s – secondary leakage resistance (ohm) and inductance (henry)

C_s , R_{sc} – Stray capacitance (farad) and resistance (ohm)

R_{sa} , L_{sa} – Load resistance (ohm) and inductance (henry)

R_t , L_t – tertiary leakage resistance (ohm) and inductance (henry)

C_t , R_{tc} – Stray capacitance (farad) and resistance (ohm)

R_{ta} , L_{ta} – Load resistance (ohm) and inductance (henry)

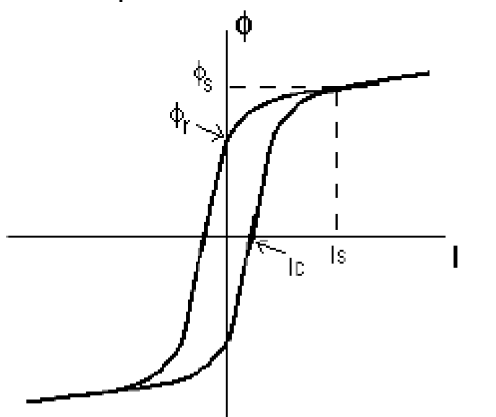
R_{sn} , L_{sn} – residual resistance (ohm) and inductance (henry)

Saturation parameter curve:

a.) $\Phi(v\text{-sec})$ vs. I_{exc}

b.) V vs. I_{exc} from zero to 115% of rated voltage.

Hysteresis parameter:



PN0301-A3	Current Transformers - Specification Data to be supplied by Manufacturer with Bid (For units not previously supplied to Entergy)	R05

PHIr: Positive remanent flux (in volts-second) at null current;

Ic: Positive coercive current (in Amperes) at null flux;

Slope @ Ic: Flux slope (in Henry) at coercive current;

Initial flux: Initial flux (in volts-second) determining initial trajectory. The initial trajectory is calculated by supposing that it has an inversion point on the main cycle;

Tolerance (Flux): Special parameter limiting the generation of minor nested loops. When the fluxes at the last inversion point and the preceding inversion point are closer than the specified tolerance (in PHIs%, it is assumed that there is displacement on the current loop).

Tolerance (Current): Special parameter limiting the generation of minor nested loops. When the magnetizing current at the last inversion point and the preceding inversion point are closer than the specified tolerance (in Ic%), it is assumed that there is displacement on a trajectory represented by a straight line segment.



**ENTERGY TRANSMISSION STANDARDS
SUBSTATION
PURCHASE SPECIFICATION**

Title: Type II Insulating Oil Purchase Specification	No. & Rev: SG0102 Rev 04	Effective: July 2025
Prepared By: Thanesh Murugesu	Approved By: Michael Walcott Manager, Transmission Design Basis	

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Rev. No	Revised Sections	Date	Rev. by	App. by
1	Reformatted to new Entergy format – added disclaimers	Jan 99		
2	Reformatted, added non-corrosive sulfur requirements. Revised table 1. Added 6.4	June 06	DS	MB
3	Reformatted, Deleted Shell and Exxon from the attachment	May 2015	DS	MB
4	Updated SG0102-A1 and Table 1	July 2025	TM	MCW

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SG0102	Type II Insulating Oil Purchase Specification	Rev 04

1.0 INTRODUCTION

1.1 Purpose

The purpose of this standard is to define a Type II Mineral Insulating Oil that is functionally interchangeable and miscible with existing oils, is compatible with existing apparatuses and with appropriate field maintenance practices and will satisfactorily maintain its functional characteristics in its application in electrical equipment. This standard applies only to new insulating oil.

1.2 Scope

This standard covers new mineral insulating oil of petroleum origin for use as an insulating and cooling medium in new and existing transformers, regulators, reactors, breakers, and associated equipment in accordance with the latest applicable API, ASTM, and IEEE standards. This standard does not include cable oils, capacitor oils, polychlorinated biphenyls (PCBs) and silicones.

1.3 Changes in This Revision

Updated SG0102-A1 and Table 1

1.4 Effective Date

This specification is effective immediately.

1.5 Training & Awareness Requirements

This standard is used by Substation Asset Management group, and it is expected that personnel in this group will individually review this standard and become familiar with its contents.

2.0 DEFINITIONS, TERMINOLOGY

Also see 2.0 of Entergy AL1203

Additives – chemical substances added to mineral insulating oil to achieve required functional properties, i.e. – inhibitor.

Inhibitor – any substances added to an insulating fluid to improve its oxidation stability and its resistance to deleterious attack in an oxidizing environment.

Type II Mineral Oil – oil for apparatuses where greater oxidation resistance is required; this is usually achieved with the addition of a suitable oxidation inhibitor.

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3.0 REFERENCE STANDARDS & DOCUMENTS

- 3.1.** Entergy AL1203, Standard Requirements-Substation Purchase Specifications
- 3.2.** Entergy AZ0202, Product Qualification Procedure
- 3.3.** Annual Book of ASTM Standards, Volume 10.03 "Electrical Insulating Liquids and Gases".
- 3.4.** ASTM D3487, Standard Specification for Mineral Insulating Liquid Used in Electrical Apparatus
- 3.5.** Doble Transformer Oil Purchase Specification (TOPS).

4.0 PRODUCT QUALIFICATION, QUALITY & PROPOSAL

4.1 Qualification

See 4.1 of Entergy AL1203

4.1.1 All oils covered by this standard shall conform to current EPA requirements, where applicable

4.1.2 Any Seller desiring to submit for approved use an insulating oil differing from that covered by this standard shall submit samples of the product and sufficient information to indicate the quality of the product.

4.2 Quality Assurance

See 4.2 of Entergy AL1203

4.3 Proposal Data

With each proposal, Seller shall include the below listed information and an oil sample, if requested.

- a)** Source of crude petroleum, refining method name of refiner, brand name, and catalog number.
- b)** Guaranteed properties of oil as per section 6.3, results of other tests if applicable, assurance that the oil offered meets Purchaser's specification, or if not, a statement of exceptions and a statement of limitations of compatibility.

5.0 SERVICE CONDITIONS

See 5.0 of Entergy AL1203.

6.0 DETAILS

6.1 Composition

6.1.1 Insulating oils shall be manufactured from predominantly naphthenic base crudes. Distillates from these crudes may be acid refined, hydrogen treated, solvent extracted, or

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processed by other suitable refining methods to yield acceptable mineral insulating oils that meet the test requirements at the point of delivery. The insulating oils shall be supplemented with 2.6 ditertiary-butyl para-cresol (DBPC), or 2.6 ditertiary-butyl phenol (DBP). Any other specific oxidation inhibitor shall require pre-approval of Entergy. Inhibited oils should otherwise be free of soluble or insoluble foreign materials and impurities.

6.1.2 The oil shall provide the optimum balance of insulating, circulating and cooling properties required of electrical insulating oil.

6.1.3 The oil shall be such as to minimize adverse effects of the oil and minerals on each other when oil is used in contact with conducting metals, structural and insulating materials, varnishes, paints and other materials commonly used in the interior of electrical equipment.

6.1.4 Oil shall maintain the required qualities described herein for at least 20 years in normal service with proper equipment and oil maintenance.

6.1.5 The oil shall have good inhibitor susceptibility so as to permit the satisfactory use of DBPC or other specifically approved inhibitor.

6.2 Production

Insulating oils covered by this specification shall be produced from proven crudes by suitable refining methods, both of which shall have been approved by the Purchaser. After such approval, no change in crude source, processing and refining methods, or shipping containers shall be made.

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6.3 Property Requirements (Bulk Shipment)

New mineral insulating oil shipped in tank cars/tank trucks shall meet the property limit listed below:

Table 1

PROPERTY		OIL LIMIT TYPE II	ASTM METHOD
Physical Properties			
Aniline Point, °C		80 max.	D 611
Color, (Note a)		0.5 max.	D 1500
Flash Point, °C		145 min.	D 92
Interfacial Tension at 25°C, min., dynes/cm		40 min.	D 971 (unfiltered)
Pour Point, °C		-40 max.	D 97
Specific gravity, 15 °C/15 °C max.		0.865 – 0.910	D 1298
Viscosity, Kinematic cST., 40 °C	100 °C	3.0 max	D 445
	40 °C	12.0 max.	
	0 °C	76 max	
Visual examination		clear and bright	D 1524
Electrical Properties			
Dielectric Breakdown, kV	(0.1" gap)	30 min.	D 877
	(0.04" gap)	20 min.	D 1816
Impulse Breakdown Voltage @ 25 °C kV, min needle negative to sphere grounded, 1" gap		145 min	D 3300
Gassing tendency under electrical stress, µL/min. @ 80 °C, hydrogen		negative (the gas is absorbed)	D 2300
Power Factor %,	100 °C	0.30 max.	D 924
	25 °C	0.05 max.	D 924
Chemical Properties			
Oxidation Stability (acid sludge test) 72 hours: % sludge, max. by mass Total acid number, max., mg KOH/g		0.1max. 0.3 max.	D 2440
Oxidation Stability (acid sludge test) 164 hours; % sludge by mass Total acid number, max., mg KOH/g		0.2 max 0.4 max.	D 2440
Oxidation stability (rotating bomb test), minutes		220 min.	D 2112
Oxidation Inhibitor content, % by wt.		0.3 max.	D 2668
Corrosive Sulfur		Non-corrosive	D 1275 Part B; Modified requiring test at a minimum duration of 48 hours at a minimum temperature of 150 °C
Water content, PPM		35 max.	D 1315, D1533
Neutralization number, mg KOH/g		0.03 max.	D 974 (modified) Neutralization number is

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PROPERTY	OIL LIMIT TYPE II	ASTM METHOD
		measured by using 1/100 normal potassium hydroxide standard alcoholic solution
Polychlorinated Biphenyls (PCBs) PPM	None Detected	D 4059

6.4 Property Requirements (Drum Shipments)

When the new mineral oil is shipped in drums or cans, it shall meet all the requirements tabulated above except that its dielectric breakdown and water content shall have the following values:

PROPERTY	OIL LIMIT TYPE II	ASTM METHOD
Dielectric Breakdown, kV	(0.1" gap)	D 877
	(0.04" gap)	D 1816
Water content, PPM	10 max.	D 1315, D1533

7.0 TESTS

The oil shall conform to all test specified herein and meet any additional requirements considered essential for the foregoing purposes. Oil failing to meet the test requirements listed in this standard shall not be accepted.

7.1 Sampling

Sampling for all test specified herein shall conform to Method for Sampling Electric Insulating Oil, ASTM Test Designation D923

7.2 Pre-Shipment Tests

7.2.1 The Seller shall secure adequate test data from the Refiner to insure compliance with the requirements of this standard and have this data available.

7.2.2 Each container of insulating oil shall be tested by the Refiner after loading at the refinery and shall not be subjected to reloading or contamination during shipment.

7.2.3 Pre-shipment test shall include:

- a)** Dielectric Strength (kV)
- b)** Total water content (PPM)
- c)** Interfacial tension (dynes/cm)
- d)** Neutralization number (mg KOH/g)
- e)** PCB contamination (PPM)
- f)** Oxygen Inhibitor Content

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7.2.4 Production tests records shall be made available for each production run for each less-than-carload (truckload) shipment.

7.3 Test Data

7.3.1 Seller shall furnish certified test reports of data in accordance with section 6.3 of this standard. Data from tests normally performed by Refiner not identified in section 6.3 should also be included.

7.3.2 Purchaser shall be given one (1) week notice of all tests and be privileged to have Purchaser's representative present for test witnessing.

7.3.3 Purchaser or Purchaser's representative shall be privileged to obtain representative samples to run additional acceptance tests.

7.3.4 Upon Purchaser's written request, the Seller shall supply an oil sample of the oil to be supplied from each tank car (tank truck) or other production run sufficient for additional testing at the same time the Refiner secures his samples as specified within this standard. Sample size and container to be stipulated within written request.

8.0 NOT USED

9.0 NOT USED

10.0 SHIPMENT

10.1 Shipment of oil shall not be made until specifically released by Purchaser.

10.2 Shipment of oil shall be in standard container(s), of the type selected by the Purchaser for each delivery. Seller shall take necessary precautions to prevent contamination of oil in his custody and to render contamination unlikely during transportation and storage in transit. New Oil shall be transported in containers that are dedicated for transporting new oil.

10.3 Tank cars/tank trucks/drums/cans transporting new oil must be cleaned, dried, and flushed with clean, dry oil prior to filling. Tank cars/trucks equipped with breathers that allow for volume changes due to temperature variations must not allow the admission of moisture or contamination into the tank.

10.4 All equipment used to load new oil into containers shall be inspected, cleaned, dried and flushed with clean, dry oil to remove any contaminants.

10.5 Each tank car/truck shall be marked with a standard API calibration sheet along with a non-PCB identification label. Additionally, the number of gallons per half inch of tank depth shall be expressed on each calibration sheet.

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10.6 Each can, drum or barrel shall be marked as follows:

- a) Purchaser's name
- b) Purchaser's order number
- c) Capacity (US Gallons)
- d) Seller's name
- e) Refiner's name
- f) Oil trade name and identification number
- g) Electrical Insulating Oil identification
- h) Non-PCB identification label

10.7 Drums used for shipment shall be equipped with gaskets and screw bungs to prevent admission of water and contamination. Screw bungs and gaskets shall be under positive pressure and shall not be exposed to standing water.

10.8 Cans shall be hermetically sealed immediately after filling. Caps shall not be exposed to standing water.

11.0 RESPONSIBILITIES

The Managers of Transmission Substation Design and Asset Management are responsible for assuring that all product is supplied in accordance with this standard.

11.1 Interpretation

Interpretation of this standard is the responsibility of Transmission Design Basis and Substation Asset Management. Questions should be directed to Transmission Design Basis.

11.2 Deviation

Deviations from this standard may be made only with the consent of Manager of Asset Management or an approved agent thereof. Any deviations granted shall be reported to the Manager of Transmission Design Basis for consideration for inclusion in the standard. No other employee is granted independent authority to grant deviations.

11.3 Regulatory Requirements

None

12.0 ACKNOWLEDGEMENTS

Richard Tullier; author of the original standard

13.0 ATTACHMENTS

SG0102-A1: Type II Insulating Oil

SG0102-A1	Type II Insulating Oil Purchase Specification Type II Insulating Oil for Substation Use	Rev 04

Manufacturer:	Oil ID#	Shipping Containers Available		
		Tank Car/Truck	55 Gal Drum	5 Gal Can
Cross	CrossTrans 206	Yes	Yes	Yes
Ergon	Hyvolt II NG	Yes	No	No



ENTERGY TRANSMISSION STANDARDS
SUBSTATIONS
APPLICATION GUIDE

Title: Transformer Fall Protection Standard (Transmission)	No. & Rev: AQ0104 R00	Effective: June 2018
Prepared By: Devki Sharma	Approved By: Kathy Balbero Manager Transmission Design Basis	

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Rev. No	Revised Sections	Date	Rev. by	App. by
0	SN1301 revised to delete safety related procedures and issued with a new number	Jun 2018	DS	KB

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AQ0104	Transformer Fall Protection Standard (Transmission)	Rev No 00

1.0 INTRODUCTION

1.1 Purpose

The purpose of this guide is to provide construction requirements for installation of fall protection equipment related to work in Transmission Substations. It is not intended to describe work practices and procedures for working on or around the equipment.

1.2 Scope

This guide applies to the method, performance and installation of fall protection devices required in substations. It includes Transmission Substation transformers and/or regulators. It includes specifications for new as well as retrofitting on existing transformers.

1.3 Changes in this Revision

This is a new guide. It includes transformer fall protection construction requirements from SN1301, and reissued with a new number. Safety related procedures were deleted as these are now covered by T&D Safe Work Rules Manual. SN1301 will be withdrawn after approval of this guide.

1.4 Effective Date

This guide is effective immediately after its approval.

1.5 Training and Awareness

This guide principally impacts Transmission Grid personnel and Project Management & Construction personnel. Personnel in these groups should review and understand this guide

2.0 DEFINITIONS

Anchorage -- a secure point of attachment for safety equipment.

Connector -- a device that is used to couple parts of the fall arrest system and positioning device systems together.

Fall Arrest System -- a system used to arrest an employee in a fall from a working level. It consists of an anchorage, connectors, a body harness and may include a lanyard, deceleration device, lifeline, or suitable combinations of these.

3.0 REFERENCE STANDARDS

3.1. Entergy Transmission & Utility Operations Safety Manual

3.2. OSHA 29 CFR, Part 1926.502: Fall Protection Systems Criteria and Practices

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4.0 SAFETY AND ENVIRONMENT

All Entergy safety rules apply. Refer to Entergy's Transmission & Distribution Safe Work Rules Manual for safety guidance and details.

5.0 TRANSFORMER FALL PROTECTION

5.1 Personal Fall Arrest System Provisions

Personal Fall Arrest Systems shall consist of an anchorage, connectors, a body harness and may include a lanyard, deceleration device, lifeline, or suitable combinations of these.

5.2 Aluminum Mast Fall Arrest System

Transformers are provided with an Aluminum Mast Fall Arrest System.

5.3 Anchor Plate Mount (Welded)

All new power and auto-transformers are specified to be supplied with FALLSOFT GM 135 fall arrest anchor plates for rescue purposes. One anchor plate shall be welded at each manhole location and one anchor plate shall be welded at the least congested corner of the transformer tank.

For existing transformers welding of the anchor plates must be performed by a certified welder. Fillet weld with 3/8 continuous welds on all four sides of plate.

5.4 Fall Arrest Anchor Structure

The Fall Arrest Anchor Structure with built-in base, locks into the GM 135 Weld-on Anchor Plate with 2 locking pins. The Anchor Structure shall be inspected for structural defects prior to use.

5.5 Welding

5.5.1 Before welding is permitted, the transformer shall be de-energized, then inspected by the individual responsible for authorizing the welding. The transformer shall have a positive nitrogen pressure within the range recommended by the Manufacturer. While welding is in progress, nitrogen pressure shall be monitored.

5.5.2. Transformers suspected of internal faults, overloads, overheating due to system cooling failures, etc., shall be vented and purged with nitrogen gas and the transformer shall have a positive nitrogen pressure established before welding is allowed. While welding is in progress, nitrogen pressure shall be monitored.

5.5.3. Transformers that are open to the atmosphere shall not be welded on until the above conditions are met.

5.5.4. All movable fire hazards in the vicinity of the welding shall be taken to a safe area.

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5.5.5 Guards shall be used to confine the heat, sparks and slag, and to protect any immovable fire hazards.

5.5.6 Suitable fire extinguishing equipment shall be immediately available at all locations where welding is in progress.

5.5.7. Welders and their supervisors shall be suitably trained in the safe operation of their equipment and the safe use of the process.

6.0 NOT USED

7.0 NOT USED

8.0 NOT USED

9.0 NOT USED

10.0 NOT USED

11.0 RESPONSIBILITIES

11.1 Interpretation

Interpretation of this guide is the responsibility of managers in the Grids, Asset Management, and Transmission Design Basis. Questions should be directed to the Manager of Transmission Design Basis.

11.2 Deviation

All Supervisors are responsible for assuring that this guide is applied to their projects. Deviations from this standard may be made only with the consent of the Manager in charge of a project in question. Any deviations granted shall be reported to Manager of Transmission Design Basis for inclusion in the guide. No other employee is granted independent authority to grant deviations.

11.3 Regulatory Requirements

OSHA CFR 29

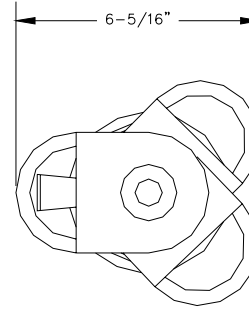
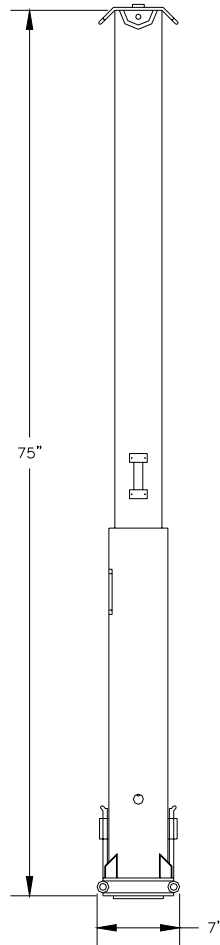
AQ0104	Transformer Fall Protection Standard (Transmission)	Rev No 00

12.0 ACKNOWLEDGEMENTS

None

13.0 ATTACHMENTS

13.1 Transformer Fall Arrest Equipment Drawings



Top View

NOTES:

1. Inspect structure for structural defects prior to use.
2. Fall arrest Anchor Structure w/built-in base, locks into the GM 135 Weld-on Anchor Plate with 2 locking pins.
3. Personnel must be connected with a shock absorbing lanyard or self-retracting lifeline with a max arrest force not exceeding 900 lbs.
4. Maximum working load 300 lbs. per person
5. Personnel must use a full body harness while connected to the Anchor Structure.

REFERENCE DRAWINGS:

TYPICAL TRANSFORMER #4 ——— XFMR #4
 TYPICAL TRANSFORMER #5 ——— XFMR #5
 FALL ARREST ANCHOR PLATE ——— ANCHRPLT
 FALL ARREST ANCHOR STR. ——— MAST1

ENTERGY SERVICES, INC.

FALL ARREST ANCHOR STR.

STD. NO. SN1301 Rev 03 SCALE: 1" = 1'

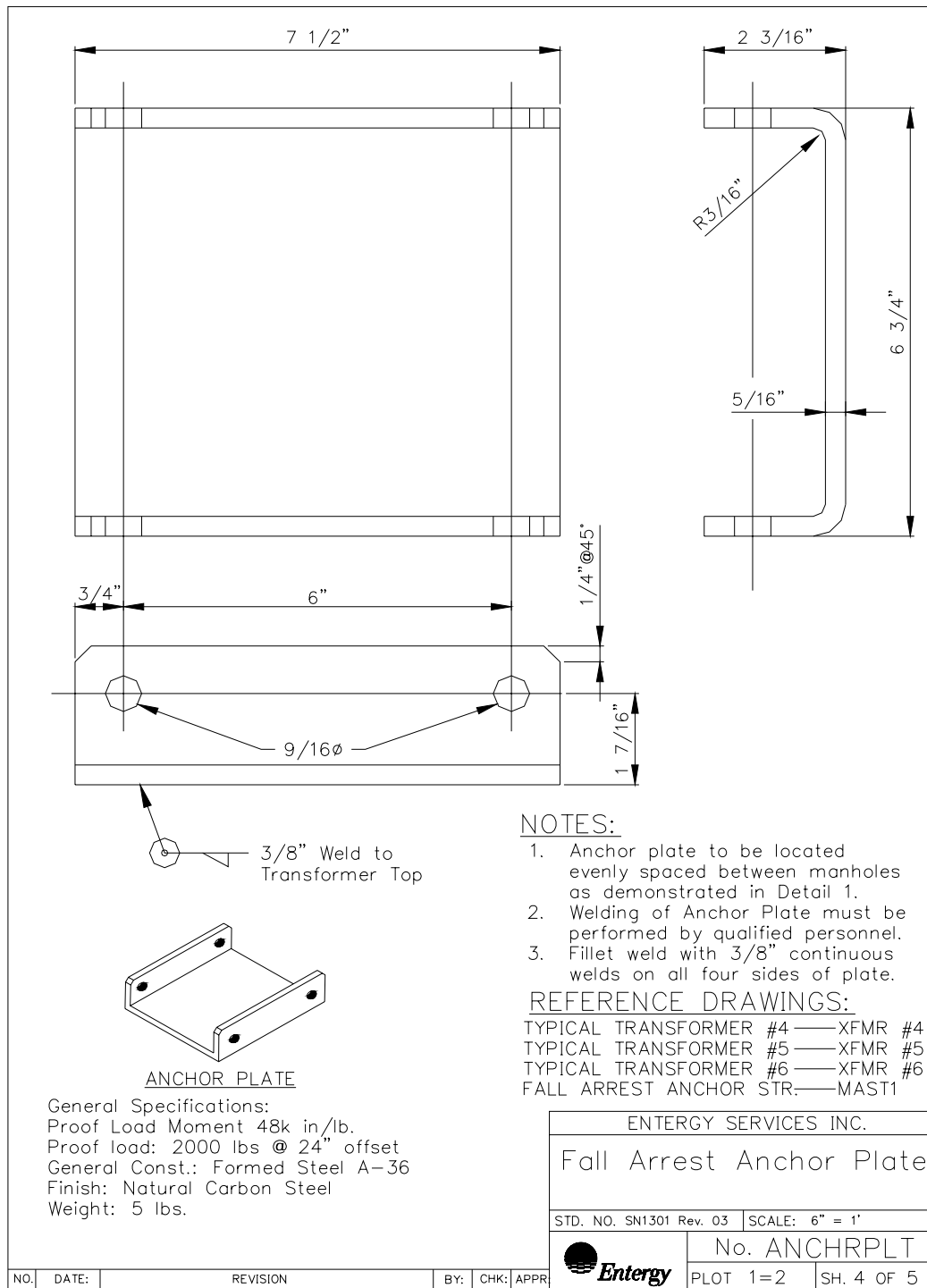


No. MAST1

PLOT 1=12

SH. 5 OF 5

NO.	DATE:	REVISION	BY:	CHK:	APPR





Entergy Texas, Inc.
Combined Cycle Plant RFP

Technical Specification: ETI-CCCT
Issue: Rev. 0
February 11, 2026

A.16.2.3 – Not Used



Entergy Texas, Inc.
Combined Cycle Plant RFP

Technical Specification: ETI-CCCT
Issue: Rev. 0
February 11, 2026

A.16.2.4 – Not Used



A.16.2.5 – NERC CIP Requirements

NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION (NERC) CRITICAL INFRASTRUCTURE PROTECTION (CIP) REQUIREMENTS APPLICABILITY

1. NERC CIP, GENERAL: The Project will comply with the latest North American Electric Reliability Corporation (NERC) Critical Infrastructure Protection (CIP) standards and Compliance Application Notices (CANs) as of 01JAN2026 (CIP-002-5.1a; CIP-003-9, CIP-004-7, CIP-005-7, CIP-006-6, CIP-007-6, CIP-008-6, CIP-009-6, CIP-010-4, CIP-011-3, CIP-012-2, CIP-013-2, CIP-014-3; henceforth described as “latest NERC CIP standards”) for a LOW impact facility. This section covers the security requirements associated with physical and cyber security for the Project. The equipment shall be designed to comply with all physical and cyber related security policies, standards, requirements and procedures as outlined herein.

1.1 NERC/FERC Requirements: **Seller’s** personnel, equipment, products, services, and Subcontractors involved with the Work must adhere to Requirements described herein. **Seller’s** equipment and products must enable **Buyer** to comply with NERC CIP, where technically feasible. Security Requirements are to be defined at the time of the contract being signed and include **Buyer** policies, Federal, State and Local Laws, regulations or industry practices including requirements that may be imposed by the Federal Energy Regulatory Commission (FERC), the North American Electric Reliability Corporation (NERC), the Southeast Electric Reliability Council (SERC), Department of Homeland Security, and Department of Energy (DOE).

2. **SUBMITTALS, GENERAL:** Equipment provided by the **Seller** shall have all necessary information needed to submit equipment capabilities, settings, etc. to the **Buyer** for NERC CIP documentation. Those items include but are not limited to the following.

- 2.1 Item 1: Make & Model
- 2.2 Item 2: Serial Number
- 2.3 Item 3: Hostname
- 2.4 Item 4: IP Address
- 2.5 Item 5: Function

3. DEFINITIONS AND ACRONYMS

3.1 Cyber Security System: A security monitoring and compliance management system that will be installed to protect all the critical and non-critical assets inside the Electronic Security Perimeter (ESP) to comply with all NERC CIP standards CIP-002 through CIP-014.

- 3.2 Applicable Acronyms
- | | |
|------|---|
| BCSI | BES Cybersecurity Sensitive Information |
| BES | Bulk Electric System |
| CIP | Critical Infrastructure Protection |
| EAP | Electronic Access Point |
| ESP | Electronic Security Perimeter |

Confidential

FERC	Federal Energy Regulatory Commission
NERC	North American Electric Reliability Corporation
PSP	Physical Security Perimeter
SIEM	Security Information and Event Management
TFE	Technical Feasibility Exceptions

4. GENERAL REQUIREMENTS

4.1 Cyber Security will not be in effect until substantial completion of the entire plant.

4.2 The **Seller** shall work with the **Buyer** to determine the list of all equipment/assets installed inside the ESP, assigning each equipment/asset to a classification identified by NERC/FERC Standards: Bulk Electric System (BES) Cyber System, Associated Protected Cyber Assets, Electronic Access Control and Monitoring Systems, and Physical Access Control and Monitoring Systems.

4.3 **Buyer** shall provide and apply labels for all Project Cyber Assets listed in the final Project Master Cyber Asset Template.

4.4 The DCS Supplier shall provide all necessary technical documentation to implement, monitor, manage, and perform reporting in accordance with NERC CIP-002 through CIP-014 requirements described herein.

4.5 The DCS Supplier shall provide the capability to generate reports to comply with NERC CIP requirements. In addition, the DCS supplier shall provide step-by-step instruction manuals on procedures to generate reports for evidence collection.

4.6 The DCS Supplier shall provide detailed training on the newly installed Cyber Security System hardware and software.

4.7 The DCS Supplier shall provide and/or enable signature, security patches, and firmware updates for all the cyber assets installed inside and at the periphery of the Electronic Security Perimeter (ESP) during the warranty period.

4.8 The DCS Supplier and individual PLC and Relay Suppliers shall provide patch management capability as identified by CIP-007 on all the BES Cyber System, Associated Protected Cyber Assets, and Electronic Access Control and Monitoring Systems. This includes security patches, software upgrades, and service packs.

4.9 The **Seller** shall assist in identifying the Technical Feasibility Exceptions (TFEs) that are required, and the **Buyer** shall be responsible to write and submit the TFEs to the necessary agencies. **Buyer** shall notify **Seller** where additional mitigation measures are required, with any work associated with the additional mitigation measures performed on a change order basis.

4.10 The DCS Supplier and individual PLC and Relay Suppliers shall use Suppliers' standardized malicious prevention tools for scanning the Control and Protection System computers,

Servers, Operator and Engineering work stations. Where technically feasible, these reports will be made available for **Buyer** consolidation into a SIEM.

4.11 The **Buyer** shall specify what drawings are to be protected. The **Seller** shall perform background checks and provide a list for all their employees (including Subcontractors) that have authorized cyber access to protected documentation or authorized unescorted physical access to BES Cyber Assets.

4.12 Remote access is not allowed.

5. EXECUTION

NERC CIP-002 through CIP-014 standards provide a framework for the identification and protection of BES Cyber Assets to support reliable operation of the BES. The **Seller** shall provide the services described herein until the project has reached its Final Acceptance milestone to comply with the NERC CIP standards.

Seller shall comply with the latest version of NERC CIP standards to be in effect at the time the Project is commissioned.

Buyer has rated this facility as Low Impact in accordance with CIP-002-5.1a.

6. NERC CIP STANDARDS

6.1 CIP-002-5.1a Cyber Security – BES Cyber System Categorization

6.1.1 CIP-002-5.1a Requirements

R1 – BES Cyber Systems Identification: The **Seller** shall assess the project's BES Cyber System impact in accordance with R1 of CIP-002-5.1a. Compliance with the remainder of NERC CIP Version 6 is dependent on which impact categorization is selected.

R2 – BES Cyber Systems Review: The **Seller** shall review the BES Cyber System impact in accordance with R2 of CIP-002-5.1a.

6.2 CIP-003-9 Cyber Security – Security Management Controls

6.2.1 CIP-003-9 Requirements

R1 - Cyber Security Policy Review: The **Seller** shall document and implement cyber-security policies that represent their management's commitment and ability to secure its BES Cyber Assets.

R2 - Cyber Security Assets Review: The **Seller** shall document and implement cyber-security policies that represent their management's commitment and ability to secure its BES Cyber Assets.

R3 – CIP Senior Manager Designation: The **Buyer** shall identify a CIP Senior Manager by name and document any change within 30 calendar days of the change.

R4 – Authority Delegation Process: The **Buyer** shall implement, in a manner that identifies, assesses, and corrects deficiencies, a documented process to delegate authority, unless no delegations are used. Where allowed by the CIP Standards, the CIP Senior Manager may delegate authority for specific actions to a delegate or delegates. These delegations shall be documented, including the name or title of the delegate, the specific actions delegated, and the date of the delegation; approved by the CIP Senior Manager; and updated within 30 days of any change to the delegation. Delegation changes do not need to be reinstated with a change to the delegator.

6.3 CIP-004-7 Cyber Security – Personnel and Training

6.3.1 CIP-004-7 Requirements

R1 - Security Awareness Program: The **Seller** shall document and implement a Security Awareness Program that includes each requirement part of CIP-004-7 Table R1.

R2 – Cyber Security Training Program: The **Buyer** shall document and implement a Cyber Security Training Program that includes each requirement part of CIP-004-7 Table R2.

R3 – Personnel Risk Assessment Program: The **Seller** shall document and implement a Personnel Risk Assessment Program that includes each requirement part of CIP-004-7 Table R3. The **Buyer and Seller** shall independently perform background checks and maintain a list for all their employees that have authorized cyber access to protected documents or authorized unescorted physical access to BES Cyber Assets. The **Buyer** shall provide their typical background check requirements for **Seller** use. The **Seller** and its **Suppliers** shall perform 7-year background checks per **Seller** and **Buyer** requirements. **Seller** and its **Suppliers** maintain a list of all their employees (including Subcontractors) that have authorized cyber access to protected documentation or authorized unescorted physical access to BES Cyber Assets. The **Buyer** is responsible for complying with all other portions of this section of the standard.

R4 – Access Management Program: The **Buyer** shall document and implement an Access Management Program that includes each requirement part of CIP-004-7 Table R4.

R5 – Access Revocation Policy: The **Buyer and Seller** shall document and implement an Access Revocation Policy that includes each requirement part of CIP-004-7 Table R5.

6.4 CIP-005-7 Cyber Security - Electronic Security Perimeter(s)

6.4.1 CIP-005-7 Pertinent Definitions

Electronic Security Perimeter: The logical border surrounding a network to which BES Cyber Systems are connected using a routable protocol.

Electronic Access Point: A Cyber Asset interface on an ESP that allows routable communications between Cyber Assets outside an ESP and Cyber Assets inside an ESP.

Electronic Access Control or Monitoring Systems: Cyber Assets that perform electronic access control or electronic access monitoring of the ESP(s) or BES Cyber Systems. This includes Intermediate Systems.

Intermediate System: A Cyber Asset or collection of Cyber Assets performing access control to restrict Interactive Remote Access to only authorized users. The Intermediate System must not be located inside the ESP(s).

External Routable Connectivity: The ability to access a BES Cyber System from a Cyber Asset that is outside of its associated ESP via a bi-directional routable protocol connection.

Interactive Remote Access: User-initiated access by a person employing a remote access client or other remote access technology using a routable protocol. Remote access originates from a Cyber Asset that is not an Intermediate System and not located within any of the Responsible Entity's ESP(s) or at a defined EAP. Remote access may be initiated from:

- a) Cyber Assets used or owned by the Responsible Entity
- b) Cyber Assets used or owned by employees
- c) Cyber Assets used or owned by vendors, contractors, or consultants.

Note: Interactive remote access does not include system to system process communications

6.4.2 CIP-005-7 Requirements

R1 – Electronic Security Perimeter: The **Seller** shall ensure that every BES Cyber Asset resides within an Electronic Security Perimeter (ESP) with review and approval by Buyer. The **Seller** shall identify and document the ESP(s) and all Electronic Access Points (EAPs) to the perimeter(s). The **Buyer** shall implement and document the procedural mechanisms and the organizational processes for control of electronic access at all electronic access points to the ESP.

The **Seller** will support NERC CIP for **Seller** provided equipment, and the **Seller** will assess the NERC CIP compliance of the connections between the **Seller** provided and the

Buyer provided equipment. Each BES Cyber Asset that is linked via the project Control System Network shall reside within an ESP. The **Buyer** is responsible for correcting NERC CIP deficiencies for **Buyer** provided equipment. To accomplish NERC CIP support, the **Seller** shall:

1. Provide initial solutions to secure all EAPs; which may include, but is not limited to: controllers, switches, routers, and workstations. Non routable devices such as smart transmitters are not considered an EAP. EAPs will be secured using hardened ports, white listing, fire walls, or physical security preventing access to those EAPs.
2. Provide Access Control and Monitoring devices to secure all the devices inside the ESP. Each ESP will be contained within a Physical Security Perimeter (PSP). This includes locating all touch screens provided by **Seller** for BES Cyber Assets or EAPs in a secure cabinet or enclosure. Each PSP will contain access control to prevent access to the ESP and to monitor personnel access.

The **Seller** shall provide a Security Information and Event Management (SIEM) system for the **Buyer** to implement password protection for monitoring and logging access at access points to the ESP(s) twenty-four hours a day, seven days a week. The **Seller** is responsible for providing data generation capabilities for the **Seller** provided equipment, in order to allow the **Buyer** to create reports containing all information pertinent to this section for evidence collection. The system and event logs for systems such as PLC's and 3rd Party Controllers will be stored on the local device and will not be available in the DCS.

3. Where technically feasible, perform authentication when establishing Dial-up Connectivity with applicable BES Cyber Assets.
4. Protect and monitor end points of the communication links connecting discrete ESPs, as these shall be considered EAPs. For example, all fiber outside of a PSP shall be armored fiber or be run in RGS conduit where above grade.

R2 – Interactive Remote Access to BES Cyber System: All hardware used for interactive remote access will be removed to eliminate remote access once the facility is synced and affects the grid. **Seller** shall perform the following until the facility is synced with the grid:

1. Provide an Intermediate System (gateway/switch) to interact and control access to the BES Cyber Assets requiring Interactive Remote Access by the **Buyer**.
2. Provide encryption and multi-factor authentication for all Interactive Remote Access sessions. For example, use of usernames and passwords.
3. Provide evidence of tracking all personnel and vendors with Interactive Remote Access permission.

6.5 CIP-006-6 Cyber Security – Physical Security of BES Cyber Systems

BES Cyber Assets that authorize and/or log access to the Physical Security Perimeter(s), excluding hardware at the PSP access point such as electronic lock control mechanisms and badge readers, shall be protected from unauthorized physical access. This section pertains strictly to the protection of the electronics associated with controlling the system.

6.5.1 CIP-006-6 Pertinent Definitions

Physical Security Perimeter: The physical border surrounding locations in which BES Cyber Assets, BES Cyber Systems, or Electronic Access Control or Monitoring Systems reside, and for which access is controlled.

Physical Access Control System: Cyber Assets that control, alert, or log access to the Physical Security Perimeter(s), exclusive of locally mounted hardware or devices at the Physical Security Perimeter. Exclusion examples include motion sensors, electronic lock control mechanisms, and badge readers.

6.5.2 CIP-006-6 Requirements

R1 - Physical Security Plan: **Buyer** will document, implement, and maintain a physical security plan, approved by the senior manager or delegate(s) to meet each requirement part of CIP-006-6 Table R1. **The Seller is not responsible for developing this plan. The Seller will adhere to the plan pending a review of the plan.** Per CIP-004-7 above, the list of cleared employees (including Subcontractors) will be used to restrict authorized cyber access to protected documentation or authorized unescorted physical access to BES cyber assets at project site.

The **Buyer** will provide cameras, card readers, and other sensors. The **Buyer** will monitor any available security system logs.

The **Buyer** shall document and implement the operational and procedural controls to manage physical access at all access points to the PSP(s) twenty-four hours a day, seven days a week. The **Seller** will support NERC CIP requirements for **Seller** provided equipment as described below. The **Seller** will investigate the feasibility of providing the same for **Buyer** provided equipment, such that each PSP is protected and monitored. **Seller** is not responsible for integration of others' equipment. To assist with compliance, the **Seller** shall:

1. Provide cabinets with access control if they are outside of a designated PSP, for example keypad(s), card reader(s), or a lock and key.
2. Ensure that all BES Cyber Assets reside within the project control room or in another approved PSP. Approved PSPs include reasonably secured enclosures with an access control locking device where no access to BES Cyber Assets can be obtained from the outside.

R2 - Visitor Control Program: The **Buyer** shall document and implement a Visitor Control Program that includes each requirement part of CIP-006-6 Table R2. **The Seller is not responsible for**

developing this program. The Seller will adhere to the program pending a review of the program.

R3 - Physical Access Control System Maintenance and Testing Program: The **Buyer** shall document and implement a Maintenance and Testing Program that includes each requirement part of CIP-006-6 Table R3. **The Seller is not responsible for complying with this section of the standard.**

6.6 CIP-007-6 Cyber Security – System Security Management

6.6.1 CIP-007-6 Requirements

R1 – Ports and Services: The **Buyer** shall document the types of protection being used and implement the operational and procedural controls for the continuous monitoring and maintenance of all ports and services. Where technically feasible the **Seller** shall:

1. Enable only those ports and services required for operations and for monitoring BES Cyber Assets within the ESP as justified with appropriate supporting documentation.
2. Document Ports and Services, individually or by specified grouping, and configuration of those ports and services. Documentation shall consist of make and model numbers of routers and switches, and a list of active and inactive ports.
3. Disable other ports and services, including those used for testing purposes, prior to production use of all BES Cyber Assets inside the ESP(s), by restricting ports at host firewall or performing IP filtering at equipment network card level.

The **Seller** will provide a means to computer generate a snap shot of these ports locally once in service, where technically feasible.

R2 – Security Patch Management: The **Seller** will provide the capability to track, evaluate, test, and install applicable cyber security software patches for all applicable **Seller** provided BES Cyber Assets. The **Buyer**, either separately or as a component of the documented Security Management process specified in CIP-003, shall establish, document, and implement, a security patch management program for tracking, evaluating, testing, and installing applicable cyber security software patches for all Cyber Assets within the ESP(s). The **Seller** shall have the most up to date software patches installed at time of turnover. The **Buyer** is responsible for evaluating and implementing security patches within the required timeframe once the facility is synced and affects the grid.

R3 – Malicious Code Prevention: The **Seller** shall provide anti-virus software and other malicious software (“malware”) prevention tools, where technically feasible, to detect, prevent, deter, and mitigate the introduction, exposure, and propagation of malware on all **Seller** provided BES Cyber Assets within the ESP(s). If Malware Protection is available for process controllers, it shall be used; otherwise, other compensating measure for the process controllers shall be used. Compensating measures will be per vendor’s standard practices. If any additional compensating measures are required it will be the **Buyer’s** responsibility.

Buyer is responsible for documenting and implementing a process for the update of anti-virus and malware prevention “signatures”.

R4 – Security Event Monitoring: The **Seller** shall ensure that all Cyber Assets within the ESP, as technically feasible, implement tools or organizational process controls to monitor security events that are related to cyber security. The Security Information and Event Monitoring System (SIEM) shall be capable of detecting, reporting, and alarming on the following incidents under R4:

1. Detect successful login attempts
2. Detect failed access attempts and failed login attempts
3. Detect malicious code

Buyer is responsible for all data retention, summarization, and reporting.

R5 – System Access Controls: The **Buyer** shall establish, implement, and document technical and procedural controls that enforce access authentication of, and accountability for, all user activity, that will minimize the risk of unauthorized system access. The **Buyer** shall identify and inventory all known enabled default or other generic account types either by system, by groups of systems, by location, or by system type(s). **Buyer** is responsible for identifying and maintaining a list of individuals who have authorized access to shared accounts.

The **Seller** shall do the following where technically feasible to assist in NERC CIP compliance:

1. Provide passwords with a minimum of eight characters or the maximum length supported by the BES Cyber Asset.
2. Each password shall consist of a combination of alpha, numeric, and “special” characters.
3. Provide the capability to change passwords annually at a minimum.
4. Limit the number of unsuccessful authentication attempts or generate alerts after a threshold of unsuccessful authentication attempts.

The **Seller** is responsible for providing the capability of generating the reports required for evidence collection pertaining to CIP-007-6 R5, where technically feasible. The **Seller** shall alert the **Buyer** of any Cyber Assets that may not meet this CIP requirement.

6.7 CIP-008-6 Cyber Security – Incident Reporting and Response Planning

6.7.1 CIP-008-6 Pertinent Definitions

Reportable Cyber Security Incident: A Cyber Security Incident that has compromised or disrupted one or more reliability tasks of a functional entity

6.7.2 CIP-008-6 Requirements

R1 – Cyber Security Incident Response Plan: The **Buyer** shall develop, implement, and maintain a Cyber Security Incident Response Plan that includes each requirement part of CIP-008-6 Table R1. **The Seller is not responsible for complying with this section of the standard.**

R2 – Cyber Security Incident Response Plan Implementation and Testing: The **Buyer** shall document and implement a Cyber Security Incident Response Plan Implementation and Testing Program that includes each requirement part of CIP-008-6 Table R2. **The Seller is not responsible for complying with this section of the standard.**

R3 – Cyber Security Incident Response Plan Review, Update, and Communication: The **Buyer** shall document and implement a Cyber Security Incident Response Plan Review, Update, and Communication Program that includes each requirement part of CIP-008-6 Table R3. **The Seller is not responsible for complying with this section of the standard.**

6.8 CIP-009-6 Cyber Security – Recovery Plans for BES Cyber Systems

6.8.1 CIP-009-6 Requirements

R1 – Recovery Plan Specifications: The **Buyer** shall develop, implement, and maintain a Recovery Plan that includes each requirement part of CIP-009-6 Table R1. **The Seller is not responsible for complying with this section of the standard.**

R2 – Recovery Plan Implementation and Testing: The **Buyer** shall document and implement a Recovery Plan Implementation and Testing Program that includes each requirement part of CIP-009-6 Table R2. **The Seller is not responsible for complying with this section of the standard.**

R3 – Recovery Plan Review, Update, and Communication: The **Buyer** shall document and implement a Recovery Plan Review, Update, and Communication Program that includes each requirement part of CIP-009-6 Table R3. **The Seller is not responsible for complying with this section of the standard.**

Seller shall provide software and configuration files necessary to perform recoveries on BES Cyber Assets provided by the **Seller**. The **Buyer** is required to develop, implement, and maintain standards for BES Cyber Asset recoveries as required in CIP-009-6.

6.9 CIP-010-4 Cyber Security – Configuration Change Management and Vulnerability Assessments

6.9.1 CIP-010-4 Requirements

R1 – Configuration Change Management: **Seller** shall develop a baseline configuration, individually or by group, for operating system(s) (including version) or firmware where no independent operating system exists. For example, any commercially available or open source

application software intentionally installed, any custom software installed, any logical network accessible ports, or any security patches applied. The **Seller** shall supply the baseline, detailed in CIP-010-4 R1, to the **Buyer** before the facility is synced and affects the grid.

R2 – Configuration Monitoring: The **Buyer** shall document and implement a Configuration Monitoring Plan that includes each requirement part of CIP-010-4 Table R2. **The Seller is not responsible for complying with this section of the standard.**

R3 – Vulnerability Assessments: The **Buyer** shall document and implement a Vulnerability Assessment Program that includes each requirement part of CIP-010-4 Table R3. **The Seller is not responsible for complying with this section of the standard.**

R4 – Transient Cyber Assets and Removable Media: The **Buyer** shall document and implement a plan for Transient Cyber Assets and Removable Media that includes each section from CIP-010-4 Attachment 1. **The Seller is not responsible for developing the plan and will adhere to the Buyer’s plan pending a review of the plan.**

6.10 CIP-011-3 Cyber Security – Information Protection

6.10.1 CIP-011-3 Requirements

R1 – Information Protection: The **Buyer** shall develop, implement, and maintain an Information Protection Plan that includes each requirement part of CIP-011-3 Table R1. The **Buyer** shall provide the Information Protection plan to the Seller before work begins to assure compliance with the **Buyer’s** standard. **The Seller shall comply with the Buyer’s standard as defined at the beginning of the project but is not responsible for the development and maintenance of the Information Protection Plan.** Per CIP-004-7 above, the list of cleared employees (including Subcontractors) will be used to restrict authorized cyber access to protected documentation or authorized unescorted physical access to BES cyber assets at project site.

R2 – BES Cyber Asset Reuse and Disposal: The **Buyer** shall document and implement a BES Cyber Asset Reuse and Disposal Program that includes each requirement part of CIP-011-3 Table R2. **The Seller is not responsible for complying with this section of the standard.**

6.11 CIP-012-1 Cyber Security – Communications between Control Centers

6.11.1 CIP-012-1 Requirements

R1 – Control Center to Control Center Risk Management Plan: The **Buyer** shall develop and maintain a Control Center to Control Center Communications Risk Management Plan that includes each requirement part of CIP-012-1 R1.

6.12 CIP-013-2 Cyber Security – Supply Chain Risk Management

6.12.1 CIP-013-2 Requirements

R1 – Supply Chain Cyber Security Risk Management Plan: The **Seller** shall develop and maintain a Supply Chain Cyber Security Risk Management Plan that includes each requirement part of CIP-013-2 R1.

R2 – Implementation of Supply Chain Management Plan: The **Seller** shall implement a Supply Chain Cyber Security Risk Management Plan that includes each requirement part of CIP-013-2 R2. The **Seller** shall provide the Supply Chain Cyber Security Risk Management Plan to the **Buyer** before work begins to assure compliance with the **Buyer's** standard. The **Seller** shall comply with the **Buyer's** standard as defined at the beginning of the project but is not responsible for the development and maintenance of the Supply Chain Cyber Security Risk Management Plan.

R3 – Supply Chain Cyber Security Risk Management Approval: The **Buyer** shall review and obtain CIP Senior Manager or delegate approval of its Supply Chain Cyber Security Risk Management Plan that includes each requirement part of CIP-013-2 R3.

6.13 CIP-014-3 Physical Security

6.13.1 CIP-014-3 Requirements

R1 – Risk Assessment of Transmission Stations and Transmission Substations: The **Transmission Owner** shall perform an initial risk assessment and subsequent risk assessments of its Transmission stations and Transmission substations (existing and planned to be in service within 24 months) that meet the criteria. **The Seller has ASIS Physical Security Professional (PSP) certified personnel that can assist in conducting assessments as an Engineering Service activity, but the Seller is not responsible for complying with this section of the standard.**

R2 – 3rd Party Verification of Risk Assessment of Transmission Stations and Transmission Substations: The **Transmission Owner** shall have an unaffiliated third party verify the risk assessment performed under Requirement R1. **The Seller has ASIS Physical Security Professional (PSP) certified personnel that can assist in conducting assessments as an Engineering Service activity, but the Seller is not responsible for complying with this section of the standard.**

R3 – Notification of Transmission Control Center over R1 and R2 sites: The **Transmission Owner** shall notify the Transmission Control Center **Owner** of any elevation or decrease in criticality of Transmission Stations and Transmission Substations from R1 and R2. **The Seller is not responsible for complying with this section of the standard.**

R4 – Vulnerability Assessment of Transmission facilities: The **Transmission Owner** shall conduct a risk assessment of facilities identified in R1, R2, and R3. The Risk assessment shall take into account:

- 4.1. Unique characteristics of the identified and verified Transmission station(s), Transmission substation(s), and primary control center(s);
- 4.2. Prior history of attack on similar facilities taking into account the frequency, geographic proximity, and severity of past physical security related events; and
- 4.3 Intelligence or threat warnings received from sources such as law enforcement, the Electric Reliability Organization (ERO), the Electricity Sector Information Sharing and Analysis Center (ES-ISAC), U.S. federal and/or Canadian governmental agencies, or their successors.

The Seller has ASIS Physical Security Professional (PSP) certified personnel that can assist in vulnerability assessments as an Engineering Service activity, but the Seller is not responsible for complying with this section of the standard.

R5 – Build a Physical Security Plan for Identified Transmission Facilities: The **Transmission Owner** shall build a physical security plan for facilities identified in R1, R2, and R3. The Risk assessment shall take into account:

- 5.1. Resiliency or security measures designed collectively to deter, detect, delay, assess, communicate, and respond to potential physical threats and vulnerabilities identified during the evaluation conducted in Requirement R4.
- 5.2. Law enforcement contact and coordination information.
- 5.3. A timeline for executing the physical security enhancements and modifications specified in the physical security plan.
- 5.4. Provisions to evaluate evolving physical threats, and their corresponding security measures, to the Transmission station(s), Transmission substation(s), or primary control center(s).

The Seller has ASIS Physical Security Professional (PSP) certified personnel that can assist in building physical security plans as an Engineering Service activity, but the Seller is not responsible for complying with this section of the standard.

R6 – Third Party Assessment of Evaluations and Physical Security Plans for Identified Transmission Facilities: The **Transmission Owner** shall assess the efficacy and coverage of the vulnerability assessment and the physical security plan for facilities identified in R1, R2, and R3. **The Seller has ASIS Physical Security Professional (PSP) certified personnel that can assist in the reviews as an Engineering Service activity, but the Seller is not responsible for complying with this section of the standard.**

END OF SECTION

Pipe Paint Colors

Rev. 0
February 11, 2026

For piping required to be painted, as described in Section A.10, the following color should be used:

PIPING DESCRIPTION	COLOR	FED STD 595 CODE (Preferred)	RAL Code (Alternate)
FIRE PROTECTION SYSTEM	SAFETY RED	21105	RAL 3020
CARBON DIOXIDE-CO ₂ , NITROGEN	SAFETY ORANGE	22544	RAL 2000
FUEL GAS and HYDROGEN	SAFETY YELLOW	23655	RAL 1023
OIL	SAFETY BROWN	33434	RAL 1024
POTABLE, COOLING, BOILER FEED, CONDENSATE, AND OTHER WATER	SAFETY GREEN	34090	RAL 6029
STEAM	CRIMSON RED	30076	RAL 3032
COMPRESSED AIR	SAFETY BLUE	35180	RAL-5019
PROCESS WATER TREATING CHEMICALS	SAFETY PURPLE	37100	RAL 4008
PLANT USAGE (Note 1)	SAFETY WHITE	37925	RAL 9016
PLANT SERVICE WATER	SAFETY GRAY	36173	RAL 7031
AQUEOUS NH ₃ >19%	SAFETY WHITE	37925	RAL 9016

NOTES:

1 – Prior to painting, Seller shall review with Buyer any / all piping considered to be "Plant Usage" to approve the use of Safety White (37925) as the pipe paint color.

2 – Seller shall select a color system (either Federal Standard or RAL) for each application in the project. Seller shall not use both the preferred and alternate colors for any common application.



Entergy Texas, Inc.
Combined Cycle Plant RFP

Technical Specification: ETI-CCCT
Issue: Rev. 0
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A.16.2.8 – Not Used



Entergy Texas, Inc.
Combined Cycle Plant RFP

Technical Specification ETI-CCCT
Issue: Rev 0
February 11, 2026

A.16.2.9 – NERC GO/GOP Requirements

The following NERC Generator Owner / Generator Operator standards require action by or input from the Seller. There are additional GO/GOP NERC standards that apply to the project which are primarily the responsibility of Buyer, however, it is required that the Seller will assist Buyer with data as required to support completion of document and/or compliance with the standard. The cited version of the standards is the one in effect currently or has an established future effective date. New versions of the standards that may be issued or published which the Buyer deems necessary for inclusion by the Seller shall be subject to a change order.

NERC Standard	Title	Seller Responsibilities	Due Date
COM-001-3	Communications	Inclusion of interpersonal communications channels (phones, backup systems) in Control Room design.	30 Days Prior to Substantial Completion
EOP-012-2	Extreme Cold Weather Preparedness and Operations	Seller responsible for implementing and commissioning all cold weather (freeze) protection features and systems as identified in EPC Agreement.	Prior to Substantial Completion.
FAC-008-5	Facility Ratings	Seller to provide electrical system configuration, rating data, and nameplate photos of power production and delivery path equipment (Gen, IPBD, GSU, HV components, etc.) to support Facility Rating Workbook completion by Buyer.	Six (6) months prior to Backfeed. Updated information (if required to supplement preliminary data) shall be provided 90 days to Substantial Completion
MOD-025-2	Verification and Data Reporting of Generator Real and Reactive Power Capability and Synchronous Condenser Reactive Power Capability	Seller shall contract with a Buyer approved company to perform required testing and deliver the required report in Buyer standard format.	Testing and approved reports must be completed no later than six (6) months after COD.
MOD-026-1	Verification of Models and Data for Generator Excitation Control System or Plant Volt/Var Control Functions	Seller shall contract with a Buyer approved company to perform required testing and deliver the required report in Buyer standard format.	Testing and approved reports must be completed no later than six (6) months after COD.



NERC Standard	Title	Seller Responsibilities	Due Date
MOD-027-1	Verification of Models and Data for Turbine/Governor and Load Control or Active Power/Frequency Control Functions	Seller shall contract with a Buyer approved company to perform required testing and deliver the required report in Buyer standard format.	Testing and approved reports must be completed no later than six (6) months after COD.
MOD-032-1	Data for Power System Modeling and Analysis	Seller to supply generator and CT control system data and model files to support model development and provide updates if data changes or confirm no changes.	Provide model data and files within 90 days of LNTP. Provide model update / confirmation of no change annually and 90 days prior to Substantial Completion Final updates (if required) within 90 days post Commercial Operation.
PRC-002-5	Disturbance Monitoring and Reporting Requirements	Seller shall provide dynamic disturbance recorder (DDR). Includes procurement of Buyer preferred SEL Digital Fault Recorder system, installation, and commission. DDR System shall meet all recording requirements of PRC-002. Seller shall work with Buyer for connection to Buyer LAN.	DDR shall be operational prior to Substantial Completion

NERC Standard	Title	Seller Responsibilities	Due Date
PRC-005-6	Protection System, Automatic Reclosing, and Sudden Pressure Relaying Maintenance	Seller shall provide: 1) Drawings depicting and list of equipment typically included Protection System Maintenance Program (PSMP). Typically includes batteries, PTs, CT, Relays in the main power delivery path. 2) Test reports or documentation showing that all listed equipment has been tested with the date(s) of testing. Records showing that all protection circuits have been verified by test.	List of equipment and system configuration information six (6) months prior to Backfeed. All completed test documentation submitted 30 days prior to Substantial Completion
PRC-019-2	Coordination of Generating Unit or Plant Capabilities, Voltage Regulating Controls, and Protection	Relay setting documentation and a specific report showing that all limiters operate before protection and control devices including the control systems and the protective system limits damage to equipment.	Compliant relay settings required six (6) months prior to Backfeed Final report demonstrating compliance of settings with standard required 90 days prior to Substantial Completion.
PRC-023-6	Transmission Relay Loadability	Attestation that PRC-023-4 does not apply or evidence of compliance	If not applicable, attestation so stating required 90 days prior to Substantial Completion. If applicable, compliant relay settings calculations required six (6) months Prior to Backfeed Final report demonstrating compliance of settings with standard required 90 days prior to Substantial Completion.
PRC-024-3	Frequency and Voltage Protection Settings for Generating Resources	Relay setting documentation and a specific report showing the frequency and voltage responsive relays and control function device comply with the setting requirements of PRC-024 by not tripping in the "No-Trip" zone.	Compliant relay settings required six (6) months Prior to Backfeed Final report demonstrating compliance of settings with standard required 90 days prior to Substantial Completion.

NERC Standard	Title	Seller Responsibilities	Due Date
PRC-025-2	Generator Relay Loadability	Relay setting documentation and a specific report showing the load responsive relays comply with the setting requirements of PRC-025.	Compliant relay settings required six (6) months prior to Backfeed Final report demonstrating compliance of settings with standard required 90 days prior to Substantial Completion.
PRC-026-2	Relay Performance During Stable Power Swings	Relay Setting Documentation and analysis showing the load responsive relays will not trip during power swings.	Compliant relay settings required six (6) months prior to Backfeed Final report demonstrating compliance of settings with standard required 90 days prior to Substantial Completion.
PRC-027-1	Coordination of Protection Systems for Performance During Faults	Complete package of relays setting documents including analysis to support review by Buyer and Transmission Owner. Documentation should include verification of electrical coordination for expected fault currents. Evidence of coordination between organizations (exchange of settings information) shall be retained and transmitted to Buyer.	Compliant relay settings calculations required six (6) months prior to Backfeed Final settings and documentation shall be provided prior to energization. Evidence of coordination required 90 days prior to Substantial Completion.
VAR-002-4.1	Generator Operation for Maintaining Network Voltage Schedules	Facility DCS design must include alarms for AVC mode off, Power System Stabilizer off and out of voltage schedule. DCS HMI to include pop-up notification to operators reminding operators that changing the AVR/controller from AVR to any other mode (PF, VAR control) MUST have documented / written approval from the TCC before changing modes.	90 Days Prior to Substantial Completion



A.16.2.10 – Pre-approved Subcontractors for NERC-Related Scope

As set forth in and subject to Section A.1 of Exhibit A, Technical Specification, relating to NERC-related Protective Relay Scopes of Work and NERC MOD testing (“NERC-Related Work”), Owner has approved the following subcontractors, subject to all other requirements of Subcontractors stated in the Agreement, for use on this Project. Seller shall not self-perform NERC-Related Work without Owner’s prior written authorization which shall be requested at least ninety (90) days prior to Seller’s required (scheduled) date to commence protective relay settings scope.

A. Relay settings development and quality review and approval of developed settings for Transmission and Generating facilities:

- Black & Veatch
- Phasor Grid
- Holden Enterprises
- Power Engineering Consultant (PEC)
- IK Power
- Quanta
- PCS2000

B. NERC MOD testing of generating units, including test planning, monitoring of conduct of testing, and preparation of final reports

- Kestrel Power Engineering
- PCS2000

C. Relay settings development and quality review and approval of developed settings for generation facility relays:

- Sargent and Lundy, L.L.C.



A.16.3.1 – Plant Arrangement

To be provided by Seller as a part of the Proposal



Entergy Texas, Inc.
Combined Cycle Plant RFP

Technical Specification: ETI-CCCT
Issue: Rev. 0
February 11, 2026

A.16.3.2 – Not Used



Entergy Texas, Inc.
Combined Cycle Plant RFP

Technical Specification: ETI-CCCT
Issue: Rev. 0
February 11, 2026

A.16.3.3 – Not Used



Entergy Texas, Inc.
Combined Cycle Plant RFP

Technical Specification: ETI-CCCT
Issue: Rev. 0
February 11, 2026

A.16.3.4 – Construction Laydown

To be provided by Seller as a part of the Proposal



Entergy Texas, Inc.
Combined Cycle Plant RFP

Technical Specification: ETI-CCCT
Issue: Rev. 0
February 11, 2026

A.16.3.5 – Project Extent Drawing

To be provided by Seller as a part of the Proposal



Entergy Texas, Inc.
Combined Cycle Plant RFP

Technical Specification: ETI-CCCT
Issue: Rev. 0
February 11, 2026

A.16.4.1 – Preliminary Heat Balance

To be provided by Seller as a part of the Proposal



Entergy Texas, Inc.
Combined Cycle Plant RFP

Technical Specification: ETI-CCCT
Issue: Rev. 0
February 11, 2026

A.16.4.2 – Water Balance

To be provided by Seller as a part of the Proposal



A.16.4.3 – Piping & Instrumentation Diagrams (P&IDs)

To be provided by Seller as a part of the Proposal



Entergy Texas, Inc.
Combined Cycle Plant RFP

Technical Specification: ETI-CCCT
Issue: Rev. 0
February 11, 2026

A.16.4.4 – Geotechnical Report

To be provided by Seller as a part of the Proposal



Entergy Texas, Inc.
Combined Cycle Plant RFP

Technical Specification: ETI-CCCT
Issue: Rev. 0
February 11, 2026

A.16.4.5 – Storm Water Layout Plan

To be provided by Seller as a part of the Proposal



Entergy Texas, Inc.
Combined Cycle Plant RFP

Technical Specification: ETI-CCCT
Issue: Rev. 0
February 11, 2026

A.16.4.6 – Wetland Delineation Report

To be provided by Seller as a part of the Proposal



A.16.4.7 – Single Line Diagram

To be provided by Seller as a part of the Proposal

A.16.4.9 - Standard Access

1. ACCESS: Access shall be provided for systems and equipment as defined in the Access Matrix below. Access for Major Subcontractor/OEM equipment shall be per their standard requirements and are not included in the Access Matrix below.

The following descriptions and matrix define the standard access provisions included in the proposal:

Type 1: Permanent access shall be provided by platform if the component is not accessible from grade. Where Buyer and Owner agree a permanent platform is not feasible or would impede access to other components, Type 2 access shall be provided.

Type 2: Temporary access to the component shall be provided by way of an Owner-furnished portable man-lift, portable platform, stepladder, crossover ladder, scaffolding (except for valves), etc. No permanent platform or direct access from grade is required.

Component	Component Type	Access Type
Analyzers	Including, but not limited to: Conductivity, CC, DO, NOX, O ₂ , PH, SC and Turbidity Meter	1
Burner Elements	Fire Switch	1
	Flame Detector	1
	Spark Igniter	1
	UV Flame Detector	1
Controllers - Local	All	1
Elements / Wells	Level Element	2
	RTD Element, Thermal Bulb, T/C Element Types "E," "J," "K"	2
	Thermowell	2
	Vibration Element	2
Equipment	Battery Charger	1
	Compressor	1
	Panel - Control & Electrical	1
	Electrical Disconnect Switches	1
	Emergency Diesel Generator	1
	Fans	1
	Fans (Ventilation)	2
	Heat Exchanger	1
	HVAC -Filter	1
	Generator Breaker (See Note 3)	1
	Instrument Junction Box	2
	Inverter	1
	Iso-Phase	2
	Manual Disconnect Operators	1
	Motor Control Center	1
	Motor	1
	Non-Segregated Bus Duct / Cable Bus	2
	Process Heater	1
	Pull/Junction Box	2
	Pump	1
	Skid	1
	Switchgear (Front / Back Access)	1 / 2
	Transformer	1

Component	Component Type	Access Type
Flow Elements/Meters	Averaging Pitot Element	2
	Condensate Pot	2
	Flow Nozzle	1
	Magnetic Flow Meter	1
Flow Elements/Meters (Cont.)	Mass Flow Meter	1
	Orifice Plate	2
	Pitot Tube	2
	Turbine Meter	1
	Venturi Tube	2
	Vortex Shedding Meter	1
Gauges/Indicators (Note 1)	All other than listed below	2
	Rotameter	1
Piping Specialties	Backflow Preventer	1
	Desuperheater	1
	Expansion Joint	2
	Eye Wash	1
	Eye Wash w/ Shower	1
	Filter (Fuel, Air)	1
	Filter (Other)	2
	Hydrant	1
	Silencer	2
	Strainer	1
	Steam Trap	1
Probes	All other than listed below	1
	Level Probe	2
	Vibration Probe	2
Switches - Hand	Emergency Stop, HOA, Local Control Station	1
Switches - Process	All other than listed below	2
	Vibration Switch with Manual Resets	1
Transmitters	All	1
Valves - Manual	Large Bore (2-1/2" and larger)	1
	Small Bore (2" and smaller) - other than those listed below	1
	Small Bore (2" and smaller) - instrument root valve, hydro vents, hydro drains, instrument air branch isolation, etc.	2
	Check Valve	2
Valves - Regulator & Control	All	1
Valves - Safety Relief (Note 2)	All other than specified below	1
	Air Release Valve	2

Note 1: Indicators and gauges shall be located, and their displays sized, so they can be read from a standing position at grade or an adjacent platform. Personnel shall be able to read indicators and gauges without relying on ladders and other temporary access devices.

Note 2: Safety Relief Valves shall be provided with permanent access. Temporary access for Pressure/Vacuum Relief Valves for use as sentinel or breather valves servicing storage tanks, pressure vessels, filtration vessels, heat exchangers, etc. is acceptable, provided Owner confirms acceptance.

Note 3: Access to all indicators, control cabinets and sight windows shall be from platform(s) and shall not require climbing over the isophase bus.



A.16.4.10 – Topographic Survey

To be provided by Seller as a part of the Proposal



Entergy Texas, Inc.
Combined Cycle Plant RFP

Technical Specification: ETI-CCCT
Issue: Rev. 0
February 11, 2026

A.16.4.11 – Buyer Tie-In Interface Drawing

To be provided by Seller as a part of the Proposal



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Combined Cycle Plant RFP

Technical Specification: ETI-CCCT
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A.16.4.13 – Seller’s Fuel Specification

To be provided by Seller as a part of the Proposal



A.16.4.14 – Raw Water Sample History

To be provided by Seller as a part of the Proposal



Entergy Texas, Inc.
Combined Cycle Plant RFP

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February 11, 2026

A.16.4.15 – Building Arrangement Drawings

To be provided by Seller as a part of the Proposal



Entergy Texas, Inc.
Combined Cycle Plant RFP

Technical Specification: ETI-CCCT
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February 11, 2026

A.16.4.16 – Not Used



Entergy Texas, Inc.
Combined Cycle Plant RFP

Technical Specification: ETI-CCCT
Issue: Rev. 0
February 11, 2026

A.16.4.17 – Not Used



A.16.4.18 – Start-up Curves

To be provided by Seller as a part of the Proposal



SECTION A.17

HIGH VOLTAGE TRANSMISSION LINE REQUIREMENTS AND DESIGN CRITERIA

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A.17.1 PURPOSE

A.17.1.1 This Section to the Scope Book provides design requirements and reference material for the design of the High Voltage (HV) (69 kV and above) overhead transmission lines that will be built and/or connected to the transmission system by or for Seller as part of the Project (Transmission Lines). This document pertains to the transmission line between the Facility substation deadend structure and the Transmission substation deadend structure delivered by the GIA. This document is intended to provide to Seller and others acting at Seller's request requirements, recommendations, and guidance in the planning, design, construction, asset management, use, and operation of the Transmission Lines.

A.17.2 SCOPE

A.17.2.1 This Section applies to all Transmission Lines. This Section primarily describes technical requirements, both performance-based and prescriptive for the design and installation of the Transmission Lines. Refer to the Scope Book and other parts of the Agreement for information regarding project sequencing and milestones, the project execution plan, project schedule and schedule management, project controls reporting, health and safety information, factory acceptance tests, training, required submittals, design reviews, equipment records, specified deliverables, project documentation, and other relevant matters not covered by this Section.

A.17.2.2 This Section addresses aspects of the Work relating to the Transmission Lines. It is not intended to be, and shall not be construed to be, a comprehensive list of each and every element or other requirement applicable to the Work and shall in no way limit Seller's obligations under the Agreement or any Ancillary Agreement. Without limiting the other terms of the Agreement or any Ancillary Agreement, in performing the Work relating to the Transmission Lines, Seller shall comply with, and cause its Contractors and Subcontractors to comply with, the terms of this Section, all Laws (including codes) and applicable Permits.

A.17.2.3 This Section provides the minimum functional specification (MFS) for the Transmission Lines, including scope and design requirements. In addition to the requirements set forth in the Agreement (including the Scope Book), the Transmission Lines shall comply with all requirements specified in the GIA or any other Required Deliverability Arrangement.

A.17.2.4 Article, Section, Table, Figure, and Attachment references in this Section are to this Section unless otherwise provided or the context otherwise requires.

A.17.2.5 Any deviations from the MFS for the Transmission Lines or the terms of this Section shall require Buyer's prior approval and will be subject to the terms of the Agreement.

A.17.3 DEFINITIONS

A.17.3.1 BIL - Basic Lightning Impulse Insulation Level is a reference insulation level in terms of the crest voltage of a standard lightning impulse.

- A.17.3.2 Conductor Displacement - With respect to clearances, conductor displacement is the conductor movement, including the effects of insulator swing and structure deflection, due to a prescribed ice, wind, or thermal load case. With respect to Right-Of-Way (ROW) determinations, conductor displacement is the maximum horizontal conductor displacement from its initial unloaded position, including the effects of insulator swing and structure deflection due to the extreme wind load case. See also (WCD) in Figure A.17.9.4-1.
- A.17.3.3 Conductor Movement Envelope - With respect to clearances, the conductor movement envelope is the full range of conductor positions in the prescribed ice, wind, or thermal load cases. With respect to ROW determinations, the conductor movement envelope is the full range of conductor movement, including the effects of insulator swing and structure deflection due to the extreme wind load case applied from both directions, and including the initial effective structure width. See also (WCME) in Figure A.17.9.4-1.
- A.17.3.4 Designer – Individual (in-house or contractor) responsible for analyzing and selecting transmission line components, structures, or foundations.
- A.17.3.5 Effective Structure Width – the width between a structure’s outboard conductors (e.g., for an H-frame configuration, it is twice the phase spacing, and for a vertical conductor configuration it is effectively zero). See also (wS) in Figure A.17.9.4-1.
- A.17.3.6 LIDAR (Light Detection and Ranging) – A method of detecting and determining the position, velocity, or other characteristics of distant objects by analysis of pulsed laser light reflected from the surfaces of such objects.
- A.17.3.7 Meridian – Electronic document management system used to archive transmission standards and documents and track revisions.
- A.17.3.8 PLS-CADD – A software package used during optimization of pole spotting, design analysis, and the development of material lists.
- A.17.3.9 Vegetation Management Width – Right of way width outside of the conductor movement envelope, purchased solely for establishment of a vegetation management cycle. See (WVM) in Figure A.17.9.4-1 and Figure A.17.9.4-2.
- A.17.4 ACRONYMS AND ABBREVIATIONS
- A.17.4.1 ACAR Aluminum Conductor Alloy Reinforced
- A.17.4.2 ACCC Aluminum Conductor Composite Core
- A.17.4.3 ACCR Aluminum Conductor Composite Reinforced
- A.17.4.4 ACSR Aluminum Conductor Steel Reinforced
- A.17.4.5 ACSS Aluminum conductor Steel Supported
- A.17.4.6 BIL Basic Lightning Impulse Insulation Level
- A.17.4.7 EPRI Electric Power Research Institute
- A.17.4.8 FAA Federal Aviation Administration
-

A.17.4.9	FAD	Foundation Analysis & Design
A.17.4.10	GFD	Ground Flash Density
A.17.4.11	IEEE	Institute of Electrical and Electronics Engineers
A.17.4.12	LIDAR	Light Detection and Ranging
A.17.4.13	MFAD	Moment Foundation Analysis & Design
A.17.4.14	MVATD	Minimum Vegetation Action Threshold Distance
A.17.4.15	MVCD	Minimum Vegetation Clearance Distance
A.17.4.16	NESC	National Electrical Safety Code
A.17.4.17	OCF	Overload Capacity Factor
A.17.4.18	ROW	Right of Way
A.17.4.19	SRF	Strength Reduction Factor
A.17.4.20	UBS	Ultimate Breaking Strength

A.17.5 INDUSTRY STANDARDS

A.17.5.1 The following Industry Standards are referenced in this Section:

ASCE MOP 91	Design of Guyed Electrical Transmission Structures
ASCE MOP 123	Prestressed Concrete Transmission Pole Structures
ASCE 48	Design of Steel Transmission Pole Structures
ASCE 74	Guidelines for Electrical Transmission Line Structural Loading
ANSI C2	National Electric Safety Code (NESC)
IEEE Std 80	IEEE Guide for Safety in AC Substation Grounding
IEEE Std 524	Guide to the Installation of Overhead Transmission Line Conductors
IEEE Std 738	Standard for Calculating the Current-Temperature of Bare Overhead Conductors
IEEE Std 1313.2	Guide for the Application of Insulation Coordination
IEE Std 1542	Guide for Installation, Maintenance, and Operation of Irrigation Equipment Located Near or Under Power Lines
APLIC 2012	Reducing Avian Collisions with Power Lines – State of the Art– 2012
APLIC 2006	Suggested Practices for Avian Protection on Power Lines
NACE RP0177	Mitigation of Alternating Current and Lightning Effects of Metallic Structures and Corrosion Control System
OSHA Std 2207, Part 1926	Safety and Health Regulations for Construction

IEEE 738	Standard for Calculating Current-Temperature Relationship of Bare Conductors
IEEE Std. 1243-1997	Guide for Improving the Lightning Performance of Transmission Lines
EPRI	Handbook for Improving Overhead Transmission Line Lightning Performance
EPRI	AC Transmission Line Reference Book - 200kV and Above
EPRI	Guide for Transmission Line Grounding
EPRI	Outline of Guide for Application of Transmission Line Surge Arrestors – 42 to 765 kV
	Pre-stressed Concrete Institute Guide Specifications
	FAA Advisory Circular AC 70/7460-1K, Obstruction Marking and Lighting

A.17.5.2 The latest issued Standards and Codes at the issuance of the effective date of the Agreement shall be used. Earlier editions are not allowed unless specifically identified in this Section.

A.17.5.3 If a revision to a standard or code is issued, it is not required to be implemented unless the Authority Have Jurisdiction (AHJ) has adopted it, in which case, Seller is obligated to any increased compliance above what is required by the Standards and Codes at the effective date of the Agreement. This risk is borne by Seller.

A.17.6 MATERIALS

A.17.6.1 Seller shall use the descriptions of materials set out in the standard drawings provided in Attachment 1 along with the Approved Vendor List in Attachment 5 to procure the equipment, materials, systems, and other items required for the development, engineering, design, procurement, construction, testing, commissioning, use, and operation of the Transmission Lines in accordance with the terms of the Agreement.

A.17.7 SAFETY AND ENVIRONMENT

A.17.7.1 Safety

A.17.7.1.1 The safety of individuals, the Project, and other life or property in the development, engineering, design, procurement, construction, testing, commissioning, use, and operation shall be the Designer's highest priority.

A.17.7.2 Avian Design

A.17.7.2.1 The primary issues to consider for avian protection on transmission lines are clearances, marking, and nests. Transmission clearances for all voltages shall exceed the established minimums, shown in Attachment 2. Where Owner standard structure configurations, shown in Attachment 1, are used, the design will meet the guidelines. Marking of wires is addressed in Section A.17.10.14.4 and is to be done only in areas where such marking is required by authorized wildlife agencies, Laws, or applicable Permits.

A.17.7.3 Future Impacts

A.17.7.3.1 Proper consideration shall be given to working space and access during siting to address direct impacts on both work safety and the need for environmental remediation. Similarly, proper consideration shall be given to the ability to re-conductor a line vs. rebuilding to address the potential considerable ecological benefits.

A.17.8 LOAD COMBINATIONS

A.17.8.1 This section covers the transmission line load cases and load case combinations to be used in the design of the Transmission Lines for the Project. It also includes the Overload Capacity Factors (**OCF**) and Strength Reduction Factors (**SRF**) used to calculate forces on the individual components of each structure within the Transmission Lines. The load combinations below are consistent with the loading requirements of NESC Rule 250; however, the boundaries for loading areas have been shifted from those in NESC Rule 250. All references to NESC 250B, 250C, and 250D refer to the District Loading, Extreme Wind, and Concurrent Ice and Wind as modified based on these shifts in loading areas.

A.17.8.1.1 District Maps

A.17.8.1.1.a Based on the NESC figures, districts were established along county and parish boundaries which envelope the NESC requirements. These boundaries were further modified to address other commitments and past operating experience. Notably: several coastal parishes and counties have design wind speeds increased to 150 mph to address hardening study recommendations and other commitments; roughly the NW half of Arkansas has been treated as NESC Heavy rather than NESC Medium based upon past operating experience and design practice; and the 1 inch ice loading was extended throughout Arkansas and much of northern Mississippi based on extensive damage from past ice storms. The districts are as follows:

A.17.8.1.1.b Transmission Line Designers shall use the most conservative loading requirements required along the entire line if the line crosses several counties or parishes requiring different loadings. Exception to this requirement may be taken where a containment structure is placed at the district boundary.

A.17.8.1.2 Load Cases - Summary

Table A.17.8-1 summarizes the various load cases used to design and analyze structures.

Table A.17.8-1 – Structural Load Cases

Description	Wind Loading	Ice Loading	Temperature	NESC Ref.
NESC 250B District Loading				
Heavy	4 psf	0.50 in.	0°F (-20°C)	250B, Table 250-1

Description	Wind Loading	Ice Loading	Temperature	NESC Ref.
Medium	4 psf	0.25 in.	15°F (-10°C)	250B, Table 250-1
Light	9 psf	0.00 in.	30°F (-1°C)	250B, Table 250-1
NESC 250C Extreme Wind				
100 mph	25.6 psf	0.00 in.	60°F (15°C)	250C, Table 250-1
110 mph	31.0 psf	0.00 in.	60°F (15°C)	250C, Table 250-1
125 mph	40.0 psf	0.00 in.	60°F (15°C)	250C, Table 250-1
140 mph	50.2 psf	0.00 in.	60°F (15°C)	250C, Table 250-1
150 mph	57.6 psf	0.00 in.	60°F (15°C)	250C, Table 250-1
NESC 250D Concurrent Ice and Wind				
0.5 in.	2.3 psf	0.50 in.	15°F (-10°C)	250D, Table 250-1
0.75 in.	2.3 psf	0.75 in.	15°F (-10°C)	250D, Table 250-1
1.0 in.	2.3 psf	1.00 in.	15°F (-10°C)	250D, Table 250-1
Cold Case – Uplift	0 psf	0.00 in.	0°F (-20°C)	
Every Day – Deflection	0 psf	0.00 in.	60°F (15°C)	
Unbalanced	0 psf	0.00 in.	60°F (15°C)	See Section A.17.8.1.6

A.17.8.1.3 Loads – Structure Analysis

A.17.8.1.3.a In addition to the cases in Table A.17.8.1, the following load cases shall be used in the analysis and structure design of all Transmission Line structures.

A.17.8.1.4 Stringing Loads on Custom Davit and Cross Arms

A.17.8.1.4.a For arms, the everyday load case shall include a vertical load of 5000 lbs. suspended from the ends of each arm (to address vertical construction loads). The described vertical load is an allowance for steep stringing angles and other construction loads.

A.17.8.1.5 NESC Load Cases with OCF = 1.0

A.17.8.1.5.a In addition to the standard NESC Overload Capacity Factors, all concrete structures shall have loads applied for NESC Load Cases with OCF = 1.0.

A.17.8.1.6 Special Load Cases - Structure Analysis

A.17.8.1.6.a The following load cases shall be used in the analysis and structure design of the following structure types.

A.17.8.1.6.b Single Dead-End and Failure Containment (Dead-End Structures)

- A.17.8.1.6.b.1 All wires up, One Side Only Loading, Initial or Final Condition using the Structural Load Cases in Table A.17.8 -1.
- A.17.8.1.6.c Stringing Longitudinal Unbalanced Load (Tangents & Run. Angles)
- A.17.8.1.6.c.1 0 mph Wind & 0 inch Ice, 60°F (15°C), Initial (Everyday Loads) with 3000 lb. Longitudinal Force (1000 lb. per phase) or with 2000 lb. Longitudinal Force per conductor (H-Frames only).
- A.17.8.1.6.d Pole without Conductors (NESC 261A1c) (Guyed Poles)
- A.17.8.1.6.d.1 Extreme Wind applied on pole in any direction.
- A.17.8.1.6.e Stringing loads on Dead-Ends
- A.17.8.1.6.e.1 Everyday loads on one side only (0 mph wind, 0 inch ice, 60F (15C), Initial.
- A.17.8.1.6.f PLS Wind Direction for Structure Loading
- A.17.8.1.6.f.1 Designers shall conservatively use wind applied normal to all spans simultaneously when selecting structures for new designs.
- A.17.8.2 Load Cases – Clearance Verification
- A.17.8.2.1 The following clearance load cases shall be included to check vertical and horizontal clearances. “Line Design Clearances” are shown in Attachment 2.

Table A.17.8-2– Clearance Load Cases

Description	Wind Loading	Ice Loading	Temp.	NESC Ref.	Condition	Clearance Check
Max. Temp. (ACSR)	0 psf	0 in.	212°F (100°C)	232A	Final	Vertical Clearance
Max. Temp (ACSS & ACCC)	0 psf	0 in.	347°F (175°C)	232A	Final	Vertical Clearance
Max. Temp (ACAR)	0 psf	0 in.	176°F (80°C)	232A	Final	Vertical Clearance
NESC Zone						
Heavy	4 psf	0.5 in.	0°F (-20°C)	230B, Table 230-1, Table 230-2	Final	
Heavy Ice	0 psf	1.0in	32°F (0°C)	232A	Final	Vertical clearance to ground, other conductors, and structures
Medium Wind	6 psf	0 in.	60°F (15°C)	234A2	Initial and Final	Horizontal clearance to ground, other conductors and structures.

Description	Wind Loading	Ice Loading	Temp.	NESC Ref.	Condition	Clearance Check
High Wind (ROW)	Extreme Wind from Table A.17.8-1	0.0 in.	60°F (15°C)		Final	Horizontal Clearance to Edge of Right-of-Way
High Wind (Horizontal Clearance)	100 mph	0.0in.	60°F (15°C)		Final	Insulator swing and Conductor movement (See Section A.17.9.4.4 for more information)
No Wind	0 psf	0.00 in.	60°F (15°C)		Initial and Final	Horizontal clearance to ground, other conductors and structures.

A.17.8.3 Load Cases – Wire Stringing

A.17.8.3.1 The following load cases shall be used to calculate stringing tensions for conductors and shield wires. Conductor & Shield Wire Stringing Tensions

A.17.8.3.2 0 mph Wind, 0” Ice, 60°F (15°C), Initial & Final Stringing Temperature – 10 to 120°F (-12 to 49°C)

A.17.8.4 Load Factor and Strength Reduction

A.17.8.4.1 Overload Capacity Factors (**OCF**) shall be coordinated with the appropriate Strength Reduction Factors (**SRF**) and confirm that material strengths are presented as ultimate or working material strengths.

Table A.17.8-3– NESC & Owner Design Overload Capacity Factors (OCF)

LOAD CASE	VERT (OCF)	WIND (OCF)	TENSION (OCF)	CODE REF.
Structural Analysis				
NESC Zone Loading (Intact)	1.5	2.5	1.65	253-1
Extreme Wind - (Intact)	1	1	1	
Concurrent Ice & Wind – (Intact)	1	1	1	
Unbalanced – (Intact)	1	1	1	
Single DE NESC Failure Containment	1.5	2.5	1.65	
Single DE Extreme Wind & Heavy Ice	1	1	1	
Cold Case – for Uplift	1	1	1	
Every Day Loads – for Deflection	1	1	1	
Clearance Calculations				
Clearance – Vertical – Heavy Ice (NESC)	1	1	1	232A3
Clearance – Vertical – Max. Temp. (NESC)	1	1	1	232A2
Clearance – Vertical – Static (NESC)	1	1	1	
Clearance – Horizontal Med. Wind – (NESC)	1	1	1	234A2
Clearance – Horizontal R/W – Owner Max. Wind	1	1	1	

Table A.17.8-4 - Strength Reduction Factors (SRF)

Structure Component	SRF NESC Loads (250B)	SRF Extreme Wind and Ice Loads (250C & 250D)	NESC Code Reference
Steel & Pre-stressed Concrete Structures	1.0	1.0	Rule 261-A, Table 261-1
Foundation & Guy Anchors	1.0	1.0	Rule 261-B, Table 261-1
Guys & Guy Insulator	0.9	0.9	Rule 261-C& 264, Tab. 261-1
Steel Crossarms & Braces	0.9	0.9	Rule 261-D1, Table 261-1
DE Fittings, Splices & Hardware ⁽³⁾	1.0	0.8	Rule 261-H2C
Support Hardware ⁽²⁾	1.0	1.0	Rule 261-D-1, Table 261-1
Insulators – Suspension	0.50	0.65	Table 277-1 ⁽⁴⁾
Insulators – Post	0.50	0.50	Table 277-1 ⁽⁴⁾
Conductor & Shield Wire	(1)	(1)	Rule 261-H1

(1) Conductor and shield wire maximum wire tensions are taken from NESC Code Section 261- H1.

(2) Support hardware includes bolts and plates supporting davit arms, braced post and post insulators, brackets, suspension tees and other miscellaneous supports not supporting conductor or shield wire dead-ends. The reduction factors shown are multiplied by the ultimate strength of the part as indicated by the manufacturer.

(3) Dead-end fittings include bolts and dead-end tees used to dead-end conductors and shield wires. The manufacturer generally gives the ultimate strength of the tees. This value is then reduced by the reduction factor shown. The “minimum tensile strength” shown for bolts by the Vendor is the allowable tensile load that shall be used on the bolt without the combined load of shear produced in a guyed structure. These loads are not reduced by the reduction factor; however, the shear values given shall be reduced depending on the actual tensile stress, in accordance with the interaction equation.

(4) NESC 2017

A.17.9 CLEARANCE AND RIGHT OF WAY REQUIREMENTS

A.17.9.1 This section covers vertical and horizontal clearance requirements for the Transmission Lines, which include NESC vertical and horizontal clearance requirements from Section 23 of the 2017 Code or counterpart for subsequent codes for HV transmission lines in Owner’s Service Area plus an added safety buffer, as described below.

A.17.9.2 Vertical Clearance – Over Ground

A.17.9.2.1 NESC and Owner vertical clearances over various ground surfaces are shown in Attachment 2. These clearances are based on the 2017 Code, Table 232-1, with the voltage adder defined in Rule 232C1a, using the sags calculated under Rules 232A2 and 232A3.

A.17.9.2.2 See Section A.17.8.2 for Clearance Load Cases.

- A.17.9.2.3 The actual clearance to ground shall be based on the measurement to ground at the low point in the line as determined when the line is at maximum sag. For purposes of determining the required clearance for the Transmission Lines:
- NESC Clearance = Table 232-1 Clearance + Voltage Adder (.4"/kV in excess of 22kV)
- Owner-Required Minimum Clearance = NESC Clearance + Safety Buffer
- A.17.9.2.4 NESC provides consideration for clearances over water surfaces, including floodwaters. Footnotes 17-21 to Table 232-1 shall be carefully considered when determining necessary clearances. For flood-prone areas that do not typically have standing surface water and are not subject to USACE or other permits, the normal flood level (10-year flood level) shall be considered along with required clearances for areas not suitable for boating. For most spans over such areas, clearances that consider or are based on vehicle access with un-flooded ground surfaces will continue to apply. Lines leading into generating facilities, EHV interconnections, or other lines where increased reliability is desired shall consider less frequent flood events (e.g., 50-year floods or 100 year floods) to avoid potential service interruptions. Such lines shall be designed to higher flood levels where the incremental costs are justified and will generally be compared to NESC requirements for water surface not suitable for sailboats.
- A.17.9.3 Other Vertical Clearances
- A.17.9.3.1 Supply Conductors (69 kV and above)
- A.17.9.3.1.a NESC and Owner vertical clearances between various electricity supply lines and non-current carrying wires are also shown in Attachment 2. These clearances are based on the 2017 Code, Table 233-1, with the voltage adder defined in Rule 233C2a, using the sags calculated under Rules 233A1a (3)(b) and 233A1a (3)(c).
- A.17.9.3.1.b The design clearance shall be measured as the distance between the field measured existing line and the design maximum sag.
- A.17.9.3.1.c The Owner-Required Minimum Clearance: NESC Clearance + Safety Buffer
- A.17.9.3.1.d Attachment 2 shows the minimum vertical clearances over various ground surfaces and uses.
- A.17.9.3.1.e The line Designer shall establish "Prohibitive Zones" with the appropriate Design Clearances on the plan profiles within PLS-CADD in the areas where these considerations occur. Considerations could be but not limited to environmental, archaeological, landowner constraints, etc.
- A.17.9.3.2 Substations
- A.17.9.3.2.a Transmission line vertical clearances inside substations shall meet the vertical clearance requirements shown in Attachment 2.
-

- A.17.9.3.3 Miscellaneous
- A.17.9.3.3.a To every extent possible, ROW shall be selected, and ROW agreements written, to preclude structures, signage, and other miscellaneous items from being located beneath the transmission circuits. To the extent such items cannot be so precluded, the vertical clearances for the Transmission Line shall meet the basic NESC clearance requirements for each applicable clearance set forth in Attachment 2, plus an additional 4.5 feet.

- A.17.9.4 Horizontal Clearance
- A.17.9.4.1 All horizontal clearances shall include the deflection of the structure and the displacement of the conductor added to the clearance requirements defined below. Clearances per Section 17.9.4.2 and Section 17.9.4.3 shall be based on the development of the clearance envelopes shown in the NESC for each situation plus 4.5 feet at a minimum. Basic NESC clearances, including horizontal clearances, are summarized in Attachment 2.
- A.17.9.4.2 Adjacent Supply Lines
- A.17.9.4.2.a Horizontal clearances to adjacent supply lines shall be calculated using loads described in Section A.17.8.1. This clearance is based on an envelope as shown in NESC Figures 233-1, 2&3 and using the following loadings:
 - A.17.9.4.2.b The horizontal movement shall be calculated using the medium wind defined under Rule 233A1a(1&2) using (1) a 6 lb/sf wind at 60°F (15°C) and no ice or (2) no wind at 60°F (15°C).
 - A.17.9.4.2.c The maximum sag, Rule 233A1a(3), shall be calculated (a) using 120° F (49°C) with no wind; (b) using the max temperature; or (c) the Code Ice thickness with a temperature of 32°F (0°C) and no wind.
 - A.17.9.4.2.d PLS-CADD shall be used to define the envelope vertices and check clearance to adjacent supply lines.
- A.17.9.4.3 Adjacent Buildings and other Structures
- A.17.9.4.3.a The required clearance between conductors and buildings or other structures is covered in Rule 234 and varies between the various structure types. The loadings used for the clearance envelopes are given in Section A.17.8.2. The Designer shall use PLS-CADD to check these clearances after specifying the required load cases and clearances.

- A.17.9.4.4 Insulator/Conductor Swing Clearance



- A.17.9.4.4.a Clearances to the supporting structure resulting from insulator swing are addressed in Section A.17.11.1. Additionally, air gap clearances between adjacent circuits on different structures are to be checked under the high wind load case in Section A.17.8.2. Minimum clearance shall be that associated for the higher voltage for the 100 mph swing clearance given in Table A.17.8 -2.
- A.17.9.4.5 Right of Way Requirements

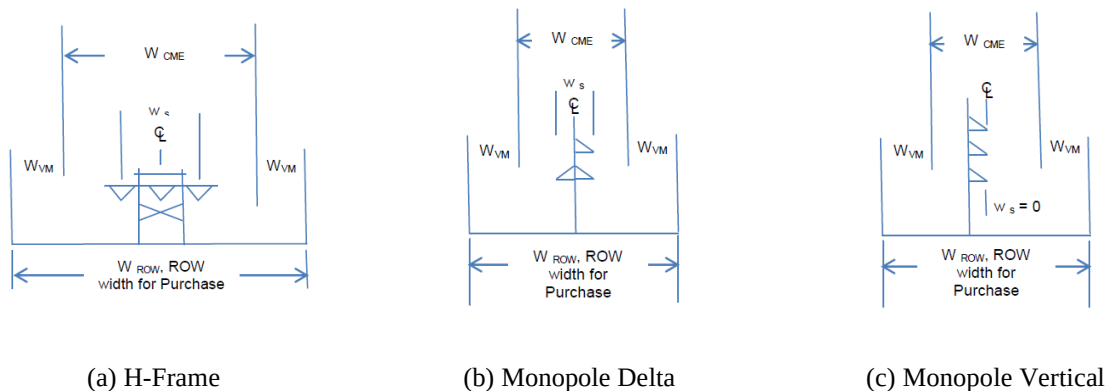
- A.17.9.4.5.a Rights of way (**ROW**) for new transmission lines must provide spacing sufficient to assure reliability and equipment accessibility for maintenance and construction.
- A.17.9.4.5.b Required ROW widths for new lines must be determined considering four primary parameters: (a) the effective structure width(s), taken as the outboard conductor spacing for the structure; (b) the minimum required spacing between adjacent circuits on separate structures; (c) the conductor displacement due to wind; and (d) a vegetation management width at the edges of the ROW to allow for a cyclical growth and periodic trimming schedules. The sum of the structure widths, any additional circuit spacing dimensions, and the conductor displacements (including the effects of structure deflection, insulator swing, and conductor movement) is called the conductor movement envelope (WCME). Adding the appropriate vegetation management width on each side of WCME gives the minimum allowed ROW width for purchase. Note that total minimum allowed ROW widths for purchase will be rounded upward in whole 5 foot increments (e.g., 161 feet is rounded to 165 feet.) The four parameters described above are illustrated for typical ROW situations in Figure A.17.9.4 -1 and Figure A.17.9.4 -2. Additional figures are found in



A.17.9.4.5.c

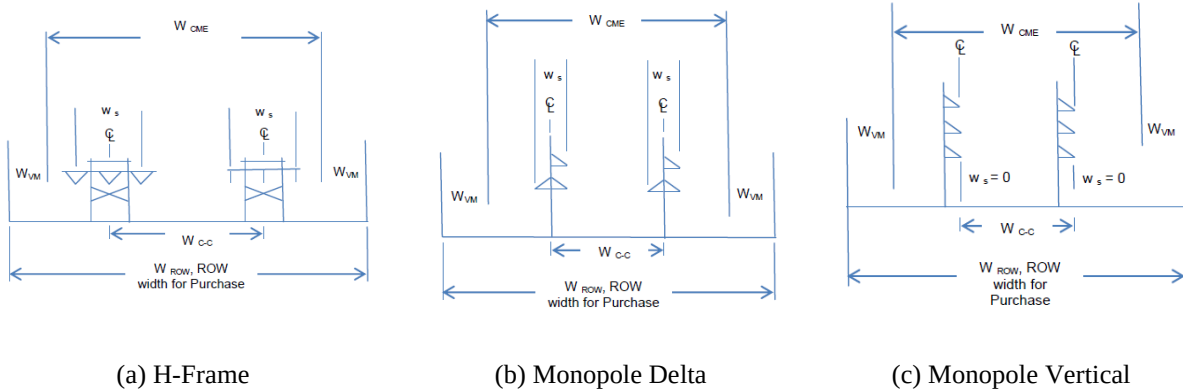
- A.17.9.4.5.d ATTACHMENT 4.

Figure A.17.9.4 -1 – Typical Single Structure ROW



Notes: w_s = Effective Structure Width (Outboard Conductor Spacing) W_{VM} = Vegetation Management Width; W_{CME} = Width, Conductor Movement Envelope; Add Width = c/c Spacing

Figure A.17.9.4 -2 – Typical Double Structure ROW



Notes: w_s = Effective Structure Width (Outboard Conductor Spacing) W_{VM} = Vegetation Management Width; W_{CME} = Width, Conductor Movement Envelope W_{c-c} = Center to Center Structure Spacing

A.17.9.4.5.e Effective Structure Width (w_s) or Outboard Conductor Spacing

A.17.9.4.5.e.1 Except where special circumstances warrant use of larger values, the minimum allowed ROW widths for new construction shall be based on the effective structure widths (w_s) for standard structure framings as set forth in Table A.17.9.4 -1.

Table A.17.9.4-1 – Typical Effective Structure Widths

Voltage	H-frames (ft.)	Single Pole	
		Delta/ Vert. Double Circuit (ft.)	Single Circuit Vertical (ft.)
500kV	67.66	28.00	0.00
345kV	51.00	24.00	0.00
230kV	40.00	18.00	0.00
161/138/115 kV	32.00	14.33	0.00
69kV	24.00	12.00	0.00

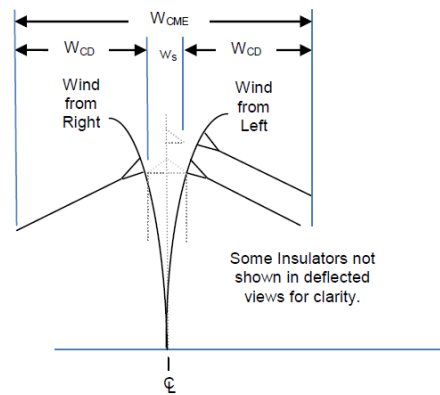
- A.17.9.4.5.e.2 Note that for vertical conductor configurations, the conductors fall on the centerline of the circuit/ROW and the monopole structure itself is offset by a function of the insulator length. In such configurations there are no outboard conductors, and the effective width of the structure is treated as zero.
- A.17.9.4.5.e.3 When determining ROW requirements for constructing a new transmission line adjacent to an existing transmission line (discussed in more detail below), the actual effective widths of the existing structure shall be determined and used in the calculation.
- A.17.9.4.5.e.4 Adjacent Circuit Separation (W_{c-c})
- A.17.9.4.5.e.5 Circuit center to center horizontal spacing for ROW determinations shall be as shown in Table A.17.9.4 -2 unless the Performance Standard requires use of higher value.

Table A.17.9.4 -2 – Minimum Spacing for Adjacent Circuits (W_{c-c})

		Single Pole	
Voltage	H-frames (ft.)	Delta/ Vert. Double Circuit (ft.)	Single Circuit Vertical (ft.)
500kV	140	96	70
345kV	120	65	45
230kV	75	50	35
161/138/115 kV	60	40	30
69kV	45	30	20

- A.17.9.4.5.e.6 For 345 kV and 500 kV Transmission Lines, the distances specified for adjacent single pole circuits reflect geometrical limits only. Electrical effects (audible noise, EMF, etc.) must be studied and will require additional separation if indicated by the study. For two adjacent circuits of different voltage or framing, the larger of the two required separation distances shall be used.
- A.17.9.4.5.f Displaced Conductor Position (WCD)
- A.17.9.4.5.f.1 During detailed line design, the displaced conductor positions are calculated including the effects of structure deflection and insulator/hardware swing; and using the load cases contained in Section A.17.8. Wind loads are applied transversely in each direction to displace the conductor away from the centerline as illustrated below.

Figure A.17.9.4-1 – Displaced Conductor Position & Relationship to W_{CME} and w_s



Notes: w_s = Effective Structure Width (Outboard Conductor Spacing) W_{CME} = Width, Conductor Movement Envelope; W_{CD} = Displaced Conductor Position Including Structure Deflection

- A.17.9.4.5.f.2 In addition to checking required horizontal clearances per Sections A.17.9.4.2 and A.17.9.4.3, the displaced conductor position shall stay within the available conductor movement envelope under the extreme wind cases described in Table A.17.8 -1. As part of the line design, pole placements and span lengths must be adjusted if required to maintain required clearances and keep the conductor within the available width.
- A.17.9.4.5.f.3 The available CME widths in Table 17.9.4 -3 and Table 17.9.4 -4 contemplate and accommodate standard framings, typical spans, the current list of typical conductors and their specified stringing limits, etc. Markedly atypical designs may require a more rigorous evaluation of the ROW requirements. Conversely, severe ROW restrictions will likely require atypical design such as shortened spans.
- A.17.9.4.5.f.4 Note that all tabulated values consider the use of V-string assemblies, braced-post assemblies, suspension units with struts, or other configurations where insulator swing is confined.

A.17.9.4.5.g Vegetation Management Width (WVM)

A.17.9.4.5.g.1 It is assumed that trees grow or someday will grow at the edge of the ROW, and that normal growth cycles will result in further encroachment into the Vegetation Management Width. Therefore, the conductor movement envelope (**CME**) alone is insufficient as a ROW. Vegetation management in the area adjacent to ROW edges is required to prevent grow-in and to comply with the Minimum Vegetation Clearance Distance (**MVCD** see also definitions). Thus, additional width between the ROW edge and the outboard conductors is essential to allow planned, efficient vegetation management without violating the MVCD.

A.17.9.4.5.g.2 To accomplish this, apply a Minimum Vegetation Action Threshold Distance (**MVATD**) for prioritizing corrective maintenance. The Vegetation Management Width (W_{VM}) to be used when determining ROW width shall bound the MVATD and MVCD, and is tabulated below (values for MVATD and MVCD are provided for reference):

Table 17.9.4-3 – Vegetation Management Widths

Voltage	WVM (ft.)	MVATD (ft.)	MVCD (ft.)
500kV	22.5	14.68	7.4
345kV	15.0	9.44	4.5
230kV	12.5	5.14	4.3
161/138/115 kV	10	3.42 / 2.94 / 2.45	2.9 / 2.4 / 2.0
69kV	7.5	2.45	1.2

A.17.9.4.5.h Where a circuit is to be built at a given voltage but operated at a lower voltage, the WVM for the higher voltage shall be used to determine ROW width.

A.17.9.4.5.i Calculation of Minimum Allowed ROW Width for Purchase - New Single Circuit Line or Double Circuit on the Same Structures

A.17.9.4.5.i.1 As illustrated in the preceding figures, at any given point, the minimum allowed ROW shall equal the applicable CME plus the applicable vegetation management width (WVM) on each side of the ROW. Assuming multiple circuits are the same voltage, standard ROW widths are determined as: $ROW = WCME + 2(WVM)$, rounded up to the next whole 5' increment and are tabulated by voltage and framing type in Table 17.9.4 -4 and Table 17.9.4 -5.

**Table 17.9.4 -4 – Minimum Required ROW Widths for Single Structures
(Single Circuit or Multi-Circuit on Same Structure)**

Line Voltage (kV)	WVM (ft.)	Typical ROW Width (ft.) for Purchase			Conductor Movement Envelope - CME (ft.)		
		H-Frame	Single Pole Delta/Vertical Double Circuit	Single Pole Vertical	H-Frame	Single Pole Delta/Vertical Double Circuit	Single Pole Vertical
500	22.50	225	125	125	180	80	80
345	15.00	190	155	135	160	125	105
230	12.50	150	125	110	125	100	85
161	10.00	120	100	90	100	80	70
69	7.50	90	75	65	75	60	50

Table 17.9.4 -5 – Minimum Allowed ROW Widths for Multiple Structures and Circuits

Line Voltage (kV)	ROW Widths (ft.) assuming two identical lines								
	ROW Width for Purchase (ft.)			Conductor Movement Envelope - CME (ft.)			Add. Width per line (ft.)		
	H-Frame	Single Pole Delta/Vertical Double Circuit	Single Pole Vertical	H-Frame	Single Pole Delta/Vertical Double Circuit	Single Pole Vertical	H-Frame	Single Pole Delta/Vertical Double Circuit	Single Pole Vertical
500	365	225	195	320	180	150	140	96	70
345	310	220	180	280	190	150	120	65	45
230	225	175	145	200	150	120	75	50	35
161	180	140	120	160	120	100	60	40	30
69	135	105	85	120	90	70	45	30	20

Notes regarding Tables 17.9.4 -4 and 17.9.4 -5:

1. Tabulated 500 kV single pole ROW reflect an atypical short span design intended to compact lines on narrower ROWs.
2. As noted in A.17.9.4.5 tabulated values reflect Vee-String, Brace Post, Suspension/Strut or other insulator assemblies where conductor attachments are somewhat restrained. Where suspension I-String assemblies are used: at 230 kV and below the ROW widths given shall be increased by 5 feet; and at 345 kV they shall be increased by 10 feet. Only Vee-String assemblies are currently approved for 500 kV.
3. The ROW values presented are indicative of what would be required in straight sections of ROW containing tangent or light angle structures. Large angle changes using multi-pole structures or extensive guying patterns will require additional ROW in the vicinity of the angle structure.

A.17.10 CONDUCTOR AND SHIELD WIRE INFORMATION

A.17.10.1 This section includes design information about standard conductors, both in single and in bundled configurations, along with standard shield wires, including fiber optic wires. It includes tension and vibration control data for the NESC and Owner design conditions. Conductors and shield wires shall be selected from these standards unless Buyer and Seller otherwise agree in a writing signed by authorized representatives of the Parties.

A.17.10.2 Owner Standard Conductors

A.17.10.2.1 The required technical standards for conductors are set forth in this Section (properties based on Southwire® data unless noted.):

Table A.17.10-1 – Standard Conductors – Mechanical Properties

Type	Size	Stranding	Code Word	Area (in ²)	Dia. (in.)	Weight (lb/ft)	Strength (lbs)
ACCC/TW ⁽⁵⁾	1949	56/1	LAPWING ⁽⁴⁾	1.647	1.504	1.938	48,900
	1582	33/1	BITTERN ⁽⁴⁾	1.336	1.345	1.566	39,400
	1428.5	33/1	BEAUMONT ⁽⁴⁾	1.232	1.294	1.436	43,700
	1222	33/1	CARDINAL ⁽⁴⁾	1.053	1.198	1.224	37,100
	821.2	18-1	GROSBEAK ⁽⁴⁾	0.725	0.990	0.836	30,400
ACSS	1590	45/7	LAPWING	1.34	1.50	1.79	27,900
	1272	45/7	BITTERN	1.07	1.35	1.43	22,300
	954	54/7	CARDINAL	0.85	1.20	1.23	26,000
	666.6	24/7	FLAMINGO	0.59	1.00	0.86	18,200
ACSR	1780	84/19	CHUKAR	1.51	1.60	2.08	51,000
	1590	45/7	LAPWING	1.34	1.50	1.79	42,200
	1272	45/7	BITTERN	1.07	1.35	1.43	34,100
	1033.5	45/7	ORTOLAN ⁽¹⁾	0.87	1.21	1.163	27,700
	954	54/7	CARDINAL	0.85	1.20	1.23	33,800
	954	45/7	RAIL ⁽²⁾	0.80	1.165	1.075	25,290
	666.6	24/7	FLAMINGO	0.59	1.00	0.86	23,700
	336.4	26/7	LINNET	0.31	0.72	0.46	14,100
ACAR	1024.5	34/13	N/A ⁽³⁾	0.80	1.165	0.96	23,100
	649.5	18/19	N/A	0.51	0.93	0.61	17,100
	395.2	15/7	N/A	0.31	0.72	0.37	10,100

(1) Not for New Construction, Capital Maintenance only

(2) 345 kV and 500 kV only – Use for new construction

(3) 500 kV only – for Capital Maintenance work only

(4) Source: General Cable/LAMIFIL Data

(5) It is generally preferential to develop a custom conductor solution using an ACCR conductor in lieu of the ACCC conductors. Use of the ACCC standards will generally be limited to extension of existing ACCC lines or other similar circumstances.

A.17.10.2.2 Ampacity ratings for the standard conductors are determined using the commercially available software SWRate, which is based on the methodology of IEEE 738. Ampacity was determined using design parameters specified in Owner standards and the conductor properties contained in the SWRate program library. Line ratings are also expressed as

conductance in MVA using the expression $MVA = V * A * 0.001 * 3^{0.5}$, where V is voltage in kV, and A is rated ampacity in amps. Ampacity and conductance ratings for the standard conductors are summarized below.

Table A.17.10 -2 – Standard Conductors – Capacity

Type	Size / Code Word	Rated Amps ⁽¹⁾	MVA 69kV	MVA 115kV	MVA 138kV	MVA 161kV	MVA 230kV	MVA 345kV	MVA 500kV
ACCC/TW ⁽³⁾	1949 / LAPWING	2490	298	496	595	694	992	-	-
	1582 / BITTERN	2180	261	434	521	608	868	-	-
	1429 / BEAUMONT	2050	245	408	490	572	817	-	-
	1222 / CARDINAL	1857	222	370	444	518	740	-	-
	821.4 / GROSBEAK	1439	172	287	344	401	573	-	-
ACSS	1590 / LAPWING	2263	270	451	541	631	902	-	-
	1272 / BITTERN	1957	234	390	468	546	780	-	-
	954 / CARDINAL	1607	192	320	384	448	640	-	-
	666.6 / FLAMINGO	1312	157	261	314	366	523	-	-
ACSR	1780 / CHUKAR	1608	192	320	384	448	641	-	-
	1590 / LAPWING	1494	179	298	357	417	595	-	-
	1272 / BITTERN	1303	156	260	311	363	519	-	-
	1033.5/ ORTOLAN ⁽²⁾	1144	137	228	273	319	456	-	-
	954 / CARDINAL	1088	130	217	260	303	433	-	-
	954 / RAIL	1088	130	217	260	303	433	650	942
	666.6 / FLAMINGO	882	105	176	211	246	351	-	-
	336.4 LINNET	575	69	115	137	160	229	-	-
ACAR	ACAR 1024.5 ⁽²⁾	878	105	175	210	245	350	-	760
	ACAR 649.5	658	79	131	157	183	626	-	-
	ACAR 395.2	483	58	96	115	135	192	-	-

(1) At normal operating temperatures, 212°F (100°C) for ACSR, 347°F (175°C) for ACSS and ACCC, and 176°F (80°C) for ACAR.

(2) Other historical limits may govern.

(3) It is generally preferential to develop a custom conductor solution using an ACCR conductor in lieu of the ACCC conductors. Use of the ACCC standards will generally be limited to extension of existing ACCC lines or other similar circumstances.

A.17.10.3 Standard Shield Wires

A.17.10.3.1 The required technical standards for shield wires are set forth in Table A.17.10 -3

Table A.17.10 -3 – Standard Shield Wires

<u>Code Word</u>	<u>Class Type</u>	<u>Size</u>	<u>Strand-Ing</u>	<u>Area (in²)</u>	<u>Dia. (in.)</u>	<u>Weight (lb/ft)</u>	<u>Strength (lbs)</u>
7 #7	Alumoweld	0.0	7	0.11	0.43	0.33	19,060

A.17.10.4 Standard Optical Ground Wires

A.17.10.4.1 The required technical standards for optical ground wires (OPGW) are set forth below:

Table A.17.10 -4 – Standard OPGW Wires

<u>Code Word</u>	<u>Class Type</u>	<u>Fibers</u>	<u>Strand-Ing</u>	<u>Area (in²)</u>	<u>Dia. (in.)</u>	<u>Weight (lb/ft)</u>	<u>Strength (lbs)</u>
DNO-5651	AlumaCore	24LT	13	0.151	0.528	0.36	18,391
DNO-6651	AlumaCore	48LT	9/6	0.221	0.646	0.42	18,053
DNO-3476	AlumaCore	24	13	0.151	0.528	0.36	18,433
DNO-4596	AlumaCore	48	9/6	0.221	0.646	0.42	18,053
DNO-6205	CentraCore	24	10	0.166	0.528	0.41	21,845
DNO-6210	CentraCore	48	10	0.166	0.528	0.41	21,845
DNO-8161 ⁽¹⁾	AlumaCore	48	13	0.151	0.528	0.36	18,391
DNO-9800 ⁽²⁾	AlumaCore	48	13	0.151	0.528	0.36	19,391

(1) DNO-8161, 48 fiber AlumaCore will be the default OPGW selection unless project specifics warrant a different selection.

(2) DNO-9800, 48 fiber AlumaCore will be the default OPGW selection for “backbone” applications where dispersion shifted fibers are required by the telecommunications department.

A.17.10.4.2 Alternative optical ground wires may be used, provided they meet the same specifications as the above-referenced wires. Similar hardware to that used for standard wires specified herein must be used so that nonstandard hardware does not have to be stocked for maintenance.

A.17.10.5 Bundled Conductors

A.17.10.5.1 Bundled Conductors (New Construction, excluding 500 kV)

A.17.10.5.1.a The standard bundled configuration is a vertical bundle in which no spacers are required. If other configurations are used, the conductor supplier and/or manufacture of the spacers shall be consulted regarding spacers requirements.

A.17.10.5.1.b The standard assembly for bundled dead-end structures shall be the “DEPY” dead-end assembly with a two-insulator attachment to the structure.

- A.17.10.5.1.c Bundled dead-end structures where the maximum tension (with OCF) in each sub-conductor is less than 9700 lbs. may use the “DEP- 2 wire” dead-end assemblies with a single insulator. This assembly shall mainly be used in reduced tension situations.
- A.17.10.5.1.d All bundled structures with angles less than 30 degrees shall be designed as running angle structures, including Structure Types “C”, “F” and “G”. Those with angles greater than 30 degrees shall be designed as dead-end structures.

A.17.10.5.2 Bundled Conductors (500 kV)

- A.17.10.5.2.a The standard 500 kV bundled conductor is a triple delta configuration with spacers at approximately 250 foot intervals.

A.17.10.6 Sag and Tension Limitations

A.17.10.6.1 NESC Tension Limits

- A.17.10.6.1.a Following are the maximum tension limits allowed in the determination of project sag and tension values. The “Zone Loading” tension limit is an NESC requirement for all load cases with an overload capacity factor of 1.65. The tension limits for extreme wind and heavy ice are Owner requirements and have an overload capacity factor of 1.0. Load cases are shown in Section 5.4. The limit is a percent of the Ultimate Breaking Strength (UBS) of the wire. Limits are based on the Initial tension of the wire.

<u>Load</u>	<u>Tension Limits</u>
• Zone loading (OCF=1.65)	60% UBS - @ Initial Ten. (NESC 261H1)
• Extreme Wind (OCF=1.0)	75% UBS - @ Initial Ten.
• Concurrent Ice & Wind (OCF=1.0)	5% UBS - @ Initial Ten.

- A.17.10.6.1.b Additionally, the NESC (Section 261 H1) requires that the tension at each of the applicable NESC Zone temperatures shown in Table A.17.8 -1, without external load, shall not exceed the following percent of their UBS:

- A.17.10.6.1.c Initial unloaded tension 35% UBS

- A.17.10.6.1.d Final unloaded tension 25% UBS

- A.17.10.6.1.e These tension limits apply at each of the applicable NESC Zone temperatures shown in Table A.17.8 -1, unless dampers are used, in which case this limitation is at a maximum of 60°F (15°C).

A.17.10.6.2 Tension Limits for Vibration Control

- A.17.10.6.2.a Except for ACCC and ACCR conductors, for vibration control, maximum catenaries (horizontal tension/weight), or “C” values, will be calculated at 0°F (-20°C), 0 mph wind, and 0 inches ice. Calculated values for “C final” shall be 4710 and for “C initial” shall be 6000. Lesser values of “C” will require approval by Buyer.
- A.17.10.6.2.b For ACCC conductors, vibration dampers shall be placed in accordance with the manufacturer’s recommendations.
- A.17.10.6.2.c The following table,” Vibration Control Values”, provides Owner’s tension limits for the standard conductors. The table was developed considering 900 ft. ruling spans. However, these values may be used for other ruling spans with only slight variations. Other ruling spans will require approval by Buyer.

Table A.17.10 -5 – Vibration Control Values

Type	Conductor Name	Load Case	Max Tension (pounds)	% of Ultimate Strength
ACSS	LAPWING	0-0-0 (I)	10740	38.5
	LAPWING	0-0-0 (F)	8431	30.2
	BITTERN	0-0-0 (I)	8580	38.5
	BITTERN	0-0-0 (F)	6735	30.2
	CARDINAL	0-0-0 (I)	7380	28.4
	CARDINAL	0-0-0 (F)	5793	22.3
	FLAMINGO	0-0-0 (I)	5160	28.4
	FLAMINGO	0-0-0 (F)	4051	22.3
ACSR	CHUKAR	0-0-0 (I)	12480	24.5
	CHUKAR	0-0-0 (F)	9796	19.2
	LAPWING	0-0-0 (I)	10740	25.5
	LAPWING	0-0-0 (F)	8431	20.0
	BITTERN	0-0-0 (I)	8580	25.2
	BITTERN	0-0-0 (F)	6735	19.8
	ORTOLAN	0-0-0 (I)	6978	25.2
	ORTOLAN	0-0-0 (F)	5478	19.8
	CARDINAL	0-0-0 (I)	7380	21.8
	CARDINAL	0-0-0 (F)	5793	17.1
	RAIL	0-0-0 (I)	6450	24.9
	RAIL	0-0-0 (F)	5063	19.5
	FLAMINGO	0-0-0 (I)	5160	21.8
	FLAMINGO	0-0-0 (F)	4051	17.1
	LINNET	0-0-0 (I)	2760	19.6

Type	Conductor Name	Load Case	Max Tension (pounds)	% of Ultimate Strength
	LINNET	0-0-0 (F)	2167	15.4
ACAR	649.5 ACAR	0-0-0 (I)	3660	21.4
	649.5 ACAR	0-0-0 (F)	2873	16.8
	395.2 ACAR	0-0-0 (I)	2220	22.0
	395.2 ACAR	0-0-0 (F)	1743	17.3
	1024.5 ACAR	0-0-0 (I)	5760	24.9
	1024.5 ACAR	0-0-0 (F)	4522	19.6
SW	7#7 AW	0-0-0 (I)	1980	10.4
	7#7 AW	0-0-0 (F)	1554	8.2
	7/16" Steel	0-0-0 (I)	2400	11.5
	7/16" Steel	0-0-0 (F)	1884	9.1
OPGW	* AlumaCore, DNO-8161	0-0-0 (I)	2160	11.7
	* AlumaCore, DNO-8161	0-0-0 (F)	1696	9.2
	* AlumaCore, DNO-9800	0-0-0 (I)	2160	11.1
	* AlumaCore, DNO-9800	0-0-0 (F)	1696	8.7
ADSS	ADSS-AE024HG611CA2	0-0-0 (I)	546	18.2
	ADSS-AE024HG611CA2	0-0-0 (F)	429	14.3

**AlumaCore, DNO-8161 is the default.
Note ADSS is not a transmission standard transmission conductor but is frequently used as an under-built non-transmission conductor. Typical ADSS span is on the order of 200 feet.
Also note that (F) load cases shall be controlled by both Creep RS and Load RS, and that bimetallic conductors shall consider the effects of compression at high temperatures*

A.17.10.6.3 Vibration Control for Long Spans Exceeding the Ruling Span

A.17.10.6.3.a For span lengths greater than the ruling span, the Designer shall take special care to compare the conductor and shield wire sags, to ensure that adequate clearances at mid-span are maintained under all conditions. The shield wire tension shall not exceed 16% of its ultimate strength at 60°F (15°C), final. To account for unusual circumstances (e.g., ravine crossings), it may be necessary to dead-end the shield wire to account for tension differentials and/or increase the tensions along with adding dampers per manufacturer's specifications.

A.17.10.7 Correction to Sag when Final Installation is Interrupted

A.17.10.7.1 Prolonged stringing durations can affect final sags due to creep beyond that considered in the sagging algorithm. Conductors and shield wires shall be clipped in within 72 hours of achieving the intended stringing tension. Where stringing operations are interrupted or extend beyond this 72-hour threshold, engineering evaluation/approval is required with final approval by Buyer, and the cable manufacturer shall be contacted to obtain technical instructions on the issue.

A.17.10.8 Galloping

A.17.10.8.1 Certain areas within the Owner Service Area have been identified as areas prone to galloping and shall require the installation of vibration control devices. These areas are generally in north Arkansas along the Mississippi River in open, flat areas where it is possible for ice to form on the cables.

A.17.10.8.2 Phase spacing shall be set to avoid mid-span interference between phases through the required assumption that double ellipse galloping will occur on any span exceeding 400 feet. A galloping overlap of less than 10 percent between phases will be allowed in the design process. It is generally assumed that using span lengths between 400 and 900 feet would eliminate this overlap. The ruling span is set at 80% of the limiting span for this analysis.

A.17.10.9 Aeolian Vibration

A.17.10.9.1 Aeolian vibration fatigue damage typically occurs in flat, open areas. The most effective way to reduce this type of vibration is to reduce the line tension. Also, the installation of dampers may eliminate or reduce this vibration; however, the conductor and damper suppliers shall be consulted regarding these conditions.

A.17.10.9.2 The use of ACSS type conductors may also reduce this vibration after one year of operation because of the self-damping characteristics built into this type of conductor.

A.17.10.10 Conductor Corona

A.17.10.10.1 Two solutions to reduce conductor corona are larger conductors and/or bundled conductors.

A.17.10.10.2 For 161 kV, 115 kV, and 69 kV, 336 kcmil ACSR "Linnet" shall be the minimum conductor size.

A.17.10.10.3 At 230 kV, bundled 395 kcmil ACAR conductors or, for single conductor lines, a recommended standard wire size of 954 kcmil ACSR. The minimum wire size for 230 kV using industry standards is approximately one inch in diameter. The smallest standard wire size that meets the industry standard minimum wire size is "Flamingo" 666.6 kcmil ACSR.

A.17.10.10.4 For 500 kV transmission lines, 1024 kcmil ACAR and 954 kcmil ACSR "Rail" shall be the minimum conductor sizes to avoid corona effects. The standard for new construction is 954 kcmil "Rail".

A.17.10.10.5 The selection of conductor size, considering corona losses, shall be estimated using the attached figure (obtained from the Westinghouse Transmission and Distribution Manual) entitled "Fig. 31 - Quick Estimating Corona-Loss Curves". This figure is attached as



A.17.10.10.6

- A.17.10.10.7 ATTACHMENT 3.
- A.17.10.11 ACSS and ACSS/TW Conductor
- A.17.10.11.1 ACSS Sags – Tensions - Stringing
- A.17.10.11.1.a ACSS suppliers have recommended that the ACSS & ACSS/TW conductors be pre-tensioned for approximately 10 to 15 minutes before final sagging of the line. This procedure inelastically stretches and elongates the aluminum wires and the steel core provides total support of the conductor in normal operation. Since little or no stress is left in the aluminum wires, initial and final sags and tensions are nearly the same. Pre-stressing is a means of reducing creep and enhancing self-damping capability. Recommendations for pre-stressing vary and range from the maximum tension. Consult with cable manufacturer for prestressing methodology and specifications.
- A.17.10.12 Fiber Optic/Shield Wire Requirements
- A.17.10.12.1 Fiber Optic Shield Wire (**OPGW**) is often the preferred shield wire. For structures with two shield wires, one shield wire will typically be OPGW and one shield wire will typically be 7#7. Project specific shield wire requirements is subject to approval by Buyer. Substation Relay Design, SCADA, Substation Networking and Corporate Telecommunications will need to determine the number of fibers that they will need. Standard Owner shield wires are found in Section A.17.10.
- A.17.10.12.1.a The fiber optic line may be dead-ended if the line angle is over 30°. For line angles between 30° and 50°, a heavy angle suspension assembly may be utilized. Fiber optic construction details are shown on the standard assembly drawings, shown in Attachment 1.
- A.17.10.12.2 Splice Box Locations
- A.17.10.12.2.a Splice boxes shall be placed at existing or expected future laterals and substations. Additional boxes will be needed at intervals along the line, generally corresponding to reel wire length, line angles, and considering the nearest points of access.
- A.17.10.13 SW Sagging Relative to Conductors
- A.17.10.13.1 Every effort shall be made to ensure that the shield wire(s) have less sag than the conductor, so that any flashovers are encouraged to occur at a structure rather than at mid-span. It is suggested that the shield wire have a lesser amount of sag by approximately 0.33 percent of the span length, or approximately two (2) feet, under normal stringing loads, i.e., 60°F (15°C). Where this is not feasible, the tension limits to control vibration in Table A.17.10 -5 may be relaxed to pull the shield wire more tightly and achieve greater separation. Where the tension limits of Table A.17.10 -5 are relaxed,

a conductor vibration study shall be performed, and vibration dampers shall be installed on the shield wire per the recommendations of the vibration study. Alternately, the standard framing may be modified with approval from Buyer to provide greater separation between the shield wire and the conductor.

A.17.10.14 Conductor and Shield Wire Marking

A.17.10.14.1 Aerial Patrol Marking

A.17.10.14.1.a Aerial patrol marking to provide early warning of the hazards due to crossing transmission lines shall be applied as described herein.

A.17.10.14.2 Marking for Federal Aviation Administration (FAA) regulations

A.17.10.14.2.a Marking required to comply with Federal Aviation Administration (FAA) regulations shall not be confused with the aerial patrol marking described in paragraph A.17.10.13. When routing new lines, it is generally better to avoid selecting routes that pass within close proximity of airports, landing strips, heliports and facilities such as hospitals that might have aircraft landing on improvised landing sites. Such facilities can be generally identified by examining aerial navigation maps available at pilot centers in most public airports, examination of quadrangle maps published by the U.S. Geological Commission, examination of aerial photographs acquired for the line project, and other sources. Where these facilities cannot be avoided and where it is determined that FAA rules apply, the requirements of FAA Advisory Circular AC 70/7460-1K shall apply.

A.17.10.14.3 Navigable Waterway Marking

A.17.10.14.3.a Lines crossing navigable waterways shall be marked as delineated in the applicable permits.

A.17.10.14.4 Avian

A.17.10.14.4.a Avian markers are to be installed where appropriate to make the line more visible to birds. Several forms of markers are commercially available and marketed to increase line visibility and reduce the possibility of avian mortality. Avian markers shall be required only where specified by wildlife agencies or by applicable permits.

A.17.10.14.5 Slow-Moving Vehicle Signs

A.17.10.14.5.a Slow-moving vehicle signs shall be placed on the third and fourth adjacent structures on both sides of any crossover lines, with the signs facing the approach to the lines from either side of the crossover. It is very important that all crossings be marked on the same number of advance structures for safety reasons. One sign on each structure shall be used to indicate a single crossover ahead. If two crossovers in close proximity exist ahead, then two signs shall be installed on each structure, one sign over the other, if possible. Two-crossover situations shall also have single signs on both sides of structures between the crossovers. Details of the installation are covered in an attachment to this Section, but generally the signs shall be near the top of the poles or towers of the structures. When used on wooden poles, the signs shall be outside any woodpecker wire covering the pole.

A.17.10.14.6 Spiral Vibration Dampers (Yellow)

A.17.10.14.6.a Spiral dampers in addition to slow-moving vehicle signs may be desirable in some cases with extraordinary visibility difficulty. When used, such dampers shall be installed with a minimum of one pair of dampers on both sides of centerline of the line being patrolled at a point just outside the conductor locations but not less than 15 feet between the pairs. If there are two shield wires on the crossover line, half of the dampers shall be installed on each shield wire.

A.17.10.14.7 QuikMark Devices

A.17.10.14.7.a QuikMark devices, in addition to slow-moving vehicle signs, may be desirable in some cases with extraordinary visibility difficulty. When used, QuikMark devices shall be installed with a minimum of three QuikMark devices on each side of centerline of the line being patrolled at a point just outside the conductor locations but not less than 15 feet between each trio. If there are two shield wires on the crossover line, install half of the QuikMarks on each shield wire.

A.17.10.14.8 QuikMark Devices Combined with Spiral Vibration Dampers

A.17.10.14.8.a QuikMark devices and spiral dampers may be combined to mark shield wires by keeping equal numbers of each on each side of the line being patrolled so the visual effects are balanced on the line. When the Transmission Line crosses under the line of another, the minimum requirement is for QuikMark devices or spiral dampers or both to be installed on the shield wires of the other line. This is for the safety of Owner aerial patrollers and to protect Owner and others from claims by the owner of the other line for property damage, lost revenues on the other line, and other claims.

A.17.11 OTHER ELECTRICAL CRITERIA

A.17.11.1 Electrical Insulation

- A.17.11.1.1 All insulators shall be polymer (non-ceramic). Insulators that are procured from one of Owner's approved vendors for insulators and adhere to Owner's standards are assumed to meet this specification. Insulator types include dead-end, braced post, post, suspension and jumpers. All new HV (69 kV and above) Transmission Lines shall have insulators with corona rings installed. Details for these insulators are included in Attachment 1.
- A.17.11.1.2 Insulator Swing
- A.17.11.1.2.a Mechanical Clearance
- A.17.11.1.2.a.1 Post and braced post assemblies have the potential for contact between their suspension shoe and their post insulator. The suspension shoe may swing towards the supporting post insulator without any wind due to line deflection angle and/or phase position changes between consecutive structures. With a 6 PSF wind (60 degrees Fahrenheit and final wire tension) further displacing the conductor hardware from its everyday displacement, contact with the sheds (or corona ring) is not allowed. With extreme wind specified in Table A.17.8-1 of the design criteria (60 degrees Fahrenheit and final wire tension) further displacing the conductor hardware from its everyday displacement, contact with the rod's sheath is not allowed. A swing angle adapter shall be used to increase mechanical clearance. This adapter does not preclude mechanical conflict, so conductor position shall still be checked.
- A.17.11.1.2.b Electrical Clearance
- A.17.11.1.2.b.1 Table A.17.11-1 specifies required certain clearances from the energized conductor shoe to non-energized portions of the structure under the prescribed conditions specified in the footnotes. These clearances were built into Owner's standard framings shown in Attachment 1. Certain atypical conditions, such as short spans, structures in dips, transition between framings or phasing, deflection angles near the top of the range, and higher tensions, can warrant deviations from standard, such conditions will require Seller to acquire approval from Buyer. Conductor position shall be verified against Table A.17.11-1 that the required minimum clearances are met, especially for suspension insulators. For posts and braced posts, the standard post lengths will ensure that these clearances are met, except for the no-wind clearance for bundled conductors. For bundled posts and bundled braced posts, the conductor hardware shall not be allowed to swing more than 30 degrees toward the pole without wind (0 degrees F, initial). Note that the swing angle adapters mentioned in Section A.17.11 do not improve electrical clearance.

Table A.17.11 -1 – Minimum Insulator Swing Clearances

FRAMING VOLTAGE	CONDITION	CLEARANCE TO ARM OR STRUCTURE	CLEARANCE TO GUY
500 kV	6 psf wind ⁽¹⁾	123 in	11 ft.



FRAMING VOLTAGE	CONDITION	CLEARANCE TO ARM OR STRUCTURE	CLEARANCE TO GUY
500 kV	100 mph ⁽²⁾	60 in	5 ft.
500 kV	no wind ⁽³⁾	140 in	12 ft.
500 kV	no wind ⁽⁴⁾	140 in	12 ft.
345 kV	6 psf wind ⁽¹⁾	85 in	8 ft.
345 kV	100 mph ⁽²⁾	41 in	4 ft.
345 kV	no wind ⁽³⁾	105 in	9 ft.
345 kV	no wind ⁽⁴⁾	105 in	9 ft.
230 kV	6 psf wind ⁽¹⁾	52 in	6 ft.
230 kV	100 mph ⁽²⁾	27 in	3 ft.
230 kV	no wind ⁽³⁾	83 in	8 ft.
230 kV	no wind ⁽⁴⁾	88 in	8 ft.
161 kV	6 psf wind ⁽¹⁾	37 in	5 ft.
161 kV	100 mph ⁽²⁾	19 in	2 ft.
161 kV	no wind ⁽³⁾	60 in	7 ft.
161 kV	no wind ⁽⁴⁾	71 in	7 ft.
138 kV	6 psf wind ⁽¹⁾	34 in	5 ft.
138 kV	100 mph ⁽²⁾	16 in	2 ft.
138 kV	no wind ⁽³⁾	54 in	7 ft.
138 kV	no wind ⁽⁴⁾	65 in	7 ft.
115 kV	6 psf wind ⁽¹⁾	28 in	5 ft.
115 kV	100 mph ⁽²⁾	13 in	2 ft.
115 kV	no wind ⁽³⁾	49 in	7 ft.
115 kV	no wind ⁽⁴⁾	60 in	7 ft.
69 kV	6 psf wind ⁽¹⁾	17 in	3 ft.
69 kV	100 mph ⁽²⁾	8 in	1 ft.
69 kV	no wind ⁽³⁾	49 in (36 in) ⁽⁵⁾	6 ft.
69 kV	no wind ⁽⁴⁾	60 in (49 in) ⁽⁵⁾	6 ft.

- (1) Max required value between switch surge and NESC air gap. Controlled by NESC with 10% Voltage Surge (1.1 x nom. Voltage).
- (2) 60 Hz minimum flash over distance.
- (3) No wind clearance for suspension insulator (Impulse Air Gap).
- (4) No wind clearance for running angles (Impulse Air Gap).
- (5) 69 kV framings use 115 kV no-wind air gaps for improved lightning performance. On existing structures where there isn't room for longer insulators and air gaps, the numbers in parentheses apply.

A.17.11.1.2.c Typical Standard Davit Arms

A.17.11.1.2.c.1 For the purpose of determining clearances presented in Table A.17.11 -1 accounting for insulator swing; as well as for the purpose of evaluating shield angle and determining conductor coordinates, the following arm lengths and insulator lengths shall be used:

Table A.17.11-2 – Typical Davit Arm and Insulator Lengths for New Construction

INSULATOR LENGTH⁽²⁾			
VOLTAGE (kV)	TYPE	INSULATOR LENGTH (IN)	DESIGN LENGTH (IN.)
69	SUS	59	66
161	SUS	73	78
230	SUS	89	96
69	DE/RA	62	80
161	DE/RA	92	98
230	DE/RA	104	110
69	LP/BP	60	60
161	LP/BP	76	78
230	LP/BP	94	94
DAVIT ARM LENGTH⁽¹⁾			
VOLTAGE (kV)	TYPE	LENGTH	RISE (IN.)
69	Tangent	5'-6"	13
161	Tangent	8'-6"	25
230	Tangent	11'-0"	24
69	Swing	3'-0"	N/A
161	Swing	4'-0"	N/A
230	Swing	5'-0"	N/A
69	DE	5'-0"	12
161	DE	6'-0"	15
230	DE	8'-0"	20

(1) Davit Arm Length is from pole face to conductor attachment

(2) Design length includes hardware.

A.17.11.1.2.d Insulator Attachments – 69 kV, 161 kV, and 230 kV Structures

A.17.11.1.2.d.1 Braced post and line post insulators are limited to a line angle of 6 degrees based on the limited compression capacities of these insulators. Insulator capacities shall be obtained from manufacturer.

A.17.11.1.2.e General

A.17.11.1.2.e.1 The same insulator type can be used for concrete and steel poles. Insulator attachments for post insulators are required to be provided by thru-bolting standard insulators to the pole structures.

A.17.11.1.2.e.2 Dead-end and suspension insulators are required to be attached to the poles via vangs on steel poles or pole-eye plates on concrete poles.

A.17.11.1.2.f Conductor and Shield Wire Vangs

A.17.11.1.2.f.1 Standard conductor and shield wire attachment vangs on all steel poles shall be ¾ inch plate with 1 1/8 inch diameter holes and 1 ½ inch radius and shall be the same on both ends.

A.17.11.1.2.f.2 Conductor attachment vangs on concrete poles will be 60,000 or 70,000 pound strength pole-eye plates mounted with 7/8 inch diameter all-thread rods, similar to those provided by Hughes Brothers in Lincoln, Nebraska.

A.17.11.1.2.g Guy Vangs

A.17.11.1.2.g.1 Standard guying vangs on all steel poles shall be ¾ inch plates with 1 1/8 inch diameter holes and 1 1/2 inch radius and shall be the same on both ends. All guy attachment vangs on all concrete poles will be 60,000 or 70,000 pound strength pole-eye plates mounted with 7/8 inch diameter all-thread rods, similar to those provided by Hughes Brothers in Lincoln, Nebraska.

A.17.11.1.2.h Polymer Insulator Standard Drawing

A.17.11.1.2.h.1 Attachment 1 has detailed drawings of the Owner Standard Insulator drawings for 115 kV, 138 kV, 161 kV and 230 kV voltages. Seller shall use the Owner Standard Insulators and must verify they meet the requirements for the design. The drawing includes the following information:

- Braced Post Insulators
- Horizontal Line Post Insulators
- Suspension Insulators
- Dead-End Insulators

- Minimum Flashover Characteristics
- Minimum Leakage Distance

A.17.11.2 Transmission Line Lightning Protection Design

A.17.11.2.1 Reference Guides

IEEE Std. 1243-1997	Guide for Improving the Lightning Performance of Transmission Lines
EPRI	Handbook for Improving Overhead Transmission Line Lightning Performance
EPRI	AC Transmission Line Reference Book - 200kV and Above
EPRI	Guide for Transmission Line Grounding
EPRI	Outline of Guide for Application of Transmission Line Surge Arrestors – 42 to 765 kV

A.17.11.2.2 Where applicable Seller shall apply the following parameters during the design process.

A.17.11.2.2.a GFD

A.17.11.2.2.a.1 The GFD varies greatly throughout Owner's transmission system and average from 2-7 flashes/Km²/yr. However, the GFD for any area for a particular year can be more than 3X the historic average. Therefore, Owner's design parameters do not consider the GFD for the specific line but assume the standard design methods will ensure an adequate reliability throughout the system no matter the GFD of any particular location.

A.17.11.2.2.b Structure BIL

A.17.11.2.2.b.1 Although local atmospheric conditions can affect the ability of air to insulate against a flashover the typical breakdown rate for a negative dry arc is 650 kV per meter. Therefore, the structure BIL is 650 kV X air gap in meters.

A.17.11.2.2.b.2 It is very difficult to maintain an acceptable BIL for distribution circuits on a transmission line structure. In order to maintain acceptable lightning performance when attached to tall shielded transmission structures, fiberglass arms and transmission class insulators are required.

A.17.11.2.2.b.3 Distribution underbuild is considered a last resort for new construction. It complicates maintenance for both organizations.

A.17.11.2.2.c Shield Wire Installation

A.17.11.2.2.c.1 The installation of a shield wire is the required method of lightning protection.

A.17.11.2.2.d Shield Wire Type and Size

A.17.11.2.2.d.1 The size and type of shield wire used will be determined by needs other than that required for lightning protection, such as fault current. Any of Owner's standard shield wires conforming to the parameters set out in the referenced guideline will be adequate for the

lightning protection of the line. Note: Supporting distribution phases on transmission structures exposes transmission shield wire to long duration distribution faults for which it was not designed. Therefore, a neutral conductor shall be bonded to each transmission structure.

A.17.11.2.2.e Shielding Angle

A.17.11.2.2.e.1 The shielding angle, as measured at the structure from the vertical plane of the shield wire clamp to the conductor clamp, shall be no more than 25° for structures adjacent to spans averaging less than 150 feet above ground level. The required shielding angle on structures where the average conductor height is greater than 150 feet above ground level need to be designed on a case by case basis and shall be subject to approval from Buyer. The average height taken as the height at the structure minus 2/3 the sag.

A.17.11.2.2.e.2 On single pole structures with one shield wire, the shielding angle shall be checked to the top conductor as well as to the bottom conductor opposite the shield wire attachment.

A.17.11.2.2.e.3 On H-type structures, the shielding angle shall be checked for each shield wire to its corresponding outer conductor. Unless the distance between the shield wires exceeds 60 feet, the shielding angle to the middle conductor is not considered.

A.17.11.2.2.f Maximum Grounding Resistance

A.17.11.2.2.f.1 The maximum allowable grounding resistance shall be obtained as specified in Section A.17.11.3

A.17.11.2.2.g Lightning Arrestors

A.17.11.2.2.g.1 Lightning arrestors shall be used on transmission lines only in cases where a shield wire cannot be installed (e.g., clearance near an airport), the maximum allowable grounding resistance cannot be obtained, or adjacent to extremely long spans where the lightning protection software shows the shield wire is insufficient.

A.17.11.3 Grounding and Cathodic Protection

A.17.11.3.1 This section covers the design of the grounding and cathodic protection systems for concrete and steel structures for transmission lines.

A.17.11.3.2 Grounding

A.17.11.3.2.a Grounding Systems

A.17.11.3.2.a.1 Owner's steel and concrete pole structures shall be "effectively grounded" as defined in Section 2 of the NESC. Shield wires are constructed, along with the associated grounding system, on all of Owner's transmission lines for lightening protection. The

use of proper structure grounding will reduce the ground resistance at the structures and will reduce line outages due to lightning strikes.

A.17.11.3.2.b Steel Structure Grounding System

A.17.11.3.2.b.1 Steel poles shall be bonded to the shield wire by a copperweld jumper. The pole then acts as a ground rod to the ground line. Because the coating at the bottom of direct embedded steel poles insulates the steel, direct embedded poles shall be grounded. This grounding shall be done with ground rods driven into the earth and bonded to the pole. The same grounding is used to ground a steel pole bolted to a concrete pier or set in a concrete pile. Steel poles socketed into steel piles shall be bonded to the steel pile.

A.17.11.3.2.c Concrete Structure Grounding System

A.17.11.3.2.c.1 Concrete poles shall be bonded to the shield wire through the grounding clip and a terminal lug at the pole top by a copperweld jumper. A copperweld wire shall then run down the pole to another terminal lug below ground. The wire may be internal or external. There are four options for grounding the direct buried pole: (1) connect the ground wire to the pancake at pole bottom; (2) extend the ground wire from the pancake to the ground rod; (3) connect the ground wire from the terminal directly to the ground rod; and (4) connect the ground to the substation ground grid using 4/0 copper. Ground wires shall be continuous (no splices). For concrete poles set in steel piles, the ground wire shall be extended from the bottom lug and bonded to the pile.

A.17.11.3.2.d Guy Wire Grounding System

A.17.11.3.2.d.1 In accordance with NESC requirements, guy wires shall be bonded directly to the steel structure or to the ground wire on a concrete structure using a copperweld wire bonded to the guy wire.

A.17.11.3.2.e Achieving Desired Structure Resistance

A.17.11.3.2.e.1 Tests to verify that the required footing resistance has been obtained using the standard methods shall be performed by Seller. Seller shall test for grounding resistance, which shall not be greater than:

• 69 kV & 115kV	13 ohms
• 138 kV & 161 kV	10 ohms
• 230 kV	7 ohms
• 345 kV & 500 kV (H-frames)	18 ohms

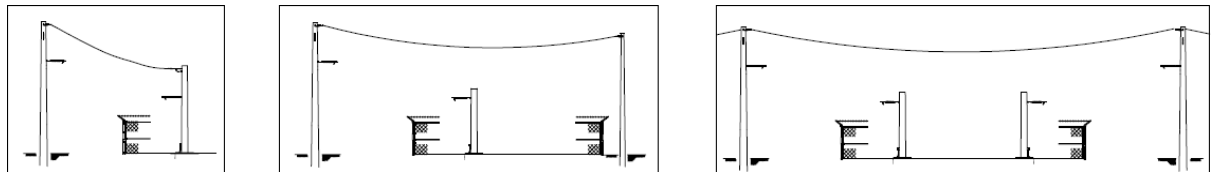
A.17.11.3.2.e.2 There are two acceptable methods to achieve these requirements: (1) driving additional rods and (2) installing a counterpoise that consists of 100 feet of conductor buried 18" deep parallel to the line.

A.17.11.3.2.f Grounding at Substations

A.17.11.3.2.f.1 Bonding of Transmission Line Shield Wire to Substation Ground Grid

A.17.11.3.2.f.2 Electrical currents can be introduced on shield wires from a variety of sources. To prevent these currents from arcing across mechanical connections to get to the substation ground grid, a bonding conductor shall be provided.

A.17.11.3.2.f.3 The following common shielding configurations and requirements shall be permitted are detailed below:



a

b

c

a. Shield wire attached to Substation pull-off structure

Generally, the transmission line will be dead-ended outside the substation and the shield wire slack span into the station will be positively grounded to the pull-off tower with a jumper and the pull-off tower will be connected to the substation ground grid. It is the responsibility of the substation to make these connections. The last transmission structure in the immediate vicinity of the station shall not be bonded to the substation ground grid unless a specific grounding analysis is performed.

b. Shield wire across station to dedicated shield wire pole

Since the shield wire pole is usually installed within close proximity to the substation; it shall be bonded to the substation ground grid. The last transmission structure in the immediate vicinity of the station shall not be bonded to the station grid unless a specific grounding analysis is performed.

c. Shield wire across station to exiting transmission line structure

One of the transmission structures on either side of the station shall be bonded to the substation ground grid. The structure selected for bonding shall be the one closest to the station or having the fewest physical obstacles between the structure and the station.

A.17.11.3.3 Cathodic Protection

A.17.11.3.3.a The cathodic protection system is a method of protecting steel transmission line structures from corrosion, generally at the ground-line where moisture can mix with air to cause corrosion and thus deterioration and loss of strength of the structures. The protection system used is to attach either magnesium or zinc anodes to the structure.

A.17.11.3.3.b These anodes provide sacrificial protection for the steel in the structures.

A.17.11.3.3.c Soil Investigations

A.17.11.3.3.c.1 The soil investigation shall include soil corrosion recommendations to determine the need for anodes and the number required for each structure.

A.17.11.3.3.d Anode Types

A.17.11.3.3.d.1 Magnesium anodes shall be used except that, in areas such as coastal marshes, zinc anodes may be used where recommended over magnesium anodes by the corrosion engineer based on in-situ conditions

A.17.11.3.4 Structure Protection

A.17.11.3.4.a Steel poles, steel piles and steel guy anchors shall be protected as described below.

A.17.11.3.5 Steel Dead-End and Guyed Structures

A.17.11.3.5.a All buried steel (embed poles and piles) at dead-end and guyed steel structures shall be installed with anodes as shown on the Framing Drawings and provided Assembly Drawings. The number of anodes per structure shall be as recommended in the corrosion consultation report or as deemed necessary by the corrosion engineer based on in-situ conditions.

A.17.11.3.6 Steel Tangent Structures

A.17.11.3.6.a Steel tangent structures are generally not installed with anodes, anodes shall be installed on structures in areas of known corrosion problems, or when structures are to be installed adjacent to a pipeline or railroad. In these cases, installation shall be in accordance with provided Assembly Drawings in Attachment 1.

A.17.11.3.6.b Guy Anchors for Steel and Concrete Structures

A.17.11.3.6.c The steel helix type anchors for both steel and concrete poles shall be installed with anodes.

A.17.12 STRUCTURE DESIGN CRITERIA

A.17.12.1 Steel Poles

A.17.12.1.1 Owner standard structure framings are shown in Attachment 1.

A.17.12.1.2 Tubular Steel Pole Purchase Specification - Details of structure design that shall be included in the purchase specification:

A.17.12.1.2.a ASCE Design Manual Requirements

A.17.12.1.2.b Material Specifications

A.17.12.1.2.c Pole Deflection Limitations

A.17.12.1.2.d Fabrication Requirements

A.17.12.1.2.e Protective Coating Requirements

A.17.12.1.2.f Cathodic Protection

A.17.12.1.2.g Grounding Requirements

A.17.12.1.2.h Seller shall procure (or cause to be procured) tubular steel poles from tubular steel pole vendors on the Approved Vendor List (



A.17.12.1.2.i

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A.17.12.1.2.j ATTACHMENT 5) for tubular steel pole vendors and direct the vendor to provide items in conformance with their applicable standard Energy specifications.

A.17.12.1.3 General Design Requirements

A.17.12.1.3.a All designs shall be in accordance with the provisions of the latest NESC, ASCE/SEI Standard 48, and the requirements stated in this document. All construction shall be Grade B, as defined in Section 24 of the NESC Code.

A.17.12.1.3.b Foundation Rotation

A.17.12.1.3.b.1 In addition to the applied loadings, all self-supported monopole and un-braced H-frame structures shall be designed with a 3 degree foundation rotation. The point of rotation is assumed to be at the ground line. Smaller foundation rotations for braced H-frame structures shall be considered on a case-by-case basis.

A.17.12.1.3.c Deflection Limitations

A.17.12.1.3.c.1 The following pole deflection limitations assume 0 degree foundation rotation and shall be adhered to in the design of all poles. The percentage listed is the percent of the pole height above ground.

Table A.17.12 -1 – Deflection Limitations

Load Case / Wires	Tangent (Intact)	Running Angle (Intact)	Dead-end (Intact)	Dead-end (DE One Side)
NESC w/OLF See Loading District	10%	10%	10%	NSL
NESC without/OLF See Loading District	NSL	NSL	NSL	NSL
High Wind See Loading District	10%	10%	10%	NSL
Wind & Ice See Loading District	10%	10%	10%	NSL
Everyday No Wind or Ice - 60°F	3% ⁽¹⁾	3% ⁽¹⁾	3% ⁽¹⁾	NSL
Longitudinal Unbalance 1K at Each Phase Location	NSL	NSL	NA	NA
DE Stringing No Wind or Ice - 60°F	NA	NA	NA	1% ⁽²⁾

NA - Not Applicable

NSL - No Specified Deflection Limit

(1) Camber if Deflection Exceeds 1%

(2) Only if Specifically Requested

A.17.12.1.3.d Pole Raking

A.17.12.1.3.d.1 For new project construction, cambering the pole when deflection exceeds 1% of the pole height above ground is the required resolution to concerns arising from what might (aesthetically) appear to be excess pole deflection.

A.17.12.1.3.e Guyed Structures – Pre-Designed

A.17.12.1.3.e.1 The Designer shall select a pre-designed light duty pole, such as an SW Class H-6 equivalent, to be used as the pole in guyed framings in the pole spotting procedure. This type of pole will make available the range of heights to complete the spotting process. PLS-CADD will select the optimal pole height.

A.17.12.1.3.f Selection of Pre-designed Poles – Optimizing Process

A.17.12.1.3.f.1 To use the line optimization features PLS-CADD, the Designer must select and input the pre-designed pole types and framings most suited for the Transmission Lines. This shall include the material, framings and pole heights, types and sizes.

A.17.12.1.3.g Pole Design and Verification Process

- A.17.12.1.3.g.1 The purchase order for the structures selected by PLS-CADD during the optimization process is then forwarded to the pole vendor along with a calculated load tree for each pole. The vendor will then review the design of the selected poles before pricing and fabrication. In some cases the poles selected may have to be revised to meet the design criteria.
- A.17.12.1.4 Procurement
- A.17.12.1.4.a To purchase the poles and associated materials, Seller shall use a type of purchase requisition known as a “White Requisition”.
- A.17.12.1.4.b “White Requisition” – This type of order is used to purchase material from Owner’s preferred vendors including steel and concrete poles, insulators and conductors. The pole order will generally include the preferred item plus most of the assembly attachment material, such as nuts, bolts, vangs. It is the vendor’s responsibility to verify the size and number of each item. “White Requisitions” are also used to order non-stock-coded items.
- A.17.12.1.5 Structure Hardware
- A.17.12.1.5.a The Owner “Standard Structure Framings” in Attachment 1 lists the standard assemblies required for each structure framing. Each assembly drawing lists the bill of materials required for that assembly. The standard hardware parts were designed to meet the maximum tensions and loads calculated for the pre-designed structures previously described but shall be verified by the designer. Unless Buyer grants an exception in writing, poles shall be ordered with sufficient step bolt mounting provisions.
- A.17.12.1.6 Grounding and Cathodic Protection
- A.17.12.1.6.a See Section A.17.11.3 for design information regarding the required grounding and cathodic protection for steel poles.
- A.17.12.1.7 Hybrid Structures
- A.17.12.1.7.a Hybrid structures, a combination of a steel top section and a concrete bottom section, shall be used where ground water conditions may cause excessive corrosion of a steel pole. For such structures, the concrete bottom piece shall directly embedded using standard embedment details. Foundation and grounding details are discussed in Section A.17.13 and Section A.17.11.3, respectively.
- A.17.12.2 Concrete Poles
- A.17.12.2.1 This section covers the design and analysis of concrete pole structures for single and bundled conductor transmission lines. It covers single pole, two pole, and three pole structures with direct-embedded foundations, socket-type foundations and base-plated foundations all for use on tangent, running angle or dead-end structures. All standard structure framings applicable to this work are delineated in Attachment 1.
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- A.17.12.2.2 Spun Pre-stressed Concrete Pole Purchase Specification - Details of structure design that shall be included in the purchase specification include:
- A.17.12.2.2.a ASCE and PCI Design Guide Requirements
 - A.17.12.2.2.b Material Specifications Pole Deflection Limitations
 - A.17.12.2.2.c Fabrication Requirements
 - A.17.12.2.2.d Testing Requirements.
 - A.17.12.2.2.e Seller shall select a concrete pole vendor from the list of concrete pole vendors set forth in the Approved Vendor List (

A.17.12.2.2.f



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- A.17.12.2.2.g ATTACHMENT 5) and direct the concrete pole vendor to provide items in conformance with their applicable standard Owner specifications.
- A.17.12.2.3 General Design Requirements

A.17.12.2.3.a All concrete pole and related designs shall be in accordance with the provisions of the latest NESC, the PCI and ASCE Guide Specifications, and the requirements stated in this document. All concrete pole construction shall be at least Grade B, as defined in Section 24 of the NESC Code.

A.17.12.2.3.b Foundation Rotation

A.17.12.2.3.b.1 In addition to the applied loadings, all self-supporting structures shall be designed with a 3 degree foundation rotation. The point of rotation shall be assumed to be at the ground line.

A.17.12.2.3.c Deflection Limitations

A.17.12.2.3.c.1 The following pole deflection limitations assume 0 degree foundation rotation and shall be adhered to in the design of all concrete poles. The percentage listed is the percent of the pole height above ground.

Load Case / Wires	Concrete Structure Type			
	Tangent	Running Angle	Dead-end	Dead-end
	(Intact)	(Intact)	(Intact)	(DE One Side)
NESC w/OLF See Loading District	10%	10%	10%	NSL
NESC without/OLF See Loading District	2%	2%	2%	NSL
High Wind See Loading District	10%	10%	10%	NSL
Wind & Ice See Loading District	10%	10%	10%	NSL
Everyday No Wind or Ice - 60°F	1%	1%	1%	NSL
Longitudinal Unbalance 1K at Each Phase Location	NSL	NSL	NA	NA
DE Stringing No Wind or Ice - 60°F	NA	NA	NA	1%

NA - Not Applicable

NSL - No Specified Deflection Limit

A.17.12.2.3.d Pole Raking

A.17.12.2.3.d.1 Where deflections under the everyday load case exceed 1% of the above ground pole height as described in Section A.17.12.2.3.c, but do not exceed 2% the pole shall be raked to improve aesthetic concerns and minimize secondary moment effects. Where poles are to be raked, the Designer shall provide specific instructions identifying the degree to which the pole shall be raked to compensate for the calculated deflection under the everyday load case.

A.17.12.2.4 Procurement

A.17.12.2.4.a To purchase the poles and associated materials, Seller shall use a type of purchase requisition known as a “White Requisition”.

A.17.12.2.4.b “White Requisition” – This type of order is used to purchase material from Owner’s preferred vendors, including steel and concrete poles, insulators and conductors. The pole order will generally include the poles plus most of the assembly attachment material, such as nuts, bolts, vangs. It is the vendor’s responsibility to verify the size and number of each item.

A.17.12.2.5 Structure Hardware

A.17.12.2.5.a The applicable Owner “Standard Structure Framings” included as Attachment 1 lists the standard assemblies required for each structure framing. Each assembly drawing lists the Bill of Materials required for that assembly. The standard hardware parts are designed to meet the maximum tensions and loads calculated for the pre-designed structures previously described. Unless a deviation is granted by Buyer, poles shall be ordered by Seller with sufficient mounting locations for attachment of climbing provisions.

A.17.12.3 H-Frame Design

A.17.12.3.1 This section covers the design of concrete and steel H-Frame structures to be used in construction of the Transmission Lines. These standard framings cover transmission structures for single and double circuit construction using standard suspension insulators. Clearance has been provided for the possible use of bundled conductors.

A.17.12.3.2 Structure Types

A.17.12.3.2.a Standard framings are developed for single and double circuit “Light” and “Medium” (HA2) tangent (0° – 1.5°) structures and “Light” and “Medium” (HB2) small angle (1.5° – 6.0°) structures. Standard tubular steel cross arms have been pre-designed and detailed for use in “Light” and “Medium” structures.

A.17.12.3.2.b The standard framings are based on the base assumption that steel structures will be X-braced and concrete structures will not be X-braced. The pole supplier shall determine if X-braces are required for each structure and shall detail and supply the X-braces and connection hardware if required.

A.17.12.3.2.c Special “Uplift” framings are included for use in certain structures to address uplift forces in those structures. These structures use the “Light” cross arms with extra vangs to dead-end the conductors.

A.17.12.3.2.d Cross Arm Design

A.17.12.3.2.d.1 The maximum allowable spans for the pre-designed standard cross arms are based on the maximum vertical load imposed on the arms. The load cases reviewed for each cross arm are NESC designated loadings with overload factors. Maximum arm deflections range from 1 inch to 2 inches.

A.17.12.3.2.d.2 The tubular steel cross arms are designed to support the vertical load of the various standard conductors used by Owner on the standard H-Frame framings. The maximum loads for each of the Standard Framings are shown on the Framing Drawings.

A.17.12.3.2.d.3 The “Light” and “Medium” standard cross arm sizes are as follows:

- Light Cross Arm – TS 6 x 6 x 3/16 inch
- Medium Cross Arm – TS 8 x 8 x ¼ inch
- Shield Wire Arm – TS 4 x 4 x 3/16 inch
- The required use (loading) for the standard cross arms is as follows:
 - 69 kV – Use the Light Cross Arm – for all conditions
 - 161 kV – Use the Light Cross Arm – for ½ inch Ice loadings
 - Use the Medium Cross Arm – for 1 inch Ice loadings
 - 230 kV – Use the Medium Cross Arm for all conditions

A.17.12.3.2.e Cross Arm Assembly Details

A.17.12.3.2.e.1 The assembly drawings for attaching cross arms to poles are included in the voltage specific assemblies.

A.17.12.3.2.f Rock Anchors

A.17.12.3.2.f.1 In rock formations, where screw type anchors will not penetrate the rock, rock anchors shall be used. There are two types of rock anchors available, to be selected based on in-situ conditions and engineering calculations.

A.17.12.3.2.g Expanding Rock Anchors

A.17.12.3.2.g.1 Rods have a diameter of 1.0 inch and an ultimate strength of 36,000 lbs. The limitation of 36,000 lbs can be overcome by using twin anchors. A more stringent limitation is that the rods are non-extendable. This prevents the expanding rock anchors from being used when the non-fractured bedrock is deeper than about four feet below the surface.

A.17.12.3.2.h Grouted Rock Anchors

A.17.12.3.2.h.1 The anchors have a 1 ¼ inch diameter round shaft ending in a 4-inch diameter bell. The anchors can be extended with either 1 ¼” round shaft extensions or 1 ½” square shaft extensions. The anchor assembly has an ultimate strength of 70,000 lbs. The strength of

the installed anchor (resistance to pullout) is dependent upon the rock type and the dimensions of the grout column. The characteristic of the rock that dominates the calculation for anchor depth is the equivalent cohesion. The installed anchor strength is calculated by multiplying the surface area of the grout column in each layer by the equivalent cohesion of the rock in that layer. For conservatism, any contribution from the overburden shall be ignored.

- A.17.12.3.2.h.2 The High Wind and Heavy Ice Tensions shall be multiplied by 1.65 to provide a safety factor for the anchor installation. For the NESC Zone load case (NESC 250B) a safety factor of 1.0 shall be used as allowed by the code, since that load case already includes an Overload Factor of 1.65. The resulting worst case force shall be resisted by the friction between the grout column and the surrounding rock.
- A.17.12.3.2.h.3 Anchor strength = (circumference) (column length per vertical foot) (constant of 0.9) [(layer 1 thickness)(layer 1 cohesion) + (layer 2 thickness)(layer 2 cohesion) + ...]
- A.17.12.3.2.h.4 Seller shall procure that the anchor manufacturer calculates the required anchor depth using their software, but the effective cohesion shall be the parameter that dominates the result. For simplicity, the formula above uses just the effective cohesion. The constant 0.9 is a factor to account for the possible effects of other rock characteristics
- A.17.12.3.2.h.5 The dimension that is to be specified is the distance along the anchor shaft from the ground surface to the bottom of the anchor. The minimum anchor length engaging rock is five feet.
- A.17.12.3.2.h.6 The grout shall be pumped into the hole to ensure that a solid column is produced.
- A.17.12.3.2.i Guying Hardware
- A.17.12.3.2.i.1 Following are listed the strength values in Owner's Standard Guying Assembly which limit line conductor tensions and are required for this Project.
- A.17.12.3.2.i.2 Insulator Assembly - Owner's Standard Polymer Dead-End Insulators have an ultimate tension capacity of 50,000 lbs. The NESC Strength Factor for insulators is 0.5, therefore the Routine Test Load (RTL or working load) of 25,000 lbs is used.
- A.17.12.3.2.i.3 Steel Vangs (Steel Poles) - Steel Dead-End vangs are thru vangs and can be designed for any applied tensions. The NESC Strength Factor for the vangs is 1.0.
- A.17.12.3.2.i.4 Pole Eye Plates for Conductor or Shield Wire (Concrete Poles) - The standard guying attachment is the "AS2720 Double Guying Tee" from Hughes Bros. The Ultimate Strength (maximum tension load) is 35,000 lbs per hole. The NESC Strength Factor is 1.0 for NESC Rule 250B Tensions (OLF=1.65) and 0.8 for Extreme Load Tensions (OLF=1.0) for Rule 250C.

- A.17.12.3.2.i.5 Pole Eye Plates for Guy Wire (Concrete Poles) - The standard guying attachment is the “A2132 Heavy Dead End Tee” from Hughes Bros. The Ultimate Strength (maximum tension load) is 70,000 lbs. The Strength Factors are the same as for the above “Double Guying Tee”. The maximum tension is along the guy slope, thus limiting the line tension depending on the actual guy slope.
- A.17.12.3.2.i.6 Double Arming Bolts (Concrete Poles) - The standard bolt used in Owner’s Dead-End Assemblies is an ANSI C135.1, 7/8 inch “Double Arming Bolt”. The maximum Tensile Strength is 25,400 lbs, the maximum shear strength through threads is 17,270 lbs. and the maximum shear strength through the shaft is 24,350 lbs. The shear strength through the threads is always used for the Dead-End Connection. The NESC Strength Factors are also the same as for the “Double Guying Tee”. The allowable bolt strength for combination shear and tension loads, such as the guying assembly, is the calculated “interaction stress”. These bolts are the limiting factor, depending on guy slope, of the line tension in the guying assembly.
- A.17.12.3.2.i.7 Thimble Clevis - The thimble clevis used in the Dead-End Assembly has a 1 inch pin and is rated at 60,000 lbs. Ultimate Strength. The NESC Strength Factors are the same as the “Double Guying Tee”.
- A.17.12.3.2.i.8 Extension Link - The extension link is used in place of the thimble clevis when a double down-guy is used with two anchors. The link uses a 1 inch pin and is rated at 60,000 lbs. Ultimate Strength. The NESC Strength Factors are the same as the “Double Guying Tee”.
- A.17.12.3.2.i.9 Vari-Grip Dead-End - The vari-grip shall be rated for a 19#8 guy wire with an Ultimate Strength of 43,240 lbs. and 61,500 lbs. with a 19#6 guy wire. The NESC Strength Factor is 1.0.
- A.17.12.3.2.i.10 Turnbuckle - The turnbuckle shall be a 1” x 6” with jaw and eye ends with an Ultimate Strength of 50,000 lbs. The NESC Strength Factor is 1.0.
- A.17.12.3.2.i.11 The following table gives the allowable line tension based on the guy assembly and guy wire slopes. All loads are in Kips.

Table A.17.12-2 – Allowable Line Tensions based on Hardware Limitations

Assembly Part	Ultimate Strength	NESC Strength Factor	Allowable Load	Line Tension Guy Slope 1.5:1	Line Tension Guy Slope 1:1
Dead-End Insulator	50.0	0.5	25	25	25
19#8 Guys	43.2	0.9	38.9	21.6	30.6
19#6 Guys	61.7	0.9	55.5	30.8	39.4

Assembly Part	Ultimate Strength	NESC Strength Factor	Allowable Load	Line Tension Guy Slope 1.5:1	Line Tension Guy Slope 1:1
Double Guy Tee (NESC)	35.0	1.0	35.0	19.4	24.8
Extreme Loads	35.0	0.8	28.0	15.5	19.9
Dead-End Tee (NESC)	70.0	1.0	70.0	38.9	49.6
Extreme Loads	70.0	0.8	56.0	31.1	39.7
7/8" D. A. Bolt (NESC)	T=25.4	1.0		21.2	28.0
Extreme Loads	V=17.3	0.8		17.0	23.0
1-1/2" SS Screw Anchor	70.0	1.0	70.0	38.9	49.6
Thimble Clevis (NESC)	60.0	1.0	60.0	33.3	42.5
Extreme Loads	60.0	0.8	48.0	26.7	34.0
Vari-Grip (NESC) w/ 19#8	43.2	1.0	43.2	24.0	30.6
Extreme Loads	43.2	0.8	34.6	19.2	24.5
Turnbuckle (NESC)	50.0	1.0	50.0	27.8	35.5
Extreme Loads	50.0	0.8	40.0	22.2	28.4
Extension Link (NESC)		1.0			
Extreme Loads		0.8			

A.17.12.3.2.j Guyed Structure Limitations

- A.17.12.3.2.j.1 Concrete Structures - The maximum line tension that can be applied on a guyed concrete structure is limited by the combined stress on the 7/8 inch D. A. Bolts, where the maximum guy tension is 18.0 kips on the 1.5:1 slope. The governing design condition, which is considerably less than the ultimate applied tensions that shall be applied on the larger standard conductors for the Hurricane loads (150 mph wind speed.).
- A.17.12.3.2.j.2 Steel Structures - Welded steel thru vangs replace the tees and bolts on the concrete pole and these vangs shall be designed to support all of the possible applied loads. Therefore, as provided in the table, the 19#8 guys, the standard guy material, will govern the line tension limit when this guy wire is used. Where 19#6 guys are used, the anchor hardware will govern the line tension limit.
- A.17.12.3.2.j.3 Heavy Ice Zone - In the heavy ice zones (NESC 250D zones), standard through bolts, guy tees and single 19#8 guy wire may be inadequate for larger conductors or bundled configurations. Special design considerations shall be investigated under these conditions.

- A.17.12.3.2.j.4 Double Down-guy Assemblies - Double down-guy assemblies shall be used when it is determined that the soil is incapable of supporting the applied load with one anchor or where the loads exceed the allowable guy tension. The double down guy assembly shall consist of one attachment to the pole, a link with two rollers, and two guy wires and two anchors. Double Down-guy assemblies shall use 19#8 guy wires. The anchors shall be separated by at least five (5) feet.
- A.17.12.3.2.j.5 Guy Anchor Groups - All standard guyed structure framings reference a particular Guy/Anchor Group which defines the structure voltage, and in turn provides the required number and size of guys, type of anchor, guy configuration and structure type.
- A.17.12.3.2.j.6 Cathodic protection - Guy anchor assemblies shall be provided with cathodic protection by the installation of anodes.
- A.17.12.3.2.j.7 Guy anchor assemblies shall be protected by anodes as shown on the “Guy Anchor Group” detail drawings. Refer to Section A.17.11.3 for details.
- A.17.12.4 Spacing of Dead-End Structures
- A.17.12.4.1 Dead-end structures shall be required where necessary to carry eccentric loads developed due to conductor tensions. Such dead-end structures shall also be required where necessary as anti-cascading structures, or where they are necessary to facilitate construction. At a maximum spacing, dead-end structure shall be spaced such that no more than two reels of conductor and a single splice are needed between them. While the length of conductor contained on a reel can vary based on the conductor’s diameter and unit weight, for most commonly used conductors this will result in a maximum spacing of approximately 4 miles between dead-end structures.
- A.17.12.5 Considerations at Major Crossings
- A.17.12.5.1 The Transmission Lines shall be designed to provide additional reliability at major crossings, in particular along major highway crossings serving as evacuation routes from coastal area. Design and maintenance/replacement activities will apply the following:
- A.17.12.5.1.a All crossing structures are non-wood, for all voltages
- A.17.12.5.1.b If a wood crossing structure is to be replaced, it shall be replaced with non-wood structure
- A.17.12.5.1.c All highways are crossed at an angle as close to perpendicular as possible
- A.17.12.5.1.d No conductor or shield wire splices within two spans of the crossing span unless expressly approved in writing by Buyer
- A.17.12.5.1.e Where conductor/shield wire splices are unavoidable, or where they are installed during conductor maintenance, install implosive, full tension splices or shunt devices in conjunction with the conventional splice.
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- A.17.12.5.1.f Install redundant insulator configurations on all crossings (e.g., braced post insulators, V-string insulators, semi-strain insulators, etc.)
 - A.17.12.5.1.g Make shield wire connections more robust at the crossings (e.g., use shackles with nut, vs. shackles with pins, etc.)
 - A.17.12.5.1.h No guys on crossing structures if possible, and where guys shall be installed, install double guys
 - A.17.12.5.1.i Install highway crossing structures in locations difficult for vehicles to hit, e.g. behind ditches
 - A.17.12.5.1.j Provide crash barriers on all highway crossing structures that are not installed in locations difficult for vehicles to hit
 - A.17.13 STRUCTURE FOUNDATIONS
 - A.17.13.1 Structure foundations shall be designed to meet the NESC District Loading and Everyday Load Cases, as discussed in Section **Error! Reference source not found.**; and considering the safety factors and deflection limitations discussed in Section A.17.13.3. Note that loads shall generally be extracted from pole manufacturer calculations where the structure has been optimized for a high percentage of utilization. Where structures are designed in groups, the reaction used shall be that of the group (as opposed to loads derived from PLS or elsewhere for the specific location). Where manufacturer calculations are not available, foundations shall be designed for the published class/capacity of the pole used (to assure that future modifications on the line do not overestimate the foundation capacity based on the strength of the pole). Where this is not done, a notation shall be made on the plan and profile sheet stating that the foundation was determined considering actual loads in lieu of the structure's capacity.
 - A.17.13.2 Soil Information
 - A.17.13.2.1 The Designer shall obtain as much subsurface information as practicable. The basic sources of information are: (1) actual soil boring samples obtained from geotechnical investigations; (2) Geological maps; (3) data from existing U.S. Dept. of Agriculture maps; or (4) other Geotechnical sources (e. g., DOT files, customer soil records, etc.)
 - A.17.13.2.2 Actual soil data obtained from structure locations is preferable. Generally, soil borings are made at angle and dead-end structures and at intervals of approximately two miles within tangent runs depending on the terrain.
 - A.17.13.2.3 Soil information used in design shall be provided by Seller to Buyer.
 - A.17.13.3 Design Methodology – Lateral Load
 - A.17.13.3.1 The Designer shall use the computer programs Moment Foundation Analysis and Design (**MFAD**), and Foundation Analysis and Design (**FAD**) to design for lateral loads.
-

A.17.13.3.2 General Acceptance Criteria

- A.17.13.3.2.a The Designer shall apply the following generally accepted factors of safety for the calculated lateral loads as related to the calculated ultimate capacity of the pile and the acceptable deflection and rotation of the pile:

Description	Normal Soil
Total Ground Line Deflection ⁽¹⁾	3.0 in.
Total Fnd. Rotation ⁽¹⁾	1.5 deg.
Non Recoverable Deflection	1.0 in.
Non Recoverable Rotation	1.0 deg.
Safety Factor (Tangents)	1.2
Safety Factor (Angles/DEs) NESC 250B	1.0
Safety Factor (Angles/DEs) other load cases	1.65

(1) Additionally, for DE Structures, total foundation rotation and ground-line deflection shall be limited to 0.5 degrees and 1 inch under Everyday load case with all conductors on one side only.

A.17.13.4 Foundation Types

- A.17.13.4.1 The Designer shall select from the following six basic foundation types typically used by Owner on steel and concrete pole structures: Direct Embedment Foundation, Steel Pile with Socket Foundation, Cap/Base Plate Foundation, Steel Pile with Anchor Bolt Foundation, Drilled Pier with Anchor Bolts Foundation, and Concrete Pile with Steel or Concrete Pole using Socket Foundation. Seller's foundation engineer shall determine suitable foundation types and dimensions. Alternative foundation types shall only be used if expressly approved in writing by Buyer.
- A.17.13.4.2 Foundation elements shall be designed using applicable material design specifications (e.g. AISC 360 for steel elements, ACI 318 for concrete elements, etc.)
- A.17.13.4.3 Reveal height for concrete or steel socket piles shall be between 4 feet and 5 feet to facilitate concrete placement and to minimize required excavation for the socketed pole. Foundation height for base-plated poles shall be at least 2 feet, to raise anchor bolts above the ground and the bulk of the wet underbrush. The Designer shall require taller reveals in floodplains, where requested for constructability purposes, or where otherwise needed. The Designer shall not all reveals outside these specifications on the foundation drawings and/or staking sheet.
- A.17.13.4.4 Grounding and Cathodic Protection

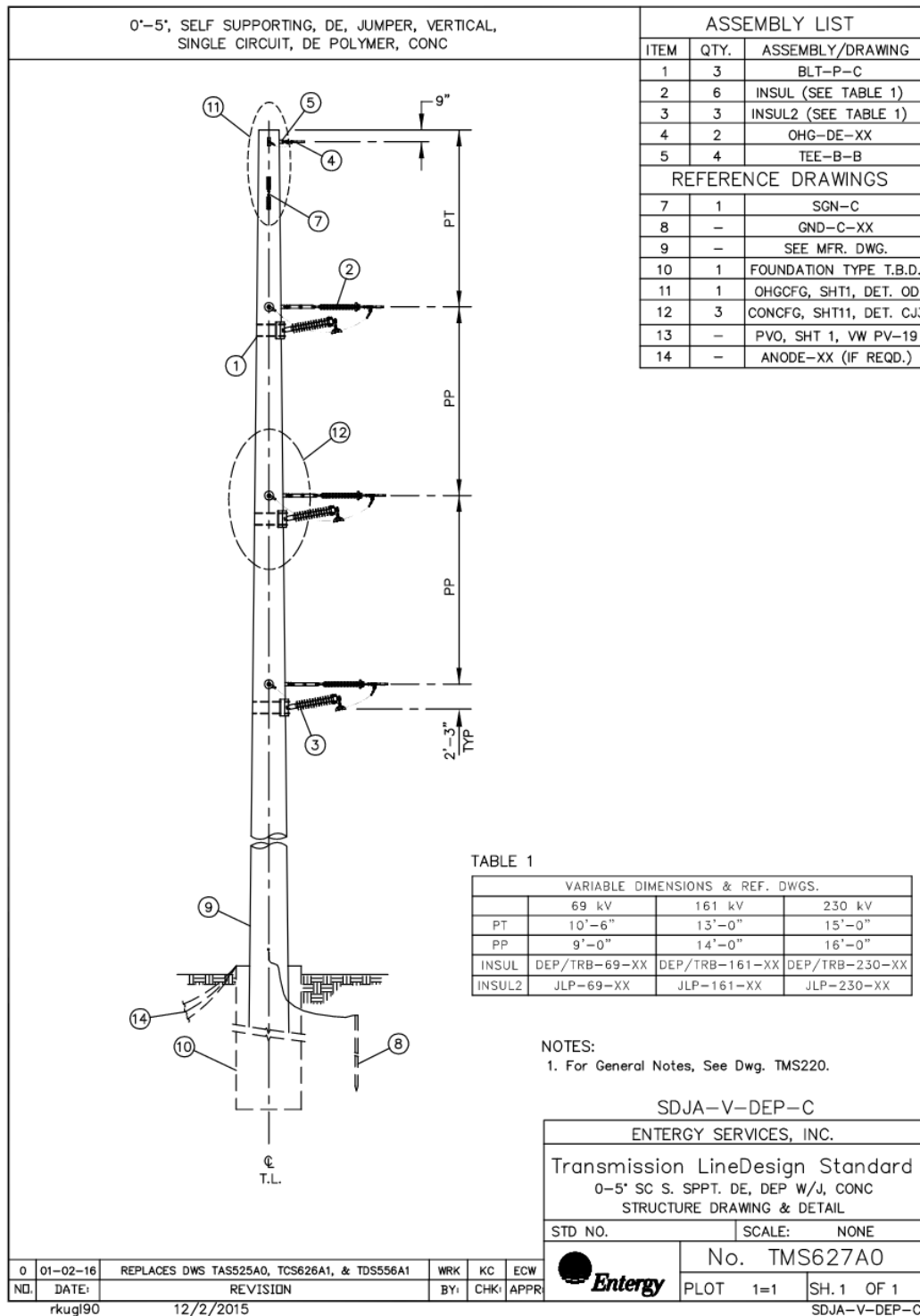
- A.17.13.4.4.a The steel pile shall be designed to act as a ground for both steel and concrete structures. Socket connections and anchor bolt connections using steel piles shall be positively connected between the pole and pile using a #4 copperweld wire connected between the pole and the Two Hole NEMA Pad welded to the pile for a good ground. The cap/base plated connections shall be designed to provide a good grounded connection. Steel and concrete poles supported by concrete drilled piers shall be grounded to copperclad steel ground rods.
- A.17.13.4.4.b Where cathodic protection is required, the anodes shall be connected to the NEMA Pads as indicated on the cathodic protection detailed drawings. In general, unless an analysis for corrosion potential indicates otherwise or the structure is located in exposed bedrock, anodes will be required at all guy anchors, and dead-end or large angle structures supported on steel foundations or embedments. In general, unless local conditions warrant (brackish marsh, shared ROW with railroads or pipelines protected by impressed current cathodic protection, etc.) anodes are not usually required for tangent structures on structures supported on concrete foundations or embedments. Reference is made to Section A.17.11.3.

ATTACHMENTS

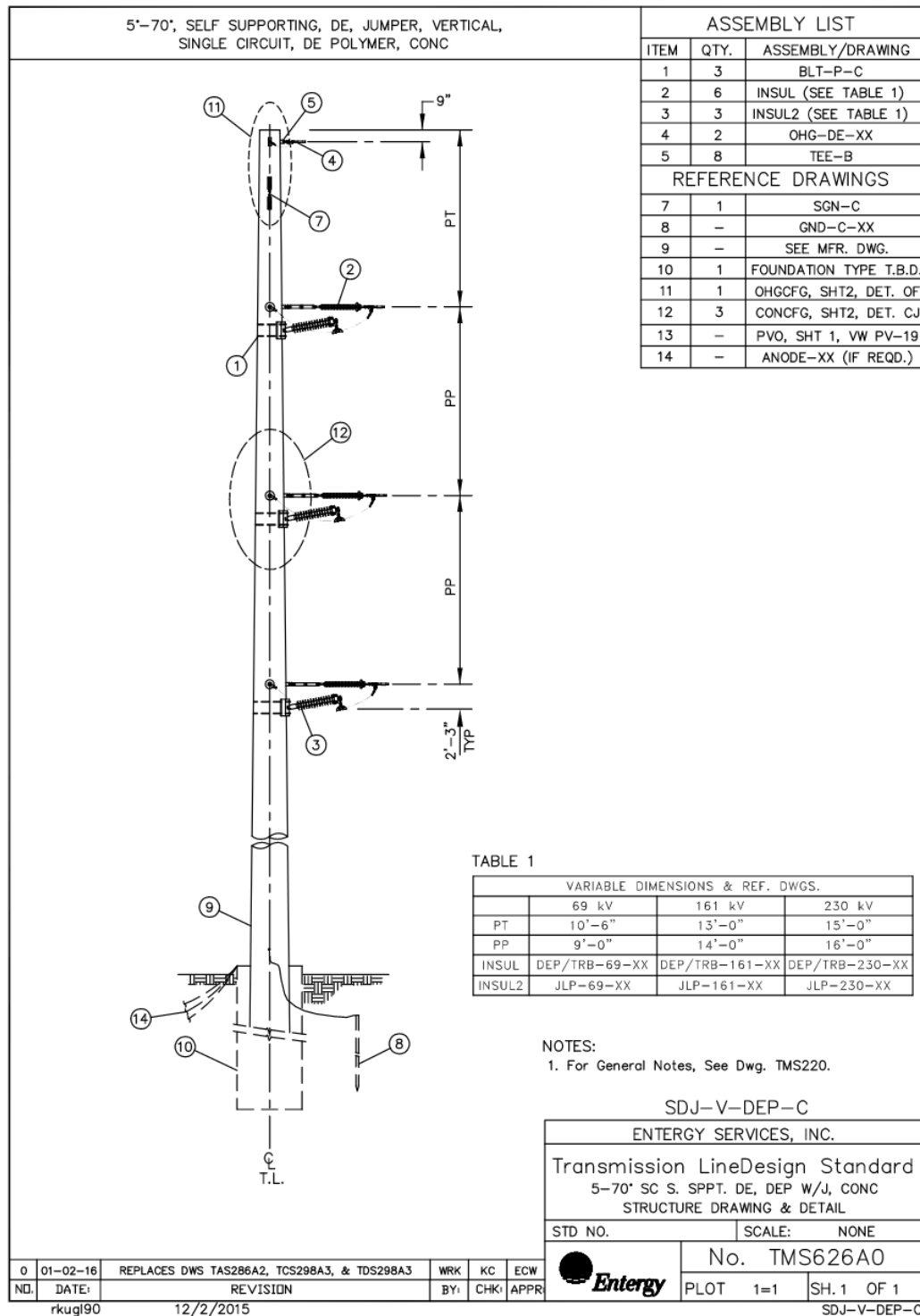
- Attachment 1 – Applicable Standard Framing and Assembly Drawings
- Attachment 2 – NESC and Owner Clearance Requirements
- Attachment 3 – Quick Estimating Corona Loss Curves
- Attachment 4 – Example ROW
- Attachment 5 – Approved Vendor List¹
- Attachment 6 – Owner Loading Districts

¹ This Attachment provides an Approved Vendor List. This Approved Vendor List is in addition to that found in the Scope Book and is considered acceptable for use, and preferred.

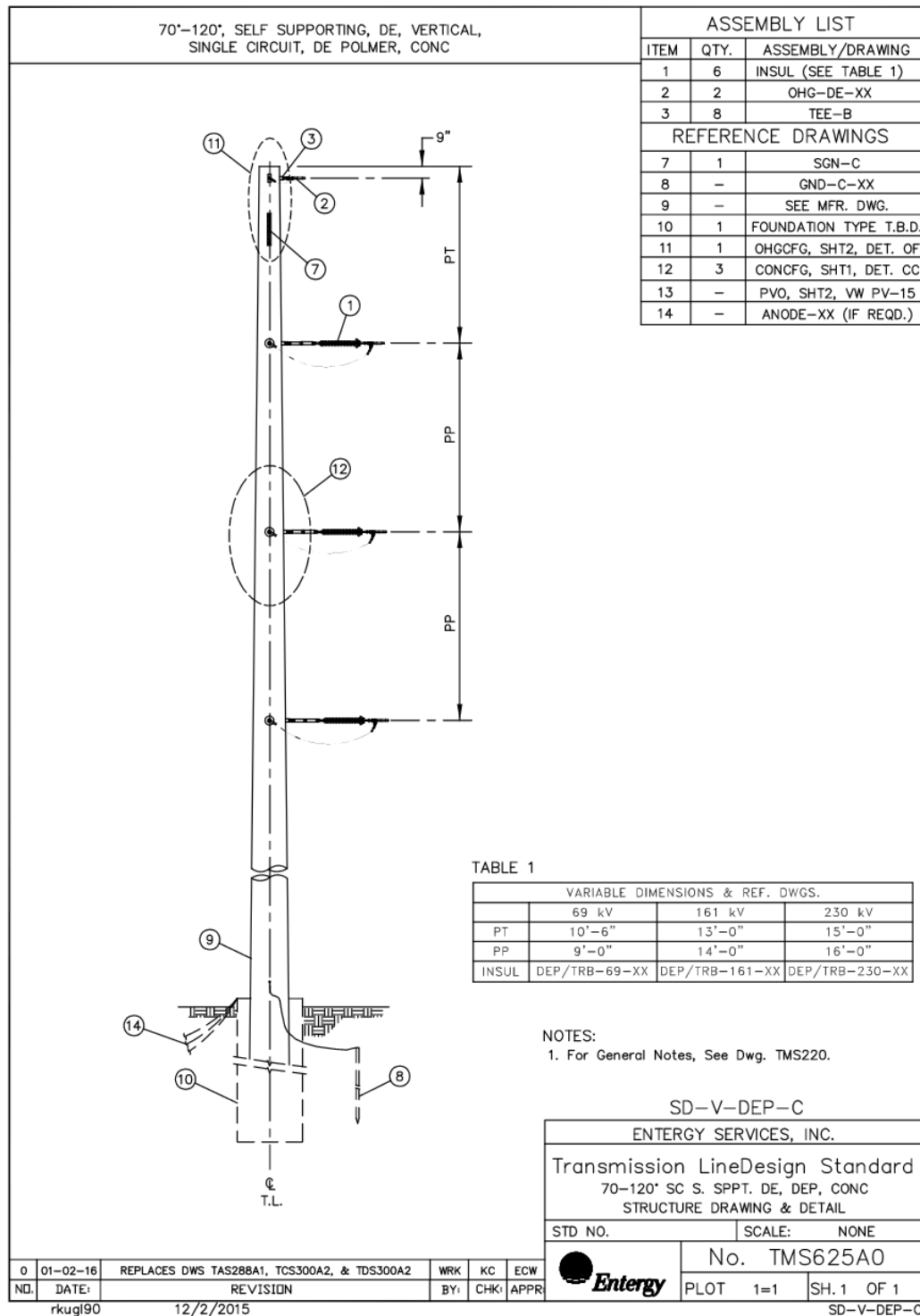
ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



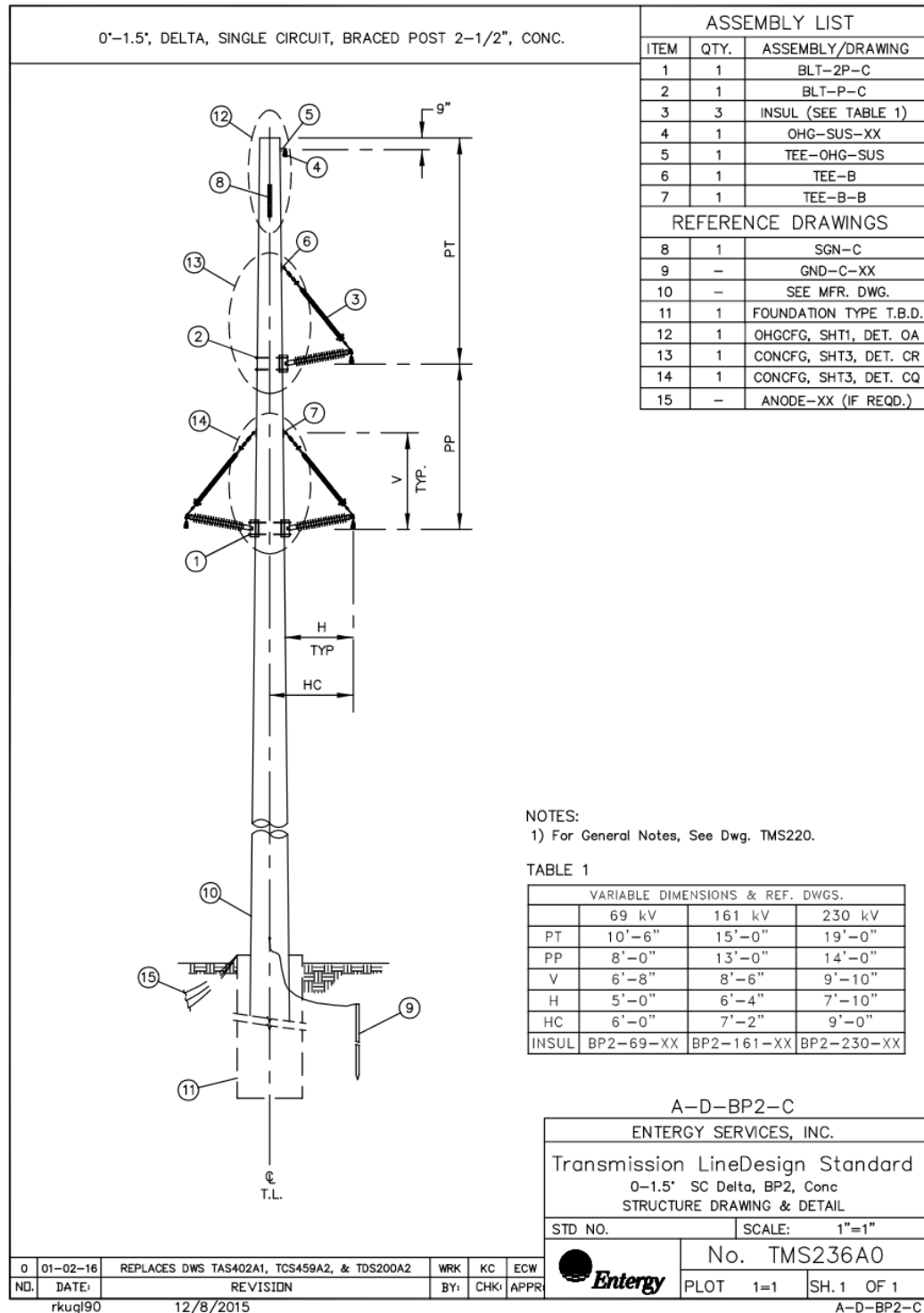
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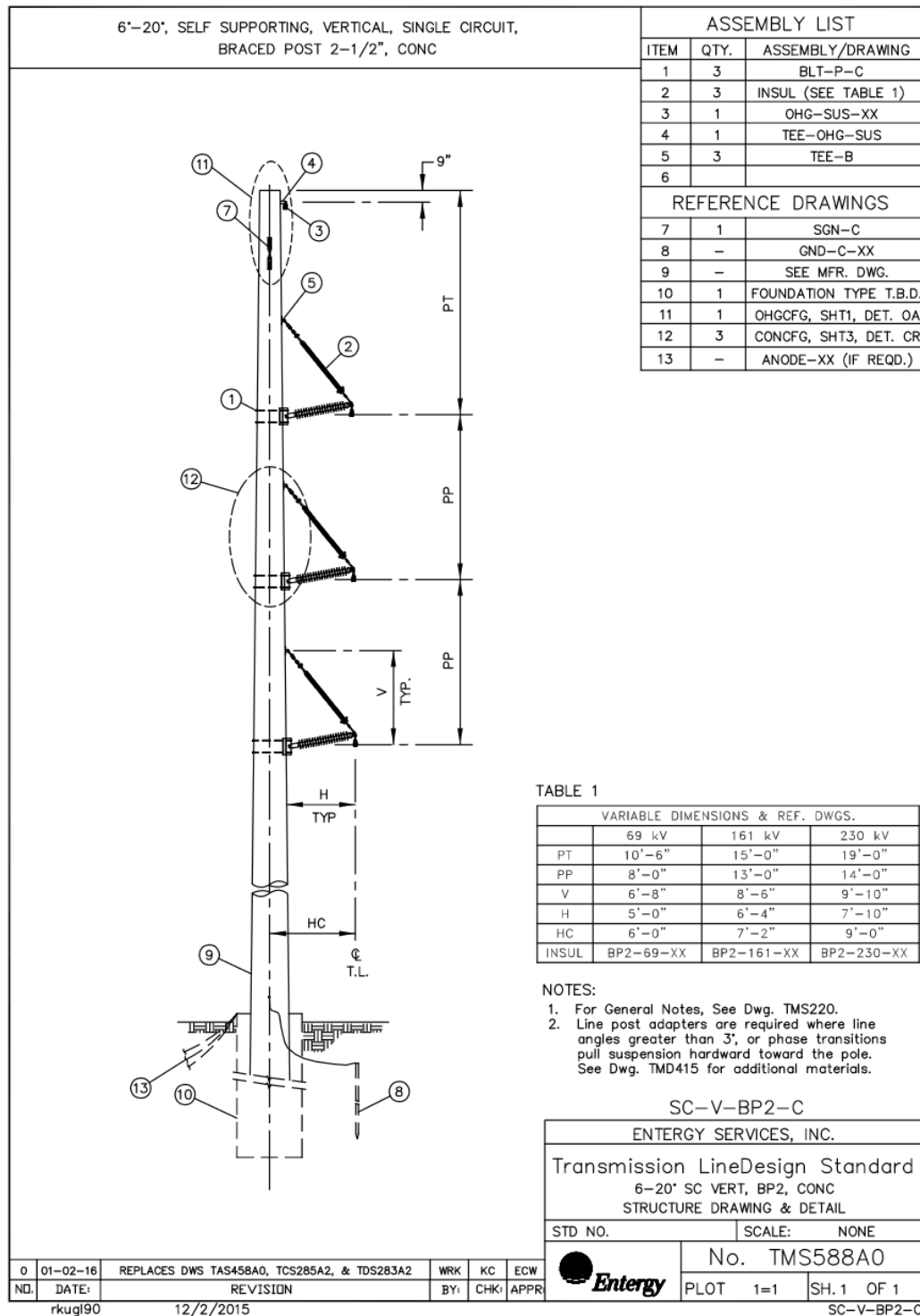
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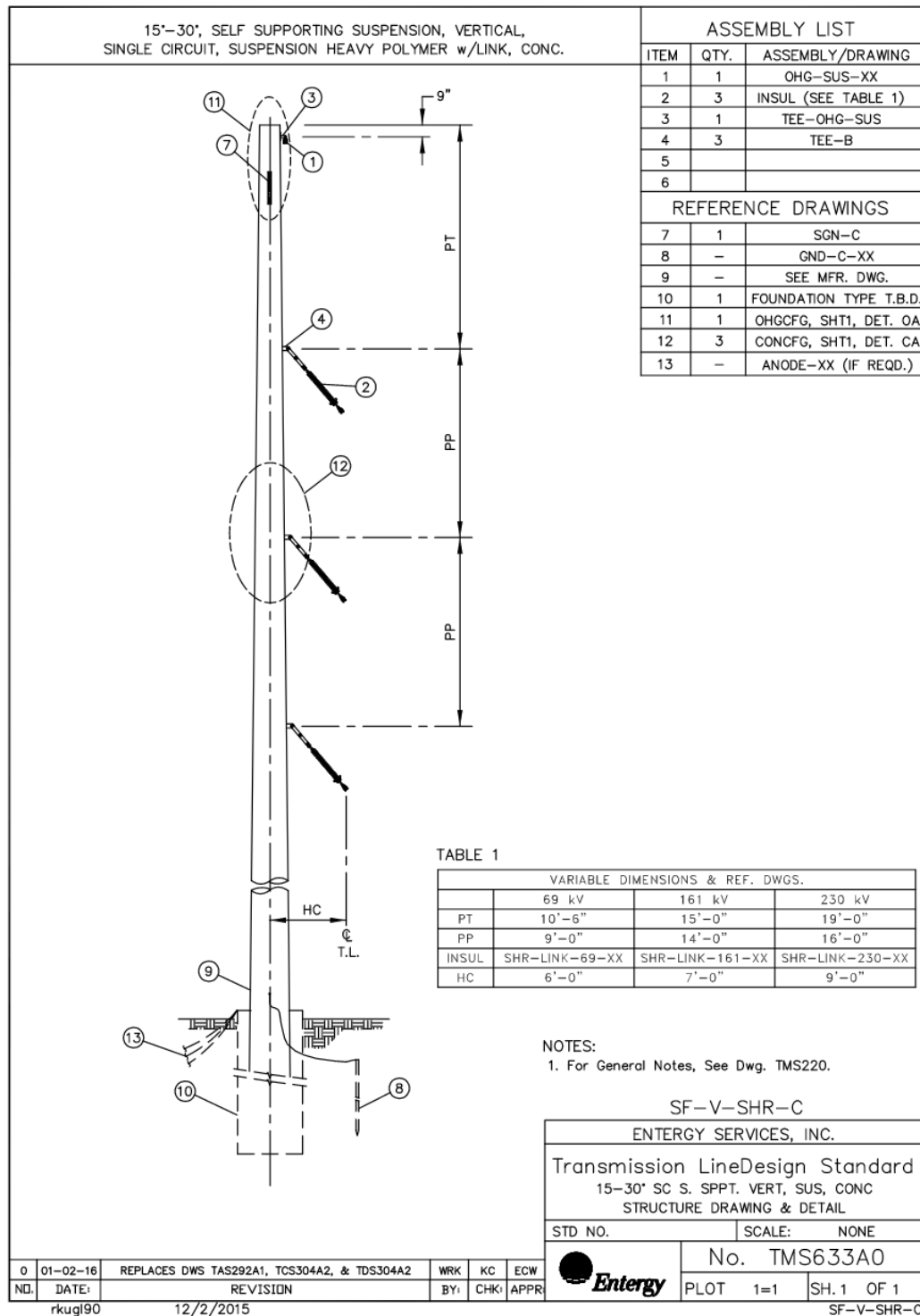
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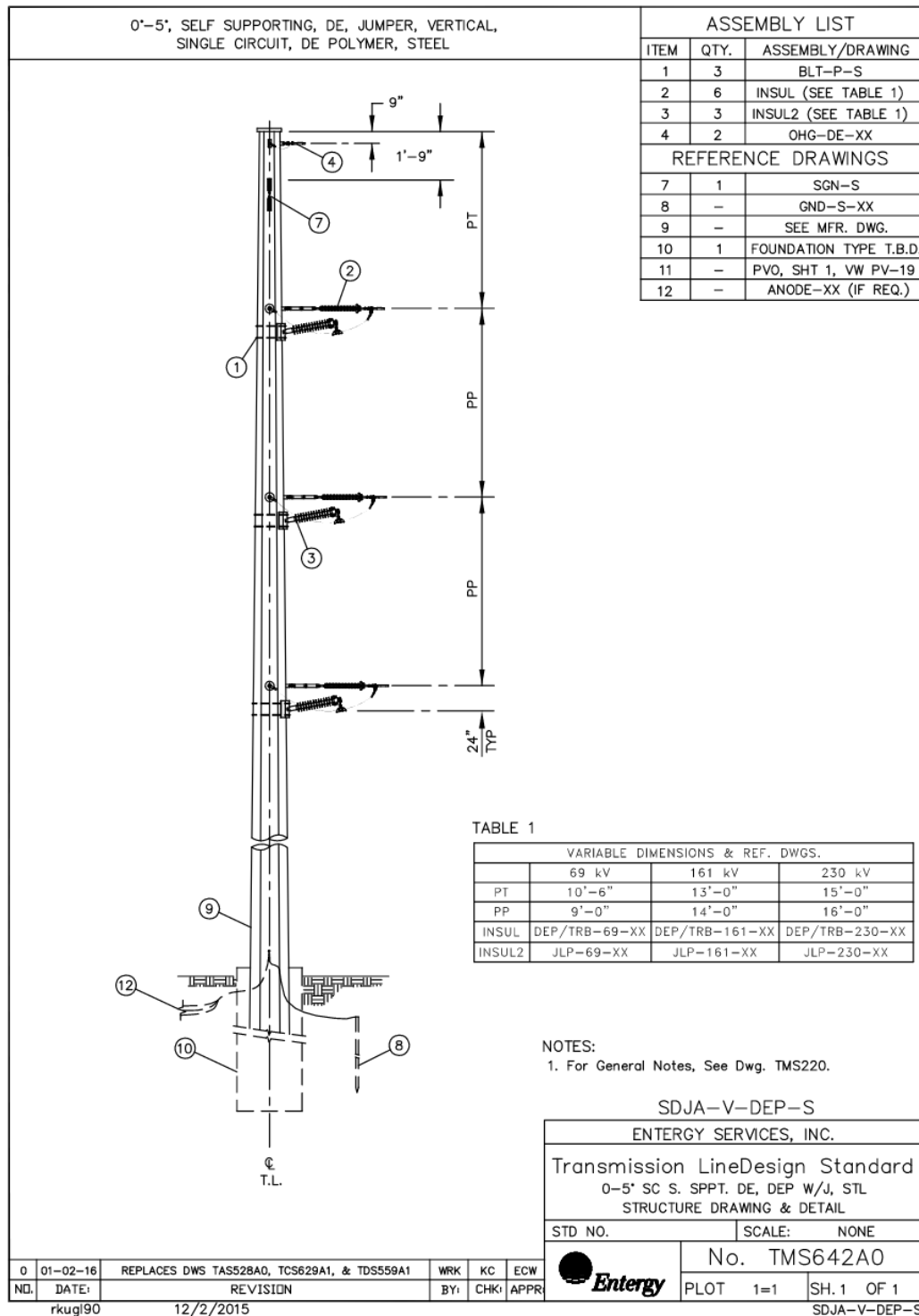
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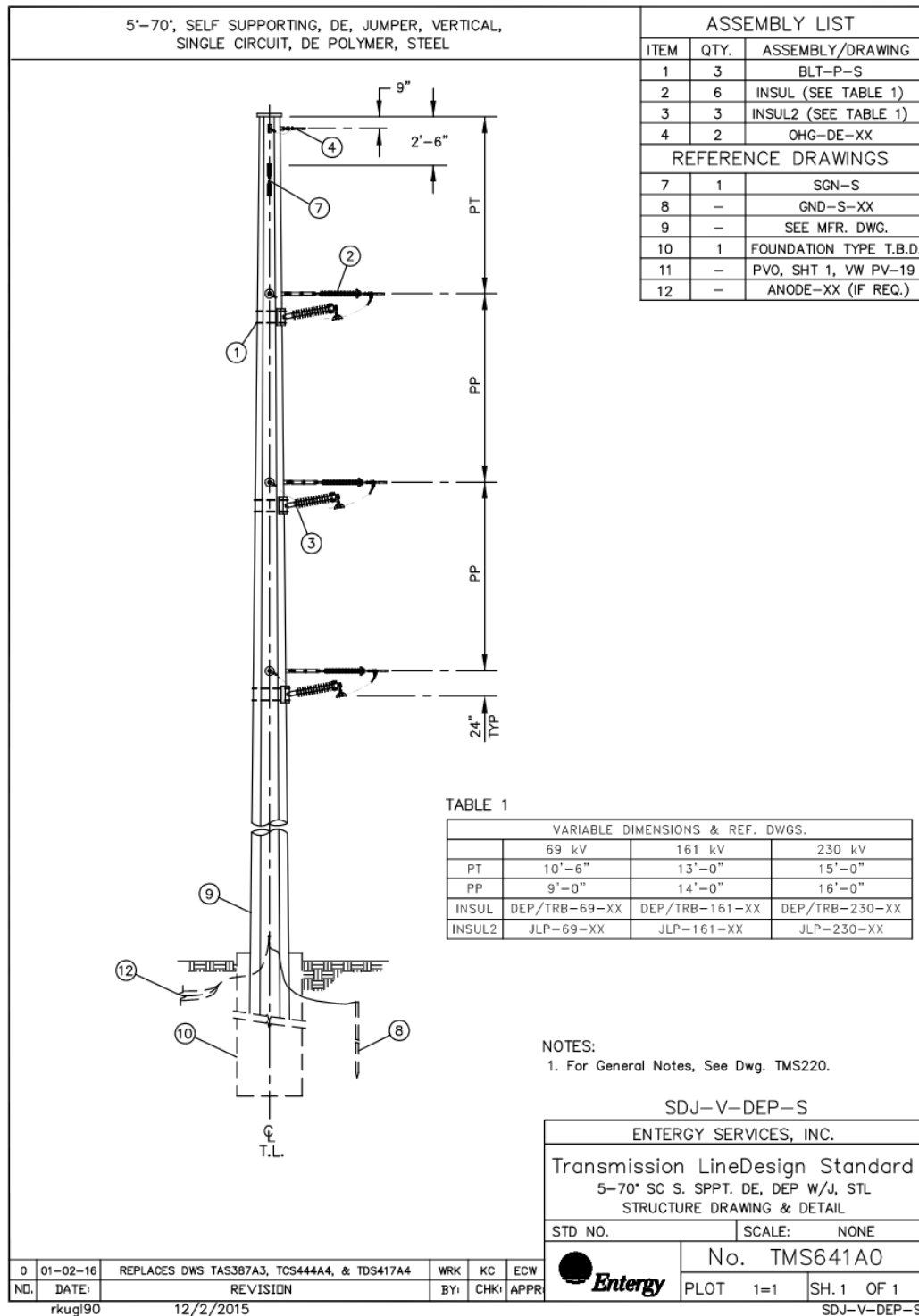
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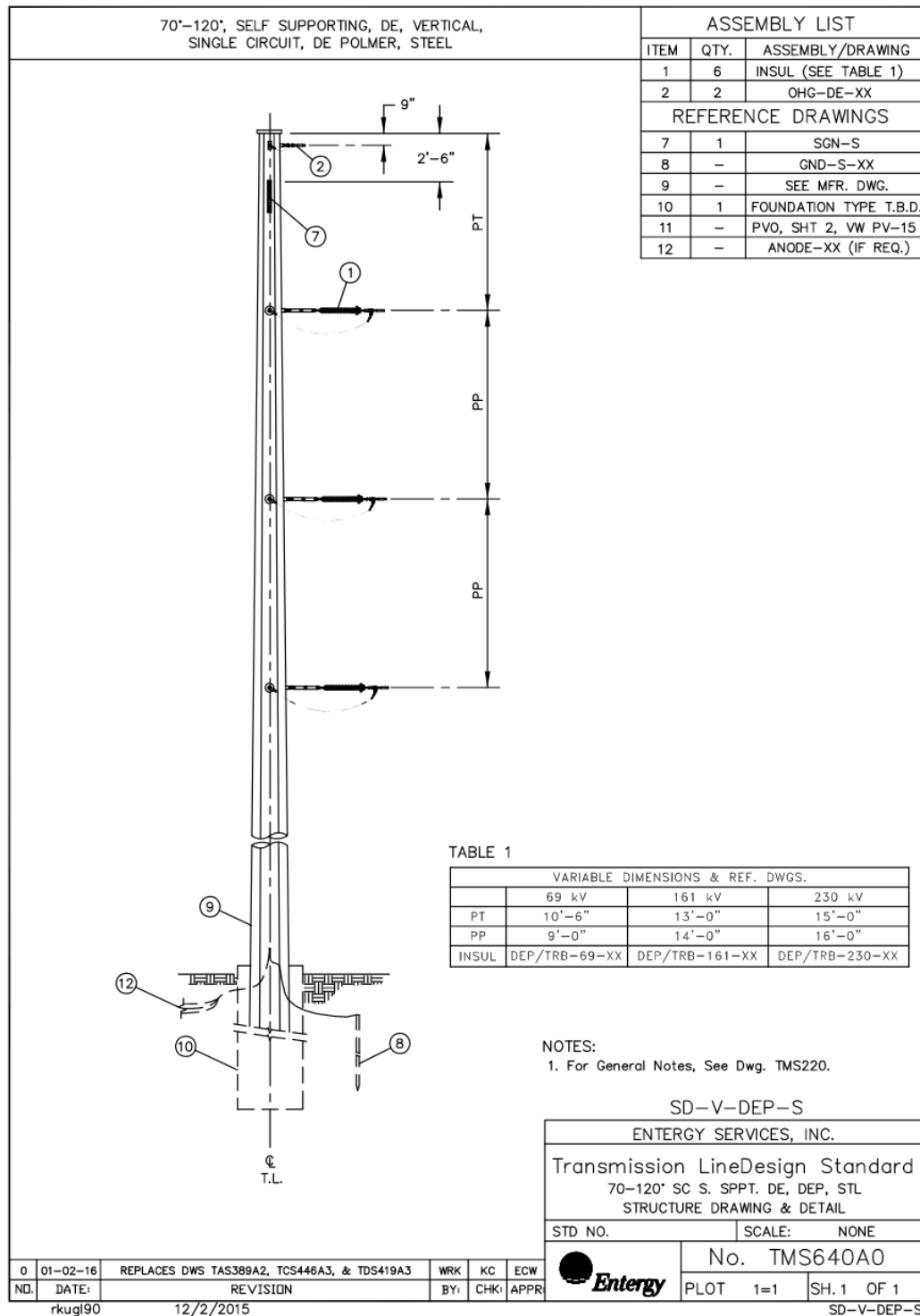
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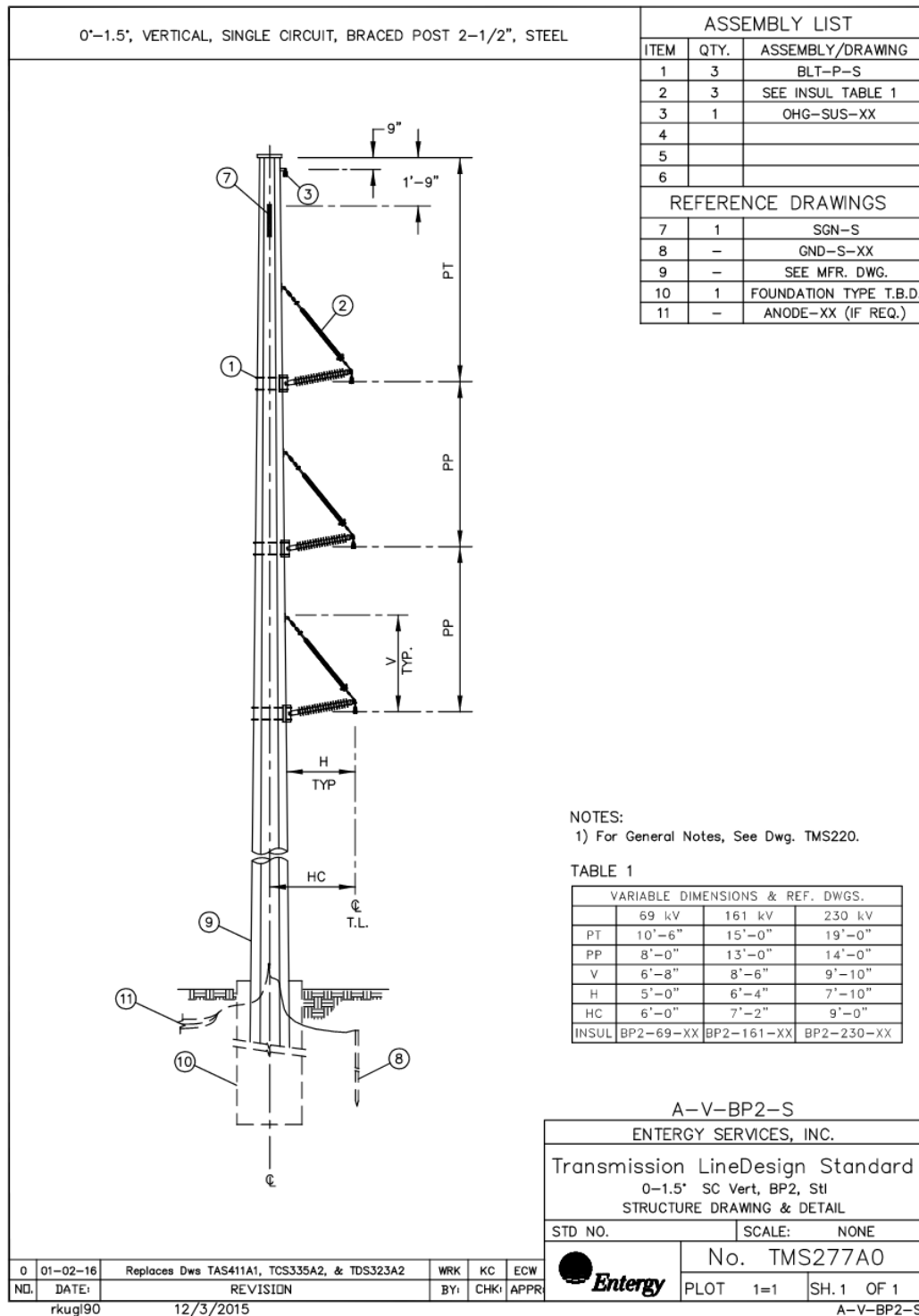
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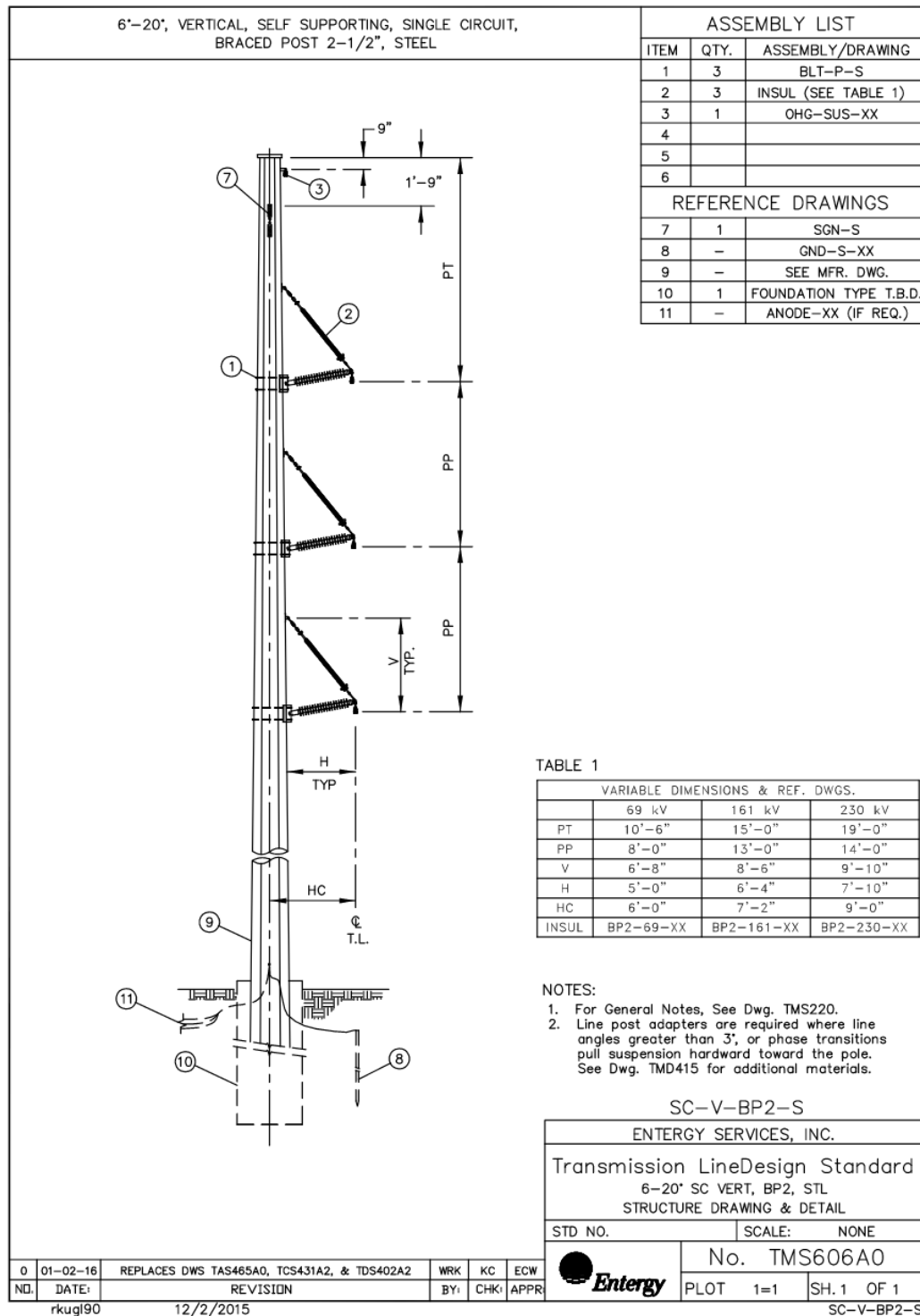
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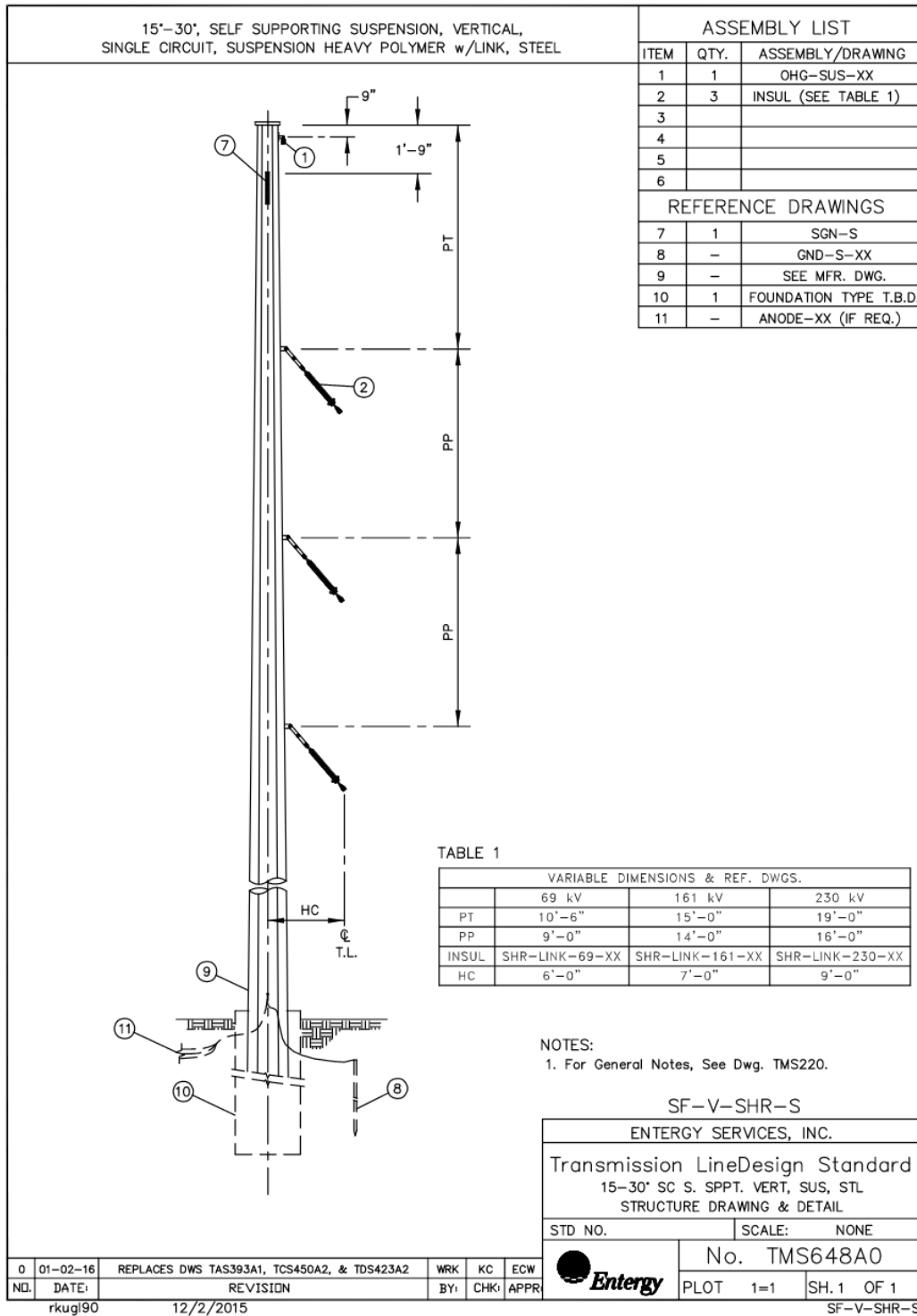
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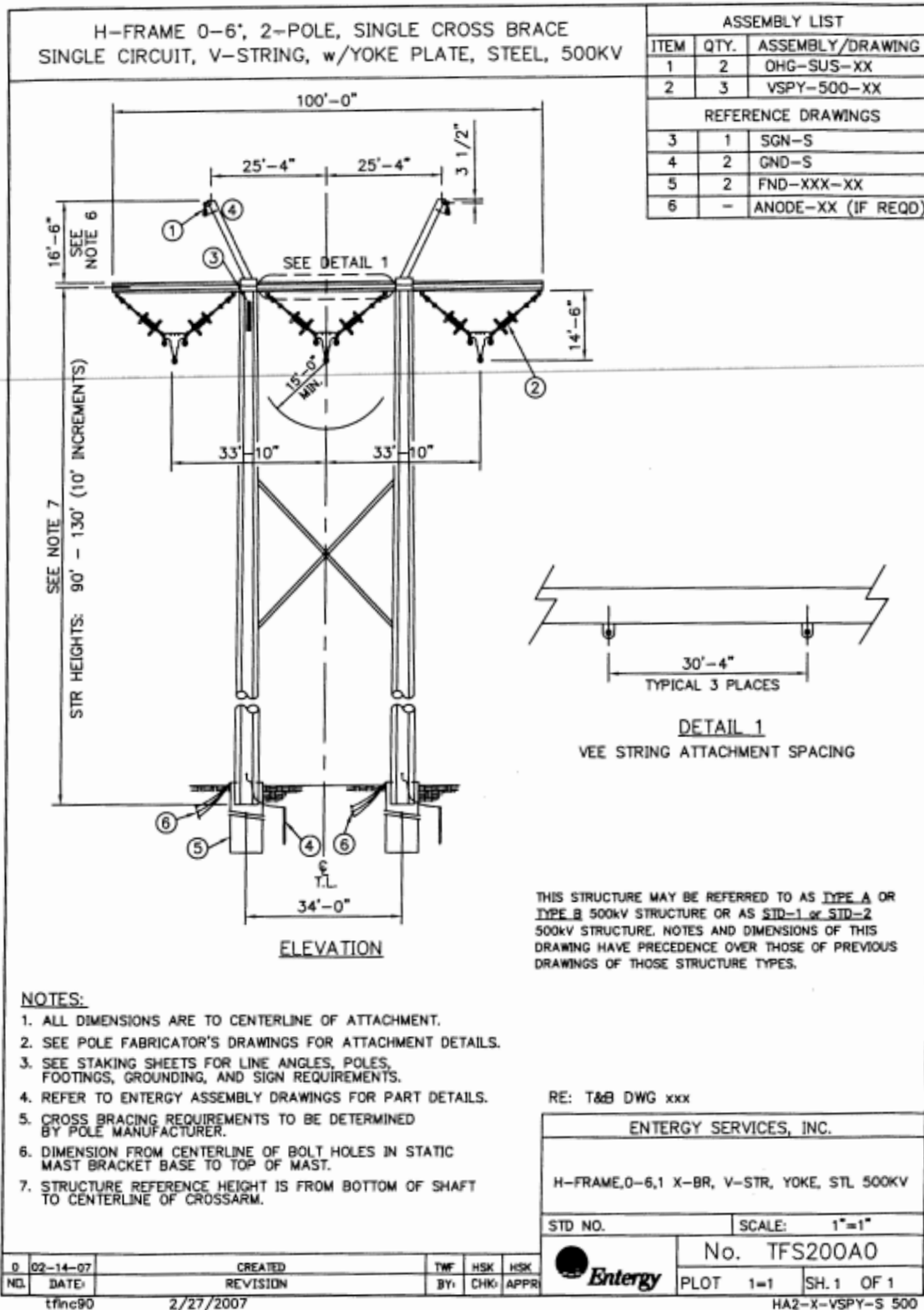
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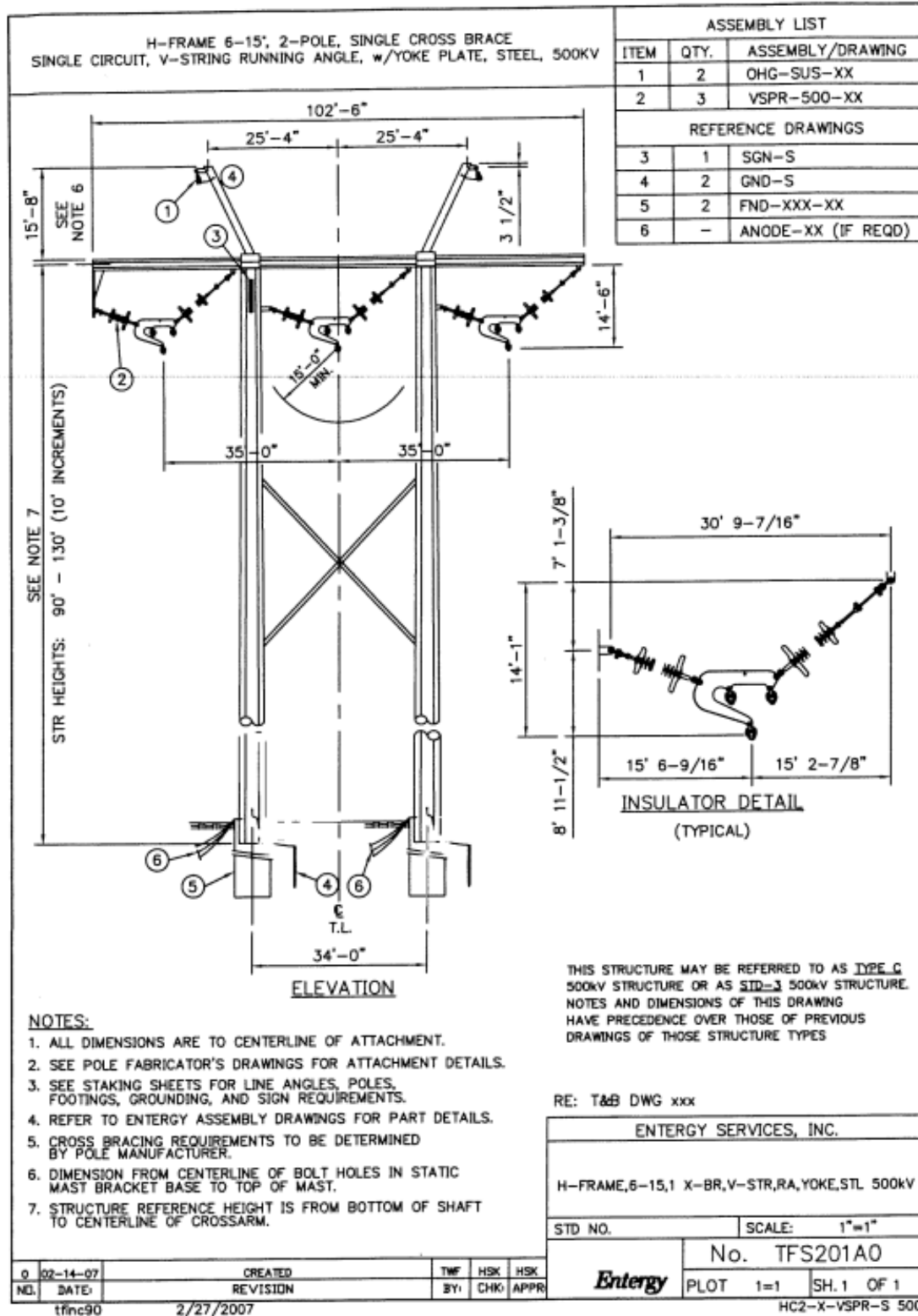
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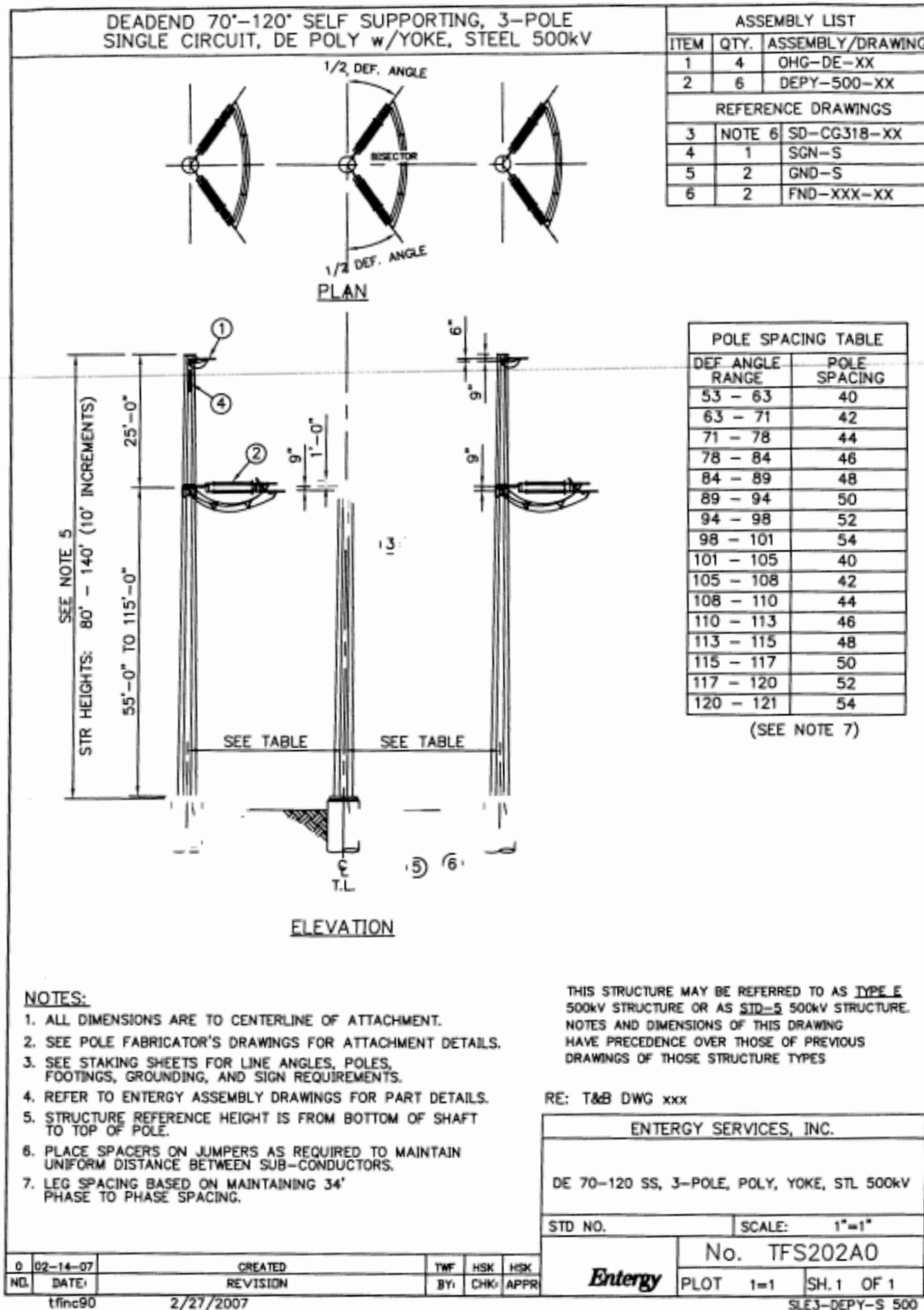
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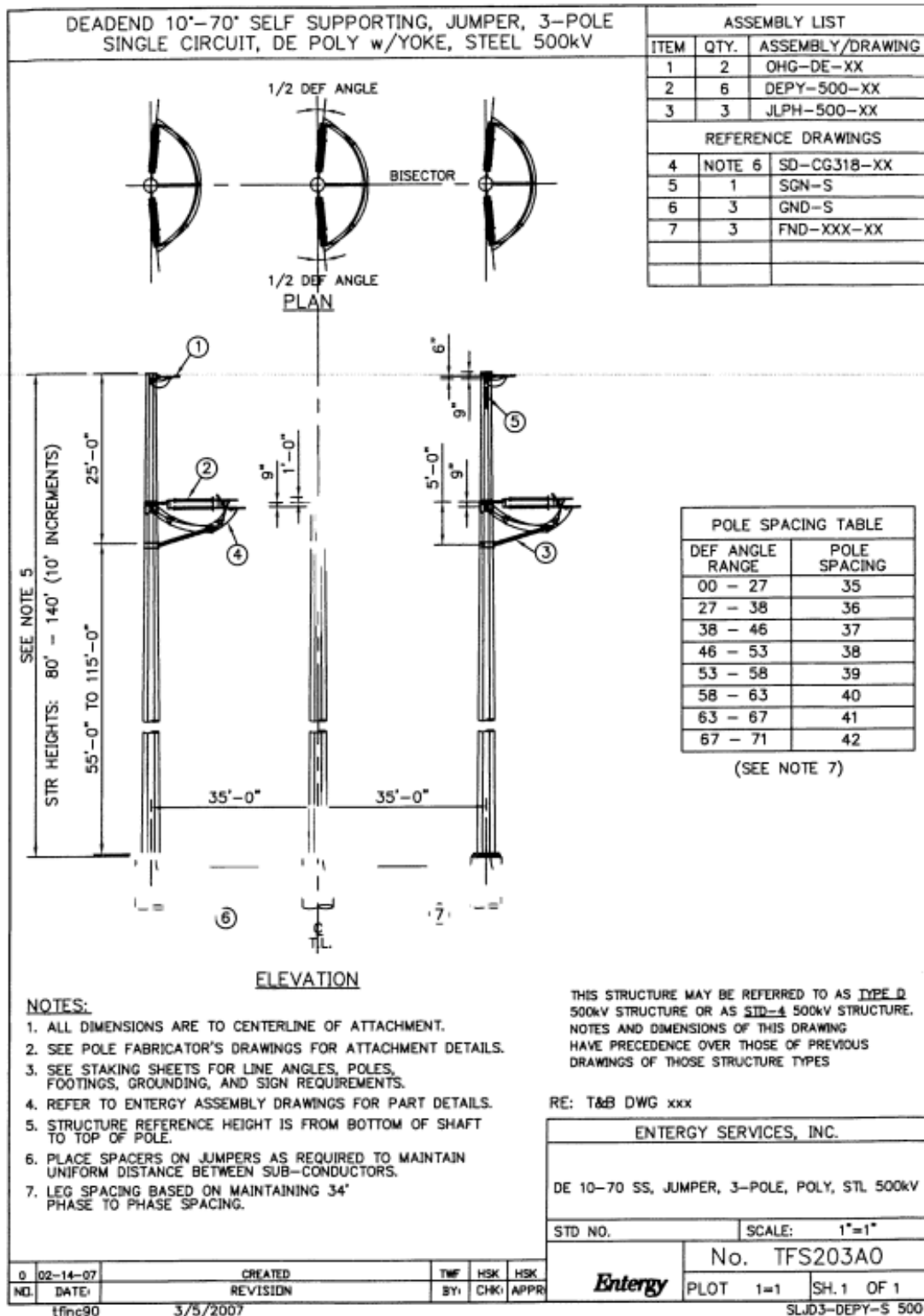
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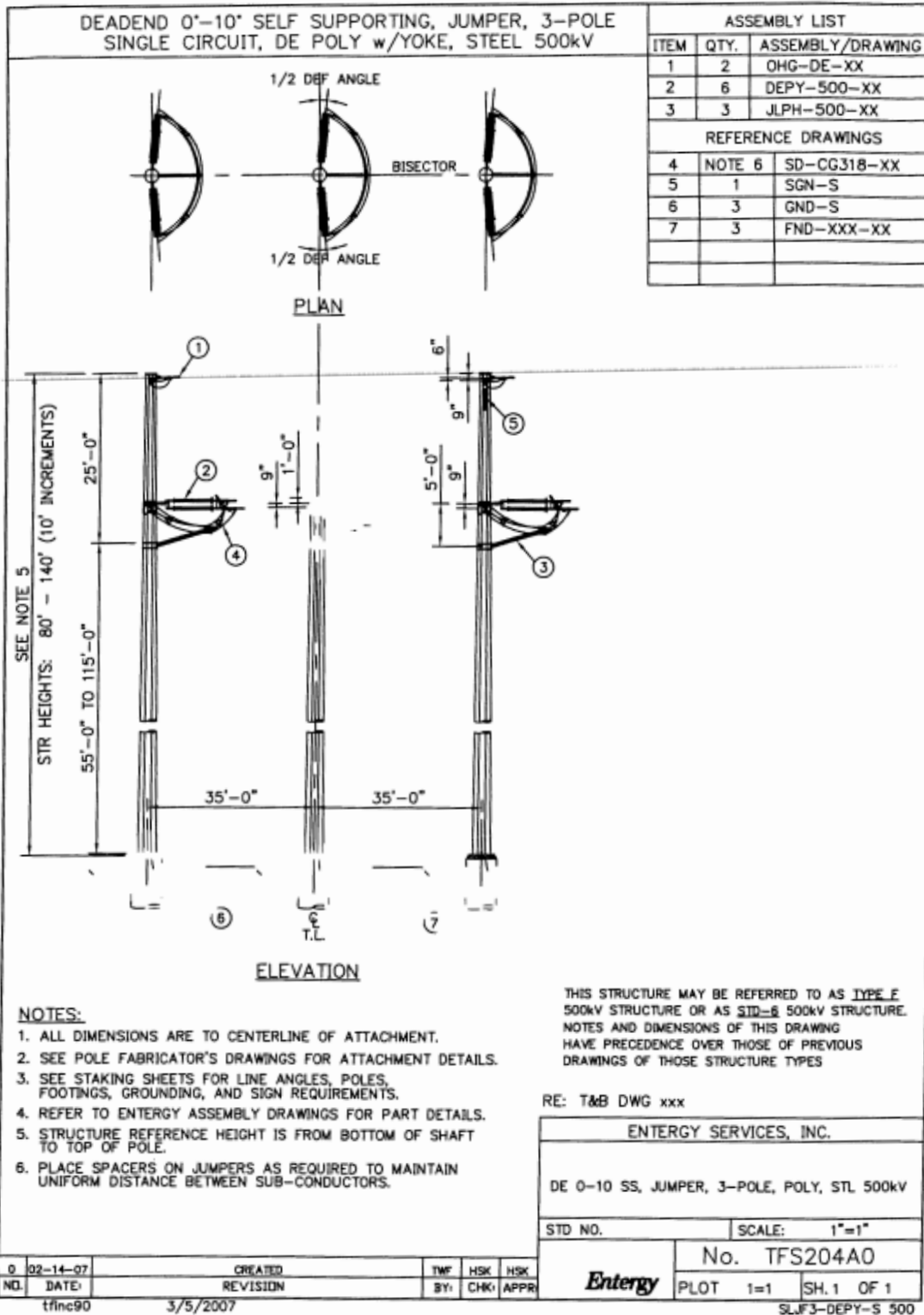
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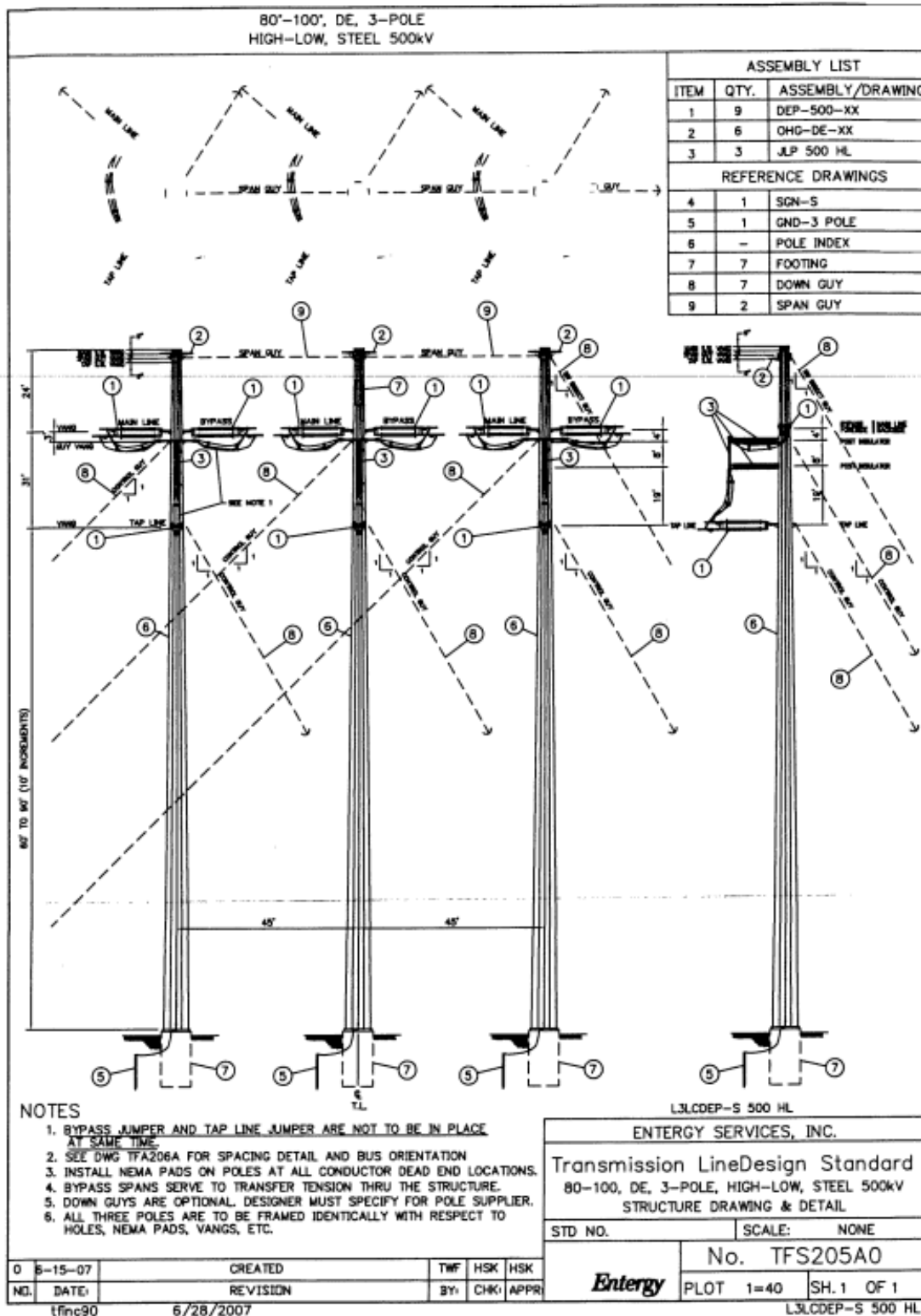
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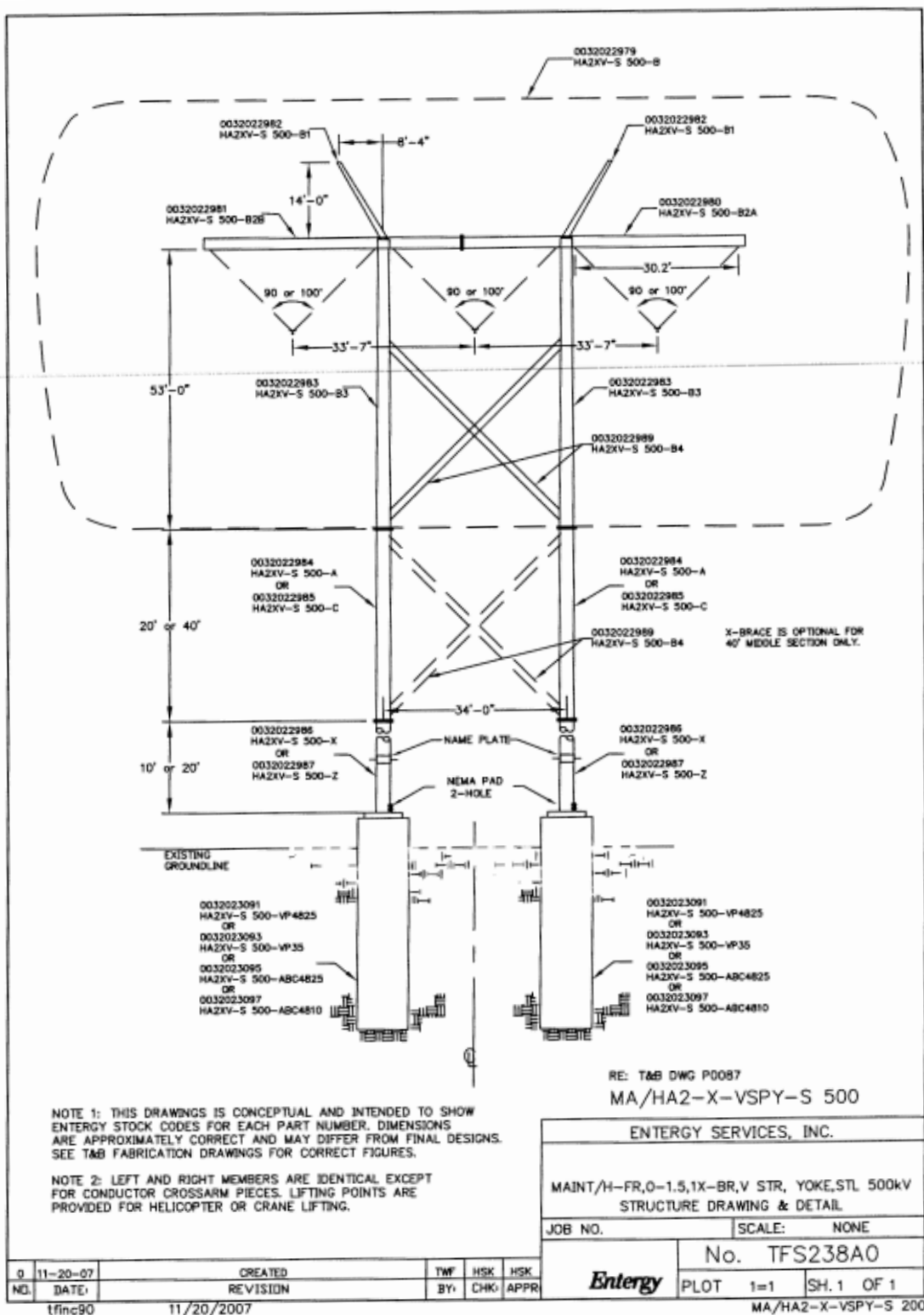
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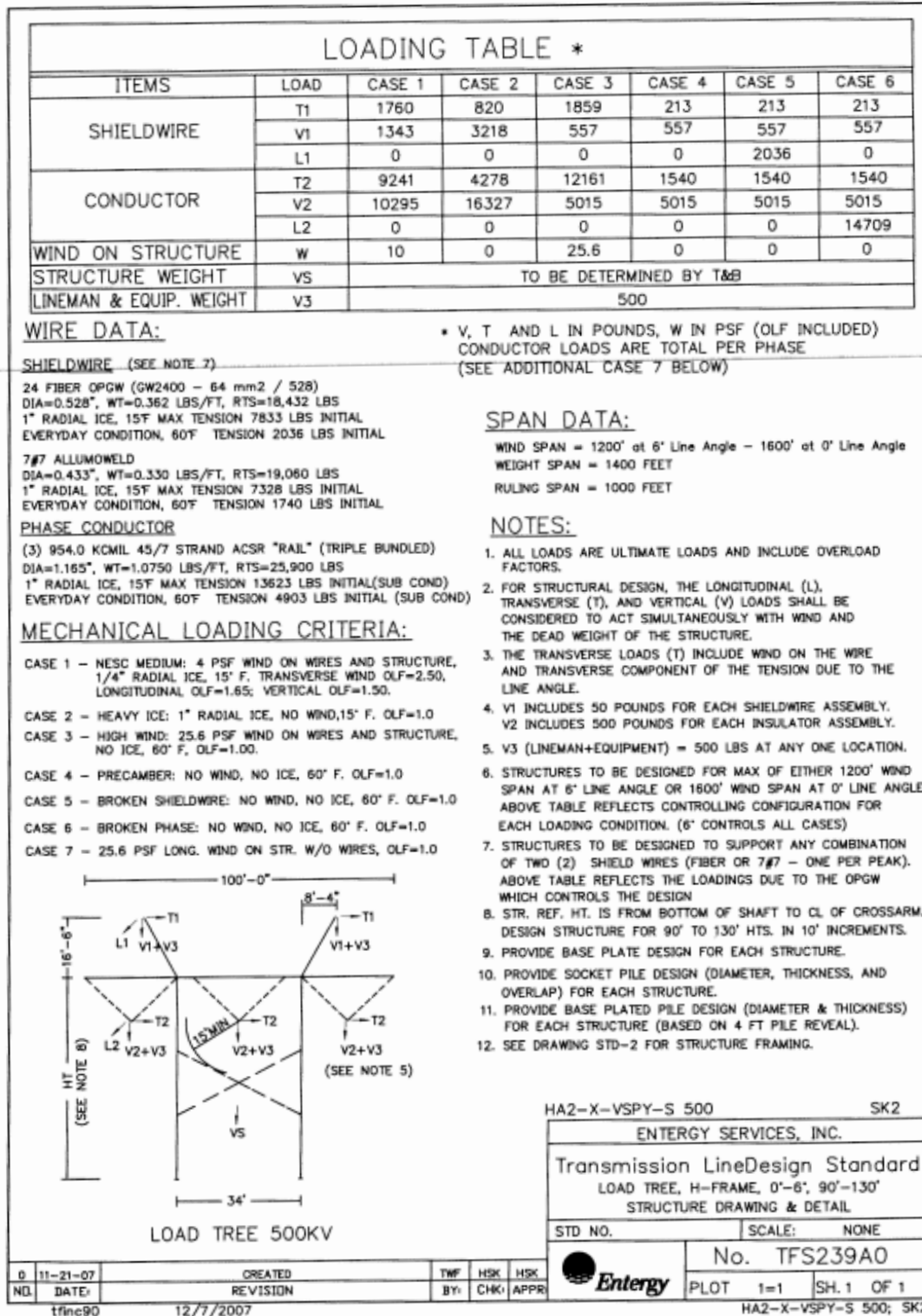
ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

LOADING TABLE *							
ITEMS	LOAD	CASE 1	CASE 2	CASE 3	CASE 4	CASE 5	CASE 6
SHIELDWIRE	T1	2682	2045	2392	532	652	532
	V1	1343	3218	557	557	557	557
	L1	0	0	0	0	5000	0
CONDUCTOR	T2	14752	10669	15472	3840	3840	3604
	V2	10295	16327	5015	5015	5015	5015
	L2	0	0	0	0	0	8000
WIND ON STRUCTURE	W	10	0	25.6	0	0	0
STRUCTURE WEIGHT	VS	TO BE DETERMINED BY T&E					
LINEMAN & EQUIP. WEIGHT	V3	500					

WIRE DATA:

SHIELDWIRE (SEE NOTE 7)
 24 FIBER OPGW (GW2400 - 64 mm2 / 528)
 DIA=0.528", WT=0.362 LBS/FT, RTS=18,432 LBS
 1" RADIAL ICE, 15F MAX TENSION 7833 LBS INITIAL
 EVERYDAY CONDITION, 60F TENSION 2036 LBS INITIAL
 7#7 ALLUMOWELD
 DIA=0.433", WT=0.330 LBS/FT, RTS=19,060 LBS
 1" RADIAL ICE, 15F MAX TENSION 7328 LBS INITIAL
 EVERYDAY CONDITION, 60F TENSION 1740 LBS INITIAL

PHASE CONDUCTOR
 (3) 954.0 KCMIL 45/7 STRAND ACSR "RAIL" (TRIPLE BUNDLED)
 DIA=1.165", WT=1.0750 LBS/FT, RTS=25,900 LBS
 1" RADIAL ICE, 15F MAX TENSION 13623 LBS INITIAL (SUB COND)
 EVERYDAY CONDITION, 60F TENSION 4903 LBS INITIAL (SUB COND)

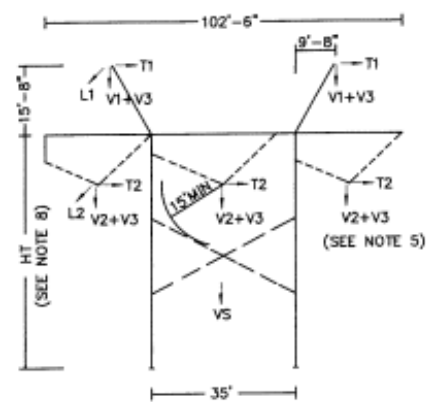
MECHANICAL LOADING CRITERIA:

CASE 1 - NESC MEDIUM: 4 PSF WIND ON WIRES AND STRUCTURE, 1/4" RADIAL ICE, 15' F. TRANSVERSE WIND OLF=2.50, LONGITUDINAL OLF=1.65; VERTICAL OLF=1.50.
 CASE 2 - HEAVY ICE: 1" RADIAL ICE, NO WIND, 15' F. OLF=1.0
 CASE 3 - HIGH WIND: 25.6 PSF WIND ON WIRES AND STRUCTURE, NO ICE, 60' F. OLF=1.00.
 CASE 4 - PRECAMBER: NO WIND, NO ICE, 60' F. OLF=1.0
 CASE 5 - BROKEN SHIELDWIRE: NO WIND, NO ICE, 60' F. OLF=1.0
 CASE 6 - UNBALANCED PHASE: NO WIND, NO ICE, 60' F. OLF=1.0
 CASE 7 - 25.6 PSF LONG. WIND ON STR. W/O WIRES, OLF=1.0

SPAN DATA:
 WIND SPAN = 1000' at 15' Line Angle
 WEIGHT SPAN = 1400 FEET
 RULING SPAN = 1000 FEET

NOTES:

- ALL LOADS ARE ULTIMATE LOADS AND INCLUDE OVERLOAD FACTORS.
- FOR STRUCTURAL DESIGN, THE LONGITUDINAL (L), TRANSVERSE (T), AND VERTICAL (V) LOADS SHALL BE CONSIDERED TO ACT SIMULTANEOUSLY WITH WIND AND THE DEAD WEIGHT OF THE STRUCTURE.
- THE TRANSVERSE LOADS (T) INCLUDE WIND ON THE WIRE AND TRANSVERSE COMPONENT OF THE TENSION DUE TO THE LINE ANGLE.
- V1 INCLUDES 50 POUNDS FOR EACH SHIELDWIRE ASSEMBLY. V2 INCLUDES 500 POUNDS FOR EACH INSULATOR ASSEMBLY.
- V3 (LINEMAN+EQUIPMENT) = 500 LBS AT ANY ONE LOCATION.
- STRUCTURES TO BE DESIGNED FOR 1000' WIND SPAN AT 15' LINE ANGLE. PROVIDE SPAN AND ANGLE CHART FOR 6' TO 14' LINE ANGLE.
- STRUCTURES TO BE DESIGNED TO SUPPORT ANY COMBINATION OF TWO (2) SHIELD WIRES (FIBER OR 7#7 - ONE PER PEAK). ABOVE TABLE REFLECTS THE LOADINGS DUE TO THE OPGW WHICH CONTROLS THE DESIGN
- STR. REF. HT. IS FROM BOTTOM OF SHAFT TO CL OF CROSSARM. DESIGN STRUCTURE FOR 90' TO 130' HTS. IN 10' INCREMENTS.
- PROVIDE BASE PLATE DESIGN FOR EACH STRUCTURE.
- PROVIDE SOCKET PILE DESIGN (DIAMETER, THICKNESS, AND OVERLAP) FOR EACH STRUCTURE.
- PROVIDE BASE PLATED PILE DESIGN (DIAMETER & THICKNESS) FOR EACH STRUCTURE (BASED ON 4 FT PILE REVEAL).
- SEE DRAWING STD-3 FOR STRUCTURE FRAMING.



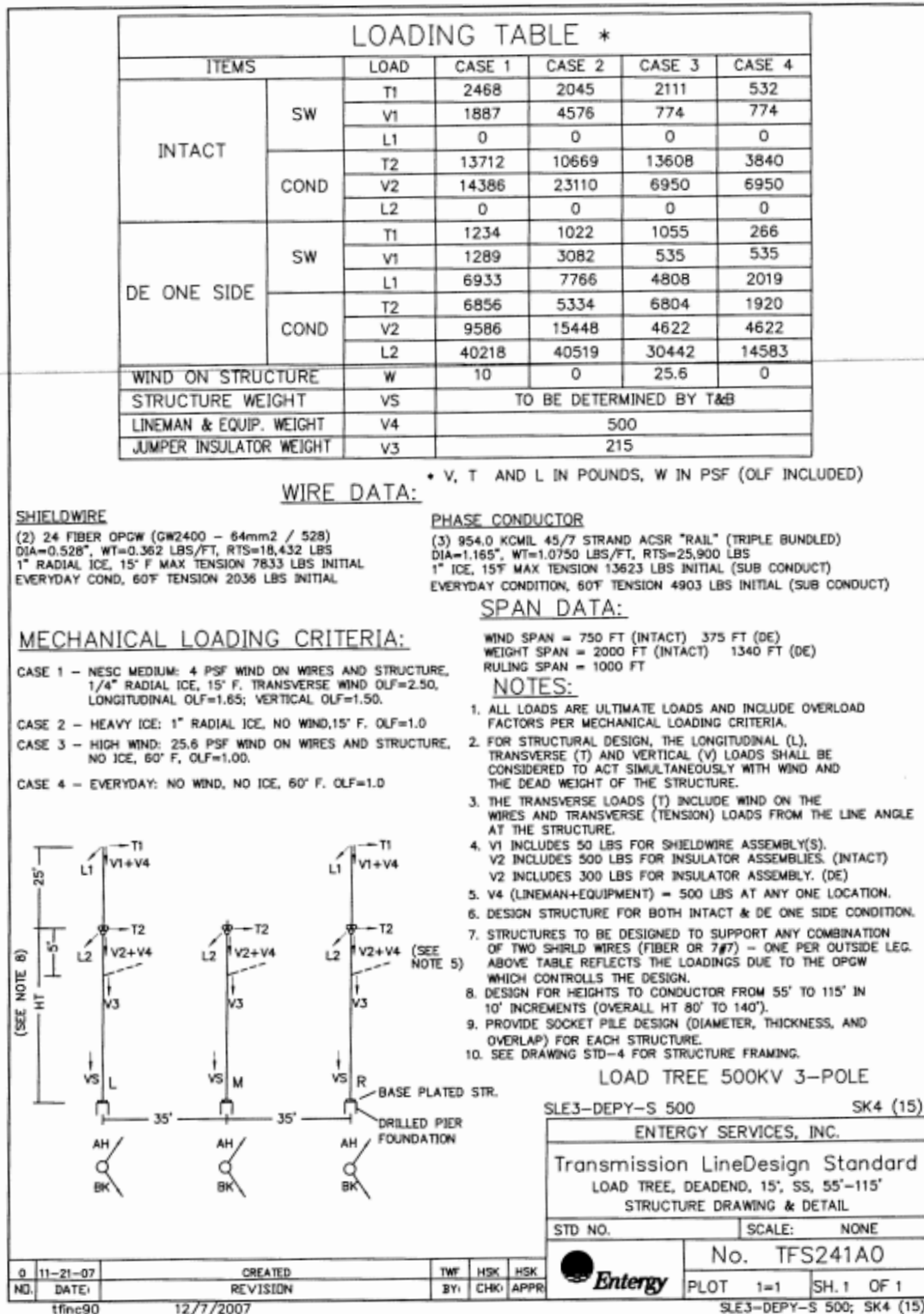
LOAD TREE 500KV

HC2-X-VSPR-S 500		SK3	
ENTERGY SERVICES, INC.			
Transmission Line Design Standard			
LOAD TREE, H-FRAME, 6'-15', 90'-130'			
STRUCTURE DRAWING & DETAIL			
STD NO.	SCALE: NONE		
No. TFS240A0			
PLOT 1=1		SH.1 OF 1	

0	11-21-07	CREATED	TWF	HSK	HSK
ND	DATE	REVISION	BY	CHK	APPR
tfn90			12/7/2007		

HC2-X-VSPR-S 500; SK3

ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

LOADING TABLE *						
ITEMS		LOAD	CASE 1	CASE 2	CASE 3	CASE 4
INTACT	SW	T1	3669	3391	2944	881
		V1	1887	4576	774	774
		L1	0	0	0	0
	COND	T2	20682	17691	18884	6397
		V2	14386	23110	6950	6950
		L2	0	0	0	0
DE ONE SIDE	SW	T1	1835	1695	1472	441
		V1	1289	3082	535	535
		L1	6827	7647	4734	1988
	COND	T2	10341	8846	9442	3184
		V2	9586	15448	4622	4622
		L2	39604	39900	29977	14360
WIND ON STRUCTURE		W	10	0	25.6	0
STRUCTURE WEIGHT		VS	TO BE DETERMINED BY T&B			
LINEMAN & EQUIP. WEIGHT		V4	500			
JUMPER INSULATOR WEIGHT		V3	215			

* V, T AND L IN POUNDS, W IN PSF (OLF INCLUDED)

WIRE DATA:

SHIELDWIRE
(2) 24 FIBER OPGW (GW2400 - 54mm2 / 528)
DIA=0.528", WT=0.362 LBS/FT, RTS=18,432 LBS
1" RADIAL ICE, 15' F MAX TENSION 7833 LBS INITIAL
EVERYDAY COND, 60' F TENSION 2036 LBS INITIAL

MECHANICAL LOADING CRITERIA:

CASE 1 - NESC MEDIUM: 4 PSF WIND ON WIRES AND STRUCTURE,
1/4" RADIAL ICE, 15' F. TRANSVERSE WIND OLF=2.50,
LONGITUDINAL OLF=1.65; VERTICAL OLF=1.50.

CASE 2 - HEAVY ICE: 1" RADIAL ICE, NO WIND, 15' F. OLF=1.0

CASE 3 - HIGH WIND: 25.6 PSF WIND ON WIRES AND STRUCTURE,
NO ICE, 60' F, OLF=1.00.

CASE 4 - EVERYDAY: NO WIND, NO ICE, 60' F. OLF=1.0

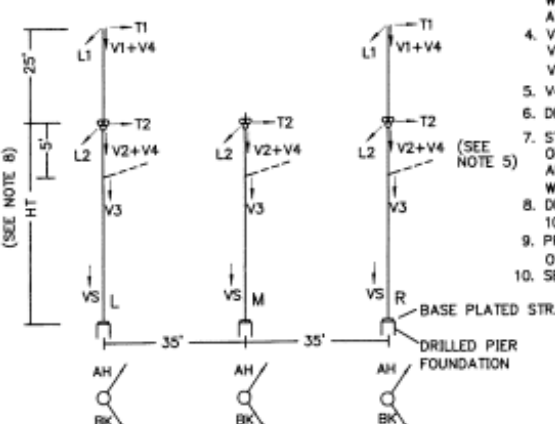
PHASE CONDUCTOR
(3) 954.0 KCMIL 45/7 STRAND ACSR "RAIL" (TRIPLE BUNDLED)
DIA=1.165", WT=1.0750 LBS/FT, RTS=25,900 LBS
1" ICE, 15' F MAX TENSION 13623 LBS INITIAL (SUB CONDUCT)
EVERYDAY CONDITION, 60' F TENSION 4903 LBS INITIAL (SUB CONDUCT)

SPAN DATA:

WIND SPAN = 750 FT (INTACT) 375 FT (DE)
WEIGHT SPAN = 2000 FT (INTACT) 1340 FT (DE)
RULING SPAN = 1000 FT

NOTES:

- ALL LOADS ARE ULTIMATE LOADS AND INCLUDE OVERLOAD FACTORS PER MECHANICAL LOADING CRITERIA.
- FOR STRUCTURAL DESIGN, THE LONGITUDINAL (L), TRANSVERSE (T) AND VERTICAL (V) LOADS SHALL BE CONSIDERED TO ACT SIMULTANEOUSLY WITH WIND AND THE DEAD WEIGHT OF THE STRUCTURE.
- THE TRANSVERSE LOADS (T) INCLUDE WIND ON THE WIRES AND TRANSVERSE (TENSION) LOADS FROM THE LINE ANGLE AT THE STRUCTURE.
- V1 INCLUDES 50 LBS FOR SHIELDWIRE ASSEMBLY(S).
V2 INCLUDES 500 LBS FOR INSULATOR ASSEMBLIES. (INTACT)
V2 INCLUDES 300 LBS FOR INSULATOR ASSEMBLY. (DE)
- V4 (LINEMAN+EQUIPMENT) = 500 LBS AT ANY ONE LOCATION.
- DESIGN STRUCTURE FOR BOTH INTACT & DE ONE SIDE CONDITION.
- STRUCTURES TO BE DESIGNED TO SUPPORT ANY COMBINATION OF TWO SHIELD WIRES (FIBER OR 7#7) - ONE PER OUTSIDE LEG. ABOVE TABLE REFLECTS THE LOADINGS DUE TO THE OPGW WHICH CONTROLS THE DESIGN.
- DESIGN FOR HEIGHTS TO CONDUCTOR FROM 55' TO 115' IN 10' INCREMENTS (OVERALL HT 80' TO 140').
- PROVIDE SOCKET PILE DESIGN (DIAMETER, THICKNESS, AND OVERLAP) FOR EACH STRUCTURE.
- SEE DRAWING STD-4 FOR STRUCTURE FRAMING.



LOAD TREE 500KV 3-POLE

SLE3-DEPY-S 500 SK4 (25)

ENTERGY SERVICES, INC.	
Transmission LineDesign Standard	
LOAD TREE, DEADEND, 25', SS, 55'-115'	
STRUCTURE DRAWING & DETAIL	
STD NO.	SCALE: NONE
No. TFS242A0	
PLOT 1=1	SH. 1 OF 1

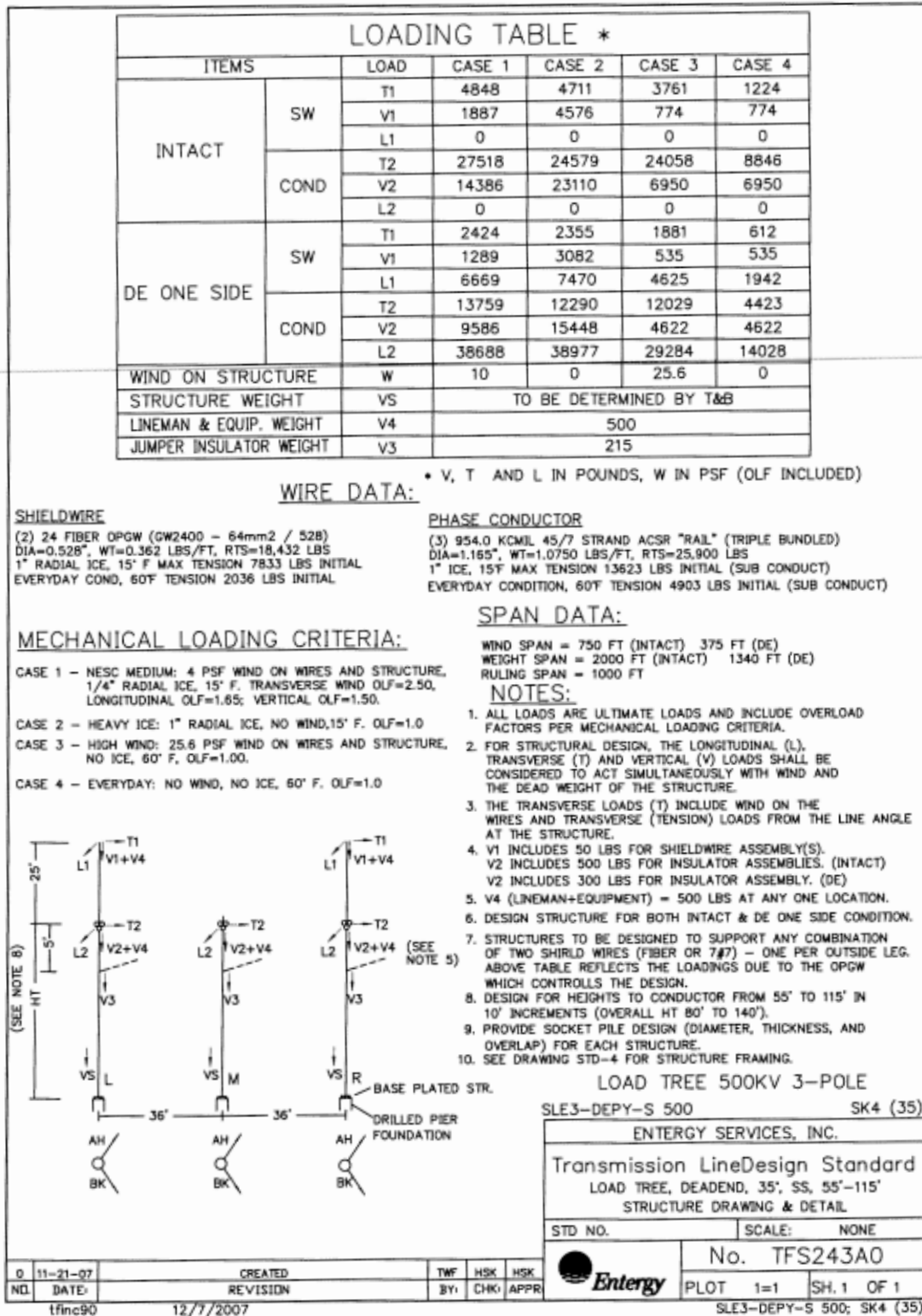
SLE3-DEPY-S 500; SK4 (25)

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1	12/7/2007	REVISION	BY:	CHK:	APPR:

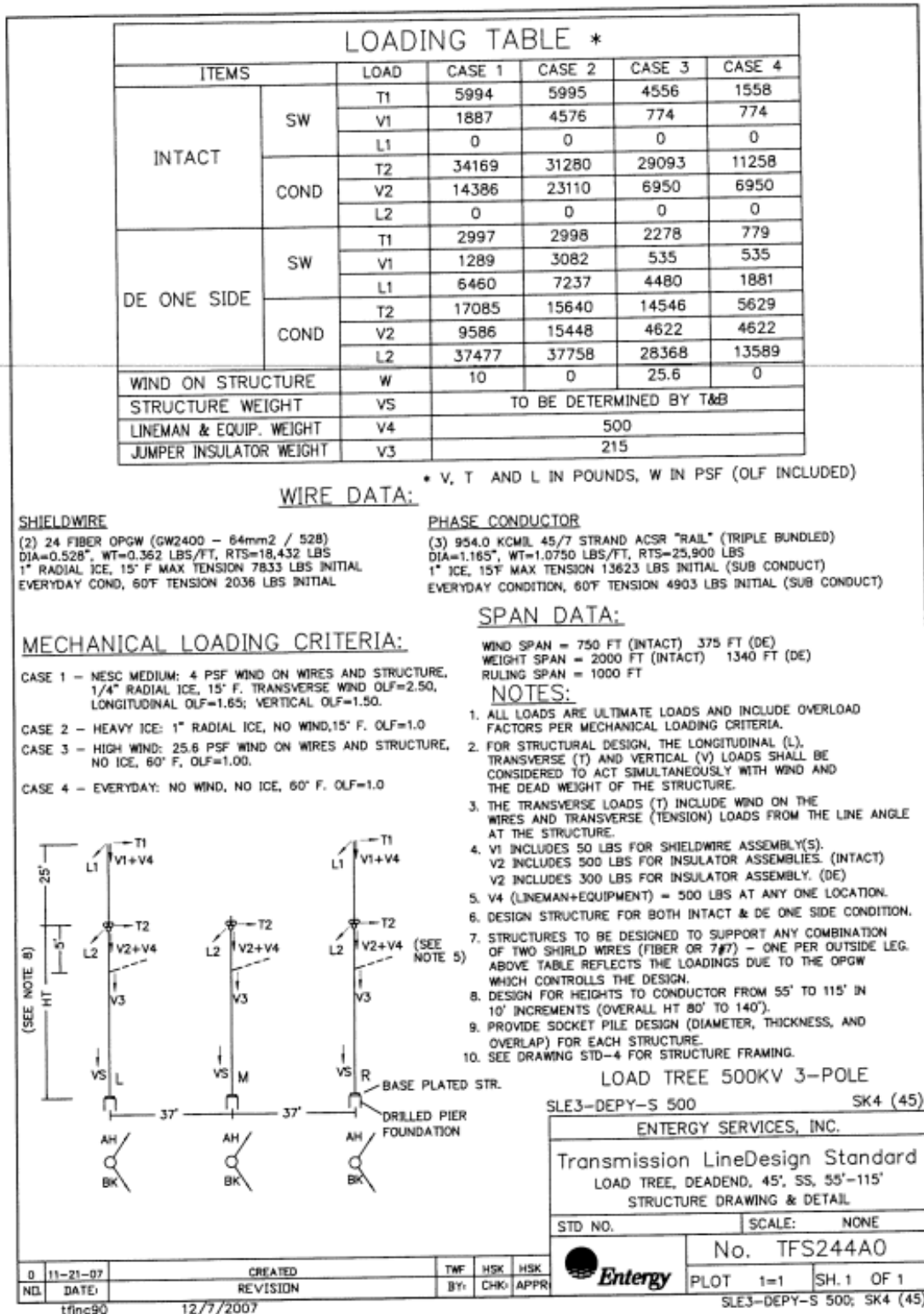
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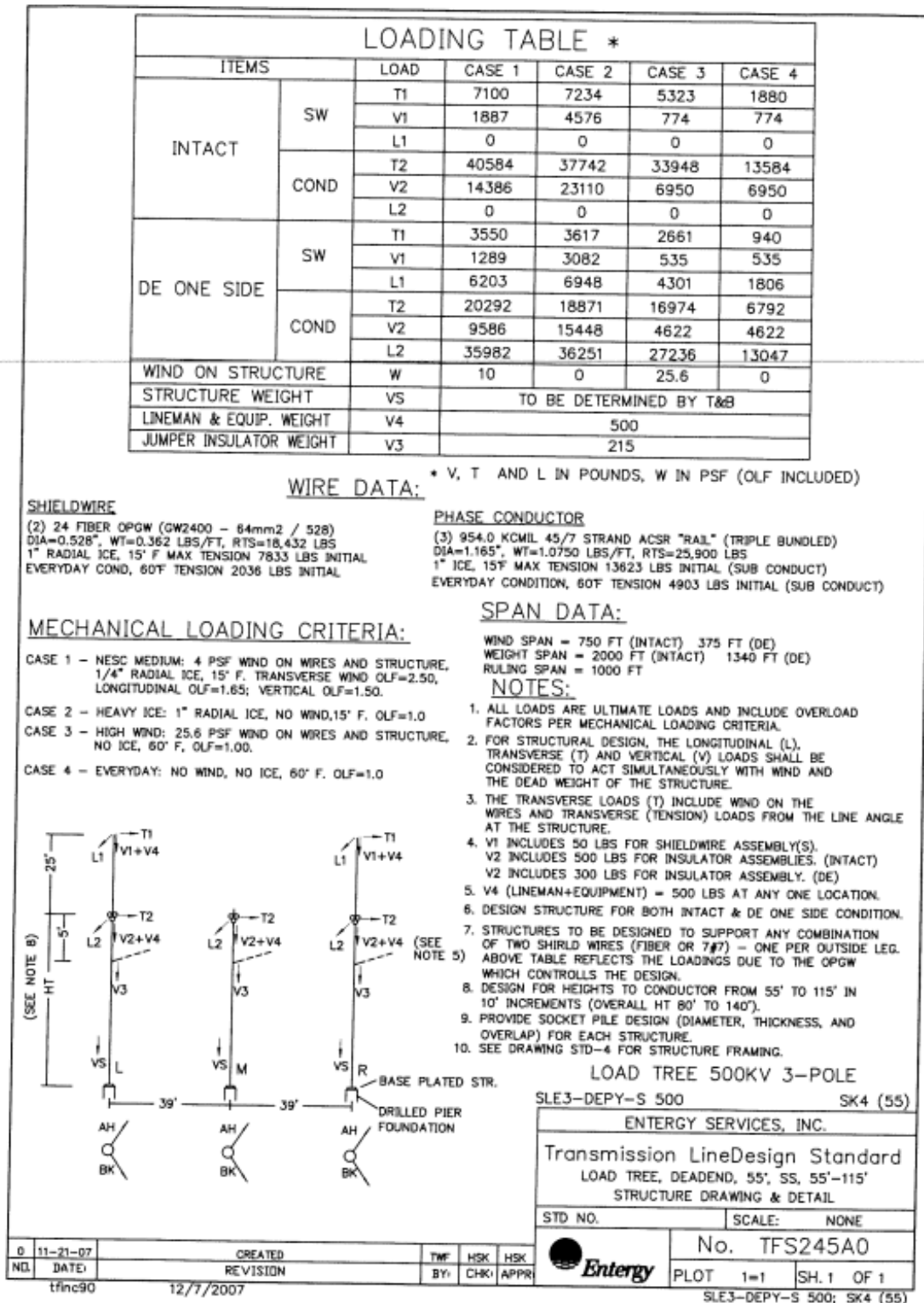
ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

LOADING TABLE *						
ITEMS		LOAD	CASE 1	CASE 2	CASE 3	CASE 4
INTACT	SW	T1	8157	8417	6056	2188
		V1	1887	4576	774	774
		L1	0	0	0	0
	COND	T2	46713	43918	38588	15806
		V2	14386	23110	6950	6950
		L2	0	0	0	0
DE ONE SIDE	SW	T1	4078	4209	3028	1094
		V1	1289	3082	535	535
		L1	5898	6606	4090	1717
	COND	T2	23357	21959	19294	7903
		V2	9586	15448	4622	4622
		L2	34212	34469	25896	12405
WIND ON STRUCTURE		W	10	0	25.6	0
STRUCTURE WEIGHT		VS	TO BE DETERMINED BY T&B			
LINEMAN & EQUIP. WEIGHT		V4	500			
JUMPER INSULATOR WEIGHT		V3	215			

* V, T AND L IN POUNDS, W IN PSF (OLF INCLUDED)

WIRE DATA:

SHIELDWIRE
(2) 24 FIBER OPGW (GW2400 - 64mm² / 528)
DIA=0.528", WT=0.362 LBS/FT, RTS=18,432 LBS
1" RADIAL ICE, 15' F MAX TENSION 7833 LBS INITIAL
EVERYDAY COND, 60' F TENSION 2036 LBS INITIAL

PHASE CONDUCTOR
(3) 954.0 KCMIL 45/7 STRAND ACSR "RAIL" (TRIPLE BUNDLED)
DIA=1.165", WT=1.0750 LBS/FT, RTS=25,900 LBS
1" ICE, 15' F MAX TENSION 13623 LBS INITIAL (SUB CONDUCT)
EVERYDAY CONDITION, 60' F TENSION 4903 LBS INITIAL (SUB CONDUCT)

SPAN DATA:

WIND SPAN = 750 FT (INTACT) 375 FT (DE)
WEIGHT SPAN = 2000 FT (INTACT) 1340 FT (DE)
RULING SPAN = 1000 FT

NOTES:

- ALL LOADS ARE ULTIMATE LOADS AND INCLUDE OVERLOAD FACTORS PER MECHANICAL LOADING CRITERIA.
- FOR STRUCTURAL DESIGN, THE LONGITUDINAL (L), TRANSVERSE (T) AND VERTICAL (V) LOADS SHALL BE CONSIDERED TO ACT SIMULTANEOUSLY WITH WIND AND THE DEAD WEIGHT OF THE STRUCTURE.
- THE TRANSVERSE LOADS (T) INCLUDE WIND ON THE WIRES AND TRANSVERSE (TENSION) LOADS FROM THE LINE ANGLE AT THE STRUCTURE.
- V1 INCLUDES 50 LBS FOR SHIELDWIRE ASSEMBLY(S).
V2 INCLUDES 500 LBS FOR INSULATOR ASSEMBLIES. (INTACT)
V2 INCLUDES 300 LBS FOR INSULATOR ASSEMBLY. (DE)
- V4 (LINEMAN+EQUIPMENT) = 500 LBS AT ANY ONE LOCATION.
- DESIGN STRUCTURE FOR BOTH INTACT & DE ONE SIDE CONDITION.
- STRUCTURES TO BE DESIGNED TO SUPPORT ANY COMBINATION OF TWO SHIELD WIRES (FIBER OR 7#7) - ONE PER OUTSIDE LEG. ABOVE TABLE REFLECTS THE LOADINGS DUE TO THE OPGW WHICH CONTROLS THE DESIGN.
- DESIGN FOR HEIGHTS TO CONDUCTOR FROM 55' TO 115' IN 10' INCREMENTS (OVERALL HT 80' TO 140').
- PROVIDE SOCKET PILE DESIGN (DIAMETER, THICKNESS, AND OVERLAP) FOR EACH STRUCTURE.
- SEE DRAWING STD-4 FOR STRUCTURE FRAMING.

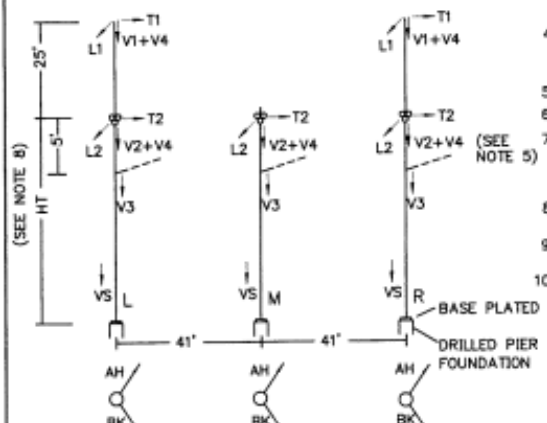
MECHANICAL LOADING CRITERIA:

CASE 1 - NESC MEDIUM: 4 PSF WIND ON WIRES AND STRUCTURE, 1/4" RADIAL ICE, 15' F. TRANSVERSE WIND OLF=2.50, LONGITUDINAL OLF=1.65; VERTICAL OLF=1.50.

CASE 2 - HEAVY ICE: 1" RADIAL ICE, NO WIND, 15' F. OLF=1.0

CASE 3 - HIGH WIND: 25.6 PSF WIND ON WIRES AND STRUCTURE, NO ICE, 60' F. OLF=1.00.

CASE 4 - EVERYDAY: NO WIND, NO ICE, 60' F. OLF=1.0



(SEE NOTE 8)

(SEE NOTE 5)

BASE PLATED STR.

DRILLED PIER FOUNDATION

LOAD TREE 500KV 3-POLE

SLE3-DEPY-S 500 SK4 (65)

ENTERGY SERVICES, INC.	
Transmission Line Design Standard	
LOAD TREE, DEADEND, 65', SS. 55'-115'	
STRUCTURE DRAWING & DETAIL	
STD NO.	SCALE: NONE
No. TFS246A0	
PLOT 1=1	SH.1 OF 1

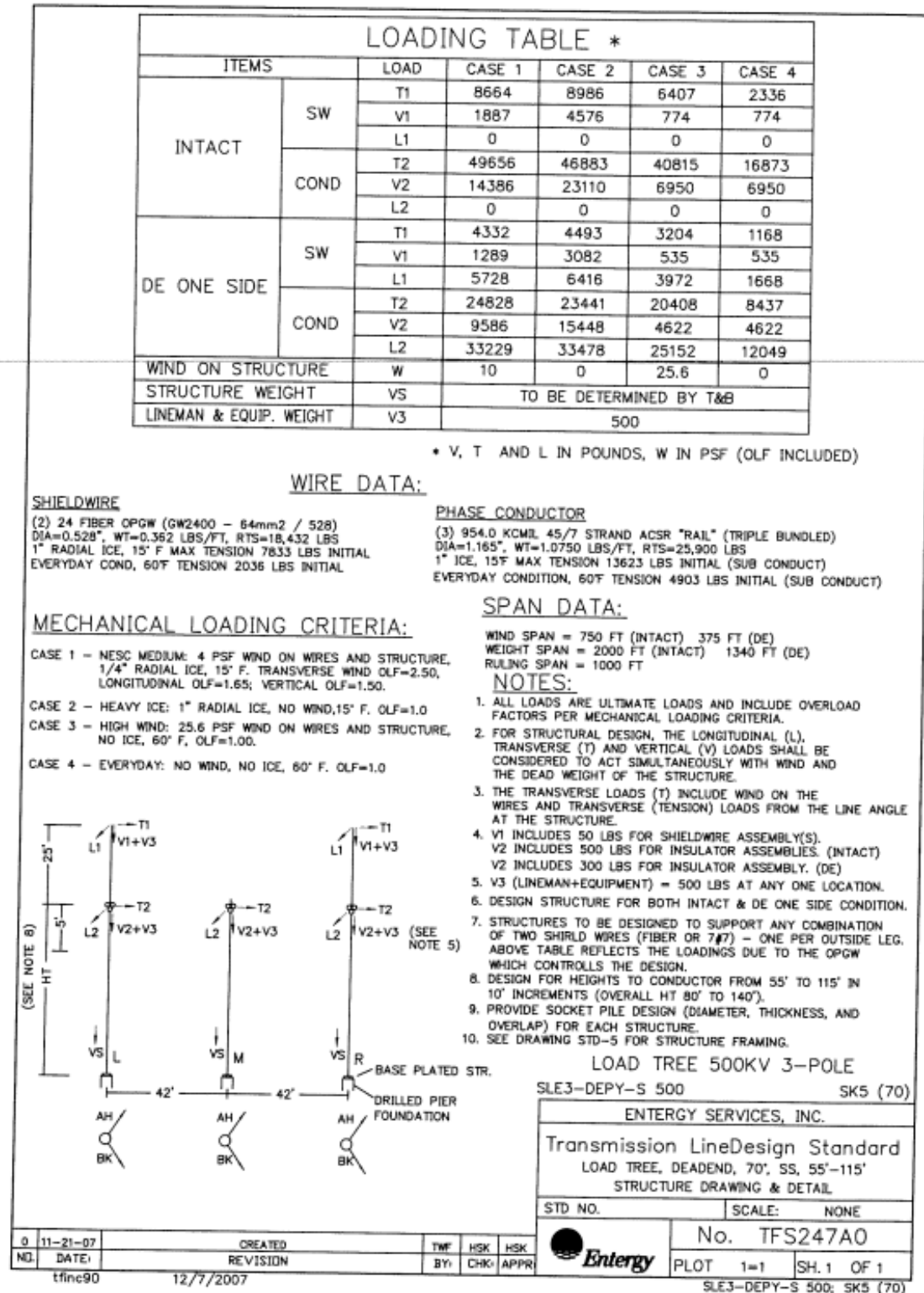
SLE3-DEPY-S 500; SK4 (65)

0	11-21-07	CREATED	TWF	HSK	HSK
NO.	DATE:	REVISION	BY:	CHK:	APPR:

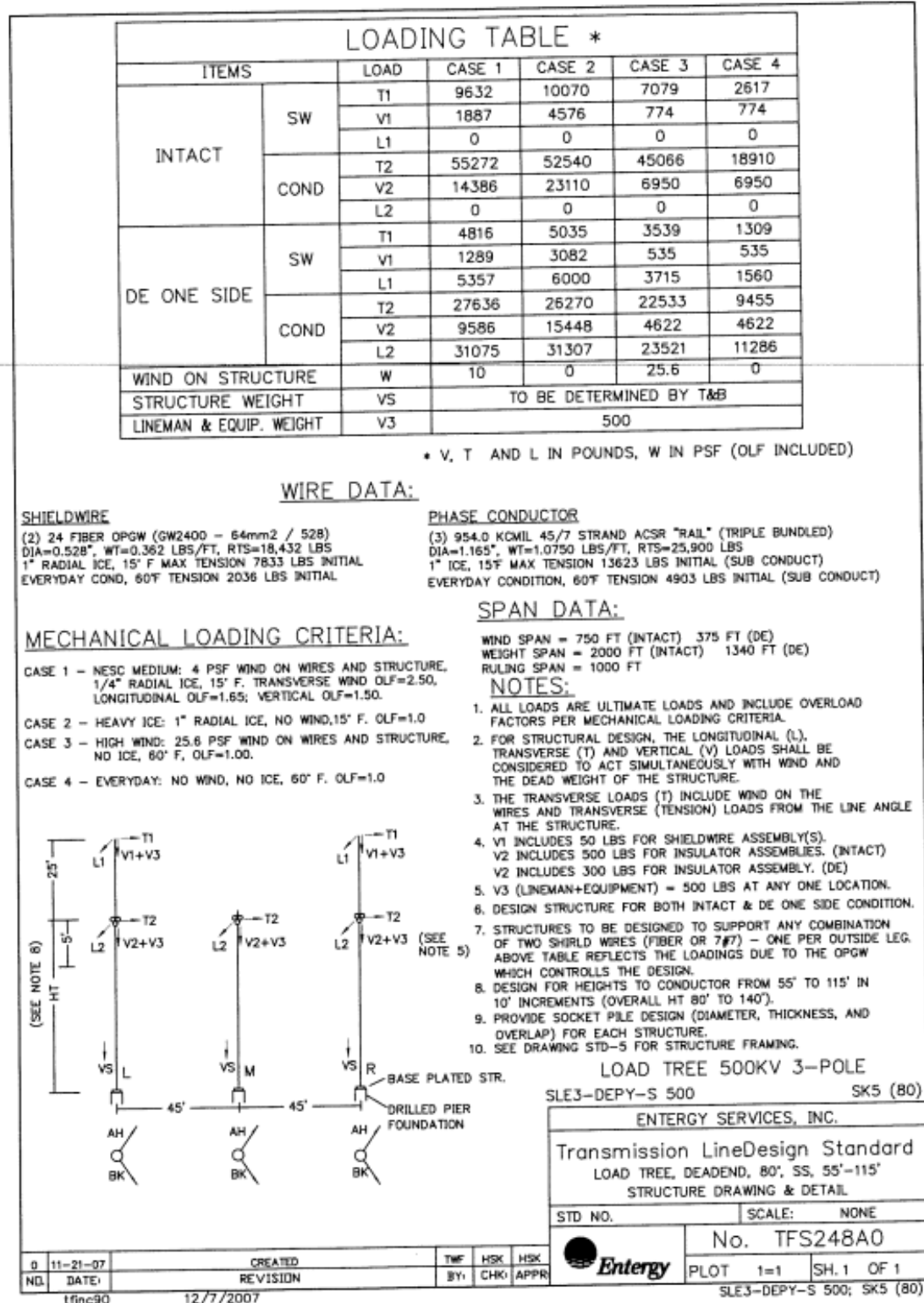
12/7/2007



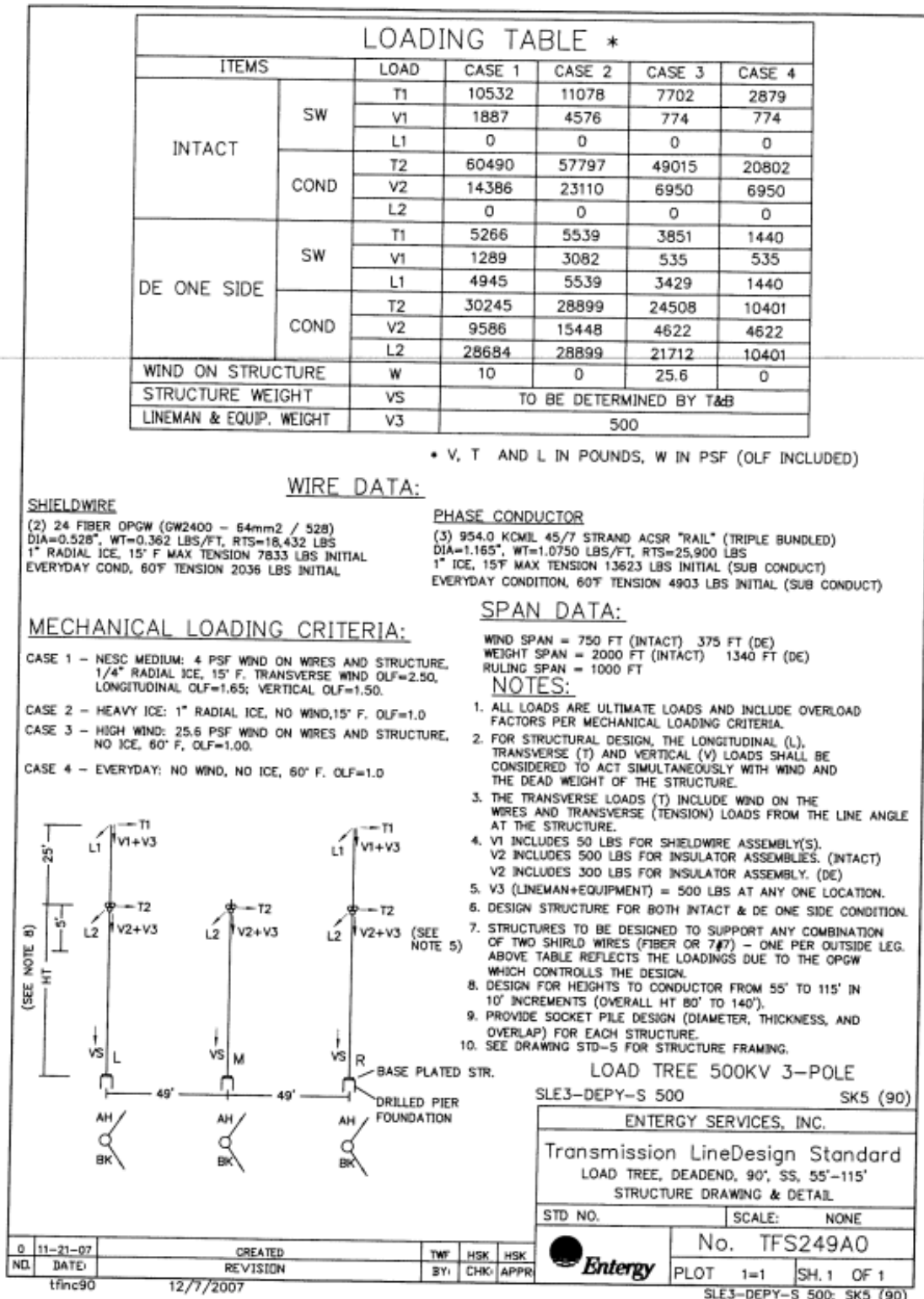
ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



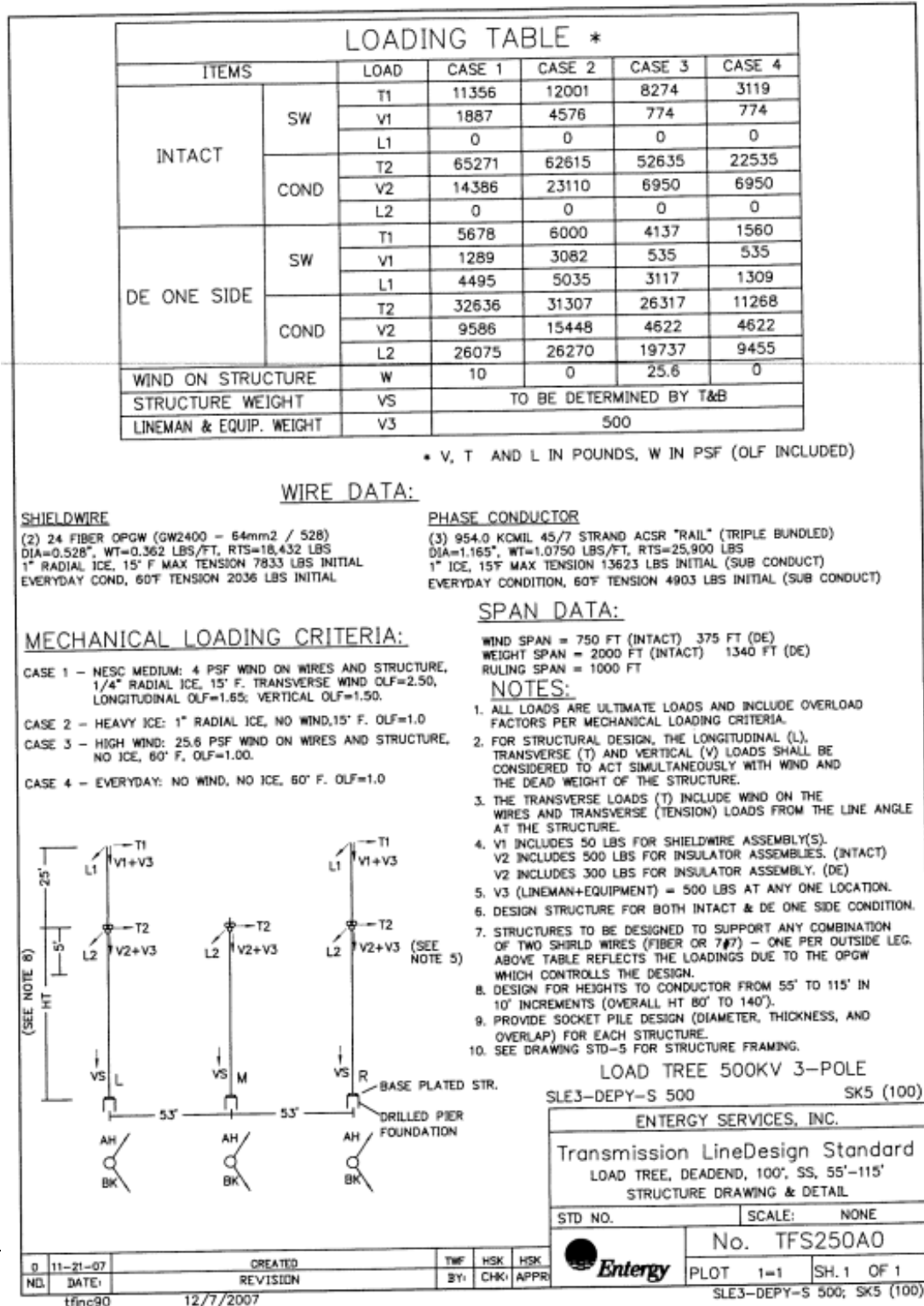
ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

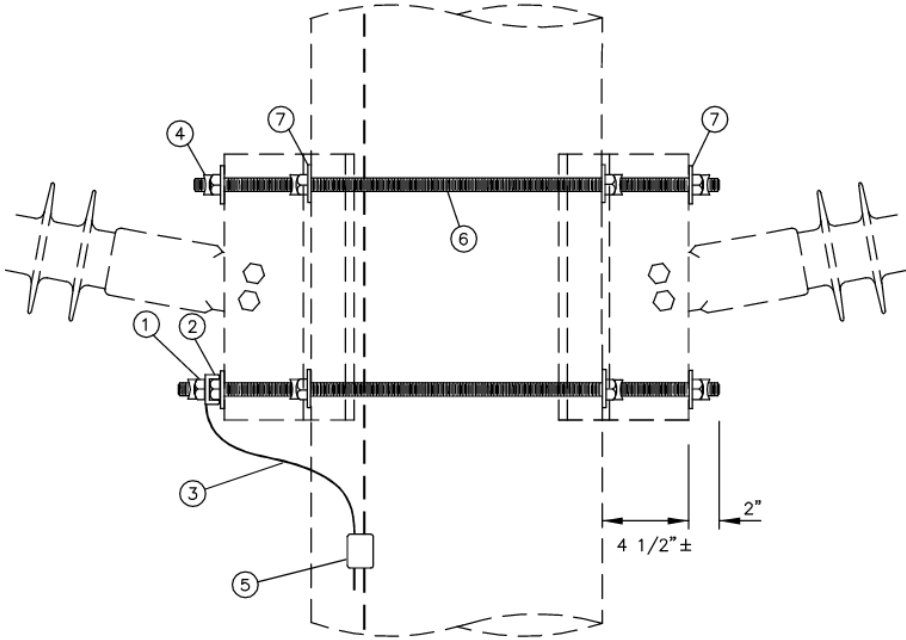


ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS			
VARIABLE BOLT ASSY, DOUBLE POLY POST FOR CONCRETE WITH GROUNDING			
ITEM	QTY.	STOCK NO.	DESCRIPTION
1	1	EN000171	NUT, SQUARE, STL, GALV, ANSI-C135.1, 7/8" DIA, 9 THD
2	1	EN000358	CLIP, BONDING, 7/8", STL, GALV, FOR GROUNDING TO 7/8" BOLT
3	1	EN000362	WIRE, COPPERWELD, #4 (.1158 lbs/ft)
4	8	EN000426	NUT, LOCK, SQUARE, STL, GALV. ANSI-C135.1, 7/8" DIA. 9 THD
5	1	EN000360	CONNECTOR, #4 COPPER CRIMPIT
6	2	LS909XX	BOLT, DOUBLE ARMING, 7/8"xVARIABLE LENGTH, GALV, w/4 SQ NUTS
7	8	EN005685	WASHER, FLAT ROUND, 2" STEEL, GALV, FOR 7/8" BOLT



1) All Double Arming Bolts shall be trimmed to avoid conflict with guys, grounding, conductors, etc. and painted with galvanized paint.

2) Grounding Lug location may be above or below assembly depending on pole tank ground location.

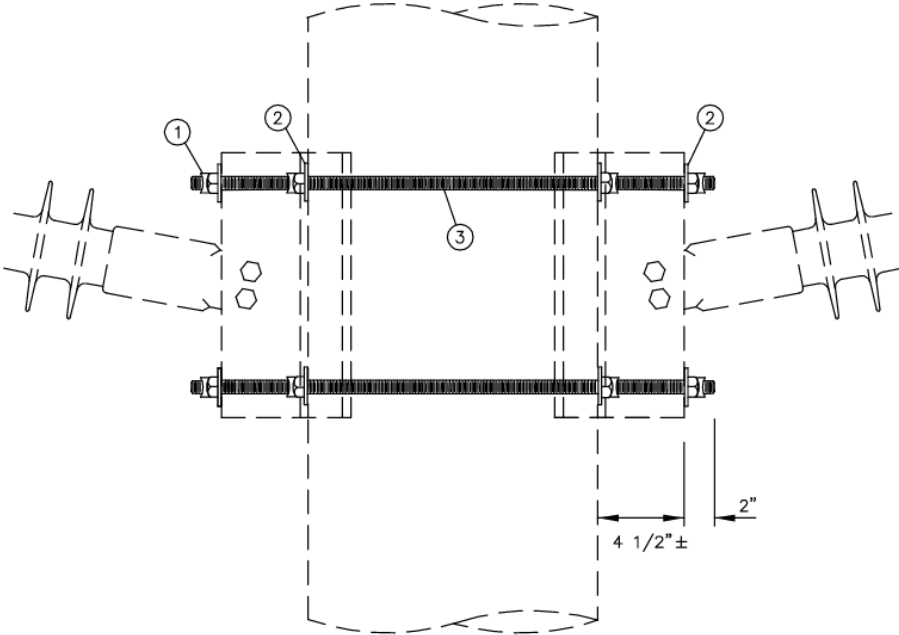
BLT-2P-C	
ENTERGY STANDARD DWG.	
DESIGN APPROVAL	STANDARDS APPROVAL
SIGNED / DATE	SIGNED / DATE
BOLT ASSY (CONCRETE) DOUBLE POLYMER POST INS.	
APPROVED BY: EJG	DATE: 01-27-97
CHECKED BY: JWS	SCALE: NONE
DRAWN BY: ECSI	ESI NO. TMD207A1
No. BLT2PC	
PLOT 1=8 SH. 1 OF 1	

1	5-28-03	REV. DIM., CHANGE WASHER FROM SQ. TO FLAT ROUND	ITRON	
NO.	DATE:	REVISION	BY:	APPR:

TEMP\AM-Work\willi2M-LITAPETSP047 D-TDocs S-Template\ESI\STANDARD\STransmission\AMISC\TMD207A1.DWG, 5/20/2010 5:26:50 PM, ewill2

ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS			
VARIABLE BOLT ASSY, DOUBLE POLY POST FOR STEEL			
ITEM	QTY.	STOCK NO.	DESCRIPTION
1	8	EN000426	NUT, LOCK, SQUARE, STL, GALV, ANSI-C135.1, 7/8" DIA, 9 THD
2	8	EN005685	WASHER, FLAT ROUND, 2" STEEL, GALV, FOR 7/8" BOLT
3	2	LS909XX	BOLT, DOUBLE ARMING, 7/8"xVARIABLE LENGTH, GALV, w/4 SQ NUTS



1) All Double Arming Bolts shall be trimmed to avoid conflict with guys, grounding, conductors, etc. and painted with galvanized paint.

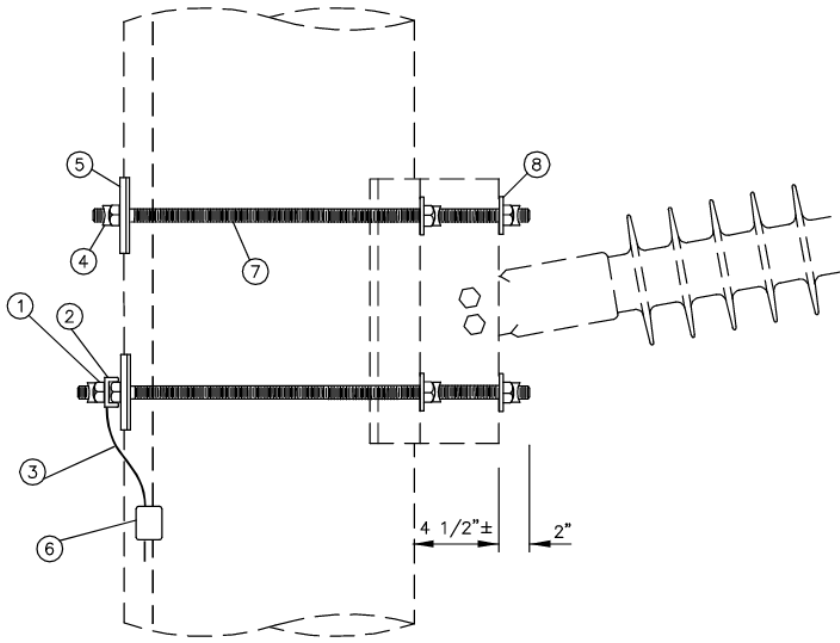
BLT-2P-S			
ENTERGY STANDARD DWG.			
DESIGN APPROVAL		STANDARDS APPROVAL	
SIGNED / DATE		SIGNED / DATE	
BOLT ASSY (STEEL) DOUBLE POLYMER POST INS.			
APPROVED BY:		DATE: 2-12-96	
CHECKED BY:		SCALE: NONE	
DRAWN BY: ECSI		ESI NO. TMD208A1	
No. BLT2PS		PLOT 1=8 SH. 1 OF 1	

1	5-28-03	CHANGE WASHER, DIM.	ITRON	
NO.	DATE:	REVISION	BY:	APPR:

TEMP\AM-Work\will2\AM-LITAP\ETSP047 D-TDocs S-Template\ESI\STANDARD\STransmission\AMISC\TMD208A1.DWG, 5/20/2010 5:31:01 PM, ewill2

ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS			
VARIABLE BOLT ASSY, SINGLE POLY POST FOR CONCRETE WITH GROUNDING			
ITEM	QTY.	STOCK NO.	DESCRIPTION
1	1	EN000171	NUT, SQUARE, STL, GALV, ANSI-C135.1, 7/8" DIA, 9 THD
2	1	EN000358	CLIP, BONDING, 7/8", STL, GALV, FOR GROUNDING TO 7/8" BOLT
3	1	EN000362	WIRE, COPPERWELD, #4 (.1158 lbs/ft)
4	6	EN000426	NUT, LOCK, SQUARE, STL, GALV, ANSI-C135.1, 7/8" DIA, 9 THD
5	2	EN012280	WASHER, SQUARE CURVED, STL, GALV, 7/8" BOLT, 3"x3"x1/4"
6	1	EN000360	CONNECTOR, #4 COPPER CRIMPIT
7	2	LS909XX	BOLT, DOUBLE ARMING, 7/8"xVARIABLE LENGTH, GALV, w/4 SQ NUTS
8	4	EN005685	WASHER, FLAT ROUND, 2" STEEL, GALV, FOR 7/8" BOLT



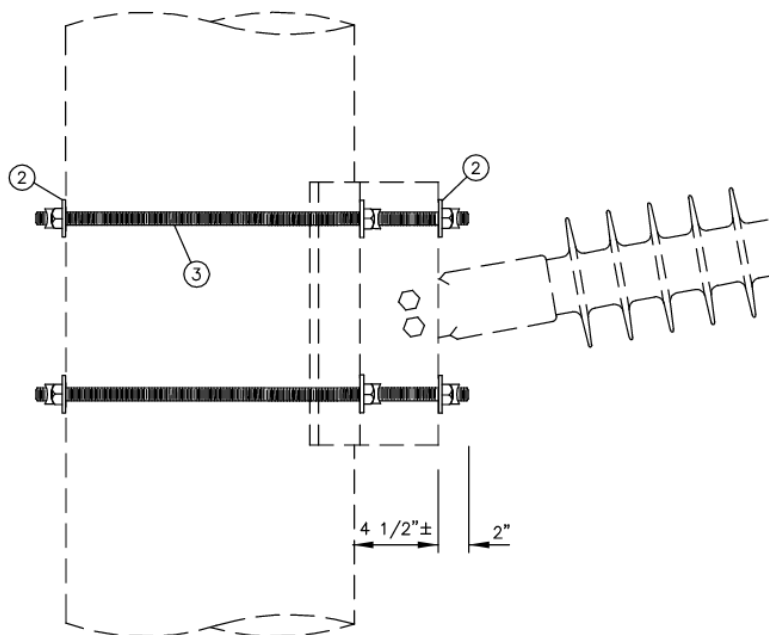
- 1) All Double Arming Bolts shall be trimmed to avoid conflict with guys, grounding, conductors, etc. and painted with galvanized paint.
- 2) Grounding Lug location may be above or below assembly depending on pole tank ground location.

BLT-P-C	
ENTERGY STANDARD DWG.	
DESIGN APPROVAL	STANDARDS APPROVAL
SIGNED _____ / DATE _____	SIGNED _____ / DATE _____
BOLT ASSY (CONCRETE) SINGLE POLYMER POST INS.	
APPROVED BY: EJG	DATE: 01-27-97
CHECKED BY: JWS	SCALE: NONE
DRAWN BY: ECSI	ESI NO. TMD211A1
 No. BLTPC PLOT 1=8 SH. 1 OF 1	

1	5-30-03	CHANGE WASHER, DIM.	ITRON	
NO.	DATE:	REVISION	BY:	APPR:

ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS			
VARIABLE BOLT ASSY, SINGLE POLY POST FOR STEEL			
ITEM	QTY.	STOCK NO.	DESCRIPTION
1	6	EN000426	NUT, LOCK, SQUARE, STL, GALV, ANSI-C135.1, 7/8" DIA, 9 THD
2	6	EN005685	WASHER, FLAT ROUND, 2" STEEL, GALV, FOR 7/8" BOLT
3	2	LS909XX	BOLT, DOUBLE ARMING, 7/8"xVARIABLE LENGTH, GALV, w/4 SQ. NUTS



1) All Double Arming Bolts shall be trimmed to avoid conflict with guys, grounding, conductors, etc. and painted with galvanized paint.

BLT-P-S

ENTERGY SERVICES, INC.

Transmission LineDesign Standard

BOLT ASSEMBLY (STEEL) SINGLE POLYMER POST INS.

STRUCTURAL ASSEMBLY DETAIL

STD NO.	SCALE:
No. TMD212A3	
PLOT	SH. OF

3	07-21-10	ADDED ASSEMBLY NAME	CBM	ECW	ECW
2	01-13-10	INCREASED STOCK NO. ITEM EN005685 FROM 4 TO 6	BAB		
1	05-30-03	CHANGE WASHER, DIM.	ITRON		
0	02-12-06	ISSUED	ECSI		
NO.	DATE:	REVISION	BY:	CHK:	APPR:

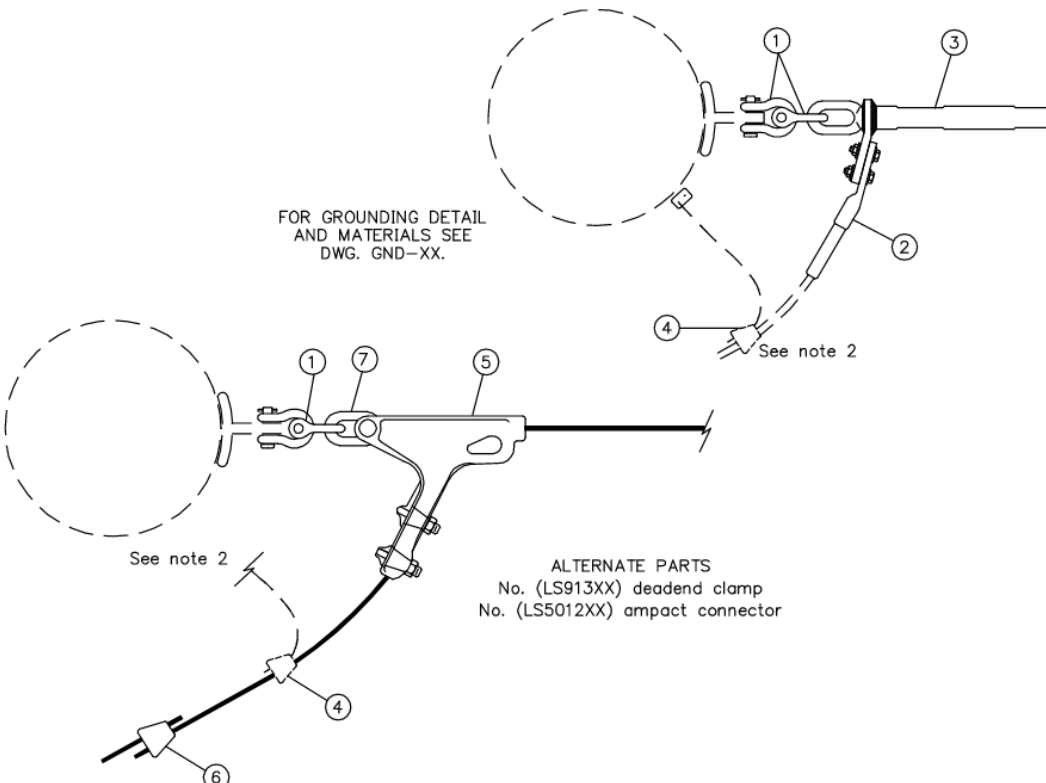
cmcgr91 8/11/2010

BLT-P-S

\\TEMP\AM-Work\will2\W-LITAP\ETSP047.D-TDocs\S-Template\ESI\STANDARDS\Transmission\AMISC\TMD212A3.DWG, 12/3/2010 4:15:45 PM, ewill2

ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS			
OHGW DEADEND			
ITEM	QTY.	STOCK NO.	DESCRIPTION
1	2	EN000492	SHACKLE, ANCHOR, 40K ULT, 3/4" PIN DIA, 2-3/4" LONG
2	1	LS9004XX	TERMINAL CONNECTOR, 15 DEG, FOR VARIABLE SIZE WIRE
3	1	LS9005XX	DEADEND, ALUMINUM COMPRESSION BODY, SINGLE TONGUE, VARIABLE WIRE SIZE
4	-	LS5012XX	CONNECTOR, AMPACT, SEE GND ASSEMBLY DRAWING FOR MATERIAL
ALTERNATE FOR BOLTED ASSEMBLY			
ITEM	QTY.	STOCK NO.	DESCRIPTION
1	2	EN000492	SHACKLE, ANCHOR, 40K ULT, 3/4" PIN DIA, 2-3/4" LONG
4	-	LS5012XX	CONNECTOR, AMPACT, SEE GND ASSEMBLY DRAWING FOR MATERIAL
5	1	LS913XX	DEADEND BOLTED STRAIN ALUMWELD
6	1	LS5012XX	CONNECTOR, AMPACT, VARIABLE CONDUCTOR SIZE TO VARIABLE CONDUCTOR SIZE
7	1	EN000390	LINK, CHAIN, XMSN: CONNECTING, CS, 1/2" PITCH; 2 1/4" LONG



FOR GROUNDING DETAIL AND MATERIALS SEE DWG. GND-XX.

See note 2

See note 2

ALTERNATE PARTS
No. (LS913XX) deadend clamp
No. (LS5012XX) ampack connector

1) Item #2, #3 and #6 are conductor dependent.

2) For grounding detail and materials, see applicable Gnd-xx drawing.

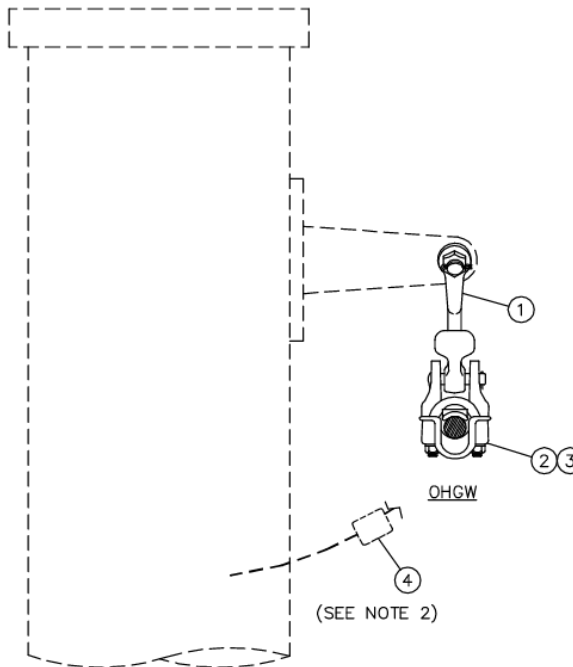
3) For horizontal vang orientation, omit one of item 1.

OHG-DE-XX			
ENTERGY SERVICES, INC.			
Transmission LineDesign Standard OVERHEAD GROUNDWIRE DEADEND ASSY STRUCTURAL ASSEMBLY DETAIL			
STD NO.		SCALE: NONE	
		No. TMD222A6	
PLOT 1=8		SH.1 OF 1	

NO.	DATE:	REVISION	BY:	CHK:	APPR:
		8/15/2006			

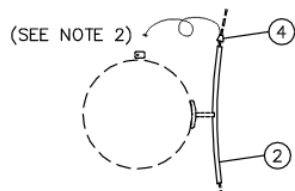
ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS			
OHGW SUSPENSION, 0-30°			
ITEM	QTY.	STOCK NO.	DESCRIPTION
1	1	EN004375	BALL CLEVIS, 45 DEG Y, 30K ULT, 3/4" PIN DIA
2	1	LS9003XX	ROD, ARMOR, PREFORMED, ALUMINUM, VARIABLE CONDUCTOR SIZE
3	1	LS9008XX	CLAMP, SUSPENSION, ALUMINUM, VARIABLE WIRE SIZE, w/SOCKET EYE
4	—	LS5012XX	CONNECTOR, AMPACT



OHGW

(SEE NOTE 2)



PLAN

1) Item #2 and #3 are conductor dependent. These items are selected for each project and may be with or without Armor Rod.

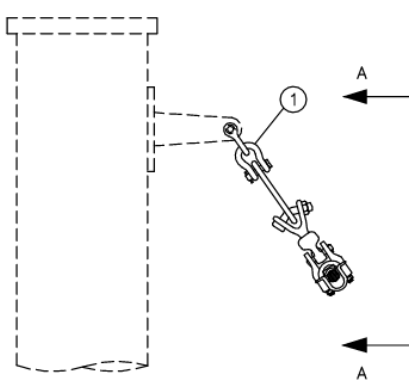
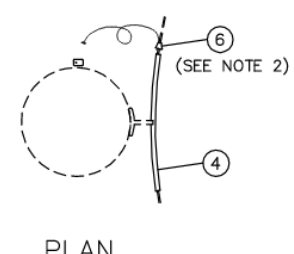
2) For grounding detail and materials see applicable GND-XX drawing.

OHG-SUS-XX	
ENTERGY STANDARD DWG.	
DESIGN APPROVAL	STANDARDS APPROVAL
SIGNED _____ / DATE _____	SIGNED _____ / DATE _____
OVERHEAD GROUNDWIRE SUSPENSION ASSY	
APPROVED BY: _____	DATE: 2-15-03
CHECKED BY: _____	SCALE: NONE
DRAWN BY: ITRON	ESI NO. TMD223A9
No. OHGSUS	
PLOT 1=8 SH. 1 OF 1	

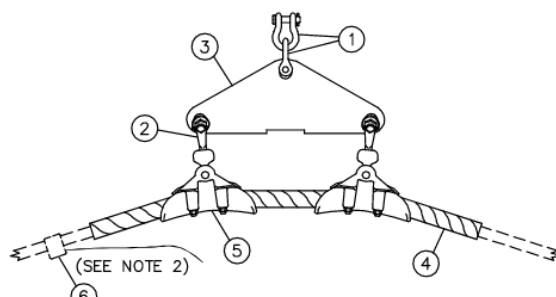
NO.	DATE:	REVISION	BY:	APPR:
9	8-15-06	REMOVED OPTGW OPTION, DELETED ITEM #4	RJL	
8	12-9-03	ADDED BACK GROUNDING DETAILS	ITRON	
7	5-30-03	ADDED OPTGW OPTION	ITRON	
6	2-17-03	ADDED POLE CAP AND GROUNDING NOTE 2	ITRON	
5	10-15-02	REMOVE GROUNDING DETAIL	ITRON	
4	1-18-02	MODIFIED ITEMS 1, 2 AND 3.	LSFT	
3	1-29-01	MODIFIED STOCK NUMBER LS9007XX	LSFT	
2	1-29-01	MODIFIED STOCK NUMBER LS5012XX	RMB	

ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS			
OHGW SUSPENSION, 30-50' WITH YOKE PLATE			
ITEM	QTY.	STOCK NO.	DESCRIPTION
1	2	EN000492	SHACKLE, ANCHOR, 40K ULT, 3/4" PIN DIA, 2-3/4" LONG
2	2	EN004375	BALL CLEVIS, 45 DEG Y, 30K ULT, 3/4 PIN DIA
3	1	EN015676	PLATE, YOKE, DUCTILE IRON, 18" WIDTH, 30K ULT, 3/4" GALV
4	1	LS9003XX	ROD, ARMOR, PREFORMED, ALUMINUM, VARIABLE CONDUCTOR SIZE
5	2	LS9007XX	CLAMP, SUSPENSION, ALUMINUM, VARIABLE SIZE WIRE, W/SOCKET EYE
6	-	LS5012XX	CONNECTOR, AMPACT, SEE GROUND ASSEMBLY DRAWING FOR MATERIAL

PLAN



DETAIL A
YOKE ASSEMBLY

1) ITEM #4 AND #5 ARE CONDUCTOR DEPENDENT. THESE ITEMS ARE SELECTED FOR EACH PROJECT AND MAY BE WITH OR WITHOUT ARMOR ROD.

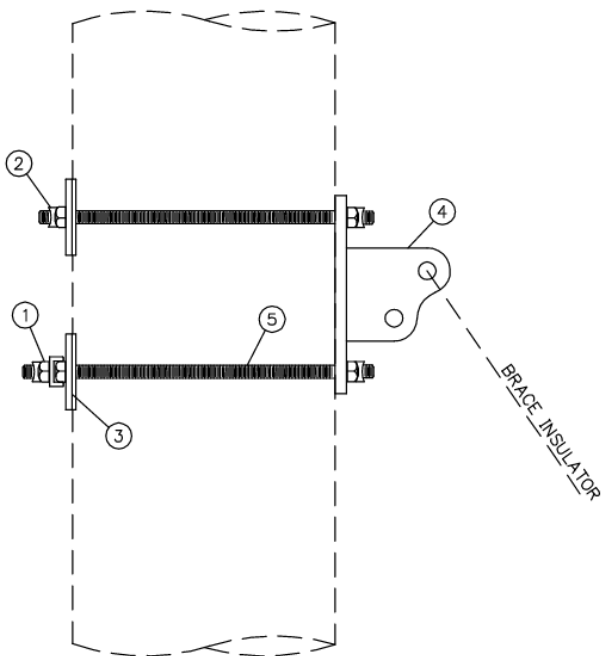
2) FOR GROUNDING DETAIL AND MATERIALS SEE APPLICABLE GND-XX DRAWING.

OHG-SUY-XX			
ENTERGY STANDARD DWG.			
DESIGN APPROVAL		STANDARDS APPROVAL	
SIGNED _____	/ DATE _____	SIGNED _____	/ DATE _____
OVERHEAD GROUNDWIRE HEAVY ANGLE ASSY			
APPROVED BY: _____		DATE: 1-29-01	
CHECKED BY: _____		SCALE: NONE	
DRAWN BY: ECSI		ESI NO. TMD224A6	
		No. OHGSUY	
		PLOT 1=16 SH. 1 OF 1	

NO.	DATE:	REVISION	BY:	APPR:
6	8-15-06	REVISED ITEM #6	RJL	
5	12-8-03	ADDED BACK GROUNDING DETAILS	ITRON	
4	2-18-03	ADDED POLE CAP AND GROUNDING NOTE	ITRON	
3	1-29-01	MODIFIED STOCK NUMBER LS9007XX	LS	
2	6-7-00	MODIFIED STOCK NUMBER LS5012XX	RMB	
1	11-16-99	ADDED AMPACT & CARTRIDGE DESCRIPTION	RMB	

ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS			
TEE ASSY, BRACE POST FOR STEEL WITH BOLTS			
ITEM	QTY.	STOCK NO.	DESCRIPTION
1	1	EN000171	NUT, SQUARE, STL, GALV, ANSI-C135.1, 7/8" DIA, 9 THD
2	4	EN000426	NUT, LOCK, SQUARE, STL, GALV, ANSI-C135.1, 7/8" DIA, 9 THD
3	2	EN003796	WASHER, SQUARE CURVED, STL, GALV, ANSI-C135.1, 7/8" BOLT, 1/4" THK, 4"x4"
4	1	EN011909	PLATE, POLE EYE, GALV STL, DBL EYE, 70K ULT, 8" BOLT SPACING
5	2	LS909XX	BOLT, DOUBLE ARMING, 7/8"xVARIABLE LENGTH, GALV, w/4 SQ NUTS



1) All Double Arming Bolts shall be trimmed to avoid conflict with guys, grounding, conductors, etc. and painted with galvanized paint.

2) Grounding Lug location may be above or below assembly depending on pole tank ground location.

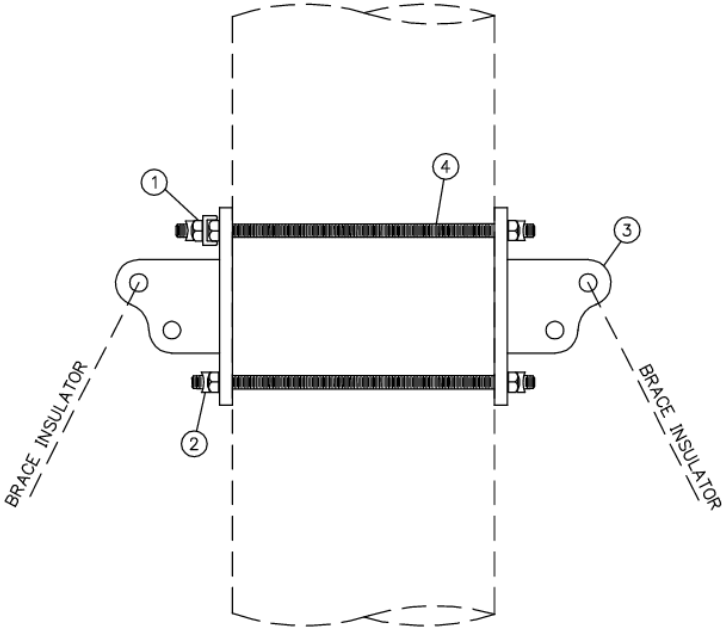
TEE-B-S	
ENTERGY STANDARD DWG.	
DESIGN APPROVAL	STANDARDS APPROVAL
SIGNED _____ / DATE _____	SIGNED _____ / DATE _____
TEE ASSY (STEEL) BRACE	
APPROVED BY: EJG	DATE: 12-19-00
CHECKED BY: JWS	SCALE: NONE
DRAWN BY: ECSI	ESI NO. TMD279A0
 No. TBS PLOT 1=8 SH. 1 OF 1	

TEMP\AM-Work\willi2\1M-LITAP\ETSP047.D-TDocs,S-Template\ESI\STANDARD\STransmission\AMISC\TMD279A0.DWG, 6/10/2010 5:04:20 PM, ewill2

NO.	DATE:	REVISION	BY:	APPR:

ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS			
TEE ASSY, BRACE TO BRACE FOR STEEL WITH BOLTS			
ITEM	QTY.	STOCK NO.	DESCRIPTION
1	1	EN000171	NUT, SQUARE, STL, GALV, ANSI-C135.1, 7/8" DIA, 9 THD
2	4	EN000426	NUT, LOCK, SQUARE, STL, GALV, ANSI-C135.1, 7/8" DIA, 9 THD
3	2	EN011909	PLATE, POLE EYE, GALV STL, DBL EYE, 70K ULT, 8" BOLT SPACING
4	2	LS909XX	BOLT, DBL ARMING, 7/8"xVARIABLE LENGTH, GALV, w/4 SQ NUTS



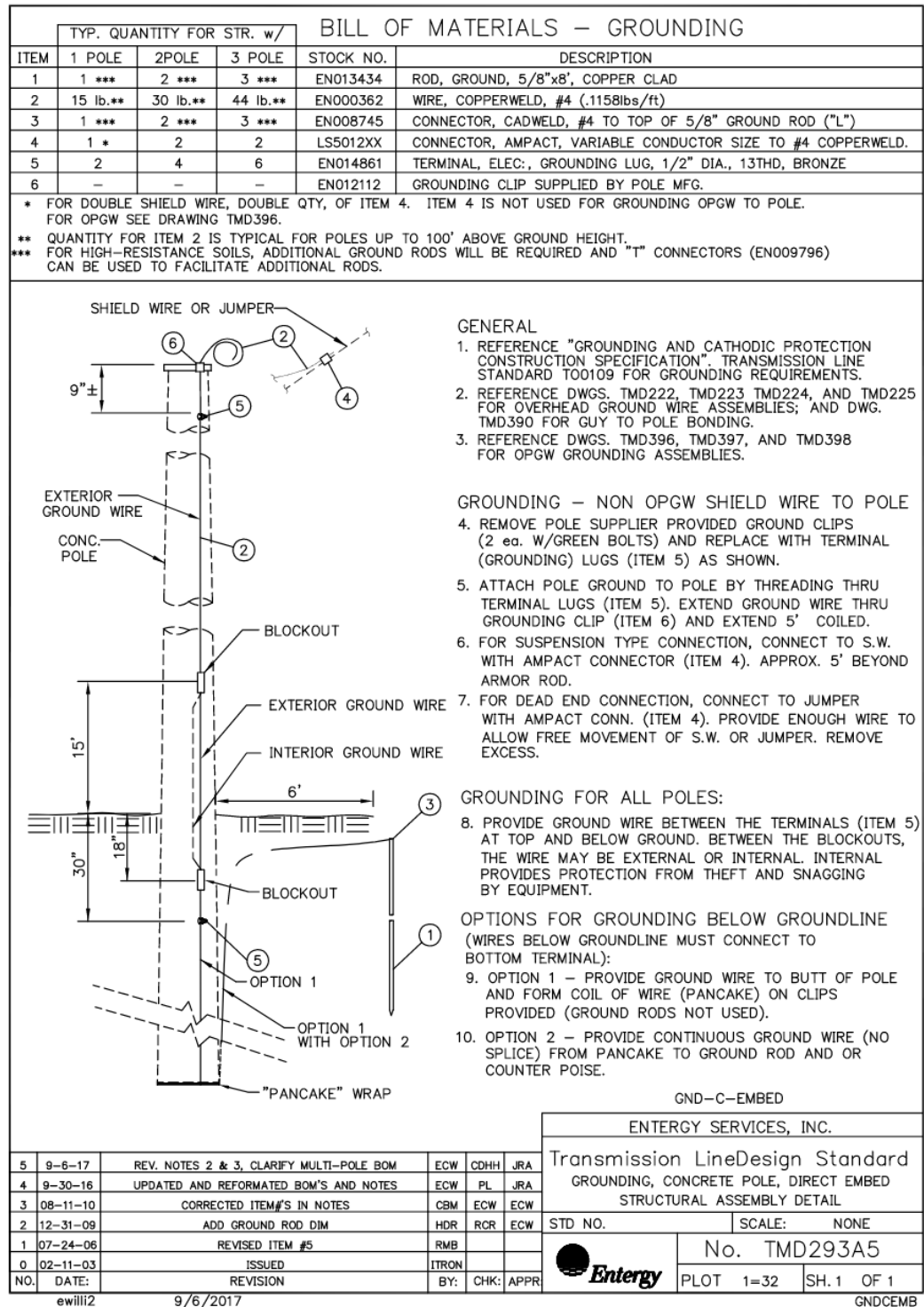
1) All Double Arming Bolts shall be trimmed to avoid conflict with guys, grounding, conductors, etc. and painted with galvanized paint.

2) Grounding Lug location may be above or below assembly depending on pole tank ground location.

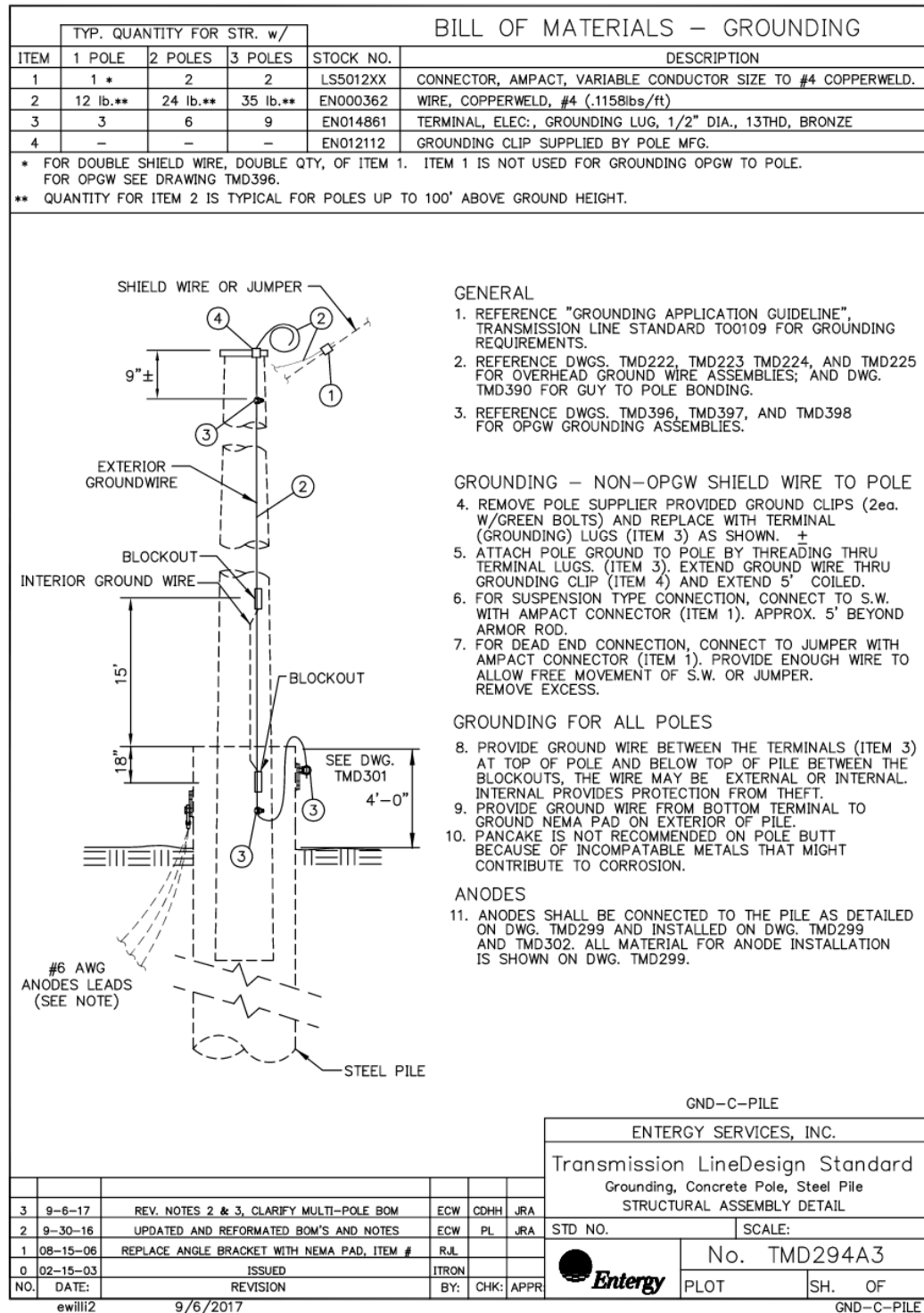
TEE-B-B-S	
ENTERGY STANDARD DWG.	
DESIGN APPROVAL	STANDARDS APPROVAL
SIGNED _____ / DATE _____	SIGNED _____ / DATE _____
TEE ASSY (STEEL) BRACE - BRACE	
APPROVED BY: EJG	DATE: 12-19-00
CHECKED BY: JWS	SCALE: NONE
DRAWN BY: ECSI	ESI NO. TMD280A0
	
No. TBBS PLOT 1=8 SH. 1 OF 1	

NO.	DATE:	REVISION	BY:	APPR:

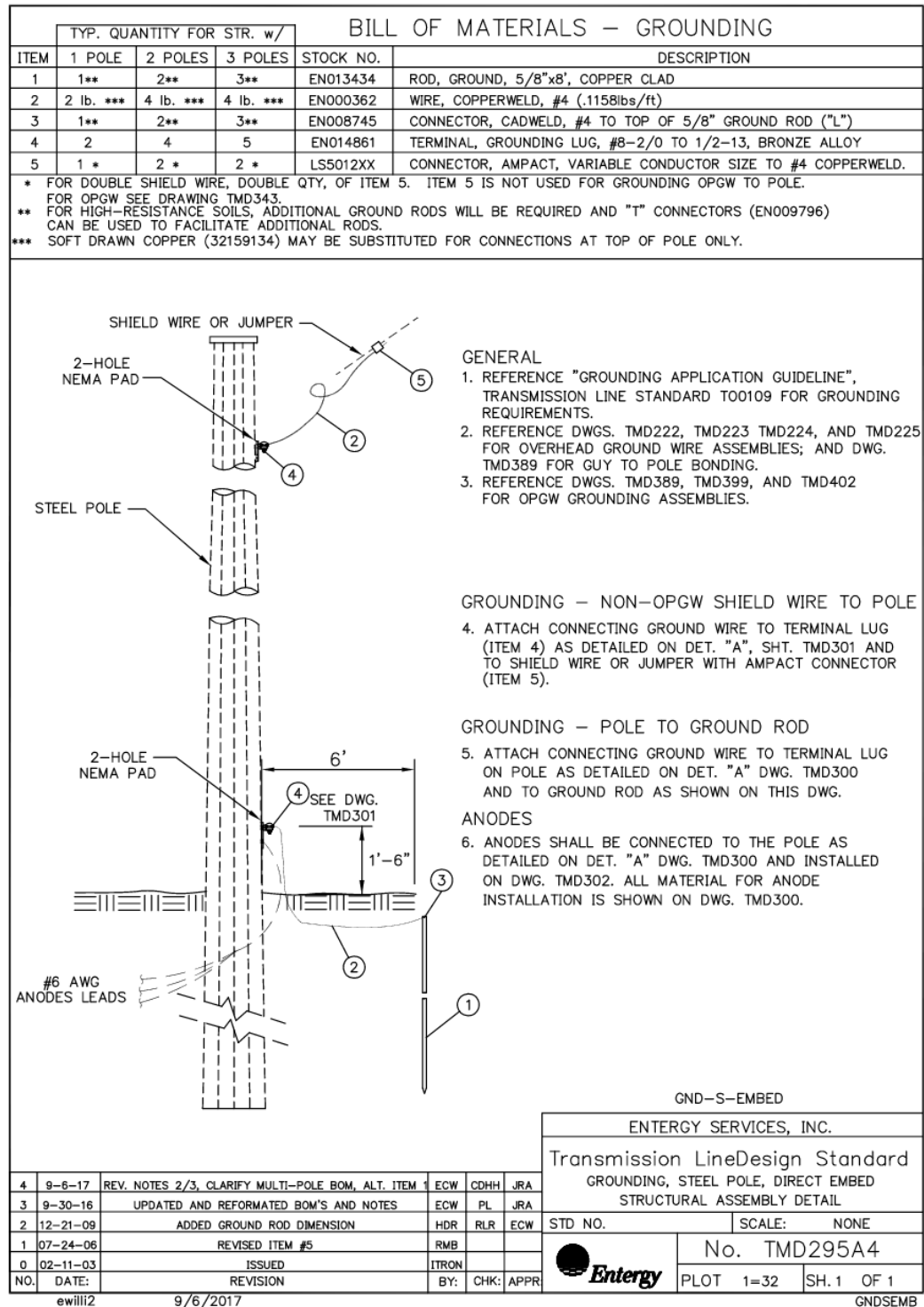
ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



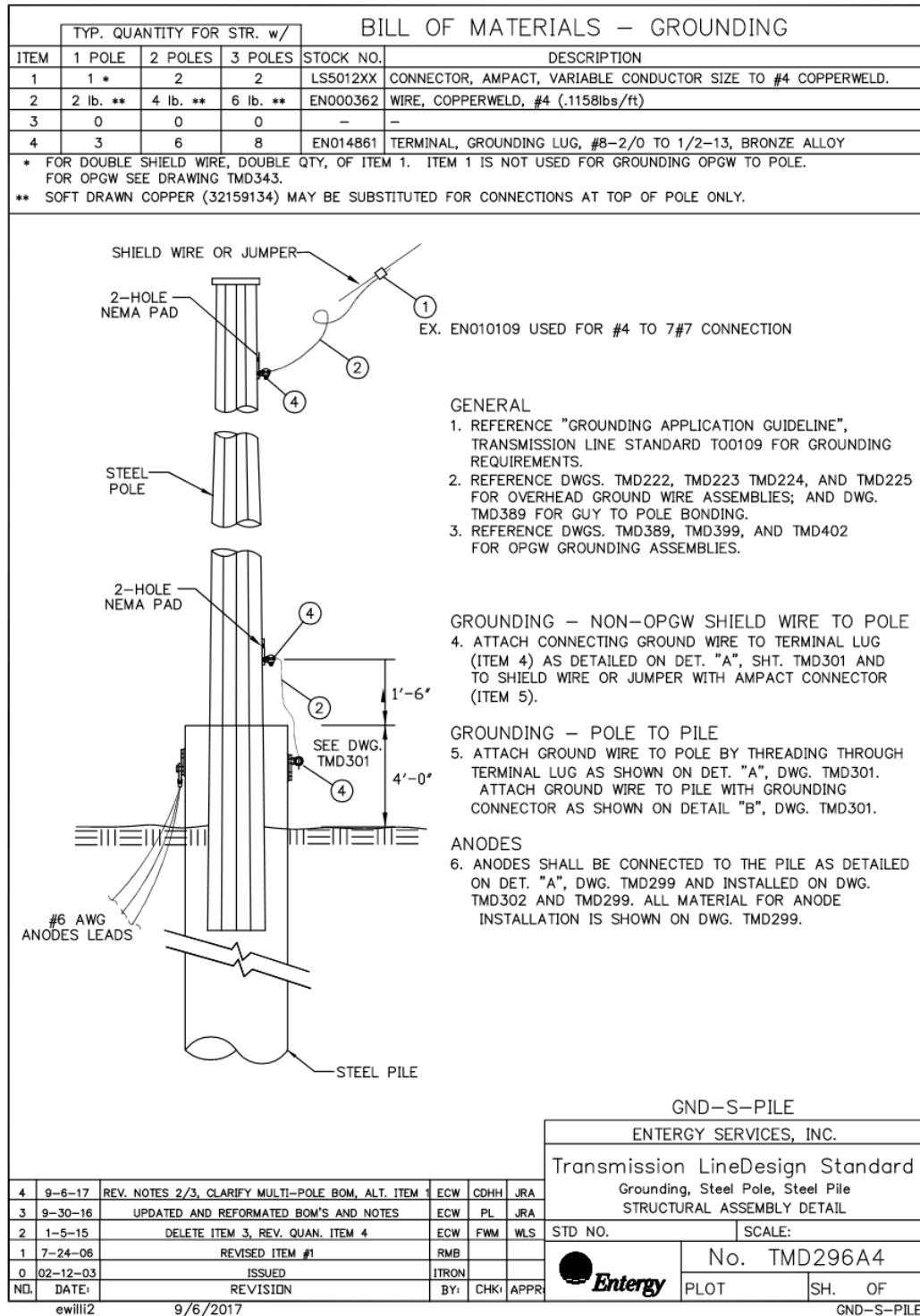
ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



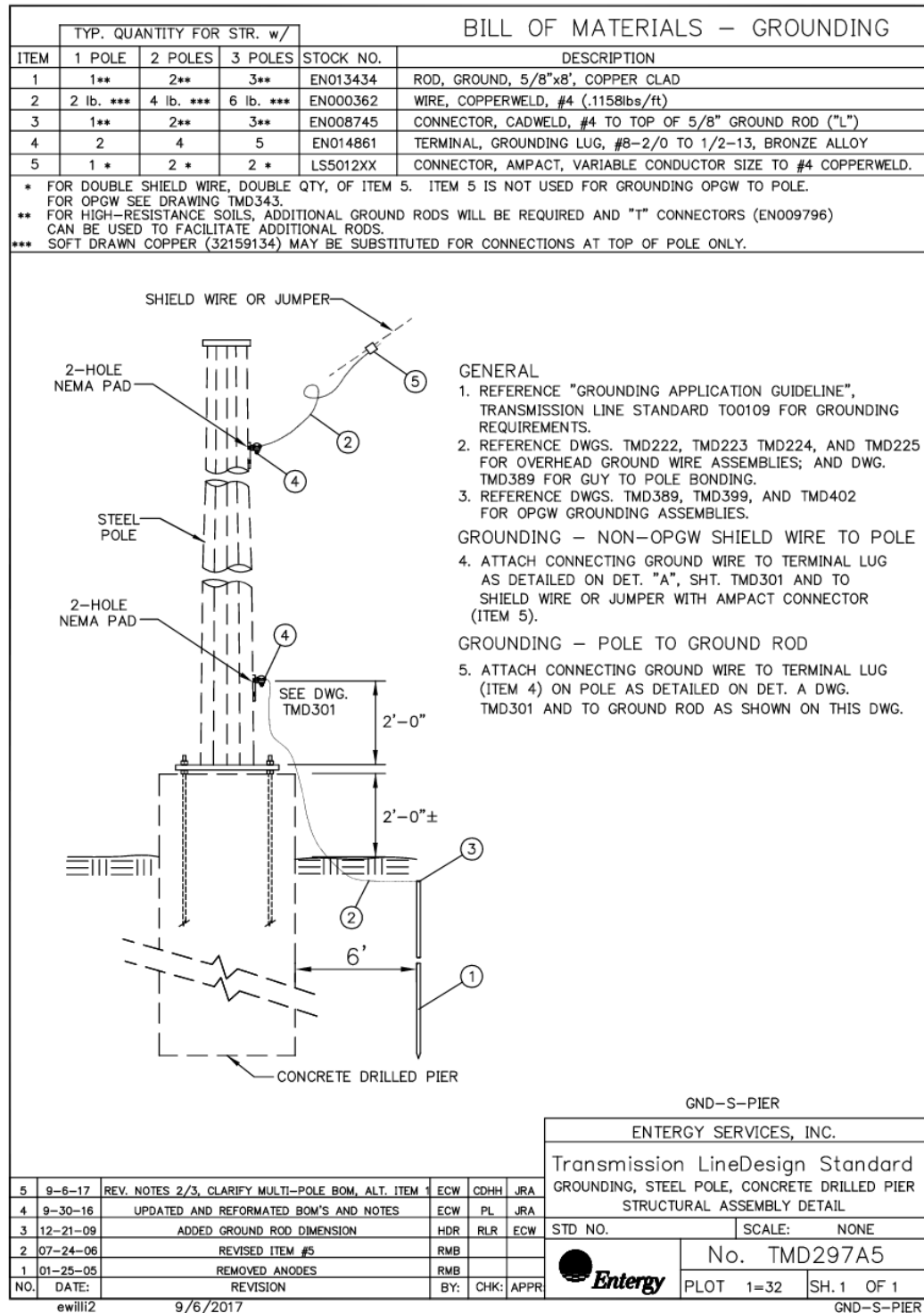
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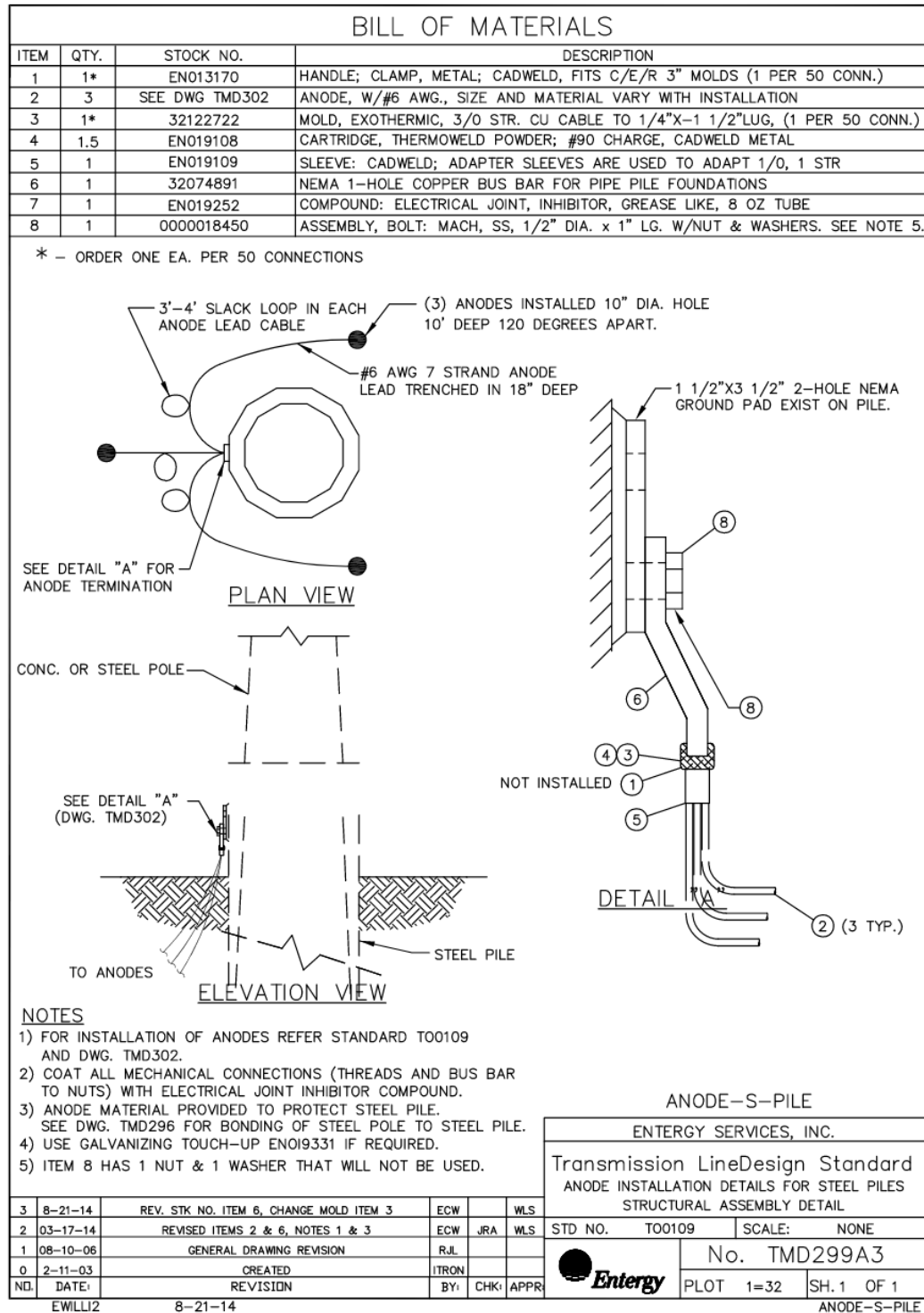
ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



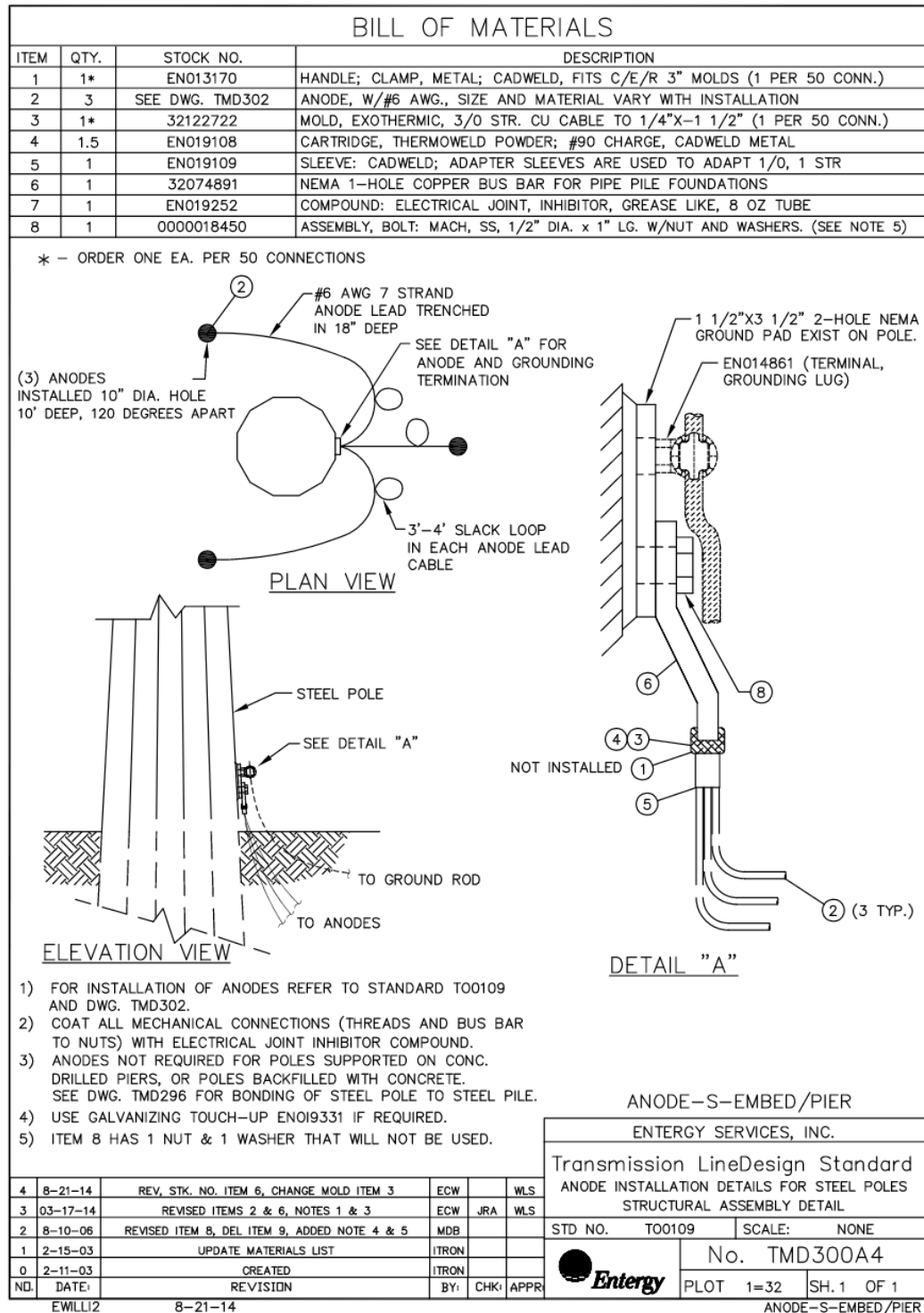
ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



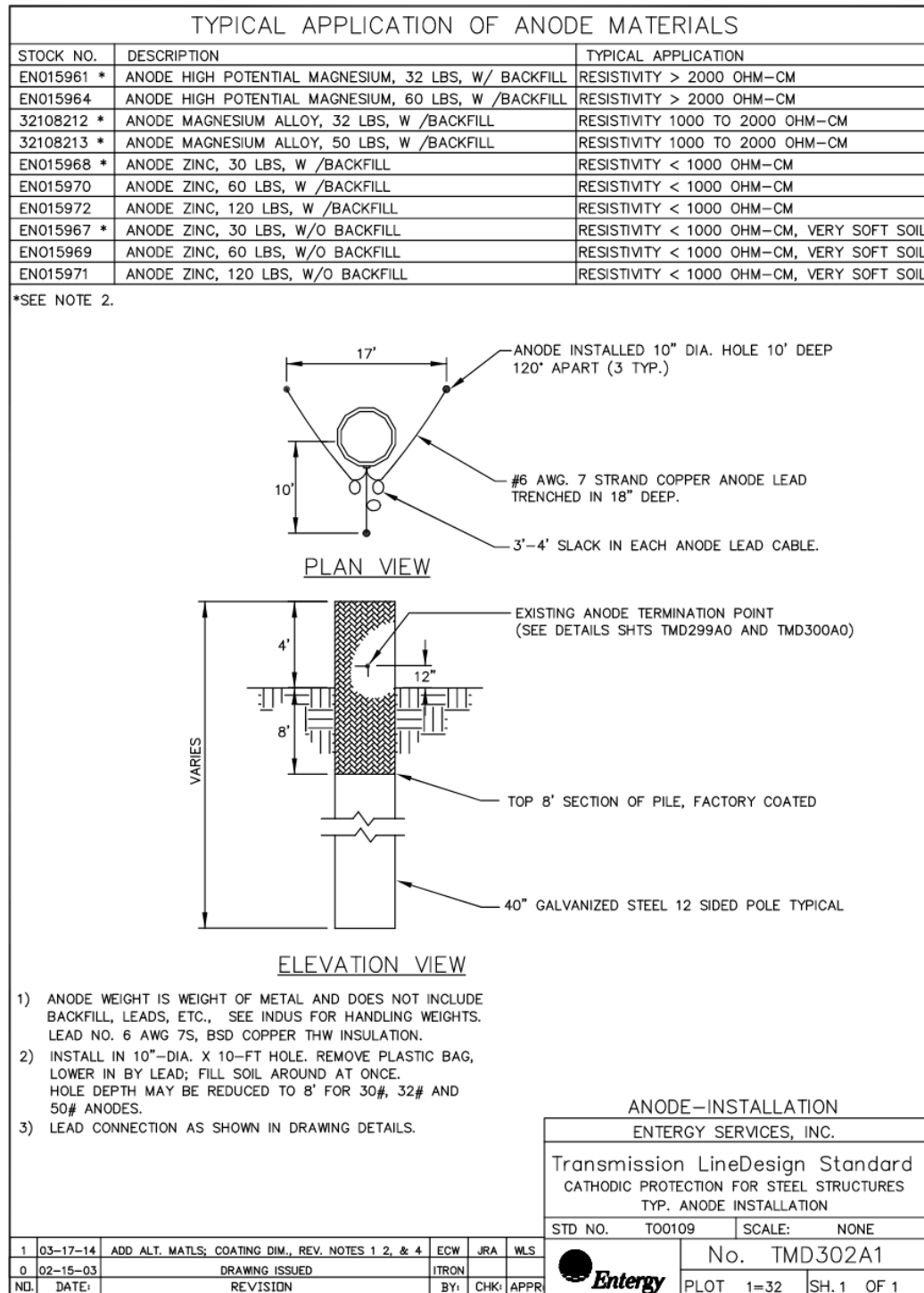
ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



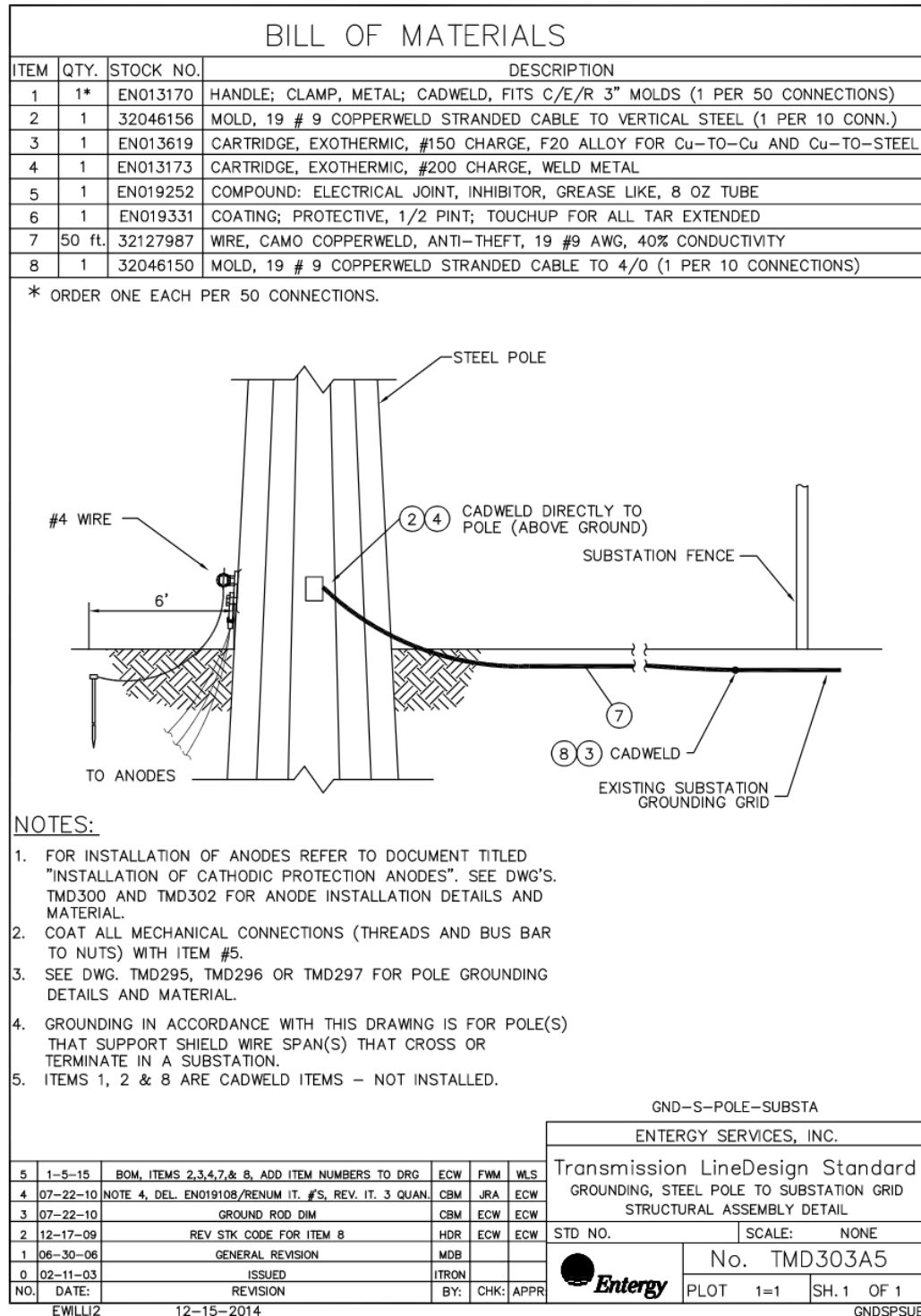
ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



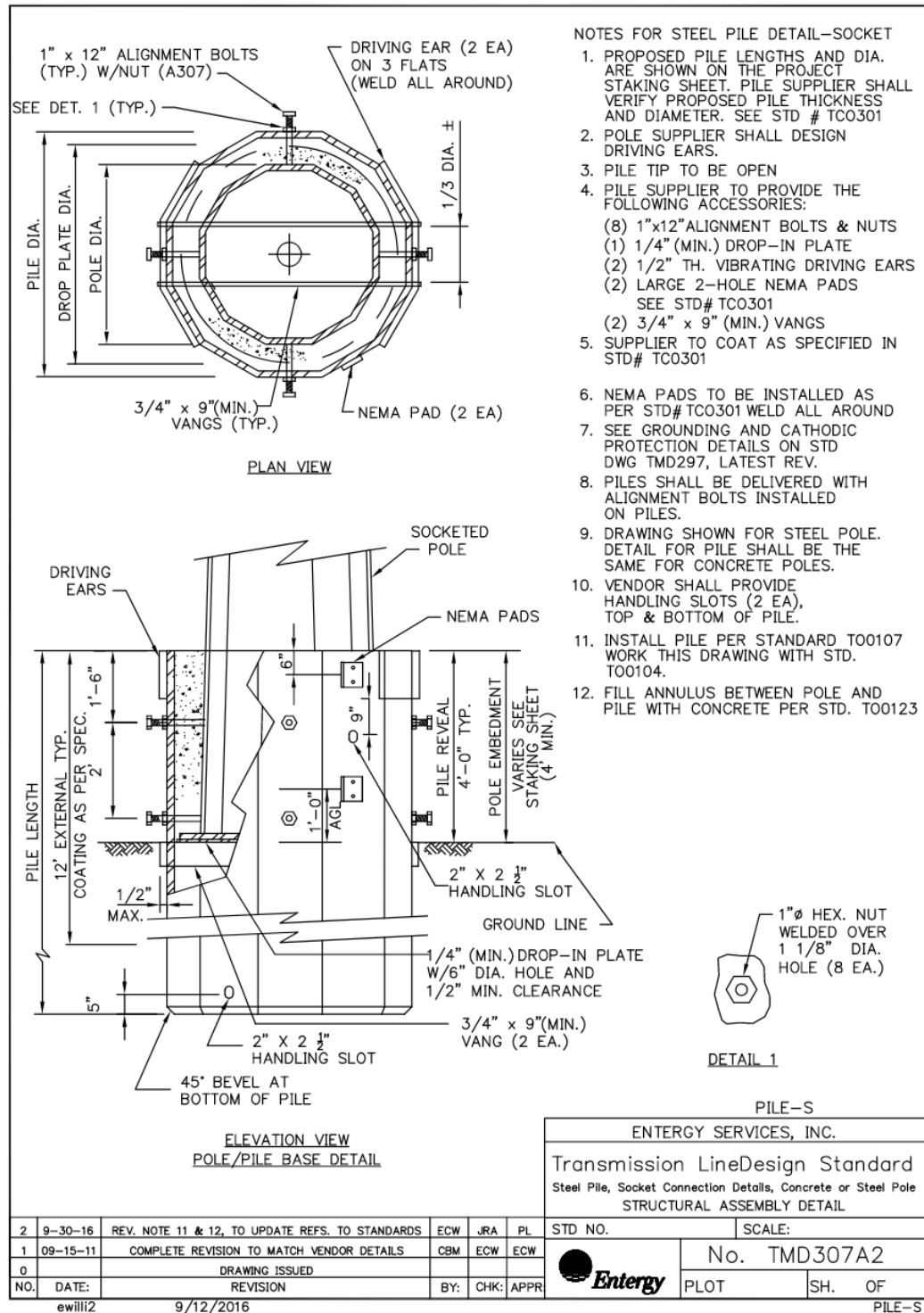
ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



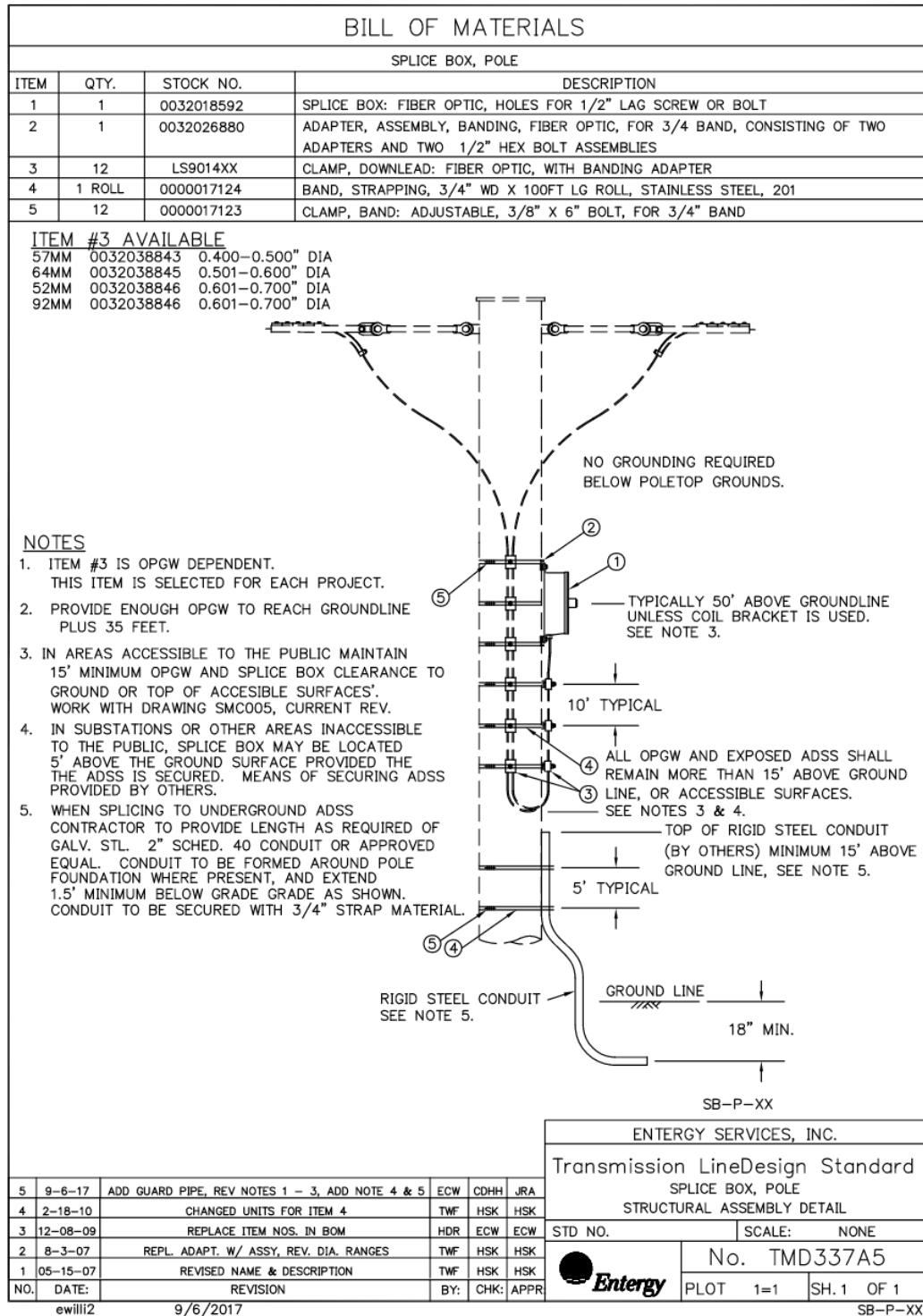
ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



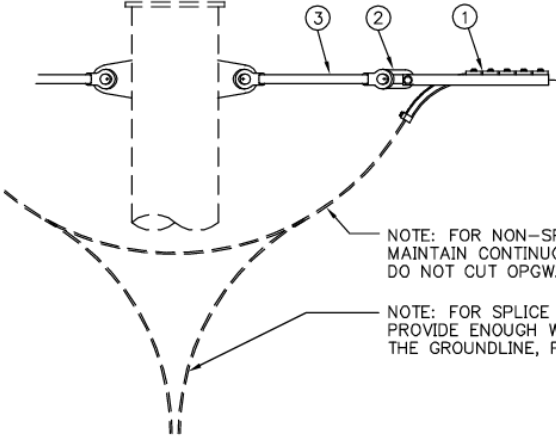
ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS					
OVERHEAD GROUND WIRE, DEADEND, OPGW, POLE					
ITEM	QTY.	STOCK NO.	DESCRIPTION		
1	1	LS9011XX	DEADEND: BOLTED STRAIN, OPGW, 3/4" PIN DIA.		
2	1	0000012586	LINK, CHAIN: 5/8" X 3-1/4", 40K		
3	1	0000024787	CLEVIS CLEVIS: Y-Y, 30K, 3/4" PD, 15" LONG		

NOTE: ILLUSTRATED AS TANGENT OR SMALL ANGLE STRUCTURE. LARGER ANGLES WILL HAVE THE PULLOFFS AT DIFFERENT ELEVATIONS BY SEVERAL INCHES.



NOTE: FOR NON-SPLICE BOX LOCATIONS, MAINTAIN CONTINUOUS LOOP AND DO NOT CUT OPGW.

NOTE: FOR SPLICE BOX LOCATIONS, PROVIDE ENOUGH WIRE TO REACH THE GROUNDLINE, PLUS 15 FEET.

ITEM #1 AVAILABLE

57MM	0000018531	0.465" DIA
64MM	0032018594	0.528" DIA
52MM	0032018595	0.646" DIA
92MM	0032018596	0.671" DIA

1) ITEM #1 IS OPGW DEPENDENT.
THIS ITEM IS SELECTED FOR EACH PROJECT.

OHG-DE-OP-P-XX

ENTERGY SERVICES, INC.

Transmission Line Design Standard

OVERHEAD GRNDWIRE, DE, OPGW, POLE

STRUCTURAL ASSEMBLY DETAIL

NO.	DATE	REVISED NOTES, NAME & DESCRIPTION	TWF	HSK	HSK
2	5-15-07	REVISED NOTES, NAME & DESCRIPTION			
1	8-23-06	UPDATED BILL OF MATERIAL	RJL	HSK	HSK
0	X	CREATED		HSK	HSK
		REVISION	BY:	CHK:	APPR:

STD NO. _____ SCALE: NONE

No. TMD339A2

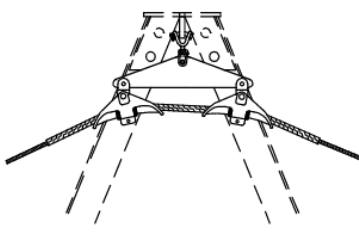
PLOT 1=1 SH. 1 OF 1

OHG-DE-OP-P-XX

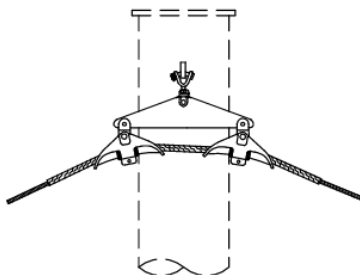
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ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

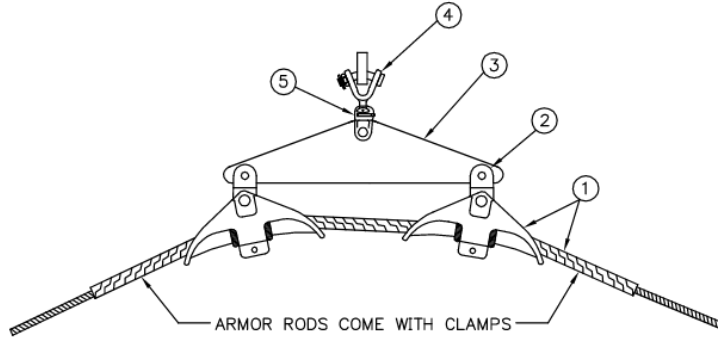
BILL OF MATERIALS					
OVERHEAD GROUND WIRE, SUSP. 30-50" w/YOKE, OPGW					
ITEM	QTY.	STOCK NO.	DESCRIPTION		
1	1	LS9010XX	CLAMP, SUSP: DOUBLE (2 CLAMPS), ALUM AL, 15K, W/48" ARM RODS, 30"-60" MAX. ANGLE		
2	2	0032020410	CLEVIS EYE: STRAIGHT, 30K, 2-7/8" LG, 1-5/8" EYE WD, 3/4" EYE RAD, 5/8" PIN DIA		
3	1	0032020414	PLATE, YOKE: DELTA, DUCTILE IRON, 18" LONG, 30K		
4	1	0000004375	BALL CLEVIS: 45 DEG Y, 30K, 3/4" PD, CLASS 52-3/5		
5	1	0000000486	SOCKET CLEVIS: STRAIGHT, 30K, 5/8" PD, CLASS 52-3/5		



AS ON LATTICE TOWER



AS ON POLE



ARMOR RODS COME WITH CLAMPS

ITEM #1 AVAILABLE

57MM	0032018593	0.450-0.475" DIA
64MM	0000017195	0.528-0.555" DIA
52MM	0000017196	0.615-0.646" DIA
92MM	0000017198	0.647-0.679" DIA

1) ITEM #1 OPGW DEPENDENT.
THIS ITEM IS SELECTED FOR EACH PROJECT.

OHG-SUY-OP-XX					
ENTERGY SERVICES, INC.					
Transmission Line Design Standard OVERHEAD GRNDWIRE, SUSP 30-50 W/YOKE, OPGW STRUCTURAL ASSEMBLY DETAIL					
2	5-15-07	REVISED NAME & DESCRIPTION. COMBINED DWGS TMD340 & TMD341	TWF	HSK	HSK
1	8-01-06	EXPANDED DESCRIPTIONS OF ITEMS 1 & 2	CDR	HSK	HSK
0	5-24-04	CREATED	.	HSK	HSK
NO.	DATE:	REVISION	BY:	CHK:	APPR:

tfinc90

6/25/2007



STD NO. _____ SCALE: NONE

No. TMD341A2

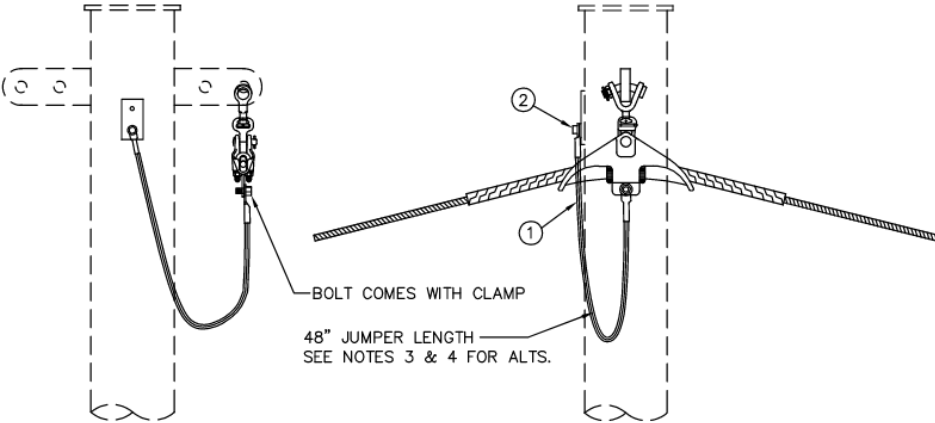
PLOT 1=1 SH. 1 OF 1

OHG-SUY-OP-XX

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ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS					
GROUND, SUSP. 0-30', OPGW, STEEL POLE					
ITEM	QTY.	STOCK NO.	DESCRIPTION		
1	1	0032033755	JUMPER, STATIC LINE: MULTI-STRANDED TINNED COPPER, 133/.0177, 48" LG, W/TERMINALS		
2	1	0000018450	ASSEMBLY, BOLT: MACH, SS, HEX HEAD, 1/2" DIA. X 1" LG., WITH NUT, 2 WASHERS AND 1 BELLEVILLE WASHER		



NOTES:

- ITEM 1 CAN BE MADE UP WITH 48" OF THE WIRE (0032018798) AND TWO TERMINALS (0032031548) AND COMPRESSING THE TERMINALS WITH AN INDENT DIE.
- ITEM 2 HAS 1 NUT AND 1 WASHER THAT WILL NOT BE NEEDED.
- USE 72" JUMPER (0032052394) FOR APPLICATION ON POLES WITH 3 FOOT SW DAVIT ARMS.
- SEE DRAWING TMQ207 FOR OTHER AVAILABLE JUMPER LENGTHS.

GND-SUS-OP-S

ENTERGY SERVICES, INC.

Transmission LineDesign Standard

GROUND, SUSP, 0-30, OPGW, STEEL POLE

STRUCTURAL ASSEMBLY DETAIL

3	3-26-14	ADD NOTES 3 AND 4 WITH ALT. JUMPER LENGTHS.	ECW	JRA	WLS
2	3-15-07	REV. NOTES, NAME & DESCRIPTION. SIDE VIEW ADDED.	TWF	HSK	HSK
1	8-17-06	DELETED 1 BOLT ON CLAMP, MADE JUMPER AND TERMINALS AN ASSEMBLY	RJL	HSK	HSK
0	5-24-04	CREATED	.	HSK	HSK
NO.	DATE:	REVISION	BY:	CHK:	APPR:

ewilll2

3-17-14



STD NO. _____ SCALE: NONE

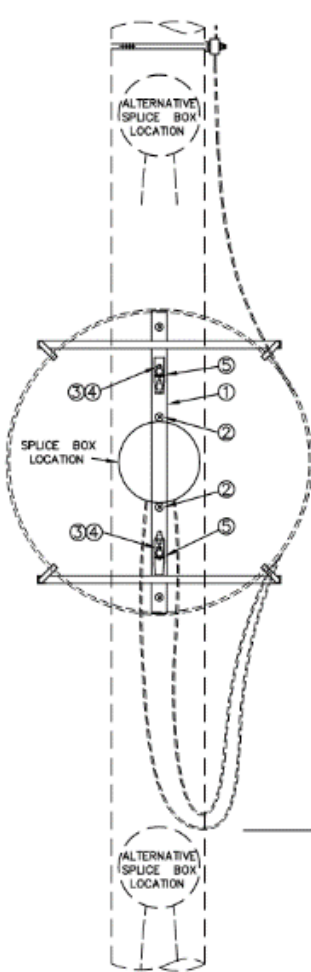
No. TMD343A3

PLOT 1=1 SH. 1 OF 1

GND-SUS-OP-S

ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS				
COIL BRACKET, OPGW, STEEL POLE				
ITEM	QTY.	STOCK NO.	DESCRIPTION	
1	1	0032031230	BRACKET, COIL,: 60 INCH, GALV. STEEL, PER ENTERGY DWG TMM060A	
2	2	—	BOLT, MACHINE, 1/2"-13 X 1", ALL THREAD, GALV. STEEL, NO NUT, NO WASHER (ANY SUPPLIER)	
3	0	0000000139	BOLT ASSEMBLY, MACHINE: HEX HEAD, GALV. STEEL, 5/8"-11 X 1-1/2", WITH HEX NUT	
4	0	0000005532	WASHER, ROUND, FLAT, 11/16" ID, 1-1/2" OD, 1/8" THICK, ASTM A153, GALV. STEEL	
5	0	0032031232	PLATE, BENT, GALV. STEEL, PER ENTERGY DWG. TMM061A	



NOTE #1: ASSEMBLY WILL TYPICALLY BE Banded TO POLE USING 3/4" SS BAND MATERIAL AND ADAPTERS SUPPLIED WITH THE SPLICE BOX. ALTERNATELY, THE COIL BRACKET ASSEMBLY MAY BE SECURED WITH TWO 1/2" BOLTS (ITEM 2) USING ANY TWO OF THE FOUR THREADED RECEIVER PROVIDED.

NOTE #2: TWO EACH OF ITEMS 3 AND 5, AND FOUR OF ITEM 4 MAY ALSO BE USED TO SECURE THE COIL BRACKET ASSEMBLY TO POLES ALREADY IN SERVICE THAT WERE MANUFACTURED WITH STEP CLIPS. THE STEP CLIP DETAIL IS COMMON ON OLDER POLES MANUFACTURED BY THOMAS & BETTS.

NOTE #3: COIL BRACKET ASSEMBLY CAN BE INSTALLED WITH EITHER END UP. BEFORE TIGHTENING BOLTS, BE SURE THAT WEIGHT OF COMPONENTS PULLS THEM FIRMLY INTO SLOTTED HOLES IN THE CHANNEL.

NOTE #4: THE LOWEST PART OF THE INSTALLATION MUST BE A MINIMUM OF 15 FEET ABOVE GROUNDLINE AND THE CABLE MUST COME INTO THE BOTTOM OF THE SPLICE BOX WITH NO STRAIN ON THE CONNECTORS. ADDITIONAL BANDING MAY BE NECESSARY TO GATHER AND STABILIZE THE EXCESS CABLE LENGTH TO THE BRACKET AND POLE. HOLES ARE PROVIDED IN THE END OF EACH ARM TO ACCOMMODATE CABLE TIES OR WIRE TIES.

15' MINIMUM ABOVE GL. IF ALTERNATE SPLICE BOX LOCATION IS USED, NO PART OF INSTALLATION CAN BE LOWER THAN 15' ABOVE THE GROUND LINE.

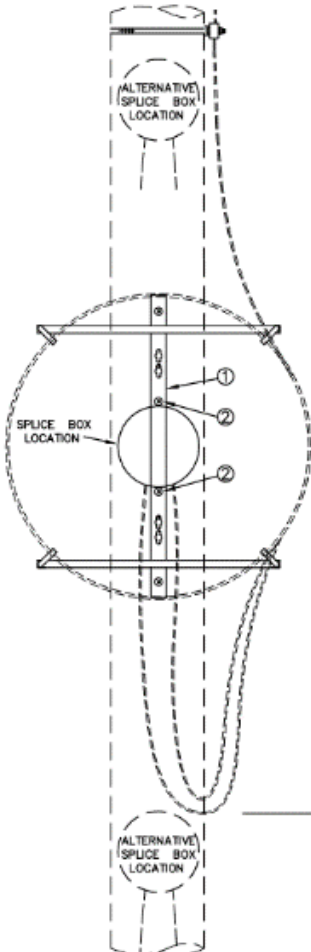
CB-OP-S				
ENTERGY SERVICES, INC.				
Transmission LineDesign Standard				
COIL BRACKET, OPGW, STEEL POLE				
STRUCTURAL ASSEMBLY DETAIL				
STD NO.		SCALE: NONE		
No. TMD386A3				
PLOT 1=1		SH. 1 OF 1		

3	9-24-15	ADD REF. LINE FOR 15' MIN. DIMENSION	ECW	ECW
2	8-21-14	QTY. ITEMS 3-5, REV. NOTES 1 & 2	ECW	WLS
1	5-15-07	REVISED NAME & DESCRIPTION	TWF	HSK
0	3-30-06	CREATED	RMB	HSK
NO.	DATE	REVISION	BY:	CHK: APPR:

EWILLJ2
08-24-15
CB-OP-S

ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS			
COIL BRACKET, OPGW, CONCRETE POLE			
ITEM	QTY.	STOCK NO.	DESCRIPTION
1	1	0032031230	BRACKET, COIL, 60 INCH, GALV. STEEL, PER ENTERGY DWG TMM060A
2	2	—	BOLT, MACHINE, 1/2"–13 X 1", ALL THREAD, GALV. STEEL, NO NUT, NO WASHER (ANY SUPPLIER)
—	—	—	—
—	—	—	—
—	—	—	—



NOTE #1: ASSEMBLY WILL TYPICALLY BE Banded TO POLE USING 3/4" SS BAND MATERIAL AND ADAPTERS SUPPLIED WITH THE SPLICE BOX. ALTERNATELY, THE COIL BRACKET ASSEMBLY MAY BE SECURED WITH TWO 1/2" BOLTS (ITEM 2) USING ANY TWO OF THE FOUR THREADED RECEIVER PROVIDED.

NOTE #2: COIL BRACKET ASSEMBLY CAN BE INSTALLED WITH EITHER END UP. BEFORE TIGHTENING BOLTS, BE SURE THAT WEIGHT OF COMPONENTS PULLS THEM FIRMLY INTO SLOTTED HOLES IN THE CHANNEL.

NOTE #3: THE LOWEST PART OF THE INSTALLATION MUST BE A MINIMUM OF 15 FEET ABOVE GROUNDLINE AND THE CABLE MUST COME INTO THE BOTTOM OF THE SPLICE BOX WITH NO STRAIN ON THE CONNECTORS. ADDITIONAL BANDING MAY BE NECESSARY TO GATHER AND STABILIZE THE EXCESS CABLE LENGTH TO THE BRACKET AND POLE. HOLES ARE PROVIDED IN THE END OF EACH ARM TO ACCOMMODATE CABLE TIES OR WIRE TIES.

15' MINIMUM ABOVE GL. IF ALTERNATE SPLICE BOX LOCATION IS USED, NO PART OF INSTALLATION CAN BE LOWER THAN 15' ABOVE THE GROUND LINE.

CB-OP-C

ENTERGY SERVICES, INC.

Transmission Line Design Standard

COIL BRACKET, OPGW, CONCRETE POLE

STRUCTURAL ASSEMBLY DETAIL

STD NO.	SCALE: NONE
No. TMD387A3	
PLOT 1=1 SH. 1 OF 1	

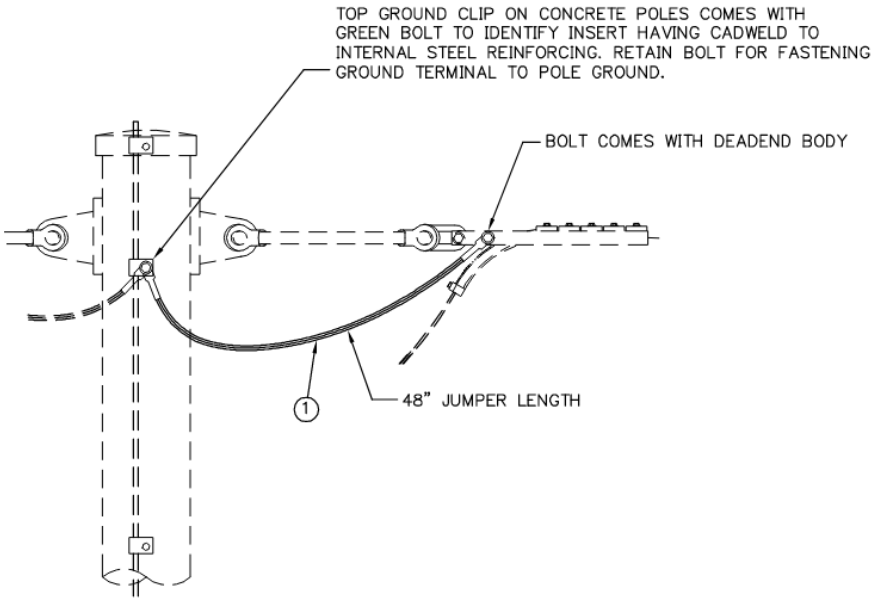
3	9-24-15	ADD REF. LINE FOR 15' MIN. DIMENSION	ECW	ECW
2	8-21-14	REV NOTE 1, DEL ITEM 3 & NOTE 2, RENUM NOTES	ECW	WLS
1	5-15-07	REVISED NAME & DESCRIPTION	TWF	HSK HSK
0	3-30-06	CREATED	RMB	HSK HSK
NO.	DATE:	REVISION	BY:	CHK: APPR:

EWILLJ2
8/24/15
CB-OP-C

ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS			
GROUND, DEADEND, OPGW, CONCRETE POLE			
ITEM	QTY.	STOCK NO.	DESCRIPTION
1	1	0032033755	JUMPER, STATIC LINE: MULTI-STRANDED TINNED COPPER, 133/.0177, 48" LG, W/TERMINALS

NOTE: ITEM 1 CAN BE MADE UP WITH 48" OF THE WIRE (0032018798) AND TWO TERMINALS (0032031548) AND COMPRESSING THE TERMINALS WITH AN INDENT DIE.



GND-DE-OP-C

ENTERGY SERVICES, INC.	
Transmission LineDesign Standard	
GROUND, DEADEND, OPGW, CONCRETE POLE	
STRUCTURAL ASSEMBLY DETAIL	
STD NO.	SCALE: NONE
No. TMD398A0	
PLOT 1=1	SH. 1 OF 1

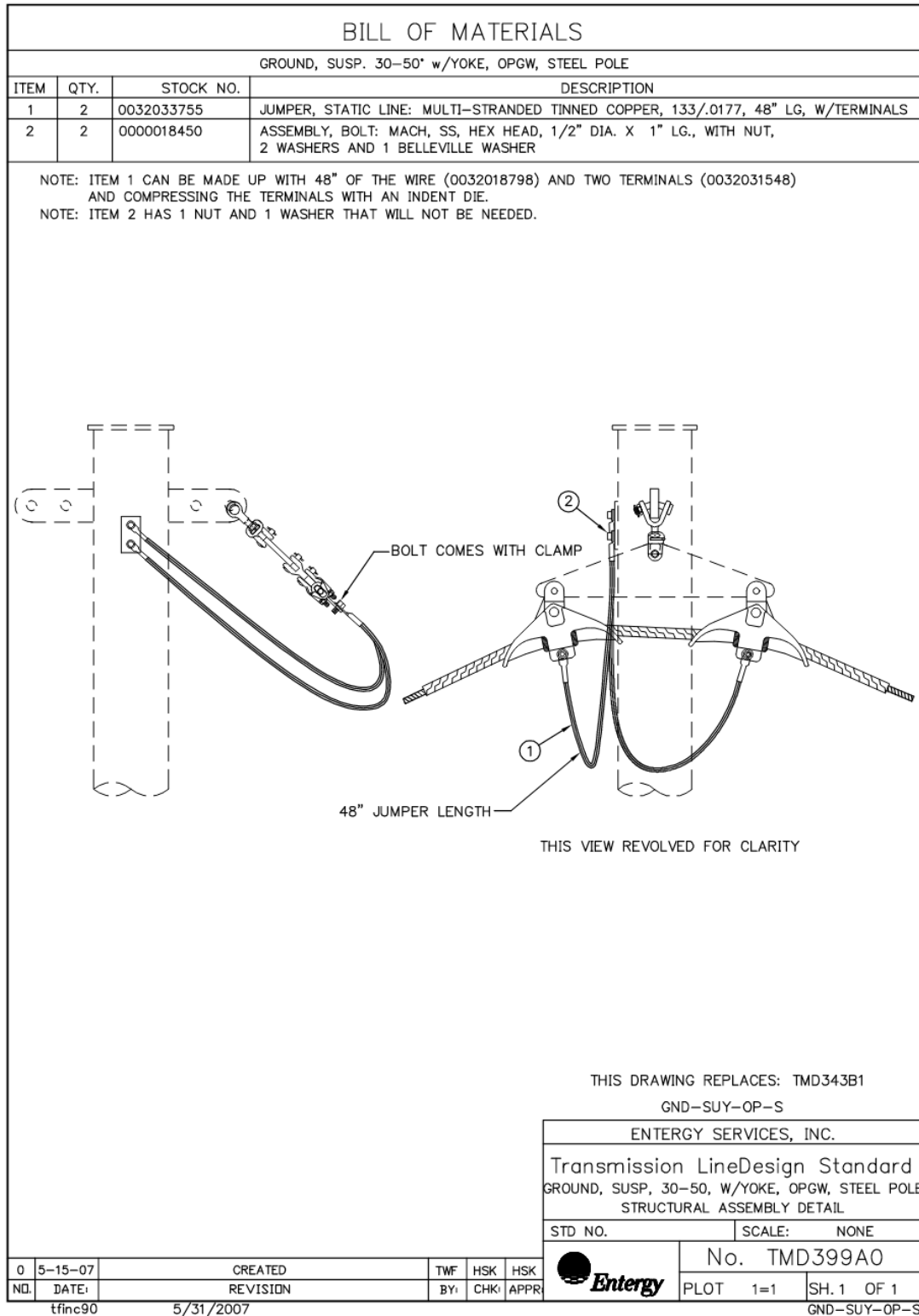
GND-DE-OP-C

0	5-15-07	CREATED	TWF	HSK	HSK
NO.	DATE:	REVISION	BY:	CHK:	APPR:

tfinc90 5/31/2007

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ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



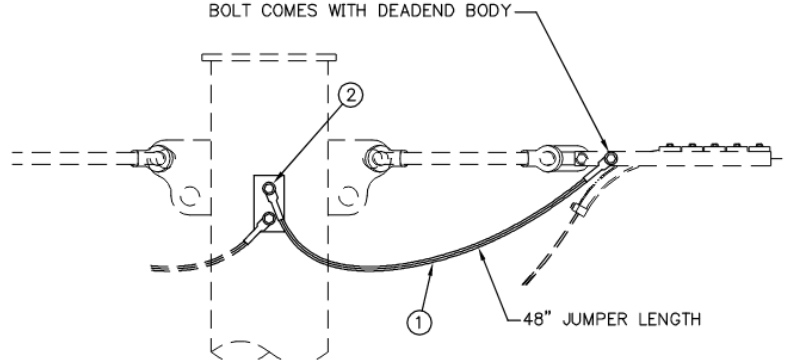
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ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS			
GROUND, DEADEND, OPGW, STEEL POLE			
ITEM	QTY.	STOCK NO.	DESCRIPTION
1	1	0032033755	JUMPER, STATIC LINE: MULTI-STRANDED TINNED COPPER, 133/.0177, 48" LG, W/TERMINALS
2	1	0000018450	ASSEMBLY, BOLT: MACH, SS, HEX HEAD, 1/2" DIA. X 1" LG., WITH NUT, 2 WASHERS AND 1 BELLEVILLE WASHER

NOTE: ITEM 1 CAN BE MADE UP WITH 48" OF THE WIRE (0032018798) AND TWO TERMINALS (0032031548) AND COMPRESSING THE TERMINALS WITH AN INDENT DIE.

NOTE: ITEM 2 HAS 1 NUT AND 1 WASHER THAT WILL NOT BE NEEDED.



THIS DRAWING REPLACES: TMD343C1

GND-DE-OP-S

ENTERGY SERVICES, INC.	
Transmission LineDesign Standard	
GROUND, DEADEND, OPGW, STEEL POLE	
STRUCTURAL ASSEMBLY DETAIL	
STD NO.	SCALE: NONE
No. TMD402A0	
PLOT 1=1	SH. 1 OF 1

0	5-15-07	CREATED	TWF	HSK	HSK
NO.	DATE:	REVISION	BY:	CHK:	APPR:

tfinc90 5/31/2007

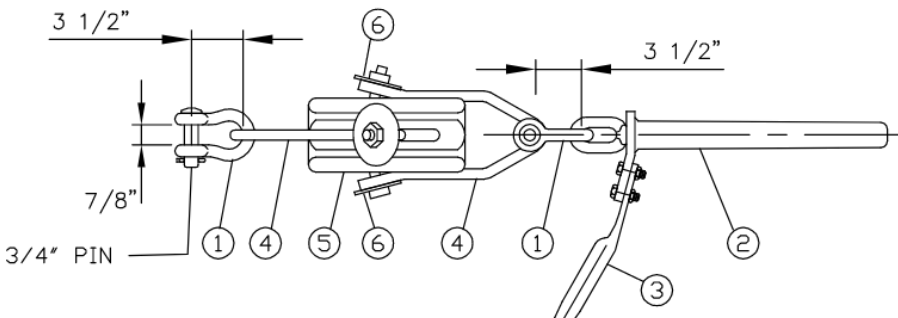


GND-DE-OP-S

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ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

LIST OF COMPONENTS							
QUAN ASSY	ITEM NO.	DESCRIPTION	CATALOG NUMBER	ULTIMATE STRENGTH	BASIC MATERIAL	WEIGHT EACH	ENTERGY STOCK NO.
2	(1)	ANCHOR SHACKLE	ASH-66A	50,000 #	F.S.	2.25 #	EN000491
1	(2)	COMPRESSION D.E.	*SEE TABLE*	—	ALUM.		*SEE TABLE*
1	(3)	TERMINAL	*SEE TABLE*	—	ALUM.		*SEE TABLE*
2	(4)	SHACKLE	J732	12,400#	F.S.	1.46#	**
1	(5)	INSULATOR	L506	20,000#	PORC.	2.90#	**
4	(6)	CLIPPED WASHER	ASM-7159-1		STL		**
** ITEMS 4, 5 & 6 ARE COMBINED INTO ENTERGY STOCK CODE 000125-308. INDUS CAT ID 000125-308 LISTS THESE ITEMS AS ONE MACLEAN PART NUMBER XXXXXXXXXXXXXXXX. FOR COMPRESSION DEAD END							
SHIELD WIRE	SHIELD WIRE DIA.	COMP. D.E. (ITEM 2)	ENTERGY STOCK NO.	TERMINAL (ITEM 3)	ENTERGY STOCK NO.	ASSEMBLY CAT. NO.	
7 NO. 7 ALUMOWELD	0.433	V3816.484T	EN005526	3916.484	EN028530	C-7687-OGWDE1-2	
3/8" EHS STEEL	0.375	V3814.386T	EN005530	3914.386	EN028531	C-7687-OGWDE2-2	
7/16" EHS STEEL	0.438	V3816.453T	EN005531	3914.386	EN028531	C-7687-OGWDE4-2	



GENERAL NOTES

THESE INSULATED SHIELD WIRE ASSEMBLIES ARE PRIMARILY FOR SELECT LINES OF THE 500KV SYSTEM WHERE POWER LOSSES ARE A CONCERN. THERE MAY BE OTHER APPLICATIONS ON THE LOWER VOLTAGE LINES WHERE RADIO INTERFERENCE IS A CONCERN.

OHG-DEJB-XX

ENTERGY SERVICES, INC.	
Transmission Line Design Standard	
OVERHEAD GROUNDWIRE DEADEND ASSY	
STRUCTURAL ASSEMBLY DETAIL	
STD NO.	SCALE: NONE
No. TMD403A0	
PLOT 1=1	SH. 1 OF 1

0	12-13-07	CREATED	TWF	HSK	HSK
NO.	DATE	REVISION	BY:	CHK:	APPR
tfinc90		12/20/2007			

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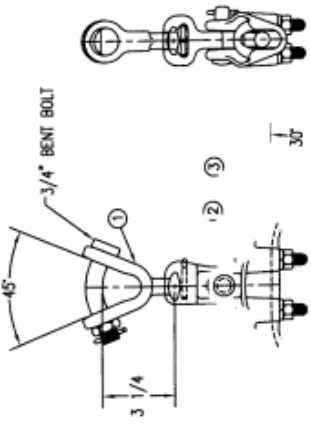
ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

REVISIONS				DESIGN APPROVAL	
NO.	DATE	DESCRIPTION	BY	CHK	DATE
1	3/23/01	GEN. REVISIONS	BS		
2	3/26/01	ADDED TABLE	BS		
3	4/17/01	ADDED STOCK NOT'S	BS		
4	6/6/01	ITEM 1 ING. ASS-56	BS		
5	9/14/01	GEN. REVISIONS	BS		
6	11/15/01	GEN. REVISIONS	BS		
7	11/15/01	GEN. REVISIONS	BS		
8	2/7/02	ADDED YCB-65A, REMOVED SHAKOLE	BS		
9	7/9/02	REVISED SHEET 2 (DOWNS & 24)	BS		

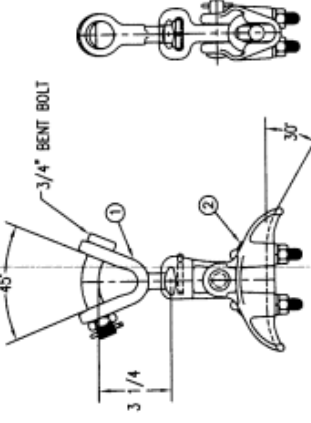
LIST OF COMPONENTS						
QTY/ASST	ITEM NO.	DESCRIPTION	CATALOG NUMBER	ULTIMATE STRENGTH-MATERIAL	BASIC WEIGHT EACH	ENTERGY STOCK NO.
1	(1)	Y-CLEVIS BALL	YCB-65A	35,000 F.S.	2.15	EN000375
1	(2)	SUSPENSION CLAMP	*SEE TABLE*	*	*	*SEE 18872
1	(3)	ARMOR ROD	AWAR-1080	-	-	EN000380

*LS-1 MATERIAL IS AL. & ULT. STR. 18,000 LBS. WT. 4.11 LBS.
 FSC-60 MATERIAL IS D.I. & ULT. STR. 17,000 LBS. WT. 4.00 LBS.

SHIELD WIRE	SHIELD WIRE DIA.	CLAMP (ITEM 2)	ENTERGY STOCK NO.	ASSEMBLY CAT. NO.
7 NO. 7 ALUMOWELD	0.433	LS-1-S	EN000392	C-7687-OGWS1
3/8" EHS	0.375	FSC-60-S	EN000377	C-7687-OGWS1A



ASSEMBLY C-7687-OGWS1



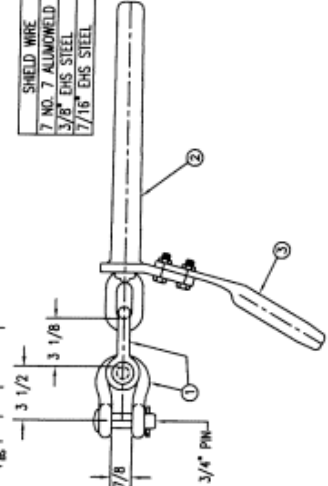
ASSEMBLY C-7687-OGWS1A

REF. DWG. NO. BC7687-0 FOR MATERIAL NOTES
 ALL DIMENSIONS IN INCHES

OHG-SUS-XX		BETHEA POWER PRODUCTS	
DESIGN APPROVAL	STANDARDS APPROVAL	PELHAM, ALABAMA	
SIGNED / DATE	SIGNED / DATE	OVERHEAD GROUNDWIRE	
ESI NO. TMD223A4		SUSPENSION ASSEMBLY	
ENTERGY NO. OHGSUS		BC-687	

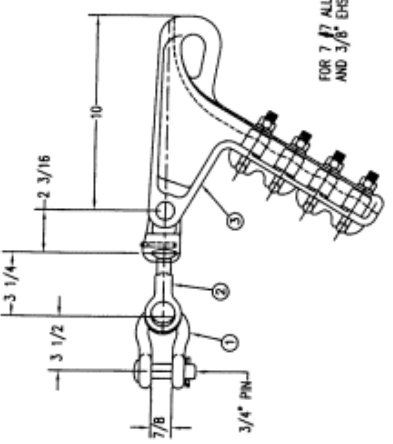
ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

REVISIONS				DESIGN APPROVAL			
NO.	DATE	DESCRIPTION	BY	CHKD	PR	DATE	
1	3/22/01	GEN. REVISIONS	BS				
2	4/11/01	ADDED STOCK NTS	BS				
3	7/25/01	CHANGED COMPRESSION FOR 7/8"	BS				
4	7/25/01	ADDED 3/4" PIN	BS				
5	8/17/01	GEN. REVISIONS	BS				
6	10/2/01	GEN. REVISIONS	BS				
7	12/10/01	GEN. REVISIONS	BS				
8	1/3/02	ADDED ASSY C-7687	BS				



LIST OF COMPONENTS						
QUAN	ITEM NO.	DESCRIPTION	CATALOG NUMBER	ULTIMATE STRENGTH MATERIAL	BASIC WEIGHT EACH	ENTERGY STOCK NO.
2	(1)	ANCHOR SHACKLE	ASH-65A	50,000 F.S.	12.25	EN000491
1	(2)	COMPRESSION D.E.	*SEE TABLE*	ALUM.		*SEE TABLE*
1	(3)	TERMINAL	*SEE TABLE*	ALUM.		*SEE TABLE*

FOR COMPRESSION DEAD END						
SHIELD WIRE	SHIELD WIRE DIA.	COMP. D.E. (ITEM 2)	ENTERGY STOCK NO.	TERMINAL (ITEM 3)	ENTERGY STOCK NO.	ASSEMBLY CAT. NO.
7 NO. 7 ALUMOWELD	0.433	V3816.484T	EN005526	3916.484	EN028530	C-7687-00WDE1
3/8" EHS STEEL	0.375	V3814.386T	EN005530	3914.386	EN028531	C-7687-00WDE2
7/16" EHS STEEL	0.438	V3816.453T	EN005531	3914.386	EN028531	C-7687-00WDE4



LIST OF COMPONENTS						
QUAN	ITEM NO.	DESCRIPTION	CATALOG NUMBER	ULTIMATE STRENGTH MATERIAL	BASIC WEIGHT EACH	ENTERGY STOCK NO.
1	(1)	ANCHOR SHACKLE	ASH-65A	50,000 F.S.	12.25	EN000491
1	(2)	Y-CLEVIS BALL	YCB-65A	35,000 F.S.	2.15	EN004375
1	(3)	STRAIN CLAMP	AUC-22-S	20,000 AL.	6.00	EN005946

FOR 7/8" ALUMOWELD AND 3/8" EHS						
SHIELD WIRE	SHIELD WIRE DIA.	COMP. D.E. (ITEM 2)	ENTERGY STOCK NO.	TERMINAL (ITEM 3)	ENTERGY STOCK NO.	ASSEMBLY CAT. NO.
7 NO. 7 ALUMOWELD	0.433	V3816.484T	EN005526	3916.484	EN028530	C-7687-00WDE1
3/8" EHS STEEL	0.375	V3814.386T	EN005530	3914.386	EN028531	C-7687-00WDE2
7/16" EHS STEEL	0.438	V3816.453T	EN005531	3914.386	EN028531	C-7687-00WDE4

ALL DIMENSIONS IN INCHES
SEE SHEET ONE FOR MATERIAL NOTES

OHG-DE-XX		STANDARD APPROVAL		BETHEA POWER PRODUCTS	
DESIGN APPROVAL	DATE	SIGNED	DATE	DESIGNER	DATE
				OVERHEAD GROUNDWIRE	
				DEADEND ASSEMBLY	
				ENTERGY NO. OHGDE	BC-7687

ASSEMBLY NUMBER C-7687-00WDE3

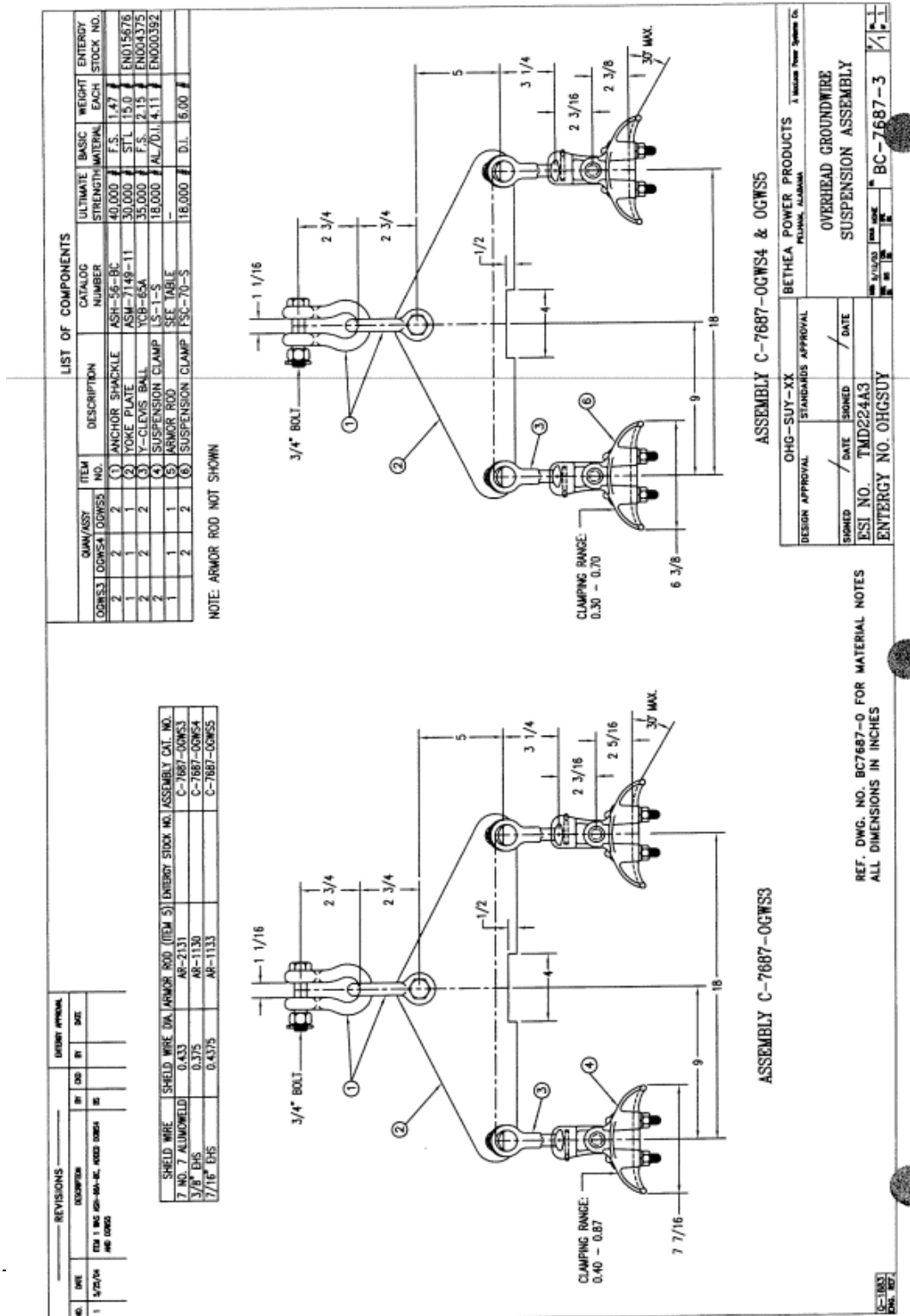
ENTERGY NO. OHGDE



Entergy Texas, Inc.
Combined Cycle Plant RFP

Technical Specification: ETI-CCCT
Issue: Rev. 0
February 11, 2026

ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

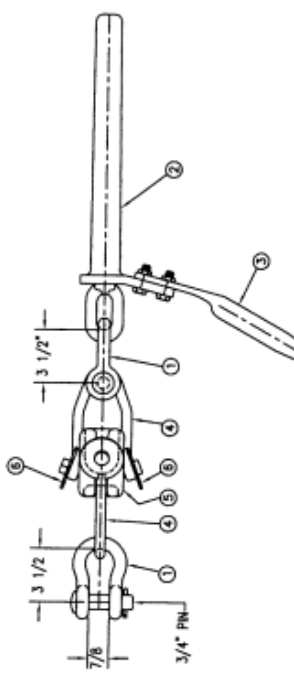


ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

MPS REVISIONS				REVISIONS			
NO.	DATE	DESCRIPTION	BY	CHKD	IN	DATE	

LIST OF COMPONENTS							
QUAN	ITEM	DESCRIPTION	CATALOG	ULTIMATE	BASIC	WEIGHT	ENTERGY
ASST	NO.		NUMBER	STRENGTH	MATERIAL	EACH	STOCK NO.
2	(1)	ANCHOR SHACKLE	ASH-65A	50,000	F.S.	2.75	EN000481
1	(2)	COMPRESSION D.E.	*SEE TABLE*	—	—	—	*SEE TABLE*
1	(3)	TERMINAL	*SEE TABLE*	—	—	—	*SEE TABLE*
2	(4)	SHACKLE	J732	12,400	F.S.	1.45	EN000481
1	(5)	INSULATOR	L506	20,000	PORC	2.80	EN000481
4	(6)	CLIPPED WASHER	ASM-7159-1	—	STL	—	—

FOR COMPRESSION DEAD END						
SHIELD WIRE	SHIELD WIRE DIA.	COMP. D.E. (ITEM 2)	ENTERGY STOCK NO.	TERMINAL (ITEM 3)	ENTERGY STOCK NO.	ASSEMBLY CAT. NO.
7 NO. 7 ALUMINUM WELD	0.433	V3816.484T	EN005526	3916.484	EN028530	C-7687-00WDE1-2
3/8" EHS STEEL	0.375	V3814.386T	EN005530	3914.386	EN028531	C-7687-00WDE2-2
7/16" EHS STEEL	0.438	V3816.453T	EN005531	3914.386	EN028531	C-7687-00WDE4-2



REF. DWG. NO. BC7687-0 FOR MATERIAL NOTES
ALL DIMENSIONS IN INCHES

ENERGY REV.		REVISION DATE	
A		10/12/07	

ESI NO.	
BC-7687-4	

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ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

NOTES

- Item #3, #4 and #6 are conductor dependent. Comps/Bundles are selected for each project and are Applied with Armor Rod, unless specifically noted.
- For Braided Post individual part details see insulator Mfg. drawings.
- Note that 161 kV insulators are used for 115 & 138 kV applications.
- Stock code shown is for Pre-Cut Chain. All hardware is 14, unless noted from EN018717.
- For Hardware Only add suffix \"-H\" to Assembly Cat. No. Ex: C-7648-BP2-1-H

MIN. ELEC./MECH. SPECIFICATIONS

MIN. ELECTRICAL VALUES
60 HZ DRY FO 590 KV
60 HZ WET FO 510 KV
CFO+
960 KV
1020 KV
STRIKE DIST. 60 IN.
LEAKAGE DIST. 140 IN.
MIN. MECHANICAL STRENGTH
MOUL. SUBMIT CURVES

BILL OF MATERIALS

INSULATOR, 2-1/2\" POLYMER BRACED LINE POST ASSY FOR 161KV

ITEM	QUANTITY	STOCK NO.	DESCRIPTION	CATALOG NUMBER	BASIC MATERIAL	WEIGHT (LBS)	STRENGTH (LBS)	ULTIMATE
1	1	EN004375	RAIL CLEVIS, 45 DEG Y, 3/8\" U.T., 3/4\" PIN DIA	YCB-65A	F.S.	2.2	35,000	
2	1	EN016149	INSULATOR, 2-1/2\" BRACED POST ASSY, POLYMER, HIGH POL. 161KV	B201076AL48A	COMP.	101.3	SEE APP. CURVE	
3	1	LS9003XX	ROD, ARMOR, PREFORMED, ALUMINUM, VARIABLE CONDUCTOR SIZE	SEE TABLE	ALUM.	VARES	25,000 U.N.O.	
4	1	LS9008XX	CLAMP, SUSPENSION, ALUMINUM, VARIABLE WIRE SIZE, W/SOCKET EYE	SEE TABLE	AL/D.I.	VARES	25,000 U.N.O.	
5	1	32103543	CHAIN, STL., GALVANIZED, 1.78 LBS/FT., 72.4K U.T.	CHS/78-14LK	F.S.	4.2	72,400	
6	1	LS9155XX	Y-CLAMP, VERTICAL DOUBLE BUNDLE, VARIABLE SIZE WIRE	SEE TABLE	AL/D.I.	VARES	25,000 *	
7	1	EN018718	Y-CLEVIS-CLEVIS (SUPPLIED AS PART OF ITEM 2)	YCC-65	D.I.	1.4	30,000	
8	1	EN014658	INSULATOR, SUSPENSION (SUPPLIED AS PART OF ITEM 2)	S148073VA12	COMP.	16.5	35,000	
9	1	EN018719	SOCKET CLEVIS H. L. (SUPPLIED AS PART OF ITEM 2)	SCHL-55	D.I.	3.3	30,000	
10	1	EN014653	INSULATOR, POST (SUPPLIED AS PART OF ITEM 2)	H201076V16	COMP.	75.2	SEE APP. CURVE	
11	1	EN020581	RING, CORONA (SUPPLIED AS PART OF ITEM 8)	CR16/78-8	ALUM.	4.0	N/A	

* ULTIMATE STRENGTH FOR BUNDLING YOKE IS AS AN ASSEMBLY

FOR SINGLE CONDUCTORS (BP2)									
CONDUCTOR	ARMOR ROD (ITEM 3)	ENTERGY W/ITEM 4	CLAMP (ITEM 4)	ENTERGY STOCK NO.	ASSEMBLY CATALOG NO.	BUNDLE (ITEM 6)	ENTERGY STOCK NO.	ASSEMBLY CATALOG NO.	
1949 (56/1), LAPWING	INCL. w/ITEM 4	32068997	TL5-0115SE **	32068997	NOT YET ASSIGNED	N/A	N/A	N/A	
1592 (33/1), BITTERN	INCL. w/ITEM 4	32068992	AGS-5138	32068992	NOT YET ASSIGNED	N/A	N/A	N/A	
1428 (33/1), BEAUMONT	INCL. w/ITEM 4	32068988	TL5-0115SE	32068988	NOT YET ASSIGNED	N/A	N/A	N/A	
1222 (33/1), CARDINAL	INCL. w/ITEM 4	32068975	TL5-0115SE	32068975	NOT YET ASSIGNED	N/A	N/A	N/A	
821 (18/1), GROSBEAK	INCL. w/ITEM 4	32068963	AGS-244-20-20-S	EN028863	C-8083-BP2-4	VACES-18-2442020-S	32127531	NOT YET ASSIGNED	
1590 (45/7), LAPWING	AR-0163	EN000381	AGS-214-20-20-S	32020716	C-8083-BP2-2	VACES-18-2142020-S	32127530	NOT YET ASSIGNED	
1272 (45/7), BITTERN	AR-0146	EN000155	AGS-175-20-20-S	32020714	C-8083-BP2-1	VACES-18-1752020-S	32127527	NOT YET ASSIGNED	
954 (54/7), CARDINAL	AR-0143	EN000383	ASC-11-S	EN0004361	C-7648-BP2-6	VLS-12-1111-S	EN027828	C-7648-BP2B-6	
666.6 (24/7), FLAMINGO	AR-0137	EN000384	ASC-11-S	EN0004361	C-7648-BP2-4	VLS-12-1111-S	EN027828	C-7648-BP2B-4	
1780 (84/15), CHICKAR	AR-0165	EN000382	ASC-11-S	EN0004361	C-7648-BP2-4	VLS-12-1111-S	EN027828	C-7648-BP2B-4	
1590 (45/7), LAPWING	AR-0163	EN000381	ASC-11-S	EN0004361	C-7648-BP2-4	VLS-12-1111-S	EN027828	C-7648-BP2B-4	
1272 (45/7), BITTERN	AR-0146	EN000155	LS-9-S	EN000370	C-7648-BP2-8	VLS-12-99-S	EN027829	C-7648-BP2B-8	
954 (54/7), CARDINAL	AR-0143	EN000383	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
666.6 (24/7), FLAMINGO	AR-0137	EN000384	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1780 (84/15), CHICKAR	AR-0165	EN000382	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1590 (45/7), LAPWING	AR-0163	EN000381	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1272 (45/7), BITTERN	AR-0146	EN000155	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
954 (54/7), CARDINAL	AR-0143	EN000383	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
666.6 (24/7), FLAMINGO	AR-0137	EN000384	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1780 (84/15), CHICKAR	AR-0165	EN000382	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1590 (45/7), LAPWING	AR-0163	EN000381	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1272 (45/7), BITTERN	AR-0146	EN000155	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
954 (54/7), CARDINAL	AR-0143	EN000383	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
666.6 (24/7), FLAMINGO	AR-0137	EN000384	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1780 (84/15), CHICKAR	AR-0165	EN000382	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1590 (45/7), LAPWING	AR-0163	EN000381	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1272 (45/7), BITTERN	AR-0146	EN000155	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
954 (54/7), CARDINAL	AR-0143	EN000383	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
666.6 (24/7), FLAMINGO	AR-0137	EN000384	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1780 (84/15), CHICKAR	AR-0165	EN000382	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1590 (45/7), LAPWING	AR-0163	EN000381	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1272 (45/7), BITTERN	AR-0146	EN000155	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
954 (54/7), CARDINAL	AR-0143	EN000383	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
666.6 (24/7), FLAMINGO	AR-0137	EN000384	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1780 (84/15), CHICKAR	AR-0165	EN000382	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1590 (45/7), LAPWING	AR-0163	EN000381	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1272 (45/7), BITTERN	AR-0146	EN000155	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
954 (54/7), CARDINAL	AR-0143	EN000383	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
666.6 (24/7), FLAMINGO	AR-0137	EN000384	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1780 (84/15), CHICKAR	AR-0165	EN000382	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1590 (45/7), LAPWING	AR-0163	EN000381	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1272 (45/7), BITTERN	AR-0146	EN000155	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
954 (54/7), CARDINAL	AR-0143	EN000383	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
666.6 (24/7), FLAMINGO	AR-0137	EN000384	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1780 (84/15), CHICKAR	AR-0165	EN000382	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1590 (45/7), LAPWING	AR-0163	EN000381	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1272 (45/7), BITTERN	AR-0146	EN000155	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
954 (54/7), CARDINAL	AR-0143	EN000383	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
666.6 (24/7), FLAMINGO	AR-0137	EN000384	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1780 (84/15), CHICKAR	AR-0165	EN000382	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1590 (45/7), LAPWING	AR-0163	EN000381	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1272 (45/7), BITTERN	AR-0146	EN000155	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
954 (54/7), CARDINAL	AR-0143	EN000383	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
666.6 (24/7), FLAMINGO	AR-0137	EN000384	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1780 (84/15), CHICKAR	AR-0165	EN000382	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1590 (45/7), LAPWING	AR-0163	EN000381	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1272 (45/7), BITTERN	AR-0146	EN000155	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
954 (54/7), CARDINAL	AR-0143	EN000383	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
666.6 (24/7), FLAMINGO	AR-0137	EN000384	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1780 (84/15), CHICKAR	AR-0165	EN000382	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1590 (45/7), LAPWING	AR-0163	EN000381	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1272 (45/7), BITTERN	AR-0146	EN000155	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
954 (54/7), CARDINAL	AR-0143	EN000383	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
666.6 (24/7), FLAMINGO	AR-0137	EN000384	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1780 (84/15), CHICKAR	AR-0165	EN000382	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1590 (45/7), LAPWING	AR-0163	EN000381	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1272 (45/7), BITTERN	AR-0146	EN000155	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
954 (54/7), CARDINAL	AR-0143	EN000383	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
666.6 (24/7), FLAMINGO	AR-0137	EN000384	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1780 (84/15), CHICKAR	AR-0165	EN000382	LS-8-S	EN000370	C-7648-BP2-3	VLS-12-88-S	EN027825	C-7648-BP2B-3	
1590 (45/7), LAPWING	AR-0163								

ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

[illegible]

ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS									
INSULATOR, DEADEND, POLYMER WITH TURNBUCKLE, 161KV									
ITEM	QTY	DE2	DE4	STOCK NO.	DESCRIPTION	CATALOG NUMBER	BASIC MATERIAL E.A. (LBS)	WEIGHT (LBS)	ULTIMATE STR. (LBS)
1	1	1	1	EN015705	SKT. CLEVS, HOT LINE, 45 DEG Y, 10-15/16" LONG, 50K ULT, 7/8" PIN	SYCHL-87	D.I.	3.45	50,000
2	1	1	1	EN014810	INSULATOR, DE, POLYMER, HIGH POLLUTION, 50K LB SML, 161KV	S29802VA10	COMP.	23.3	50,000
3	1	1	1	EN015176	LINK, EXTENSION, CLEVS-CLEVS, 15" C-C, 50K ULT	YCYCHL-77	D.I.	10.0	50,000
4	1	1	1	LS9004XX	TERMINAL CONNECTOR, 15 DEG, FOR VARIABLE SIZE WIRE	SEE TABLE	ALUM.	VARIES	-
5	1	1	1	LS9003XX	TERMINAL CONNECTOR, 15 DEG, FOR VARIABLE SIZE WIRE	SEE TABLE	ALUM.	VARIES	-
6	1	1	1	LS913XX	DEADEND, ALUM. COMP. BODY, SINGLE TONGUE, FOR VAR. SIZE WIRE	SEE TABLE	ALUM.	VARIES	-
7	1	1	1	LS9029	JUMPER BRACE (NOT INCLUDED WITH ASSEMBLY)	SEE TABLE	ALUM.	VARIES	-
8	1	1	1	EN015815	TURNBUCKLE, 1" x 6", JAW-EYE	G227N-BC-1x6	F.S.	9.2	50,000
9	1	1	1	EN015815	TURNBUCKLE, 1" x 6", JAW-EYE	SEE TABLE	F.S.	9.2	50,000
10	1	1	1	EN015815	TURNBUCKLE, 1" x 6", JAW-EYE	SEE TABLE	F.S.	9.2	50,000
11	1	1	1	EN015815	TURNBUCKLE, 1" x 6", JAW-EYE	SEE TABLE	F.S.	9.2	50,000
12	1	1	1	EN015815	TURNBUCKLE, 1" x 6", JAW-EYE	SEE TABLE	F.S.	9.2	50,000
13	1	1	1	EN015815	TURNBUCKLE, 1" x 6", JAW-EYE	SEE TABLE	F.S.	9.2	50,000
14	1	1	1	EN015815	TURNBUCKLE, 1" x 6", JAW-EYE	SEE TABLE	F.S.	9.2	50,000
15	1	1	1	EN020683	RING, CORONA (SUPPLIED WITH ITEM 2)	CR24/32-8	ALUM.	5.0	N/A
16	1	1	1	EN020683	RING, CORONA (SUPPLIED WITH ITEM 2)	NOTE 3	-	-	N/A
17	1	1	1	EN020683	RING, CORONA (SUPPLIED WITH ITEM 2)	NOTE 4	-	-	N/A
COND. DIA. (IN)									
1949.0 (56/7)	LAPMING	1.504	5600-1090NT	32181749	600-353-1	32181749	NOT YET ASSIGNED	N/A	N/A
1982.0 (33/7)	BITTERN	1.345	5600-1090NT	32069426	600-253-11	32069448	NOT YET ASSIGNED	N/A	N/A
1428.5 (33/7)	BEALMONT	1.294	5600-1078NT	32181745	600-253-9	3201160	NOT YET ASSIGNED	N/A	N/A
1222.0 (33/7)	CARDINAL	1.198	5600-1078NT	32069424	600-253-7	32069447	NOT YET ASSIGNED	N/A	N/A
821.2 (15/7)	GROSBREAK	0.990	5600-1050NT	32069419	600-153-7	32069445	NOT YET ASSIGNED	N/A	N/A
1950.0 (45/7)	LAPMING	1.504	E3373HT-NT	32020679	5140162HT-S5	32003549	C-8083-DE2-4	N/A	N/A
1272.0 (45/7)	BITTERN	1.345	E3373HT-NT	32020677	5136144HT-S5	32020420	C-8083-DE2-3	N/A	N/A
954.0 (54/7)	CARDINAL	1.196	E3373HT-NT	32019804	5130125HT-S5	32019813	C-8083-DE2-2	N/A	N/A
1760.0 (84/7)	FLAMINGO	1.602	ENG3373HT-NT	32020675	5127106HT-S5	32020419	C-8083-DE2-1	N/A	N/A
1590.0 (45/7)	LAPMING	1.504	VES-174-NT	EN004275	TF-17-S5	EN004445	C-7648-DE2-7	ADP-27-CE-S8	EN005957 C-7648-DE4-4
1272.0 (45/7)	BITTERN	1.345	VES-164-NT	EN000161	TF-16-S5	EN000164	C-7648-DE2-6	ADP-27-S8	EN005721 C-7648-DE4-2
1033.5 (45/7)	ORTOLAN	1.213	VES-153-NT	32009718	TF-15-S5	EN004447	C-7648-DE2-13	ADP-2526-S8	EN005015 C-7648-DE4-1
954.0 (54/7)	CARDINAL	1.196	VES-135-NT	EN004083	TF-13-S5	EN004447	C-7648-DE2-4	ADP-2526-S8	EN005015 C-7648-DE4-1
954.0 (45/7)	RAIL	1.165	VES-133-NT	EN004352	TF-13-S5	EN004447	C-7648-DE2-3	ADP-2526-S8	EN005015 C-7648-DE4-1
795.0 (26/7)	DRAKE	1.108	VES-126-NT	EN027808	TF-12-S5	EN027817	C-7648-DE2-2	ADP-2526-S8	EN005015 C-7648-DE4-1
666.6 (24/7)	FLAMINGO	1.000	VES-115-NT	EN004277	TF-11-S5	EN004448	C-7648-DE2-1	ADP-24-S8	EN005298 C-7648-DE4-3
336.4 (26/7)	LINNET	0.720	VES-086-NT	EN004278	TF-08-S5	EN004449	C-7648-DE2-12	ADP-2526-S8	EN005015 C-7648-DE4-1
1024.5 (24/13)		1.165	VES-130-NT	EN027818	TF-13-S5	EN027819	C-7648-DE2-11	ADP-2526-S8	EN005015 C-7648-DE4-1
648.5 (16/7)		0.928	VES-100-NT	EN027817	TF-10-S5	EN027818	C-7648-DE2-10	ADP-24-S8	EN005298 C-7648-DE4-3
395.2 (15/7)		0.720	VES-080-NT	EN027816	TF-08-S5	EN004449	C-7648-DE2-10	ADP-24-S8	EN005298 C-7648-DE4-3
FOR COMPRESSION ASSEMBLY (DE2)									
FOR BOLTED ASSEMBLY (DE4)									
ENTERTY SERVICES, INC.									
TRANSMISSION LINE STANDARD									
POLYMER ASST., DEADEND W/ TURNBUCKLE									
161 KV INSULATOR ASSEMBLY DETAIL									
STANDARD NO. TCA205A5									
PLOT 1:24 SH.1 DF.1									

20 5/8" (CLOSED)
26 5/8" (OPEN)

15"

92"

12"

7/8" BOLT
1 3/16" JAW OPENING

COMPRESSION ASSEMBLY

52-11 SOCKET EYE (SEE NOTE 2)

BOLTED ASSEMBLY

ALTERNATE PARTS
NOT PERMITTED FOR ACSS & ACCC
(SEE NOTE 2)

JUMPER CONNECTION
(NOT INCL. WITH ASSY.)

NOTES

1) Item #4, #5, #6 and #7 are conductor dependent and are selected for each project.

2) Designer may substitute #6 and #7 for items #4 and #5. Strain clamp shall include socket eye for a 52-11 ball. Use of bolted clamps will require the use of non-tension jumper splices.

3) ACSS & ACCC terminals and compression DE fittings are supplied pre-filled (zero quantity req.). Make up as needed with EN005687 (AFC107). ACSS compression hardware requires High Temp. Compound 32063032 (AFC01107). ACCC compression hardware requires High Temp. Compound 32119113 (PENHT-1LB).

4) ACSS & ACCC terminals require normal temperature joint compound EN019252 (CTB8). ACSS & ACCC terminals require high temperature joint compound 3211109 (ALNOX107).

5) For hardware only, add suffix "-H" to assembly catalog number.

Ex.: C-7648-DE2-1-H.

MIN. ELEC. MECH. SPECIFICATIONS

MIN. ELECTRICAL VALUES
60 HZ DRY FO 690 KV
60 HZ WET FO 625 KV
CFO+ 1215 KV
CFO- 1275 KV
DRY ARC DIST. 75 IN.
LEAKAGE DIST. 180 IN.
MIN. MECHANICAL STRENGTH
ULT. 50,000 LBS

ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS

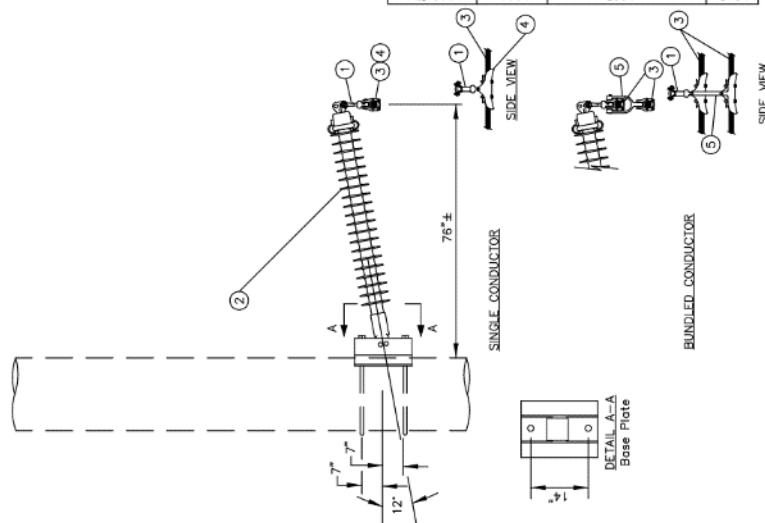
ITEM	QUANTITY J/LP	STOCK NO.	DESCRIPTION	CATALOG NUMBER	BASIC MATERIAL	WEIGHT EA. (LBS)	STRENGTH (LBS)	ULTIMATE
1	1	32004375	BALL CLEVIS, 45 DEG Y, 3/8" ULT, 3/4" PIN DIA	H9B-65A	C.S.	2.2	35,000	
2	1	EN204117	INSULATOR, 2-1/2" POST, POLYMER, HIGH PHL 161 kV	Y291078VAG4	FMP.	80.2	SEE APP. CURVE	
3	1 *	LS9003XX	ROD, ARMOR, PREFORMED, ALUMINUM, VARIABLE CONDUCTOR SIZE	SEE TABLE	AL/VOL	VARIES	N/A	
4	1 *	LS9008XX	CLAMP, SUSPENSION, ALUMINUM, VARIABLE WIRE SIZE #/SOCKET EYE	SEE TABLE	AL/VOL	VARIES	25,000 U.N.O.	
5	1	LS915XX	Yoke, VERTICAL DOUBLE BUNDLE, VARIABLE SIZE WIRE	SEE TABLE	AL/VOL	VARIES	25,000 U.N.O. **	
6	-	32093707	RING, CORONA (SUPPLIED WITH ITEM 2.)	LP25CR6	ALUM.	5.0	N/A	

* ITEM NOT REQUIRED WHEN USING ACAR & ACSR CONDUCTORS ** ULTIMATE STRENGTH FOR BUNDLING YOKE IS AS AN ASSEMBLY

	CONDUCTOR	ARMOR ROD	ENTERGY STK. NO.	DIA. (IN)	TAKEOFF ANGLE (DEG)	FOR SINGLE CONDUCTORS (ΔP)				FOR BUNDLED CONDUCTORS (ΔPB)			
						CLAMP (ITEM 4)	ENTERGY STOCK NO.	ASSEMBLY CATALOG. NO.	BUNDLE (ITEM 5)	ENTERGY STOCK NO.	ASSEMBLY CATALOG. NO.		
ACCC/TW	1949 (56/1), LAPWING	INCL. w/ ITEM 4	—	—	—	TL5-01195E ***	32068992	NOT YET ASSIGNED	N/A	N/A	N/A	N/A	N/A
	1582 (33/1), BITTERN	INCL. w/ ITEM 4	—	—	—	TL5-01155E ***	32068992	NOT YET ASSIGNED	N/A	N/A	N/A	N/A	N/A
	1428 (33/1), BEAUKONT	INCL. w/ ITEM 4	—	—	—	A05-5138	32062067	NOT YET ASSIGNED	N/A	N/A	N/A	N/A	N/A
	1222 (33/1), CARDINAL	INCL. w/ ITEM 4	—	—	—	TL5-01151E	32069988	NOT YET ASSIGNED	N/A	N/A	N/A	N/A	N/A
ACSS	1821 (18/1), GROSBEAK	INCL. w/ ITEM 4	—	—	—	TL5-01055E	—	NOT YET ASSIGNED	N/A	N/A	N/A	N/A	N/A
	1590 (45/7), LAPWING	ARAI590-45-59 32117836	2.376	15	—	ACFS-244-20-20-S	32026983	C-80B3-ΔP-4	VBAGFS-18-2442020-S	32127531	NOT YET ASSIGNED	—	—
	1590 (45/7), LAPWING	ARAI590-45-59 32117836	2.075	15	—	ACFS-244-20-20-S	32027016	C-80B3-ΔP-2	VBAGFS-18-1862020-S	32127530	NOT YET ASSIGNED	—	—
	1272 (54/7), BITTERN	ARAI272-45-51 32117829	1.816	15	—	ACFS-186-20-20-S	32020716	C-80B3-ΔP-2	VBAGFS-18-1862020-S	32127529	NOT YET ASSIGNED	—	—
	954 (54/7), CARDINAL	ARAB54-45-51 32117829	1.816	15	—	ACFS-186-20-20-S	32020716	C-80B3-ΔP-2	VBAGFS-18-1862020-S	32127529	NOT YET ASSIGNED	—	—
	666.6 (24/7), FLAMINGO	ARAB66-26-45 32117825	1.620	15	—	ACFS-175-20-20-S	32020716	C-80B3-ΔP-1	VBAGFS-17-1752020-S	32127527	NOT YET ASSIGNED	—	—
	1780 (64/7), CHUKAR	—	1.602	30	—	LS-9-S	EN000370	C-7648-ΔLP-1	VBLS-12-1-86-S	EN027655	C-7648-ΔLPB-5	—	—
	1590 (45/7), LAPWING	—	—	1.504	30	LS-7-S	EN000366	C-7648-ΔLP-4	VBLS-12-7-77-S	EN027624	C-7648-ΔLPB-4	—	—
	1322 (45/7), BITTERN	—	—	1.345	30	LS-6-S	EN000158	C-7648-ΔLP-3	VBLS-12-6-6-S	EN027623	C-7648-ΔLPB-3	—	—
	1033.5 (46/7), ORTOLAN	—	—	1.213	30	LS-6-S	EN000158	C-7648-ΔLP-7	VBLS-12-6-6-S	EN027623	C-7648-ΔLPB-7	—	—
ACSR	954 (54/7), CARDINAL	—	—	1.196	30	LS-6-S	EN000158	C-7648-ΔLP-3	VBLS-12-6-6-S	EN027623	C-7648-ΔLPB-3	—	—
	785 (28/7), RAIL	—	—	1.165	30	LS-6-S	EN000158	C-7648-ΔLP-6	VBLS-12-6-6-S	EN027623	C-7648-ΔLPB-6	—	—
	785 (28/7), DRAKE	—	—	1.108	30	LS-6-S	EN000158	C-7648-ΔLP-2	VBLS-12-6-6-S	EN027623	C-7648-ΔLPB-2	—	—
	666.6 (24/7), FLAMINGO	—	—	1.070	30	LS-2-S	EN000397	C-7648-ΔLP-2	VBLS-12-2-2-S	EN027622	C-7648-ΔLPB-2	—	—
	336.4 (26/7), UNNET	—	—	0.720	30	LS-1-S ***	EN000392	C-7648-ΔLP-1	VBLS-12-2-2-S	EN027623	C-7648-ΔLPB-1	—	—
	1024.5 24/13	—	—	1.165	30	LS-6-S	EN000158	C-7648-ΔLP-1	VBLS-12-6-6-S	EN027623	C-7648-ΔLPB-2	—	—
ACSR	649.5 18/19	—	—	0.720	30	LS-2-S	EN000387	C-7648-ΔLP-2	VBLS-12-2-2-S	EN027622	C-7648-ΔLPB-2	—	—
	395.25 15/17	—	—	0.820	30	LS-1-S ***	EN000392	C-7648-ΔLP-1	VBLS-12-2-2-S	EN027622	C-7648-ΔLPB-2	—	—

MIN. ELEC./MECH. SPECIFICATIONS

MIN. ELECTRICAL VALUES
60 HZ DRY F0 590 KV
60 HZ WET F0 510 KV
CFO+ 960 KV
CFO- 1020 KV
STRIKE DIST. 60 IN.
LEAKAGE DIST. 140 IN.
MIN. MECHANICAL STRENGTH
MDCL 1176 LBS.



NOTES

- 1) Item #3, #4 and #5 are conductor dependent.
Clamps/Bundles are selected for each project and are
Applied with Armor Rod, unless specifically noted.
- 2) Note that 161 kV Insulators are used for 115 kV
138 kV and 161 kV applications.
- 3) For Hardware Only, add suffix "-H" to Assembly Cat. No.
Ex: C-7648-JLH-1-H

[illegible]

JLP-161-XX

Y SERVICES, INC.

TRANSMISSION LINE STANDARD
POLYMER ASSY., 2 1/2" JUMPER LINE POST
161 kV INSULATOR ASSEMBLY DETAIL

Q NO.	TA0504	SCALE:	N. T. S.
		No. TCA207A5	

PLOT	1:24	SH. 1	DF 1

100

INSULATOR LINE SUSPENSION HEAVY POLYMER WITH LINK 161xV

BILL OF MATERIALS

QUANTITY	ITEM	SHL	SHLB	STOCK NO.	DESCRIPTION	CATALOG NUMBER	BASIC MATERIAL	WEIGHT (LBS)	ULTIMATE STRENGTH (LBS)
1	1	1	1	EN01576	LINK, EXTENSION, CLEVIS-15" 50K ULT.	YCHL-77	COMP.	23	50,000
2	1	1	1	EN014810	INSULATOR, DEADEND, EYE-BALL, POLYMER, HIGH POLL, 161 KV, 50K	S28092V10	COMP.	10	50,000
3	1	2	1	LS9003XX	ROD, ARMOR, PREFORMED, ALUMINUM, VARIABLE CONDUCTOR SIZE	SEE TABLE	AL/D.L.	VARIES	N/A
4	1	1	1	LS9008XX	CLAMP, SUSPENSION, ALUMINUM, VARIABLE WIRE SIZE, W/SOCKET EYE	SEE TABLE	AL/D.L.	VARIES	25,000 U.N.O.
5	1	1	1	LS9044XX	SOCKET EYE, VARIABLE WIDTH, FOR 52-11 BALL (ACCC ONLY)	SEE TABLE	F.S.	VARIES	VARIES
6	1	1	1	LS915XX	YOKER, VERTICAL DOUBLE BUNDLE, VARIABLE SIZE WIRE	SEE TABLE	AL/D.L.	VARIES	25,000 *
7	1	1	1	EN020683	RING, CORONA (SUPPLIED WITH ITEM 2)	CR24-32-8	ALUM.	5	N/A
8	1	1	1	EN020683	RING, CORONA (SUPPLIED WITH ITEM 2)	CR24-32-8	ALUM.	5	N/A
9	1	1	1	EN020683	RING, CORONA (SUPPLIED WITH ITEM 2)	CR24-32-8	ALUM.	5	N/A
10	1	1	1	EN020683	RING, CORONA (SUPPLIED WITH ITEM 2)	CR24-32-8	ALUM.	5	N/A
11	1	1	1	EN020683	RING, CORONA (SUPPLIED WITH ITEM 2)	CR24-32-8	ALUM.	5	N/A

QUANTITY	ITEM	SHL	SHLB	STOCK NO.	DESCRIPTION	CATALOG NUMBER	BASIC MATERIAL	WEIGHT (LBS)	ULTIMATE STRENGTH (LBS)
1	1	1	1	EN01576	LINK, EXTENSION, CLEVIS-15" 50K ULT.	YCHL-77	COMP.	23	50,000
2	1	1	1	EN014810	INSULATOR, DEADEND, EYE-BALL, POLYMER, HIGH POLL, 161 KV, 50K	S28092V10	COMP.	10	50,000
3	1	2	1	LS9003XX	ROD, ARMOR, PREFORMED, ALUMINUM, VARIABLE CONDUCTOR SIZE	SEE TABLE	AL/D.L.	VARIES	N/A
4	1	1	1	LS9008XX	CLAMP, SUSPENSION, ALUMINUM, VARIABLE WIRE SIZE, W/SOCKET EYE	SEE TABLE	AL/D.L.	VARIES	25,000 U.N.O.
5	1	1	1	LS9044XX	SOCKET EYE, VARIABLE WIDTH, FOR 52-11 BALL (ACCC ONLY)	SEE TABLE	F.S.	VARIES	VARIES
6	1	1	1	LS915XX	YOKER, VERTICAL DOUBLE BUNDLE, VARIABLE SIZE WIRE	SEE TABLE	AL/D.L.	VARIES	25,000 *
7	1	1	1	EN020683	RING, CORONA (SUPPLIED WITH ITEM 2)	CR24-32-8	ALUM.	5	N/A
8	1	1	1	EN020683	RING, CORONA (SUPPLIED WITH ITEM 2)	CR24-32-8	ALUM.	5	N/A
9	1	1	1	EN020683	RING, CORONA (SUPPLIED WITH ITEM 2)	CR24-32-8	ALUM.	5	N/A
10	1	1	1	EN020683	RING, CORONA (SUPPLIED WITH ITEM 2)	CR24-32-8	ALUM.	5	N/A
11	1	1	1	EN020683	RING, CORONA (SUPPLIED WITH ITEM 2)	CR24-32-8	ALUM.	5	N/A

QUANTITY	ITEM	SHL	SHLB	STOCK NO.	DESCRIPTION	CATALOG NUMBER	BASIC MATERIAL	WEIGHT (LBS)	ULTIMATE STRENGTH (LBS)
1	1	1	1	EN01576	LINK, EXTENSION, CLEVIS-15" 50K ULT.	YCHL-77	COMP.	23	50,000
2	1	1	1	EN014810	INSULATOR, DEADEND, EYE-BALL, POLYMER, HIGH POLL, 161 KV, 50K	S28092V10	COMP.	10	50,000
3	1	2	1	LS9003XX	ROD, ARMOR, PREFORMED, ALUMINUM, VARIABLE CONDUCTOR SIZE	SEE TABLE	AL/D.L.	VARIES	N/A
4	1	1	1	LS9008XX	CLAMP, SUSPENSION, ALUMINUM, VARIABLE WIRE SIZE, W/SOCKET EYE	SEE TABLE	AL/D.L.	VARIES	25,000 U.N.O.
5	1	1	1	LS9044XX	SOCKET EYE, VARIABLE WIDTH, FOR 52-11 BALL (ACCC ONLY)	SEE TABLE	F.S.	VARIES	VARIES
6	1	1	1	LS915XX	YOKER, VERTICAL DOUBLE BUNDLE, VARIABLE SIZE WIRE	SEE TABLE	AL/D.L.	VARIES	25,000 *
7	1	1	1	EN020683	RING, CORONA (SUPPLIED WITH ITEM 2)	CR24-32-8	ALUM.	5	N/A
8	1	1	1	EN020683	RING, CORONA (SUPPLIED WITH ITEM 2)	CR24-32-8	ALUM.	5	N/A
9	1	1	1	EN020683	RING, CORONA (SUPPLIED WITH ITEM 2)	CR24-32-8	ALUM.	5	N/A
10	1	1	1	EN020683	RING, CORONA (SUPPLIED WITH ITEM 2)	CR24-32-8	ALUM.	5	N/A
11	1	1	1	EN020683	RING, CORONA (SUPPLIED WITH ITEM 2)	CR24-32-8	ALUM.	5	N/A

QUANTITY	ITEM	SHL	SHLB	STOCK NO.	DESCRIPTION	CATALOG NUMBER	BASIC MATERIAL	WEIGHT (LBS)	ULTIMATE STRENGTH (LBS)
1	1	1	1	EN01576	LINK, EXTENSION, CLEVIS-15" 50K ULT.	YCHL-77	COMP.	23	50,000
2	1	1	1	EN014810	INSULATOR, DEADEND, EYE-BALL, POLYMER, HIGH POLL, 161 KV, 50K	S28092V10	COMP.	10	50,000
3	1	2	1	LS9003XX	ROD, ARMOR, PREFORMED, ALUMINUM, VARIABLE CONDUCTOR SIZE	SEE TABLE	AL/D.L.	VARIES	N/A
4	1	1	1	LS9008XX	CLAMP, SUSPENSION, ALUMINUM, VARIABLE WIRE SIZE, W/SOCKET EYE	SEE TABLE	AL/D.L.	VARIES	

ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

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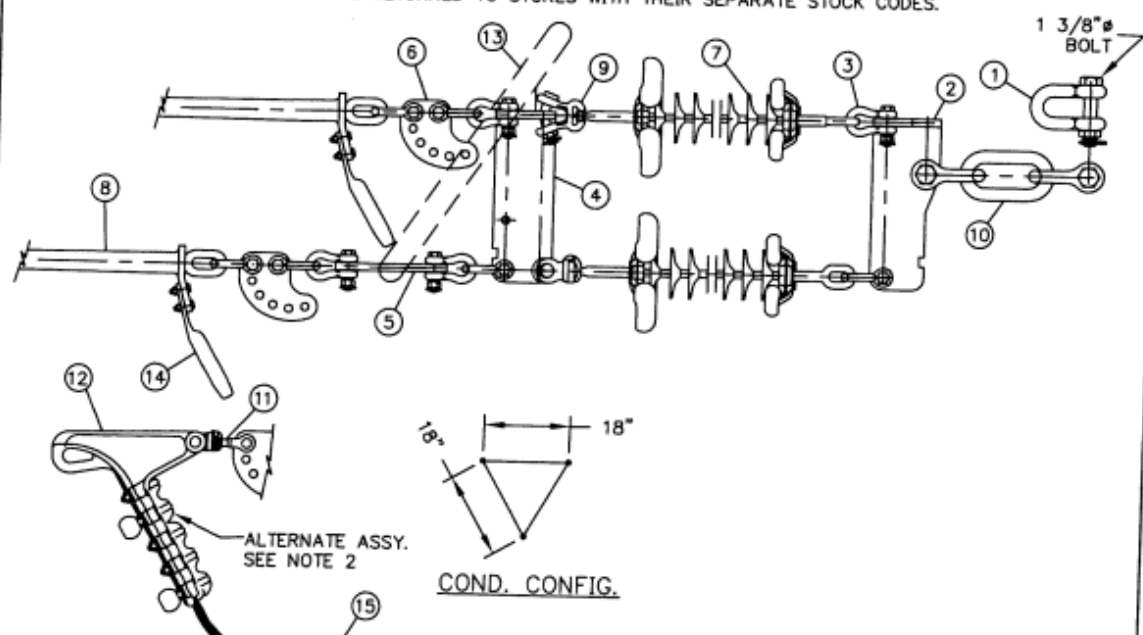
ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS				
DEADEND, POLYMER, WITH BUNDLING YOKE, 500KV				
ITEM	COMP. QTY.	BOLTED QTY.	STOCK NO.	DESCRIPTION
1	2	2	0032009672	SHACKLE, CHAIN, 150k ULT .STR.
2	1	1	0032009669	YOKE PLATE, TRIPLE BUNDLE, DEADEND, 18" SEPARATION, 110k ULT. STR.
3	14	11	0000000689	SHACKLE, ANCHOR, 60k ULT. STR.
4	1	1	0032009670	YOKE PLATE, TRIPLE BUNOLED, DEADEND, 18" SEPARATION, 110k ULT. STR.
5	1	1	0032009665	LINK EXTENSION, EYE-EYE, 40k ULT. STR.
6	3	3	0032009668	PLATE, ADJUSTMENT, 40k ULT. STR.
7	3	3	0032000342	INSULATOR, LINE, EYE-BALL, POLYMER, 500kv, 50k ULT .STR.
8	3		LS9012XX	DEADEND, COMPRESSION, ALUMINIUM, SINGLE TONGUE, 33k, FOR VARIABLE
9	3	3	0000028529	SOCKET, Y-CLEVIS, 50k
10	1	1	0032000136	LINK, CHAIN, 132k ULT., 7" LONG
11		3	0032021867	CLEVIS BALL, 35k, BALL CLASS 52-3/5
12		3	LS9013XX	DEADEND, BOLTED, STRAIN, ALUM., 30k, FOR VARIABLE WIRE SIZE
13	1	1	0032009685	CORONA RING, 500kv DEADEND, ALUM.
14	3		LS9014XX	TERMINAL CONNECTOR, 15 DEG., FOR VARIABLE WIRE SIZE
15*		3	LS5029XX	JUMPER, SPLICE, FOR VARIABLE WIRE SIZE

CONDUCTOR	CONDUCTOR DIA.	COMP. D.E. (ITEMS 8 & 14)	ENTERGY STOCK NO.	ASSEMBLY CAT. NO.	ENTERGY STOCK NO.
1024 ACAR	1.165	VES-130-EHV**	0032000078	C-7686-DE1	NA
954.0 45/7 "RAIL"	1.165	VES-133-EHV**	0032021873	C-7686-DE2	NA
954 54/7 "CARDINAL"	1.196	VES-135-EHV**	0032021874	C-7686-DE4	NA

CONDUCTOR RANGE:	BOLTED STRAIN CLAMP (ITEM 12)	ENTERGY STOCK NO.	ASSEMBLY CAT. NO.	ENTERGY STOCK NO.
.710" - 1.318"	ADE-2526-S-SPH4	0000028892	C-7686-DE3	NA

* ITEMS 15 ARE NOT FURNISHED WITH THE MACLEAN ASSEMBLIES.
** COMPRESSION DEADEND BODIES COME WITH JUMPER TERMINALS, ITEM 14. EITHER OF OF ITEMS 8 AND 14 CAN BE RETURNED TO STORES WITH THEIR SEPARATE STOCK CODES.



COND. CONFIG.

1) ITEM #8, #12, #14 & #15 ARE CONDUCTOR DEPENDENT.
2) DESIGNER MAY SUBSTITUTE #11 & #12 & #15, FOR ITEMS #3 (QTY. 2) & #8. STRAIN CLAMP SHALL INCLUDE SOCKET EYE FOR A 52-3/5 BALL. USE OF BOLTED CLAMPS WILL REQUIRE THE USE OF NON-TENSION JUMPER SPLICES.

RE: MACLEAN DWG. BC-7686-1

ENTERGY SERVICES, INC.	
DEADEND, POLYMER, W/BUNDLING YOKE, 500kv	
STD NO.	SCALE: NONE
No. TFA200A0	
PLOT 1=1	SH. 1 OF 1

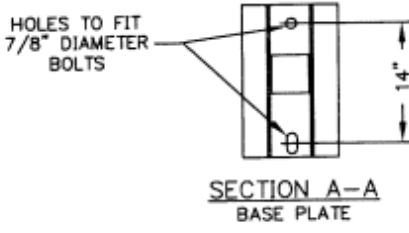
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NO.	DATE	REVISION	BY:	CHK: APPR
tfinc90	3/5/2007			

DEPY-500-XX; BC-7686-1

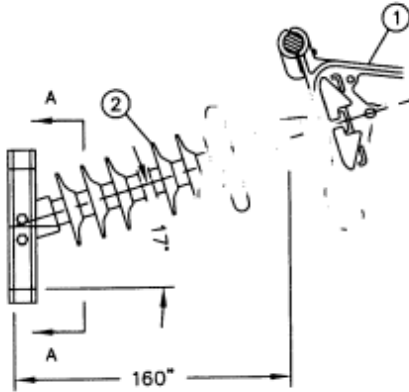
ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS					
JUMPER LINE POST, POLYMER, w/BUNDLING YOKE, HORIZONTAL, 500kV					
ITEM	QTY.	STOCK NO.	DESCRIPTION		
1	1	LS9015XX	JUMPER YOKE, 10k ULT. STR. 18" SEPARATION, ALUMINUM ALLOY		
2	1	0032021878	INSULATOR, LINE POST, 3", POLYMER, 500kV, 10k ULT. STR.		

CONDUCTOR	CONDUCTOR DIA.	JMPR. YOKE (ITEM 1)	ENTERGY STOCK NO.	ASSEMBLY CAT. NO.	ENTERGY STOCK NO.
1024 ACAR	1.165	C-7686-4	0032021850	C-7686-J2	NA
954.0 45/7 "RAIL"	1.165	C-7686-4	0032021850	C-7686-J2	NA
954 54/7 "CARDINAL"	1.196	C-7686-4A	0032021860	C-7686-J2A	NA



SECTION A-A
BASE PLATE



160"

1) ITEM #1 IS CONDUCTOR DEPENDENT. THIS ITEM IS SELECTED FOR EACH PROJECT (WITHOUT ARMOR RODS).

RE: MACLEAN DWG. BC-7686-4

ENTERGY SERVICES, INC.	
JUMPER LINE POST, POLYMER, W/YOKE, HOR, 500kV	
STD NO.	SCALE: NONE
No. TFA201A0	
PLOT 1=1 SH. 1 OF 1	

ENTERGY

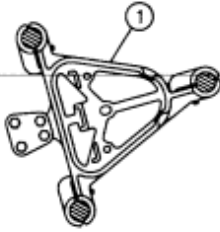
0	03-05-07	CREATED	TWF	HSK	
NO.	DATE	REVISION	BY	CHK	APPR

tfinc90 3/19/2007 JLPB-HJ-500-XX; BC-7686-4

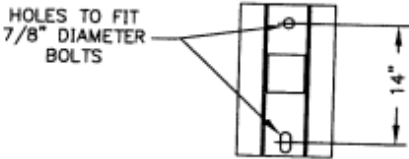
ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS					
JUMPER LINE POST, POLYMER, w/BUNDLING YOKE, VERTICAL, 500kV					
ITEM	QTY.	STOCK NO.	DESCRIPTION		
1	1	LS9015XX	JUMPER YOKE, 10k ULT. STR. 18" SEPARATION, ALUMINUM ALLOY		
2	1	0032021879	INSULATOR, LINE POST, 3", POLYMER, 500kV, 10k ULT. STR.		

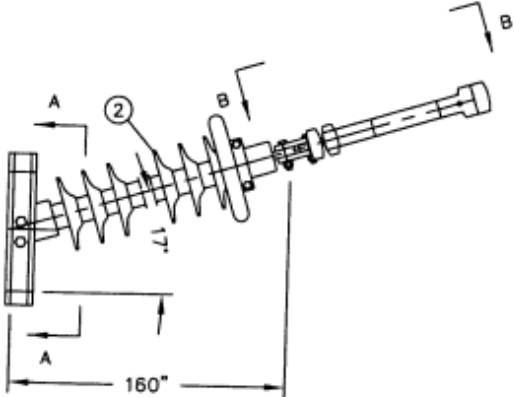
CONDUCTOR	CONDUCTOR DIA.	JMPR. YOKE (ITEM 1)	ENTERGY STOCK NO.	ASSEMBLY CAT. NO.	ENTERGY STOCK NO.
1024 ACAR	1.165	C-7686-4	0032021850	C-7686-J3	NA
954.0 45/7 "RAIL"	1.165	C-7686-4	0032021850	C-7686-J3	NA
954 54/7 "CARDINAL"	1.196	C-7686-4A	0032021860	C-7686-J3A	NA



SECTION B-B
YOKE PLATE



SECTION A-A
BASE PLATE



SECTION A-A
INSULATOR

1) ITEM #1 IS CONDUCTOR DEPENDENT. THIS ITEM IS SELECTED FOR EACH PROJECT (WITHOUT ARMOR RODS).

RE: MACLEAN DWG. BC-7686-5

ENTERGY SERVICES, INC.	
JUMPER LINE POST, POLYMER, W/YOKE, VER, 500kV	
STD NO.	SCALE: NONE
No. TFA202A0	
PLOT 1=1	SH.1 OF 1

0	03-05-07	CREATED	TWF	HSK	
NO.	DATE	REVISION	BY	CHK	APPR
tfinc90		3/5/2007			

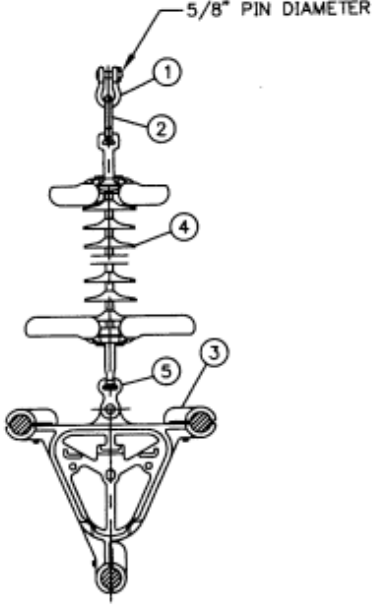


JLPB-VJ-500-XX; BC-7686-5

ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS					
JUMPER SUSPENSION, POLYMER, w/ BUNDLING YOKE 500kV					
ITEM	QTY.	STOCK NO.	DESCRIPTION		
1	1	0000004466	SHACKLE, ANCHOR, 30k ULT. STR., 5/8" PIN DIA. 2-13/16"		
2	1	0000028889	BALL EYE, OVAL, 35k ULT. STR., BALL CLASS 52-3/5		
3	1	LS9016XX	YOKE, JUMPER, 10k ULT. STR. 18" SEPARATION, ALUM. ALLOY		
4	1	0032000277	INSULATOR, SUSPENSION, B&S, POLYMER, 500kV, 25k ULT. STR.		
5	1	0032021870	CLEVIS, SOCKET, 30k ULT. STR., CLASS 52-3/5		

CONDUCTOR	CONDUCTOR DIA.	JMPR. YOKE (ITEM 3)	ENTERGY STOCK NO.	ASSEMBLY CAT. NO.	ENTERGY STOCK NO.
1024 ACAR	1.165	C-6549-3	0032021827	C-7686-J1	NA
954.0 45/7 "RAIL"	1.165	C-6549-3	0032021827	C-7686-J1	NA
954 54/7 "CARDINAL"	1.196	C-7686-5	0032021863	C-7686-J1A	NA



1) ITEM #3 IS CONDUCTOR DEPENDENT.
THIS ITEM IS SELECTED FOR EACH
PROJECT WITHOUT ARMOR RODS.

RE: MACLEAN DWG. BC-7686-2

ENTERGY SERVICES, INC.	
JUMPER SUSPENSION, POLYMER, W/YOKE, 500kV	
STD NO.	SCALE: NONE
No. TFA203A0	

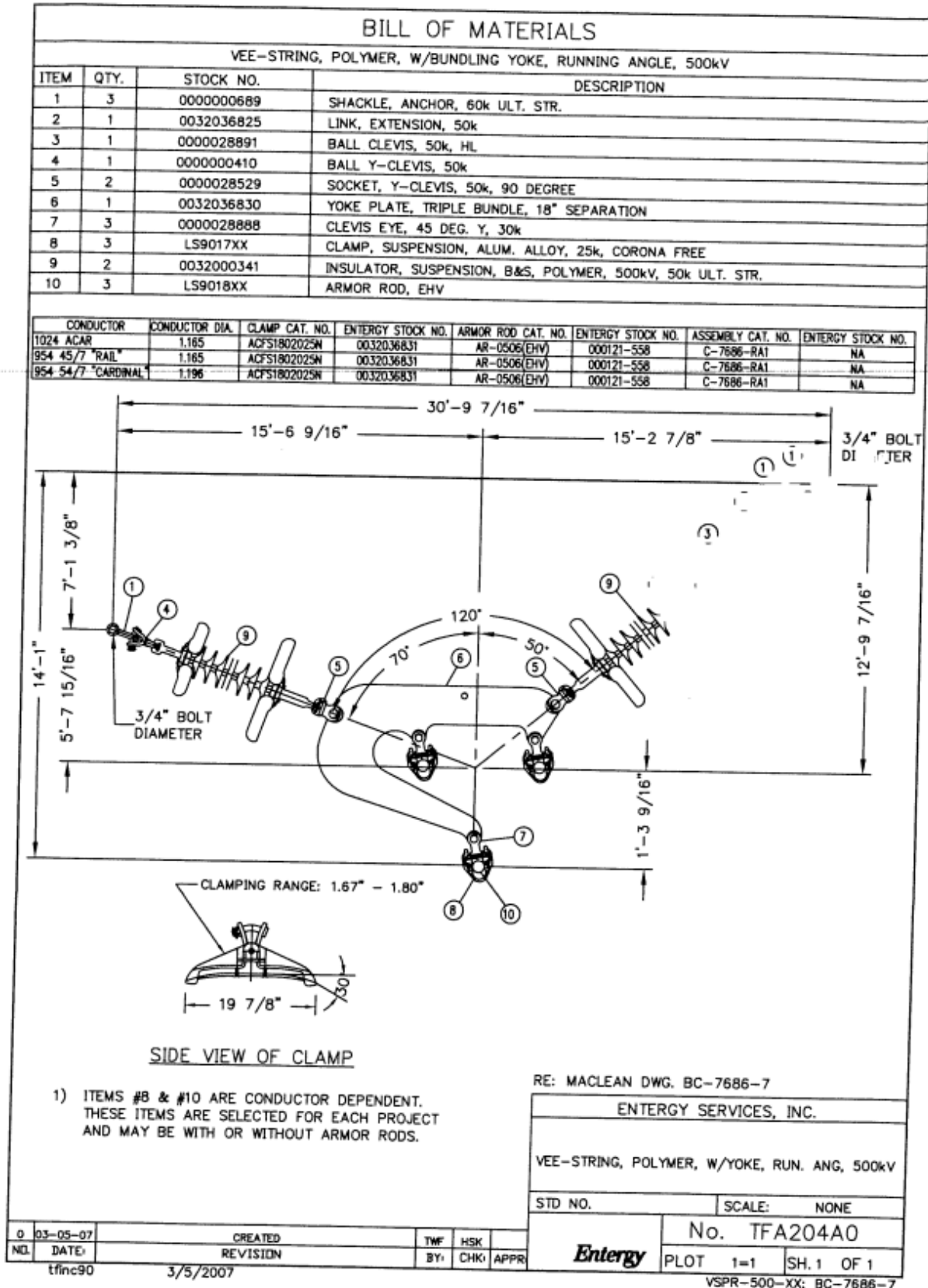
-05-07	CREATED	TWF	HSK	
DATE:	REVISION	BY:	CHK:	APP:
tfinc90	3 5 2007			



PLOT 1=1 SH. 1 OF 1

JSPB-500-XX; BC-7686-2

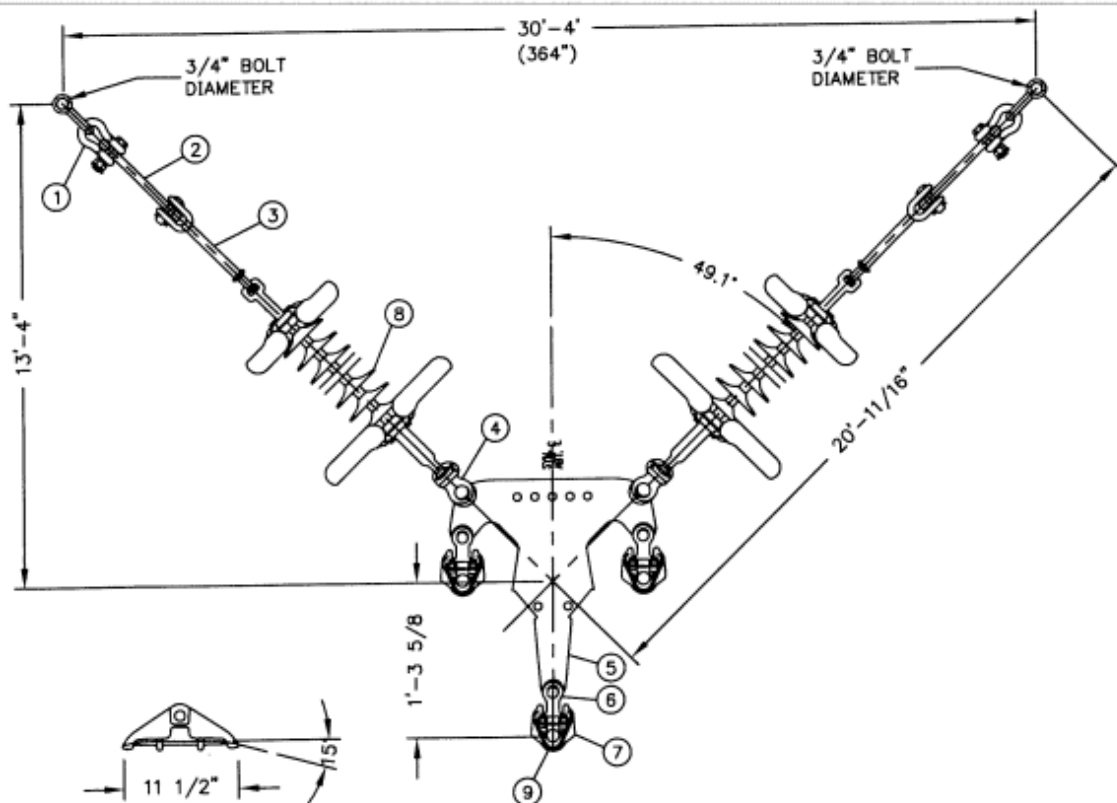
ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIALS							
VEE-STRING, POLYMER, W/BUNDLING YOKE, 500kV							
ITEM	QTY.	STOCK NO.	DESCRIPTION				
1	4	0000000689	SHACKLE, ANCHOR, 60k ULT. STR.				
2	2	0032034296	LINK, EXTENSION, 50k				
3	2	0000028891	BALL CLEVIS, 50k				
4	2	0000028529	SOCKET, Y-CLEVIS, 50k				
5	1	0032021845	YOKE PLATE, TRIPLE BUNDLE, 18" SEPARATION				
6	3	0000028888	CLEVIS EYE, 45 DEG. Y, 30k				
7	3	LS9019XX	CLAMP, SUSPENSION, ALUM. ALLOY, 25k, CORONA FREE				
8	2	0032000341	INSULATOR, SUSPENSION, B&S, POLYMER, 500kV, 50k ULT. STR.				
9	3	LS9018XX	ARMOR ROD, EHV				

CONDUCTOR	CONDUCTOR DIA.	CLAMP CAT. NO.	ENTERGY STOCK NO.	ARMOR ROD CAT. NO.	ENTERGY STOCK NO.	ASSEMBLY CAT. NO.	ENTERGY STOCK NO.
11024 ACAR	1.165	CF-184-N	0000028890	AR-0506(EHV)	000121-558	C-8098-VS1	NA
954 45/7 "RAIL"	1.165	CF-184-N	0000028890	AR-0506(EHV)	000121-558	C-8098-VS1	NA
954 54/7 "CARDINAL"	1.196	CF-184-N	0000028890	AR-0506(EHV)	000121-558	C-8098-VS1	NA



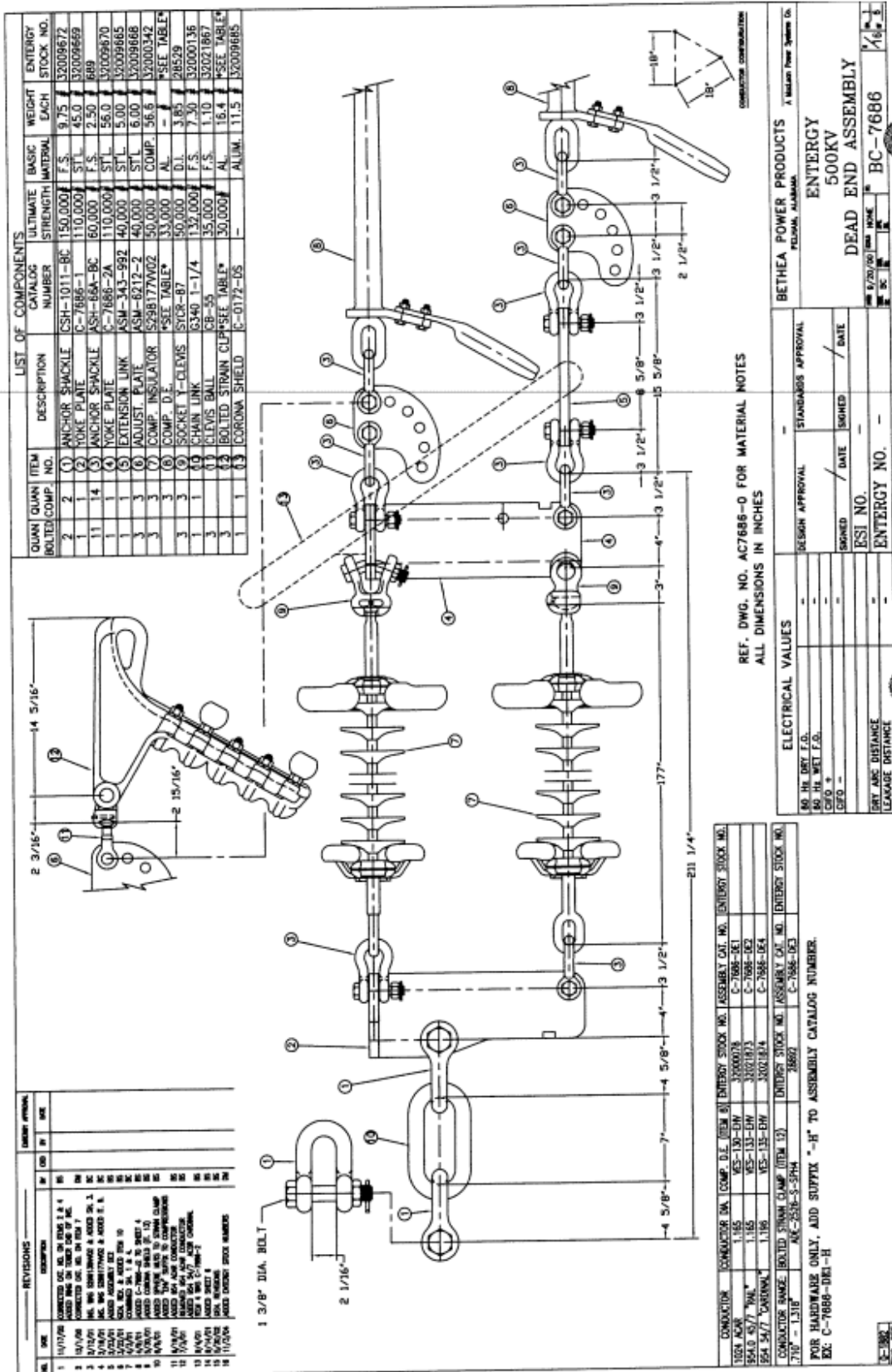
SIDE VIEW OF CLAMP

- 1) ITEMS #7 & #9 ARE CONDUCTOR DEPENDENT. THESE ITEMS ARE SELECTED FOR EACH PROJECT AND MAY BE WITH OR WITHOUT ARMOR RODS.

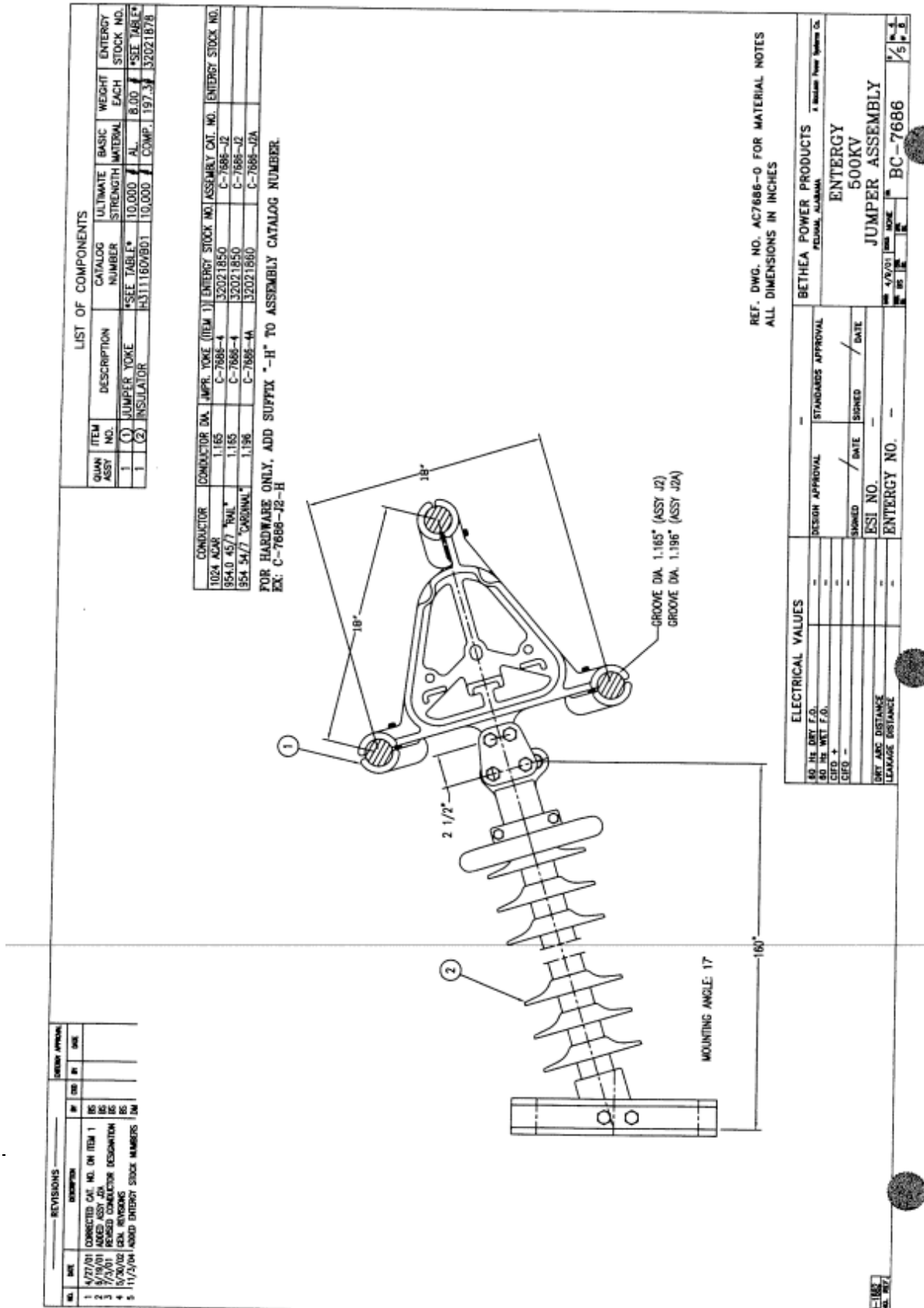
RE: MACLEAN DWG. BC-8098-1

ENTERGY SERVICES, INC.	
VEE-STRING, POLYMER, W/BUNDLING YOKE, 500kV	
STD NO.	SCALE: NONE
No. TFA205A0	
PLOT 1=1	SH. 1 OF 1
VSPY-500-XX; BC-8098-1	

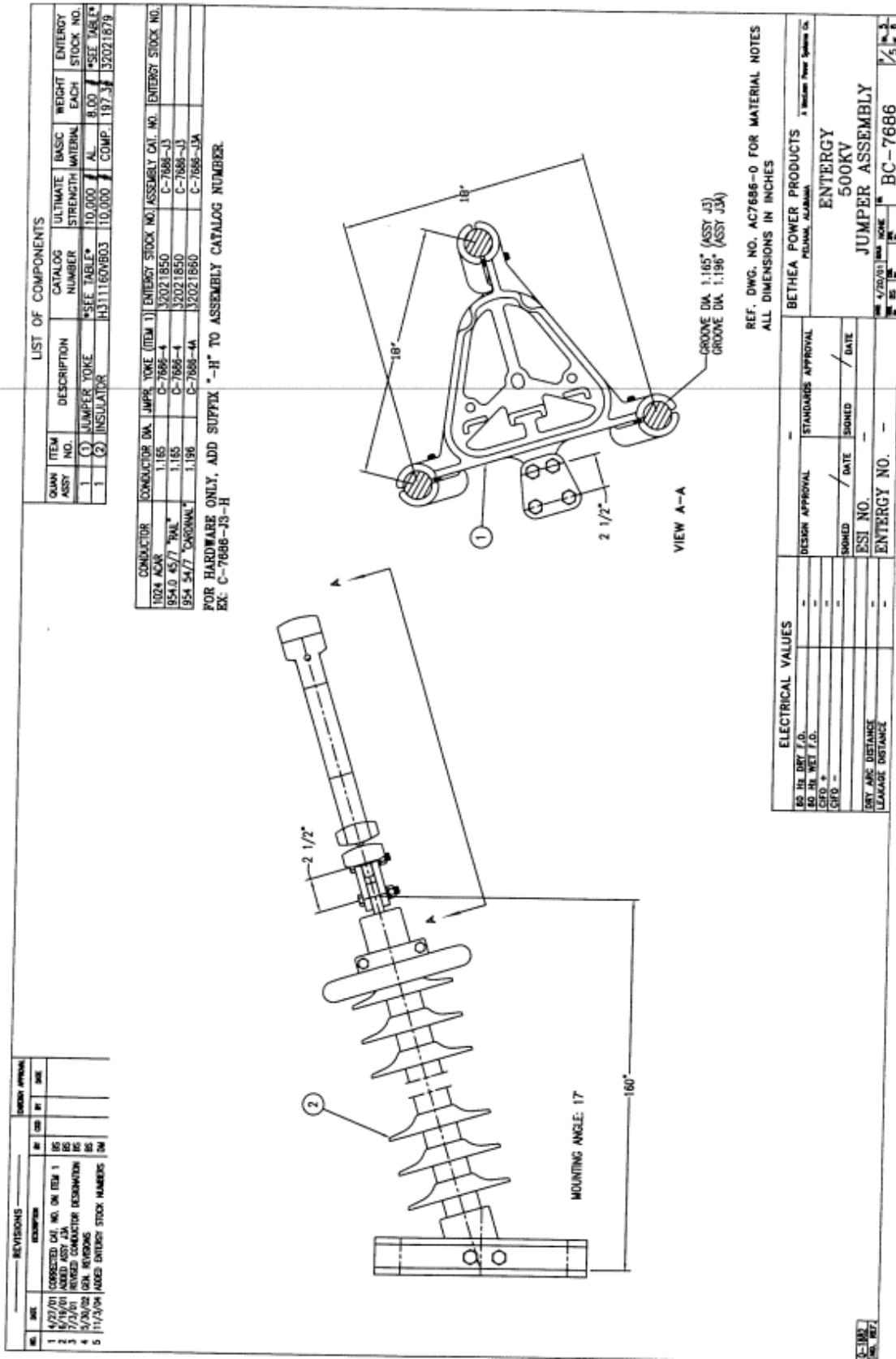
ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



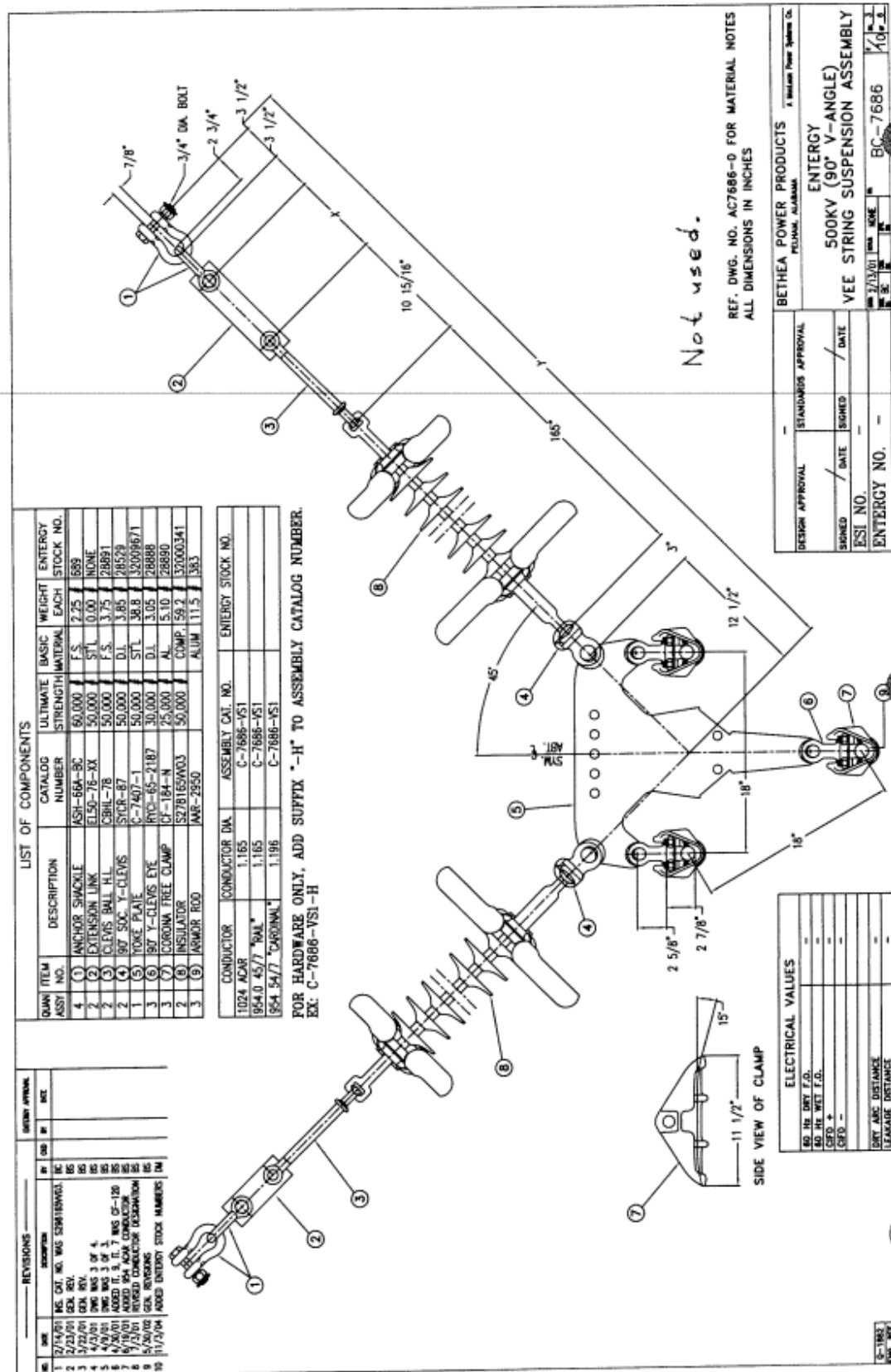
ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



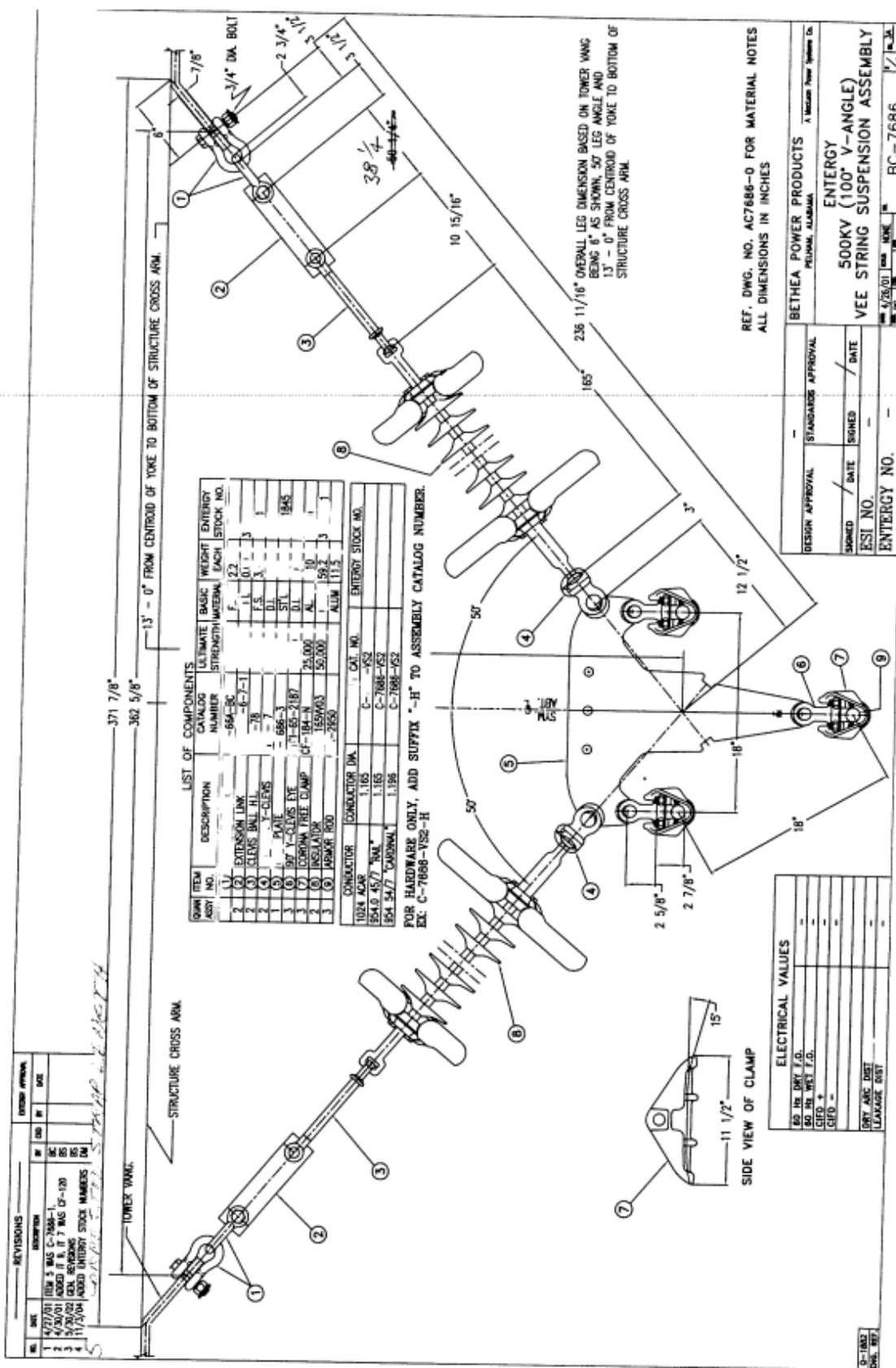
ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

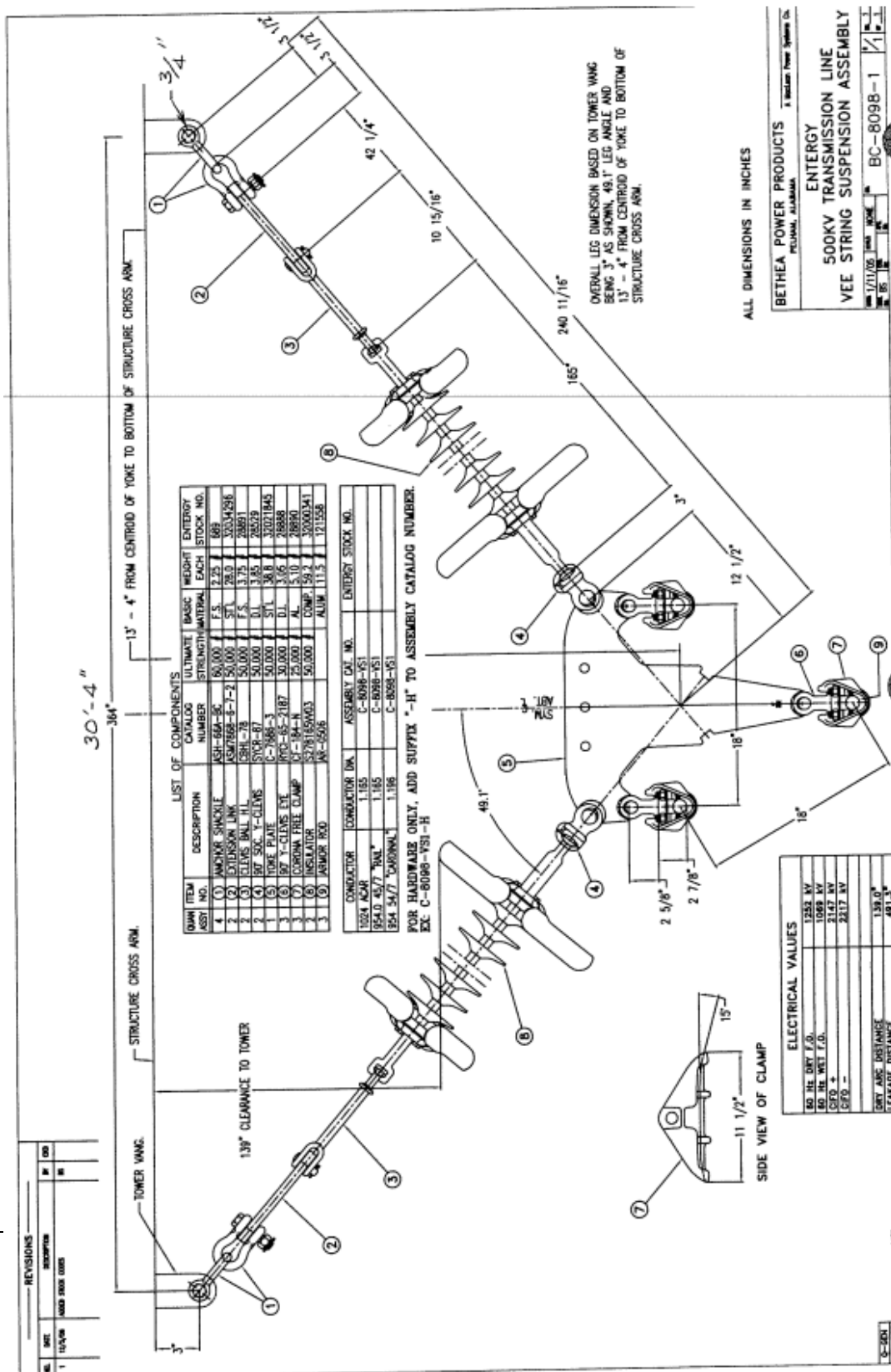


ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

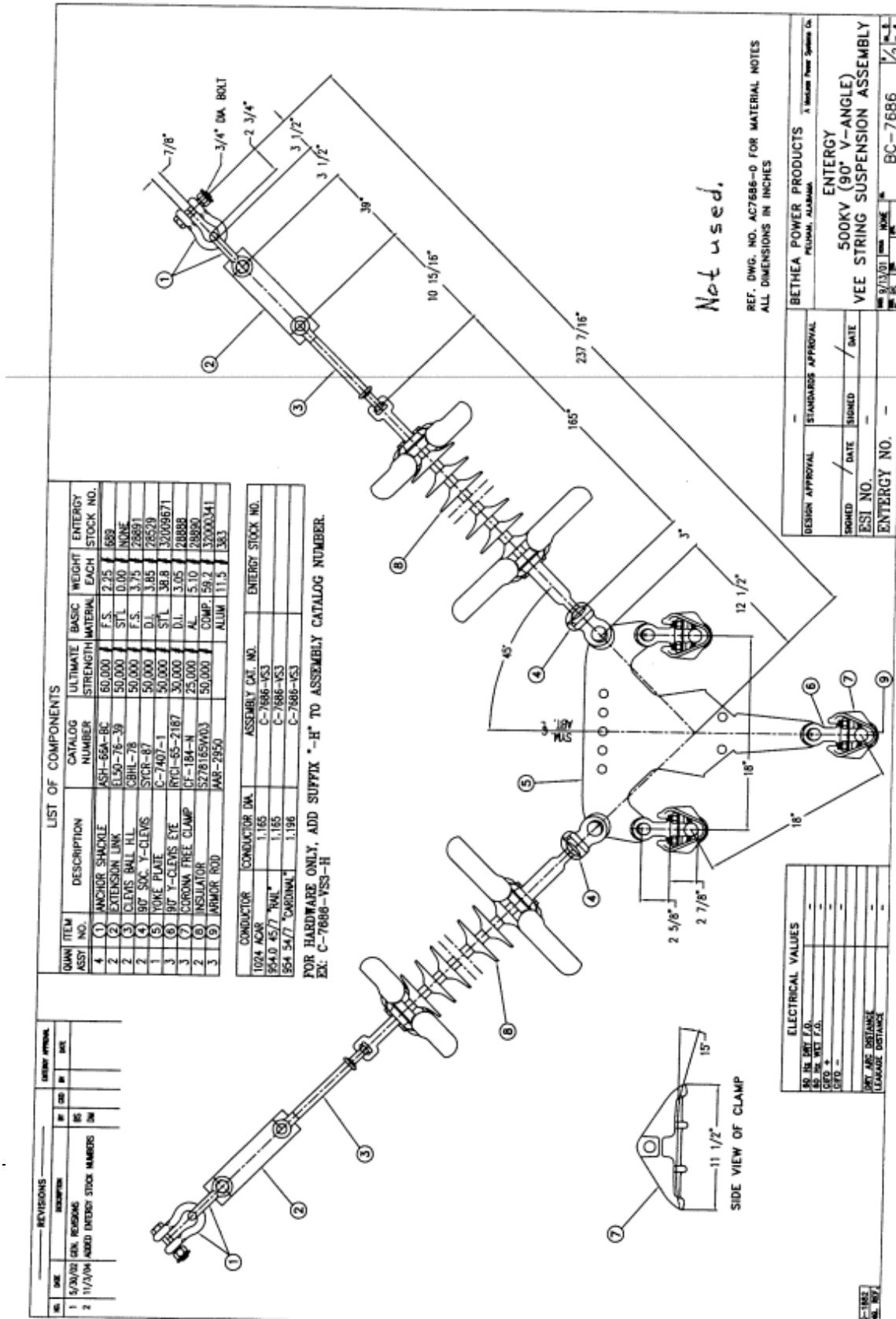


ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

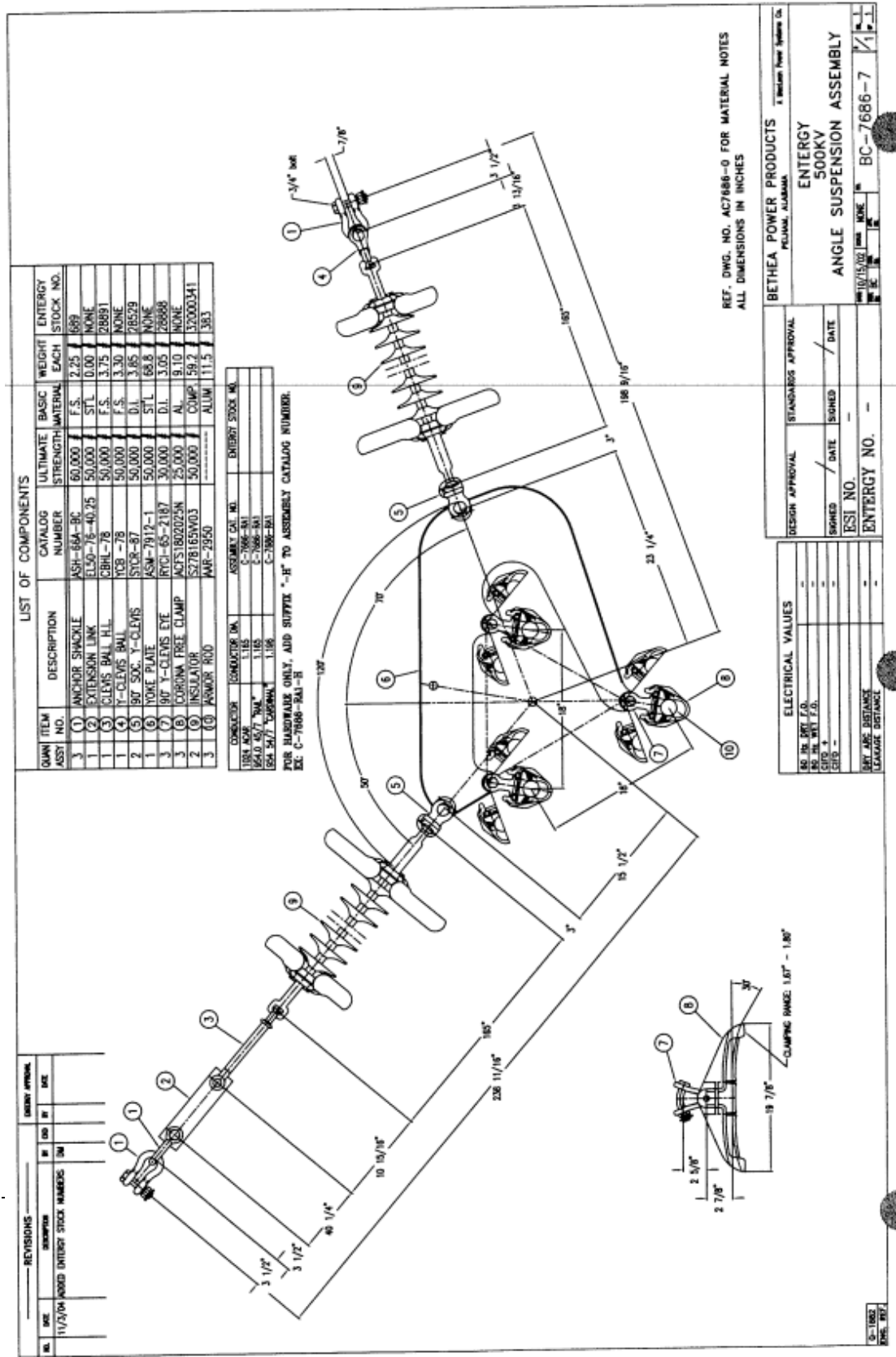




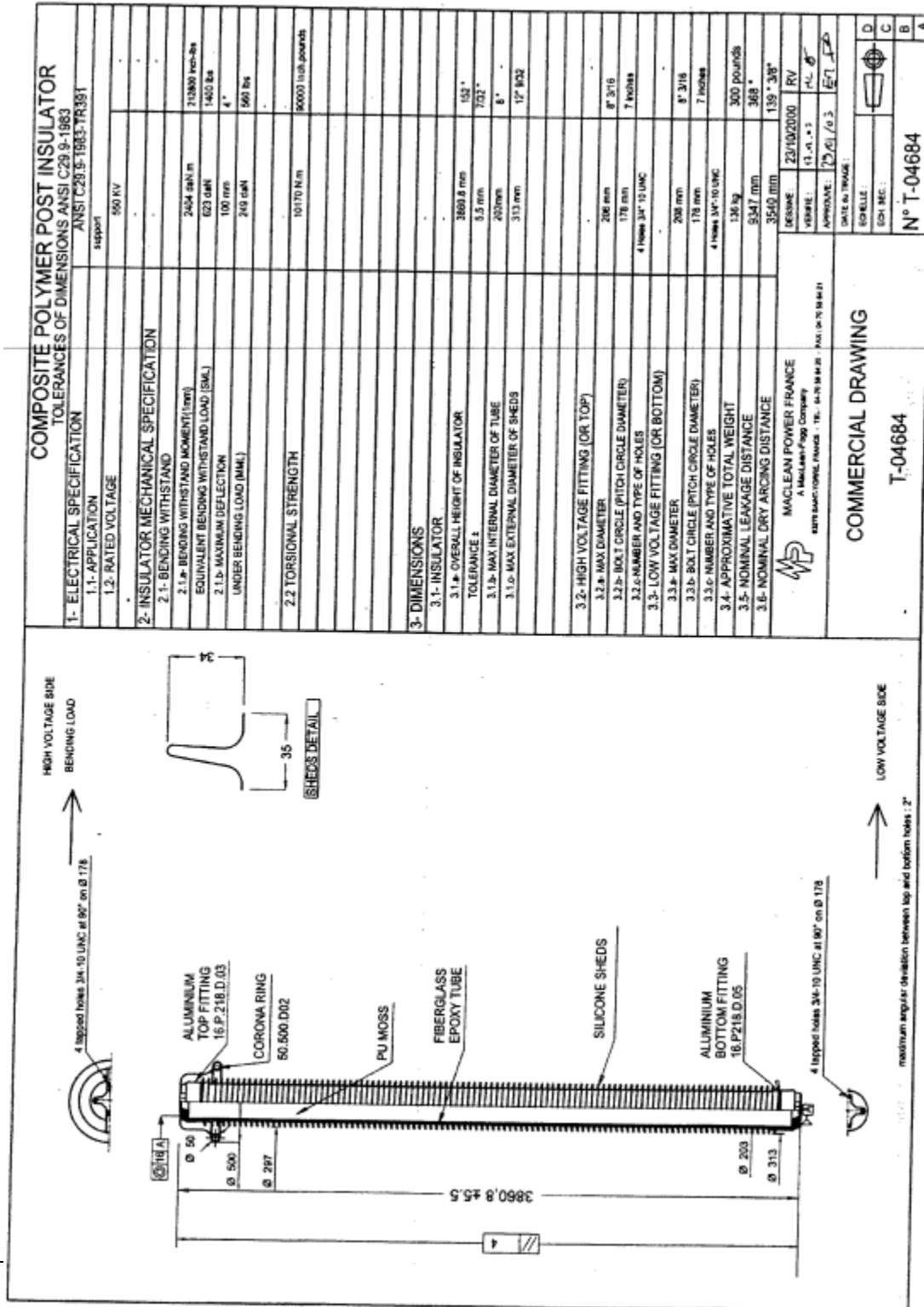
ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



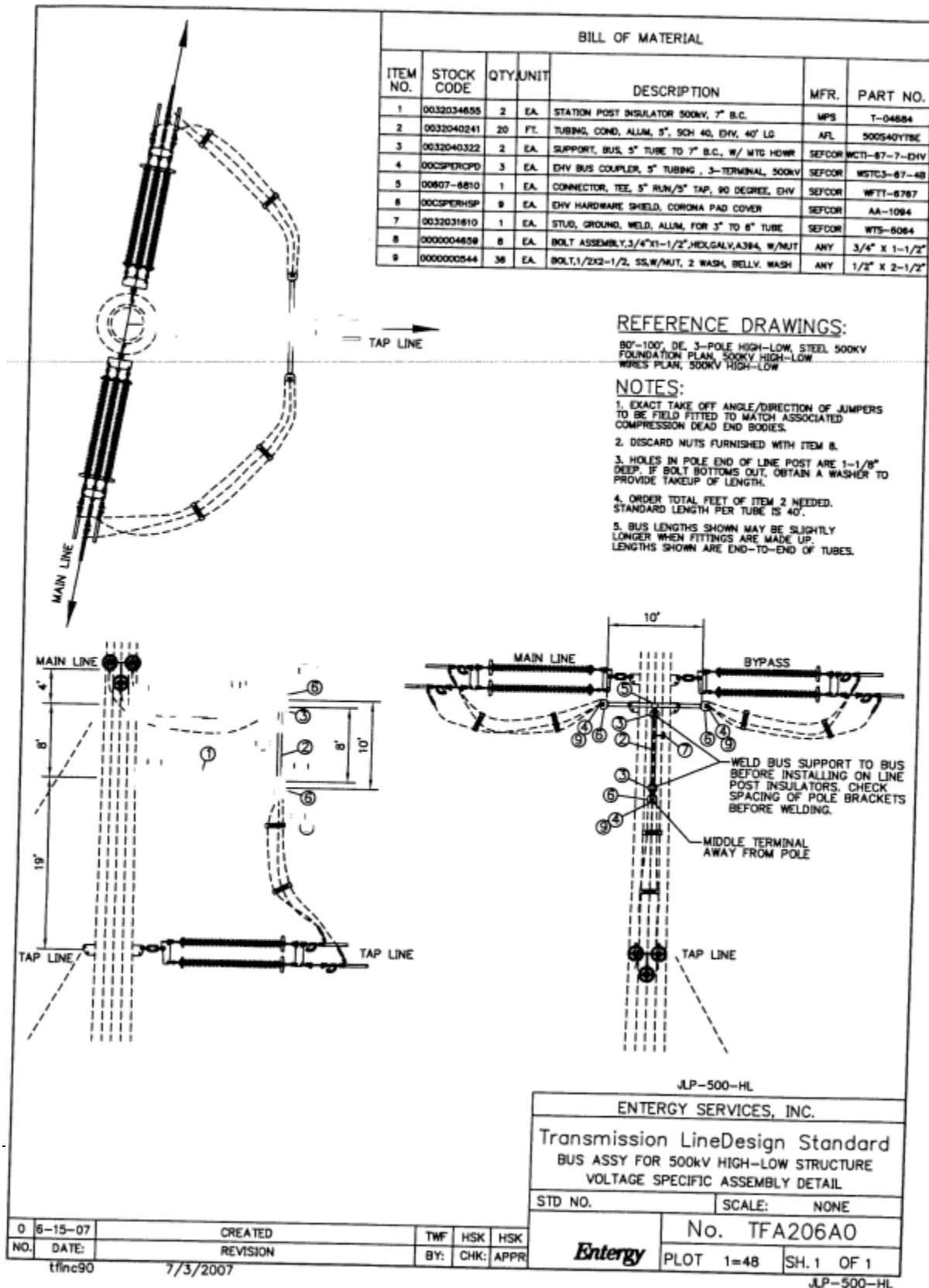
ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



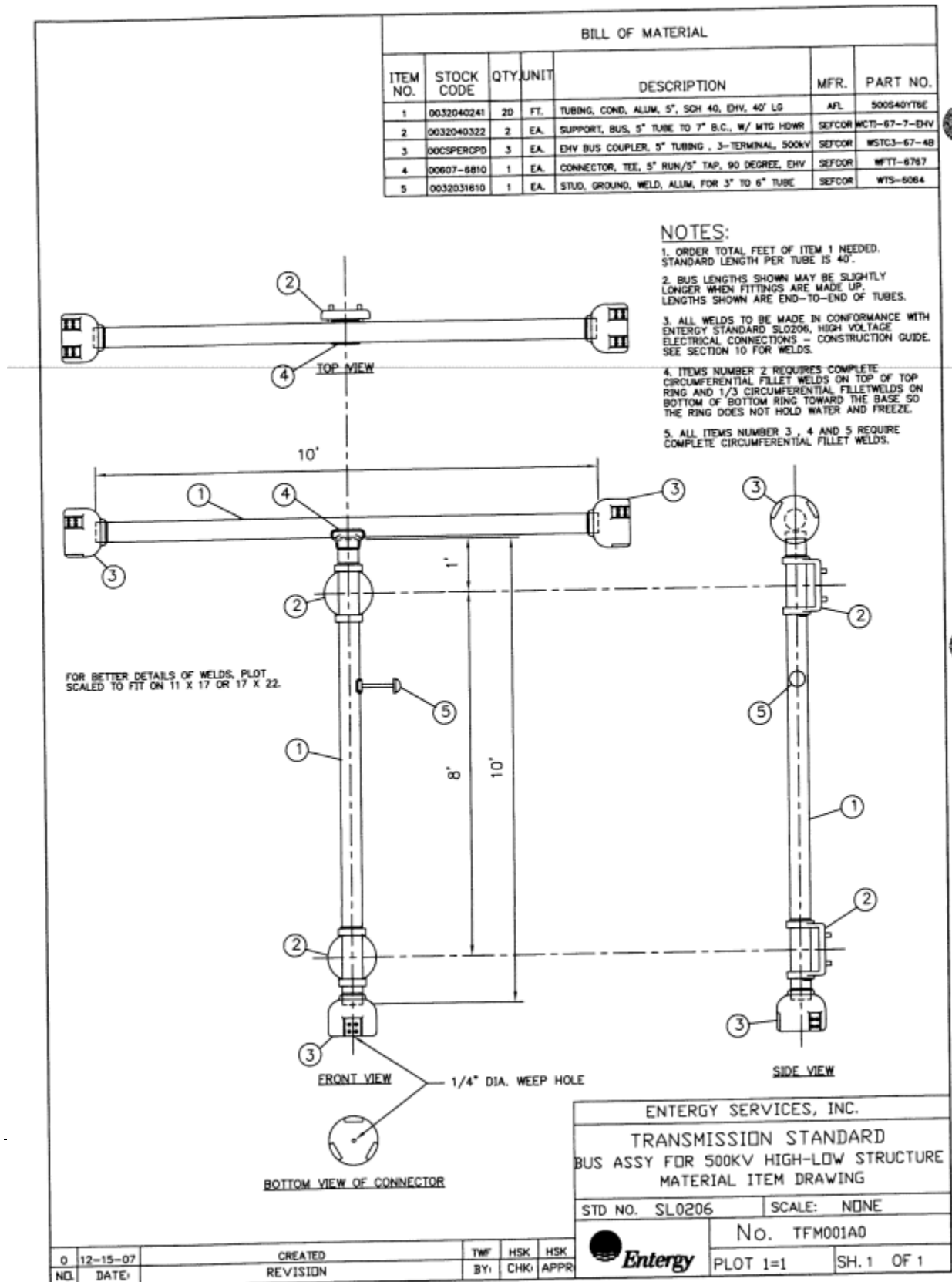
ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

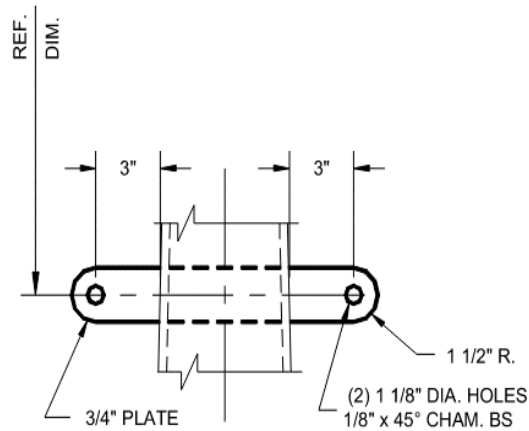


ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

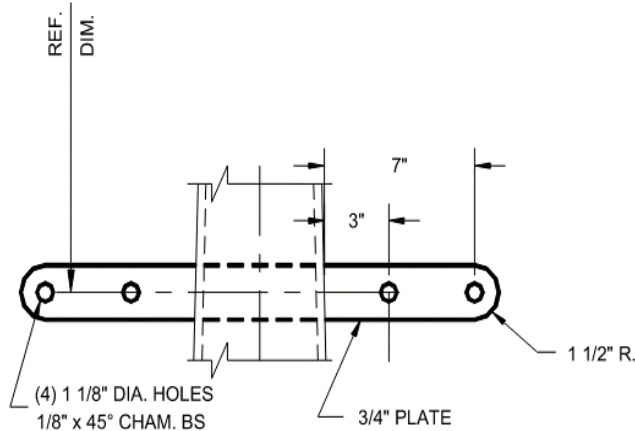
Vang Details for Steel Poles



LIGHT-DUTY 2-HOLE VANG

Primary uses:

- Support shield wire span guys
- Support top of braced-post insulator assemblies
- Support conductor swinging angle assemblies



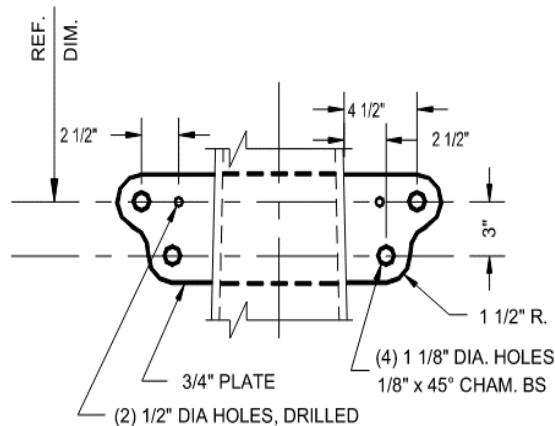
LIGHT-DUTY 4-HOLE VANG

Primary use:

- Support shield wire suspension

ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

Vang Details for Steel Poles



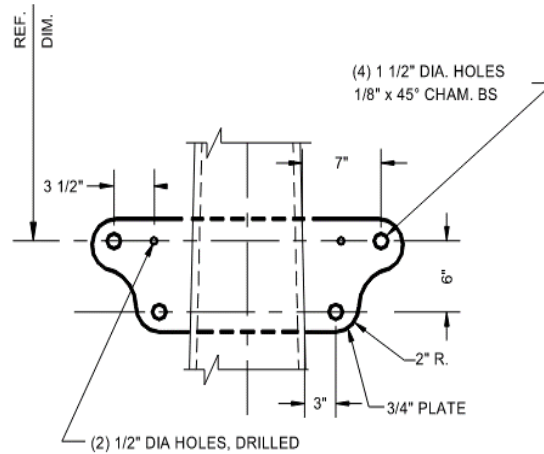
HEAVY-DUTY 4-HOLE VANG

Primary use:

Support shield wire deadend assemblies
Support conductor deadend assemblies
Support conductor deadend down guys
Support conductor bisector down guys
Support shield wire deadend down guys
Support shield wire bisector down guys
All conductor and shield wire vangs on structures with running angle insulators (E, F and G)

ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

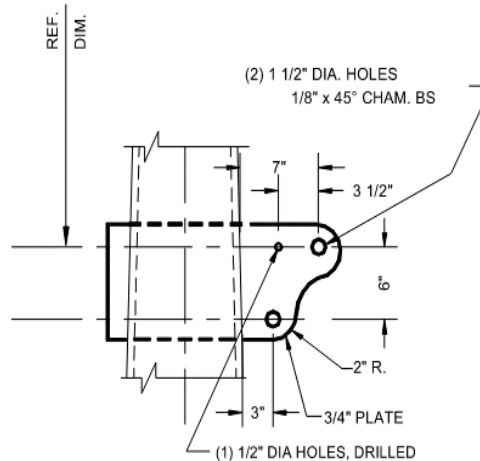
Vang Details for Steel Poles



HEAVY-DUTY 4-HOLE VANG FOR TRIPLE BUNDLE SINGLE POINT DEAD ENDS

Primary use:

Support 500kv conductor dead end assemblies where guys will be at the same elevation as the conductors and when guys are not specified.



HEAVY-DUTY 2-HOLE VANG FOR TRIPLE BUNDLE SINGLE POINT DEAD ENDS

Primary use:

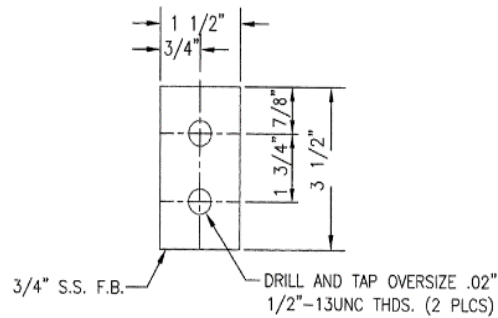
Support 500kv conductor dead end assemblies and guys where guys are specified and will attach at locations below the conductors. Do not install guy vangs on unguyed structures with this type of vang unless specified by Entergy.

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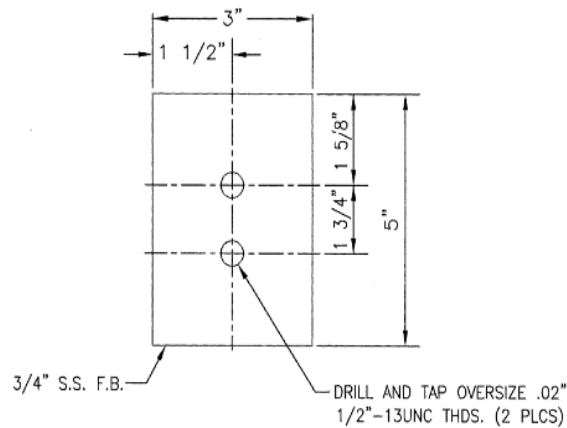
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ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

NEMA Pad Details for Steel Poles or Caissons



SMALL NEMA 2-HOLE PAD



LARGE NEMA 2-HOLE PAD

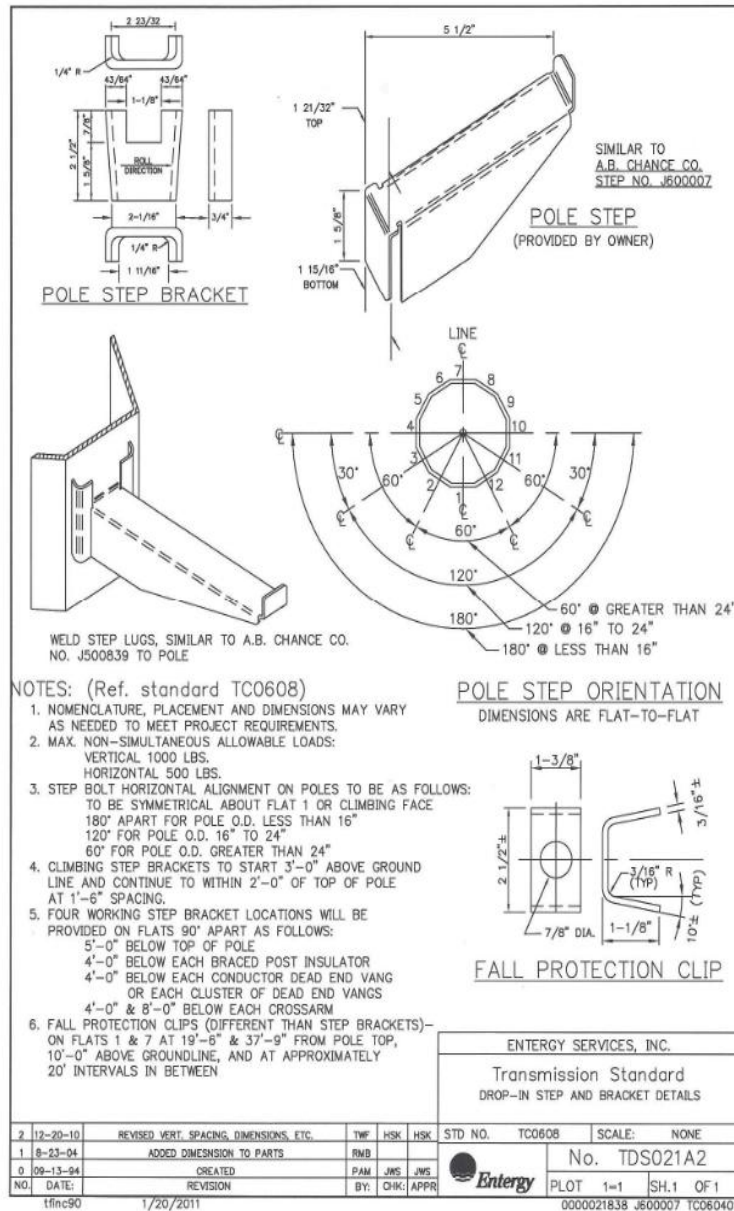
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ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

Climbing Details

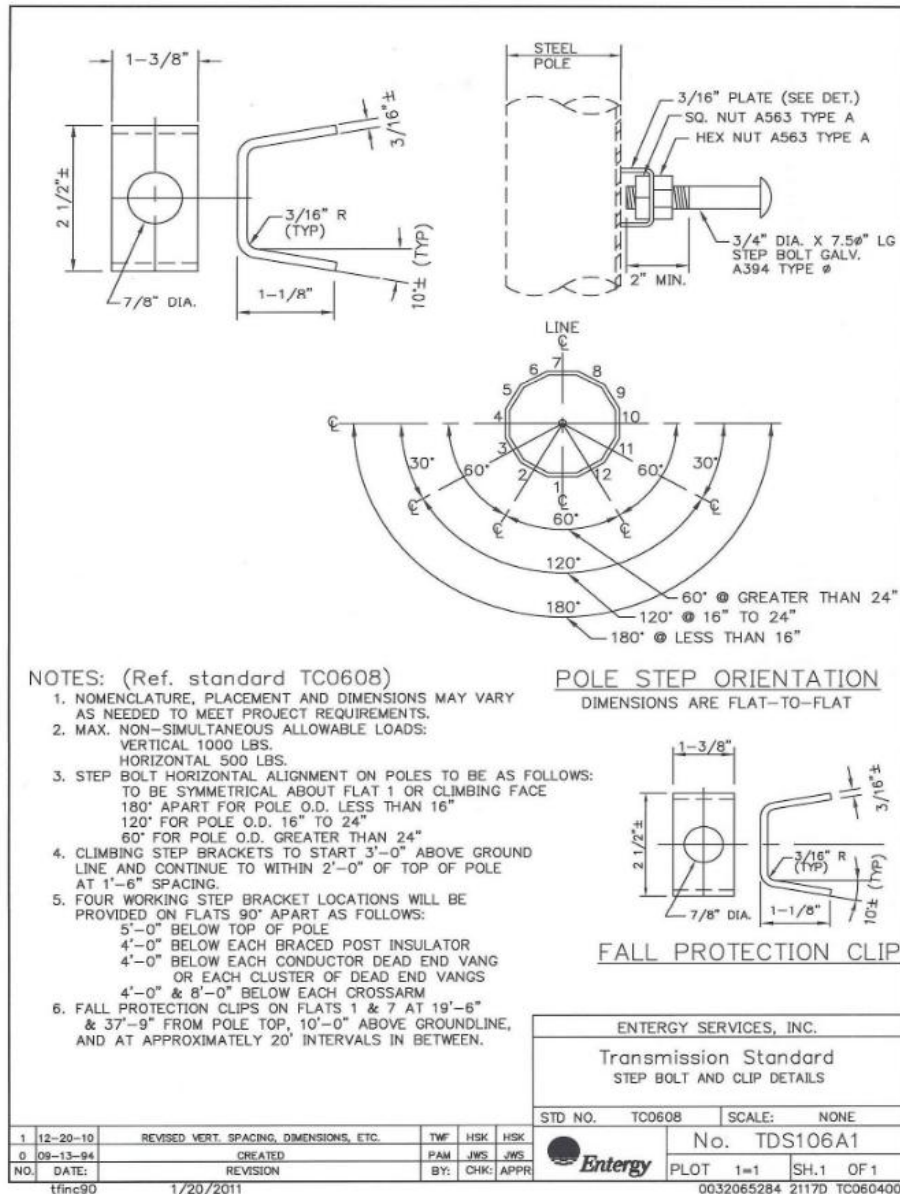
TDS021A1, Step and Bracket Details, represents the Entergy specifications for drop-in steps.



ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

Climbing Details

TDS106A1, Step Bolt Details, represents the Entergy specifications for pole steps.

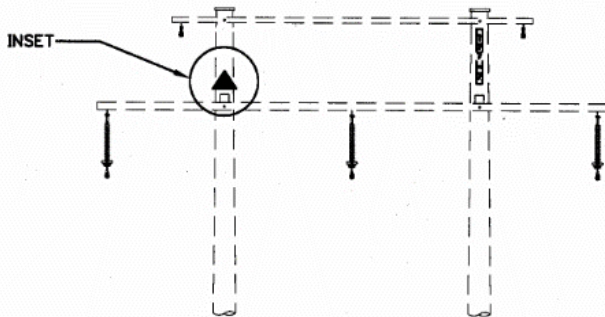


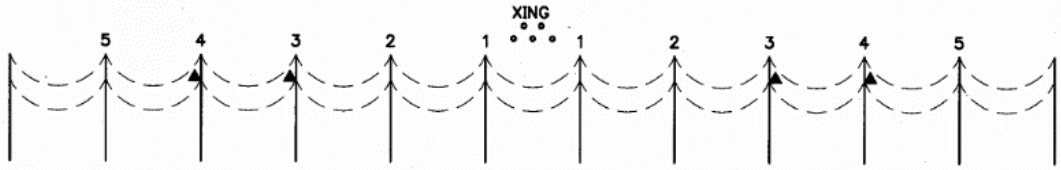
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ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

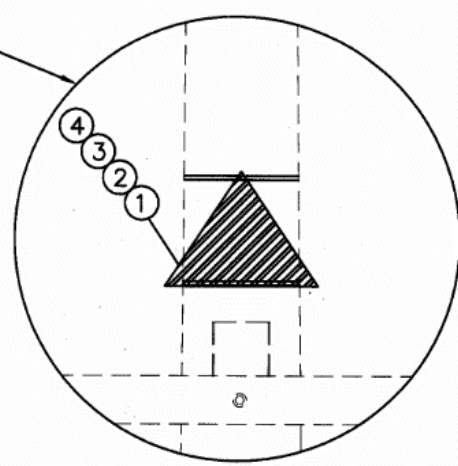
BILL OF MATERIAL			
ITEM	QTY.	STOCK NO.	DESCRIPTION
1	1	NONE	SIGN, SLOW-VEHICLE, ACQUIRED BY LOCAL PURCHASE
2	8 FT.	0000017124	BAND, STRAPPING, 3/4" WD X 100FT LG ROLL, STAINLESS STEEL, 201
3	2	0032047234	BRACKET, BANDING, FLARED LEG, SS, WITH ONE 5/16"-18 X 3/4" HEX HEAD SS BOLT AND FIBER WASHER, 3/4" SLOT, SHIPPED 50/BOX
4	2	0000017123	BOLT, CLAMP ASSEMBLY, CARRIAGE HD, GALVANIZED STEEL, HIGH STRENGTH, ASTM B221 MILITARY QQ-A-200/8, 5 GR, 3/8" DIA, 6" LG HIGH STR CARR BOLT, WASH AND NUT.





NOTES:

- 1) This installation is optional with the grids, and represents a standard for uniformity across the system wherever it is used.
- 2) Install one slow-vehicle sign on third & fourth structures on each side of overhead line crossings of lines to be patrolled by helicopter to provide advance warning of aerial hazard ahead. Additional structures may be marked where sight distance or visibility is limited.
- 3) Place the markers near the pole tops and away from the hazard so it will be seen as the helicopter approaches the line crossing.
- 4) Slow-vehicle signs are available for local purchase at farm supply stores and major hardware stores.
- 5) If there are two overhead line crossings in close proximity of each other, install two markers one above the other on each structure. Some structures in between may require single markers on both sides of each structure.
- 6) Fasten markers to poles with 3/4" banding as indicated in the Bill of Material above. Wooden poles may have the markers fastened with galvanized lag screws, 1/4" by 2-1/2" and washers. Additional holes or enlarged holes may be necessary in the marker.
- 7) On wooden poles, do not install hardware cloth over the face of the markers.

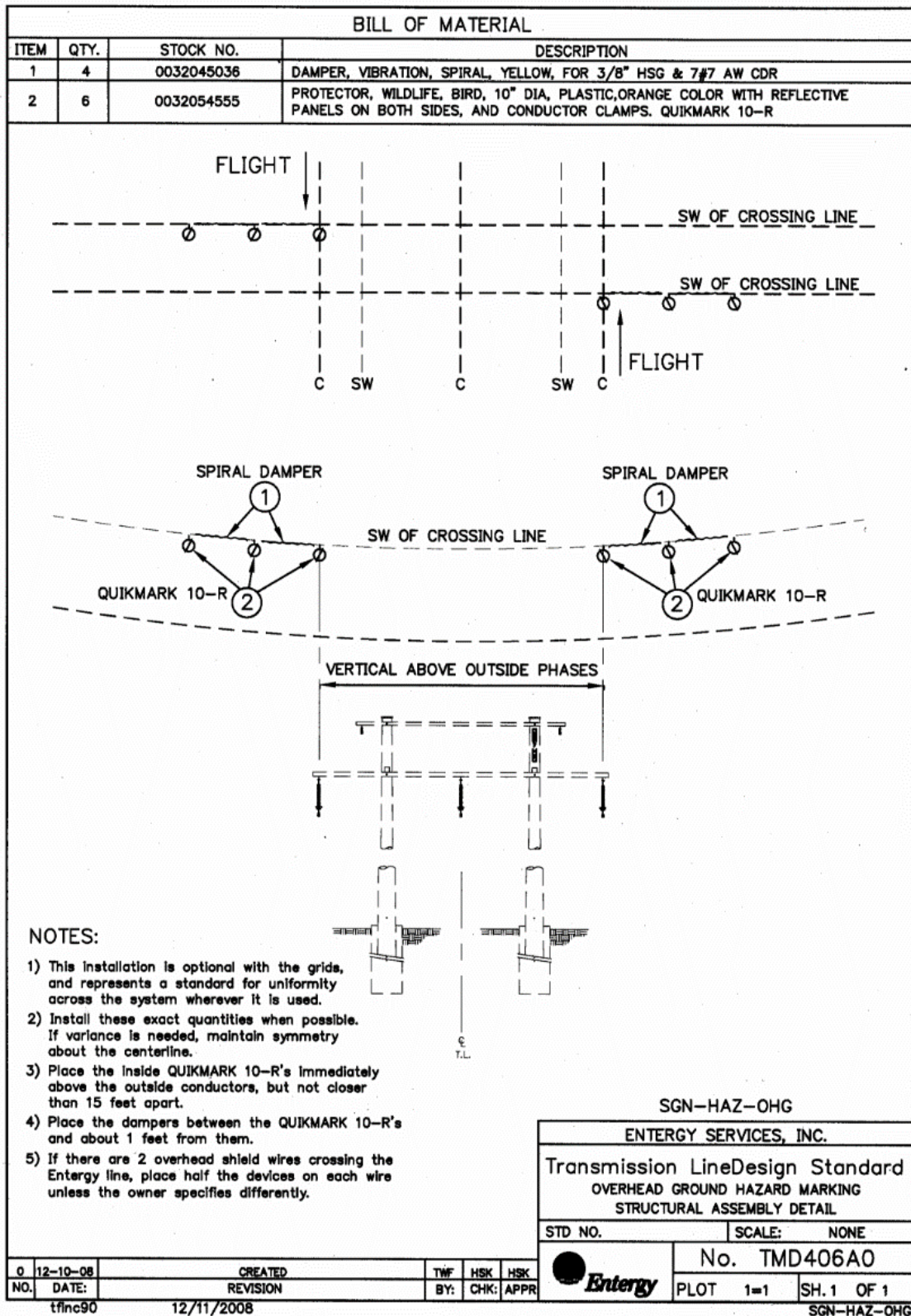


SGN-HAZ-XNG	
ENTERGY SERVICES, INC.	
Transmission LineDesign Standard LINE CROSSING HAZARD MARKING STRUCTURAL ASSEMBLY DETAIL	
STD NO.	SCALE: NONE
No. TMD407A0	
PLOT 1=1 SH. 1 OF 1	

0 12-10-08	CREATED	TWF	HSK	HSK		
NO. DATE:	REVISION	BY:	CHK:	APPR		
tfinc90		12/11/2008				

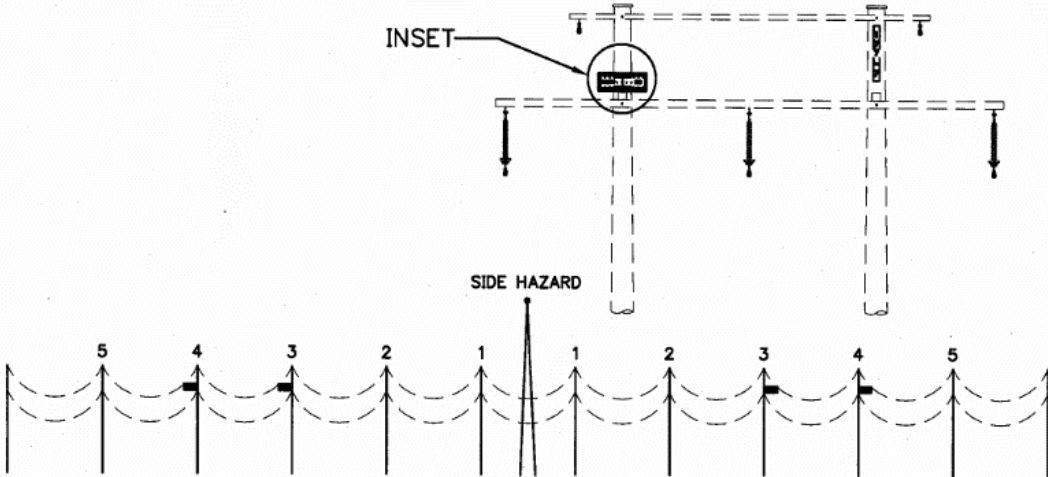
SGN-HAZ-XNG

ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS



ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIAL			
ITEM	QTY.	STOCK NO.	DESCRIPTION
1	1	0032048218	NUMBER, BLANK, 10" X 14", POLYPROPYLENE, ALL YELLOW BACKGROUND, 0.23" TH
2	1	0032048221	NUMBER, BLANK, 10" X 14", POLYPROPYLENE, ALL RED BACKGROUND, 0.23" TH
3	1	0032048222	BRACKET, AERIAL NUMBER, ALUM, 30" LG, FOR 2 10"X14" EVERLAST PLAQUES
4	8 FT.	0000017124	BAND, STRAPPING, 3/4" WD X 100FT LG ROLL, STAINLESS STEEL, 201
5	2	0032047234	BRACKET, BANDING, FLARED LEG, SS, WITH ONE 5/16"-18 X 3/4" HEX HEAD SS BOLT AND FIBER WASHER, 3/4" SLOT, SHIPPED 50/BOX
6	2	0000017123	BOLT, CLAMP ASSEMBLY, CARRIAGE HD, GALVANIZED STEEL, HIGH STRENGTH, ASTM B221 MILITARY QQ-A-200/8, 5 GR, 3/8" DIA, 6" LG HIGH STR CARR BOLT, WASH AND NUT.



NOTES:

- 1) This installation is optional with the grids, and represents a standard for uniformity across the system wherever it is used.
- 2) Install one adjacent hazard marker on third & fourth structures on each side of the hazard adjacent to lines to be patrolled by helicopter to provide advance warning of adjacent hazard ahead. Additional structures may be marked where sight distance or visibility is limited.
- 3) Place the markers near the pole tops and away from the hazard so it will be seen as the helicopter approaches the hazard.
- 4) Adjacent-hazard markers are available from Entergy stores or directly from Tech Products, Inc., by white-req.
- 5) Fasten markers to poles with 3/4" banding as indicated in the Bill of Material above. Wooden poles may have the markers fastened with galvanized lag screws, 1/4" by 2-1/2" and washers. Additional holes or enlarged holes may be necessary in the plastic marker.
- 6) On wooden poles, do not install hardware cloth over the face of the markers.

SGN-HAZ-ADJ

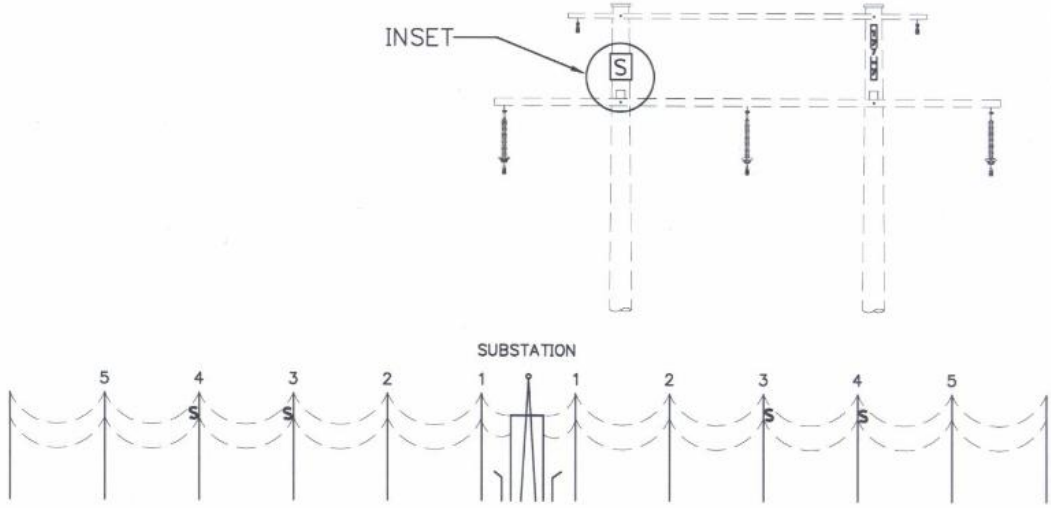
ENTERGY SERVICES, INC.	
Transmission LineDesign Standard	
ADJACENT HAZARD MARKING	
STRUCTURAL ASSEMBLY DETAIL	
STD NO.	SCALE: NONE
No. TMD408A0	
PLOT 1=1	SH.1 OF 1

0	12-10-08	CREATED	TWF	HSK	HSK
NO.	DATE:	REVISION	BY:	CHK:	APPR
tfinc90		12/11/2008			

SGN-HAZ-ADJ

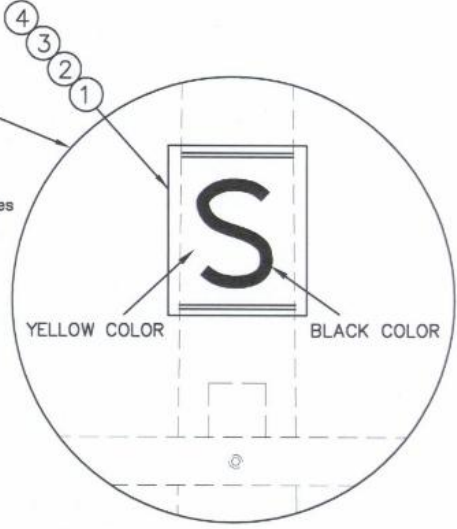
ATTACHMENT 1: APPLICABLE STANDARD FRAMING AND ASSEMBLY DRAWINGS

BILL OF MATERIAL			
ITEM	QTY.	STOCK NO.	DESCRIPTION
1	1	0032054553	LETTER, "S", 10" X 14", BLACK ON YELLOW, TECH PRODUCTS PART NUMBER EL 12KYS
2	8 FT.	0000017124	BAND, STRAPPING, 3/4" WD X 100FT LG ROLL, STAINLESS STEEL, 201
3	2	0032047234	BRACKET, BANDING, FLARED LEG, SS, WITH ONE 5/16"-18 X 3/4" HEX HEAD SS BOLT AND FIBER WASHER, 3/4" SLOT, SHIPPED 50/BOX
4	2	0000017123	BOLT, CLAMP ASSEMBLY, CARRIAGE HD, GALVANIZED STEEL, HIGH STRENGTH, ASTM B221 MILITARY QQ-A-200/8, 5 GR, 3/8" DIA, 6" LG HIGH STR CARR BOLT, WASH AND NUT.



NOTES:

- 1) This installation is optional with the grids, and represents a standard for uniformity across the system wherever it is used.
- 2) Install one substation hazard marker on third & fourth structures on each side of the substation with hazard along lines to be patrolled by helicopter to provide advance warning of potential hazard ahead. Additional structures may be marked where sight distance or visibility is limited.
- 3) Place the markers near the pole tops and away from the substation so it will be seen as the helicopter approaches the substation
- 4) Substation hazard markers are available from Tech Products, Inc., EL12KYS.
- 5) Fasten markers to poles with 3/4" banding as indicated in the Bill of Material above. Wooden poles may have the markers fastened with galvanized lag screws, 1/4" by 2-1/2" and washers. Additional holes or enlarged holes may be necessary in the marker.
- 6) On wooden poles, do not install hardware cloth over the face of the markers.



SGN-HAZ-SUB

ENTERGY SERVICES, INC.	
Transmission LineDesign Standard	
SUBSTATION HAZARD MARKINGS	
STRUCTURAL ASSEMBLY DETAIL	
STD NO.	SCALE: NONE
No. TMD409A0	
PLOT 1=1 SH. 1 OF 1	SGN-HAZ-SUB

0	12-10-08	CREATED	TWF	HSK	HSK
NO.	DATE:	REVISION	BY:	CHK:	APPR
		tfinc90	12/11/2008		



ATTACHMENT 2: NESC AND OWNER CLEARANCE REQUIREMENTS

Basic NESC Clearance Requirements

Rule 230A2, Emergency Vertical Clearances to Ground							
	69	115	138	161	230	345	500
Truck Accessible	16.2	17.1	17.6	18.0	19.4	21.7	24.9
Pedestrian Only	9.7	10.6	11.1	11.5	12.9	15.2	18.4

RULE 232B&C - Vertical Clearance over Ground, Roadway, Rail or Water Surfaces							
	69	115	138	161	230	345	500
Railroad	27.16	28.09	28.56	29.02	30.41	32.74	35.87
Roads	19.16	20.09	20.56	21.02	22.41	24.74	27.87
Other Area Traversed by Vehicles	19.16	20.09	20.56	21.02	22.41	24.74	27.87
Accessible to Pedestrian Traffic Only	15.16	16.09	16.56	17.02	18.41	20.74	23.87

RULE 233C - Vertical Clearance over Another Wire With or Without Wind							
	69	115	138	161	230	345	500
0	2.66	3.59	4.06	4.52	5.91	8.24	11.85
13.8	2.93	3.86	4.32	4.79	6.18	8.50	12.12
34.5	3.32	4.25	4.72	5.18	6.58	8.90	12.52
69	4.06	4.98	5.45	5.91	7.31	9.63	13.25
115	4.98	5.91	6.38	6.84	8.24	10.56	14.18
138	5.45	6.38	6.84	7.31	8.70	11.03	14.64
161	5.91	6.84	7.31	7.77	9.17	11.49	15.10
230	7.31	8.24	8.70	9.17	10.56	12.89	16.50
345	9.63	10.56	11.03	11.49	12.89	15.21	18.82
500	13.25	14.18	14.64	15.10	16.50	18.82	22.44

RULE 234B, C & G - Vertical Clearance over Various Structures							
	69	115	138	161	230	345	500



ATTACHMENT 2: NESC AND OWNER CLEARANCE REQUIREMENTS

Lighting Supports	5.23	6.16	6.62	7.09	8.48	10.80	13.94
Traffic Signal Supports	5.23	6.16	6.62	7.09	8.48	10.80	13.94
Supporting Structures of Other Lines	5.23	6.16	6.62	7.09	8.48	10.80	13.94
Intermediate Poles in Skip-Span Construction	5.23	6.16	6.62	7.09	8.48	10.80	13.94
Building Roofs not Accessible to Pedestrians	13.16	14.09	14.56	15.02	16.41	18.74	21.87
Building Areas Accessible to Pedestrians	14.16	15.09	15.56	16.02	17.41	19.74	22.87
Building Areas Accessible to Vehicles (not Trucks)	14.16	15.09	15.56	16.02	17.41	19.74	22.87
Building Areas Accessible to Trucks	19.16	20.09	20.56	21.02	22.41	24.74	27.87
Signs, Chimneys, Billboards, Radio and TV antennas, Flagpoles and Flags, Banners, Tanks with Catwalks	14.16	15.09	15.56	16.02	17.41	19.74	22.87
Signs, Chimneys, Billboards, Radio and TV antennas, Flagpoles and Flags, Banners, Tanks without Catwalks	8.66	9.59	10.06	10.52	11.91	14.24	17.37

RULE 234B, C & G - Horizontal Clearance to Various Structures with No Wind							
	69	115	138	161	230	345	500
Lighting Supports	5.00	5.66	6.12	6.59	7.98	10.30	13.44
Traffic Signal Supports	5.00	5.66	6.12	6.59	7.98	10.30	13.44
Supporting Structures of Other Lines	5.00	5.66	6.12	6.59	7.98	10.30	13.44
Intermediate Poles in Skip Span Construction	5.00	5.66	6.12	6.59	7.98	10.30	13.44
Buildings	8.16	9.09	9.56	10.02	11.41	13.74	16.87
Signs, Chimneys, Billboards,	8.16	9.09	9.56	10.02	11.41	13.74	16.87
Radio and TV Antennas, Flagpoles & Flags	8.16	9.09	9.56	10.02	11.41	13.74	16.87
Banners, Tanks	8.16	9.09	9.56	10.02	11.41	13.74	16.87



ATTACHMENT 2: NESC AND OWNER CLEARANCE REQUIREMENTS

RULE 234B, C & G - Horizontal Clearance to Various Structures with Wind							
	69	115	138	161	230	345	500
Lighting Supports	5.16	6.09	6.56	7.02	8.41	10.74	13.87
Traffic Signal Supports	5.16	6.09	6.56	7.02	8.41	10.74	13.87
Supporting Structures of Other Lines	5.16	6.09	6.56	7.02	8.41	10.74	13.87
Intermediate Poles in Skip Span Construction	5.16	6.09	6.56	7.02	8.41	10.74	13.87
Buildings	5.16	6.09	6.56	7.02	8.41	10.74	13.87
Signs, Chimneys, Billboards,	5.16	6.09	6.56	7.02	8.41	10.74	13.87
Radio and TV Antennas, Flagpoles & Flags	5.16	6.09	6.56	7.02	8.41	10.74	13.87
Banners, Tanks	5.16	6.09	6.56	7.02	8.41	10.74	13.87

RULE 235C2b1 - Vertical Clearance Between Wires Supported at Different Levels on the Same Structures							
	69	115	138	161	230	345	500
0	2.03	2.58	3.02	3.47	4.79	7.01	9.99
13.8	2.03	2.85	3.29	3.73	5.06	7.27	10.25
34.5	2.36	3.24	3.69	4.13	5.46	7.67	10.65
69	3.02	3.91	4.35	4.79	6.12	8.33	11.32
115	3.91	4.79	5.24	5.68	7.01	9.22	12.20
138	4.35	5.24	5.68	6.12	7.45	9.66	12.64
161	4.79	5.68	6.12	6.56	7.89	10.10	13.09
230	6.12	7.01	7.45	7.89	9.22	11.43	14.42
345	8.33	9.22	9.66	10.10	11.43	13.65	16.63
500	11.32	12.20	12.64	13.09	14.42	16.63	19.61



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RULE 235B - Horizontal Clearance Between Wires Supported on the Same Structure

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	69	115	138	161	230	345	500
0	2.08	2.96	3.41	3.85	5.18	7.39	10.37
13.8	2.94	3.29	3.63	4.11	5.44	7.66	10.64
34.5	2.74	3.63	4.07	4.51	5.84	8.05	11.04
69	3.41	4.29	4.73	5.18	6.50	8.72	11.70
115	4.29	5.18	5.62	6.06	7.39	9.60	12.59
138	4.73	5.62	6.06	6.50	7.83	10.05	13.03
161	5.18	6.06	6.50	6.95	8.27	10.49	13.47
230	6.50	7.39	7.83	8.27	9.60	11.82	14.80
345	8.72	9.60	10.05	10.49	11.82	14.03	17.01
500	11.70	12.59	13.03	13.47	14.80	17.01	20.00

RULE 233B1 - Horizontal Clearance to Other Wires (With or without Wind)

	69	115	138	161	230	345	500
0	5.66	6.59	7.06	7.52	8.91	11.24	14.37
13.8	5.94	6.87	7.33	7.80	9.19	11.52	14.65
34.5	6.36	7.29	7.75	8.22	9.61	11.94	15.07
69	7.06	7.98	8.45	8.91	10.31	12.63	15.76
115	7.98	8.91	9.38	9.84	11.24	13.56	16.69
138	8.45	9.38	9.84	10.31	11.70	14.03	17.16
161	8.91	9.84	10.31	10.77	12.17	14.49	17.62
230	10.31	11.24	11.70	12.17	13.56	15.89	19.02
345	12.63	13.56	14.03	14.49	15.89	18.21	21.34
500	15.76	16.69	17.16	17.62	19.02	21.34	24.47

Vertical Clearance Requirements; NESC 2012 & Owner Design Clearance

	69 kV ⁽¹⁾		115/138/161 kV ⁽¹⁾		230 kV ⁽¹⁾		345 kV ⁽¹⁾		500 kV ^{(1) (3)}	
	NESC ⁽²⁾	ETR	NESC ⁽²⁾	ETR	NESC ⁽²⁾	ETR	NESC ⁽²⁾	ETR	NESC ⁽²⁾	ETR
	@ Max. Sag(ft.)	@ Max. Sag(ft.)	@ Max. Sag(ft.)	@ Max. Sag(ft.)	@ Max. Sag(ft.)	@ Max. Sag(ft.)	@ Max. Sag(ft.)	@ Max. Sag(ft.)	@ Max. Sag(ft.)	@ Max. Sag(ft.)
Railroads	27.16	33.00	29.02	35.00	30.41	37.00	32.74	41.00	35.87	48.00
Roads	19.16	28.00	21.02	30.00	22.41	32.00	24.74	33.00	27.87	40.00



ATTACHMENT 2: NESC AND OWNER CLEARANCE REQUIREMENTS

Other Land Traversed by any kind of Vehicle	19.16	24.00	21.02	26.00	22.41	28.00	24.74	33.00	27.87	40.00
Cultivated Farmland	19.16	27.00	21.02	29.00	22.41	31.00	24.74	33.00	27.87	40.00
Land accessible to pedestrians only	15.16	24.00	17.02	26.00	18.41	28.00	20.74	29.00	23.87	36.00
Water Areas Suitable for sailboats:										
Less than 20 acres	21.16	24.00	23.02	26.00	24.41	28.00	26.74	35.00	29.87	42.00
20-200 acres	29.16	32.00	31.02	34.00	32.41	36.00	34.74	43.00	37.87	50.00
200-2000 acres	35.16	37.00	37.02	40.00	38.41	42.00	40.74	49.00	43.87	56.00
Over 2000 acres	41.16	44.00	43.02	46.00	44.41	48.00	46.74	55.00	49.87	62.00
Sailboat launch sites adjacent to water: Add 5'										
Less than 20 acres	26.16	29.00	28.02	31.00	29.41	33.00	31.74	40.00	34.87	47.00
20-200 acres	34.16	37.00	36.02	39.00	37.41	41.00	39.74	48.00	42.87	53.00
200-2000 acres	40.16	43.00	42.02	45.00	43.41	47.00	45.74	54.00	48.87	61.00
Over 2000 acres	46.16	49.00	48.02	51.00	49.41	53.00	51.74	60.00	54.87	67.00
Other supply lines 34.5kV and under	2.66	8.00	4.52	10.00	5.91	15.00	8.24	17.00	11.85	23.00
Other supply lines:										
69 kV	4.06	10.00	5.91	11.00	7.31	16.00	9.63	18.00	13.25	20.00
115/138/161 kV	5.91	11.00	7.77	13.00	9.17	18.00	11.49	20.00	15.10	22.00
230 kV	7.31	16.00	9.17	18.00	10.56	20.00	12.89	22.00	16.50	24.00
345 kV	9.63	18.00	11.49	20.00	12.89	22.00	15.21	24.00	18.82	26.00
500 kV	13.25	20.00	15.10	22.00	16.50	24.00	18.82	26.00	22.44	28.00
Guys, Neutrals and shield wires	2.66	8.00	4.52	10.00	5.91	15.00	8.24	17.00	11.85	19.00
Communications lines	5.66	10.00	7.52	12.00	8.91	15.00	11.24	17.00	14.37	19.00

Notes:

(1) Conductor Temperature: 100°C for ACSR, see table 7.1(b) for other conductor types



ATTACHMENT 2: NESC AND OWNER CLEARANCE REQUIREMENTS

- (2) NESC Vertical Clearance = Basic Clearance + Voltage Adder; Voltage Adder = 0.4"/kV in excess of 22kV; refer to 2012 NESC Clearance Calculations.
- (3) For 500 kV, the NESC clearance is approximately equal to the clearance requirements derived from a Switching Surge factor of 2.6.

ATTACHMENT 3: QUICK ESTIMATING CORONA LOSS CURVES

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Chapter 8
Characteristics of Aerial Lines

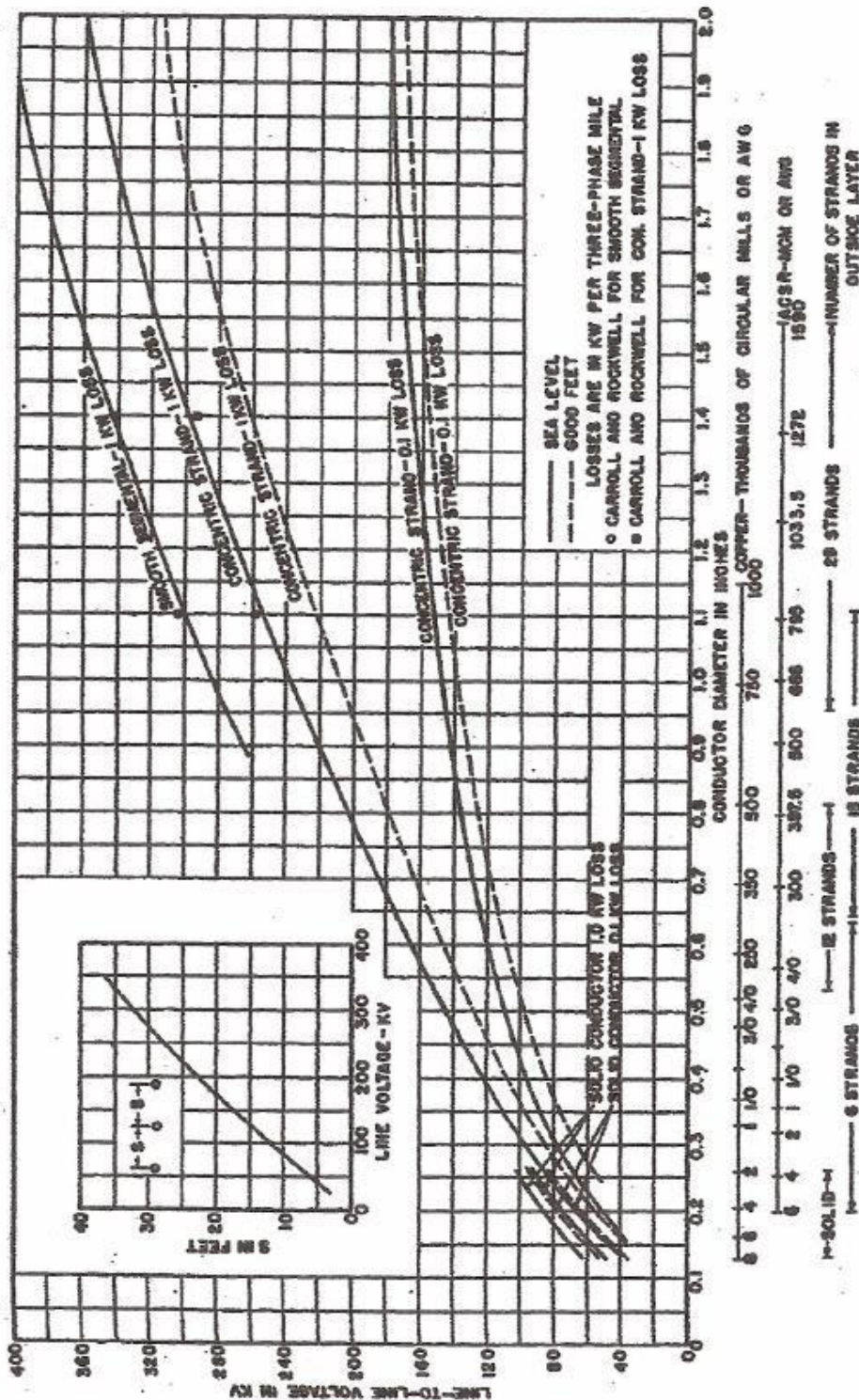
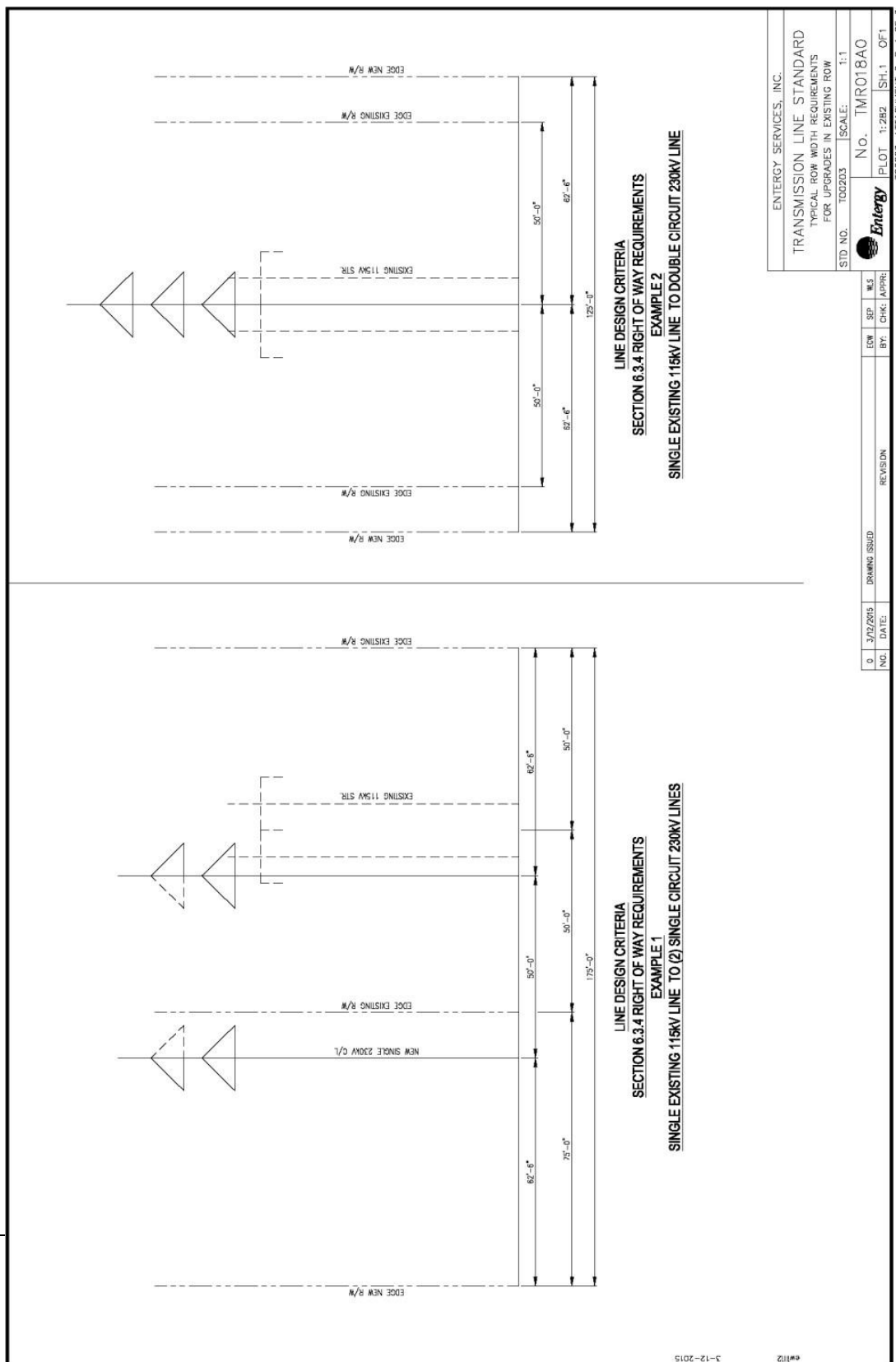
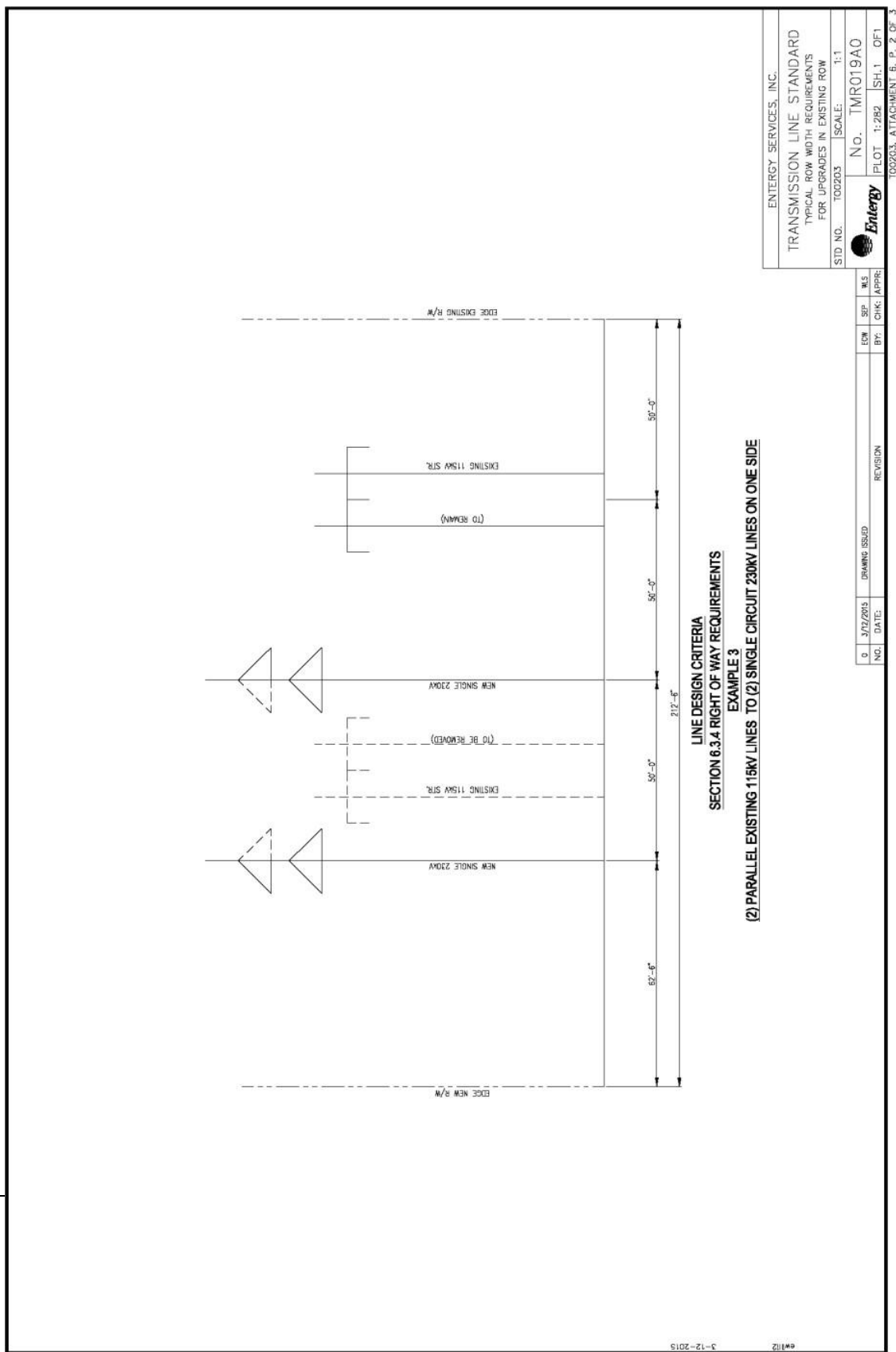


Fig. 31—Quick-Estimating Corona-Loss Curves. Curves based on Peterson's formula with a few check points from the Carroll and Rockwell paper for comparison.

ATTACHMENT 4: EXAMPLE ROW



ATTACHMENT 4: EXAMPLE ROW

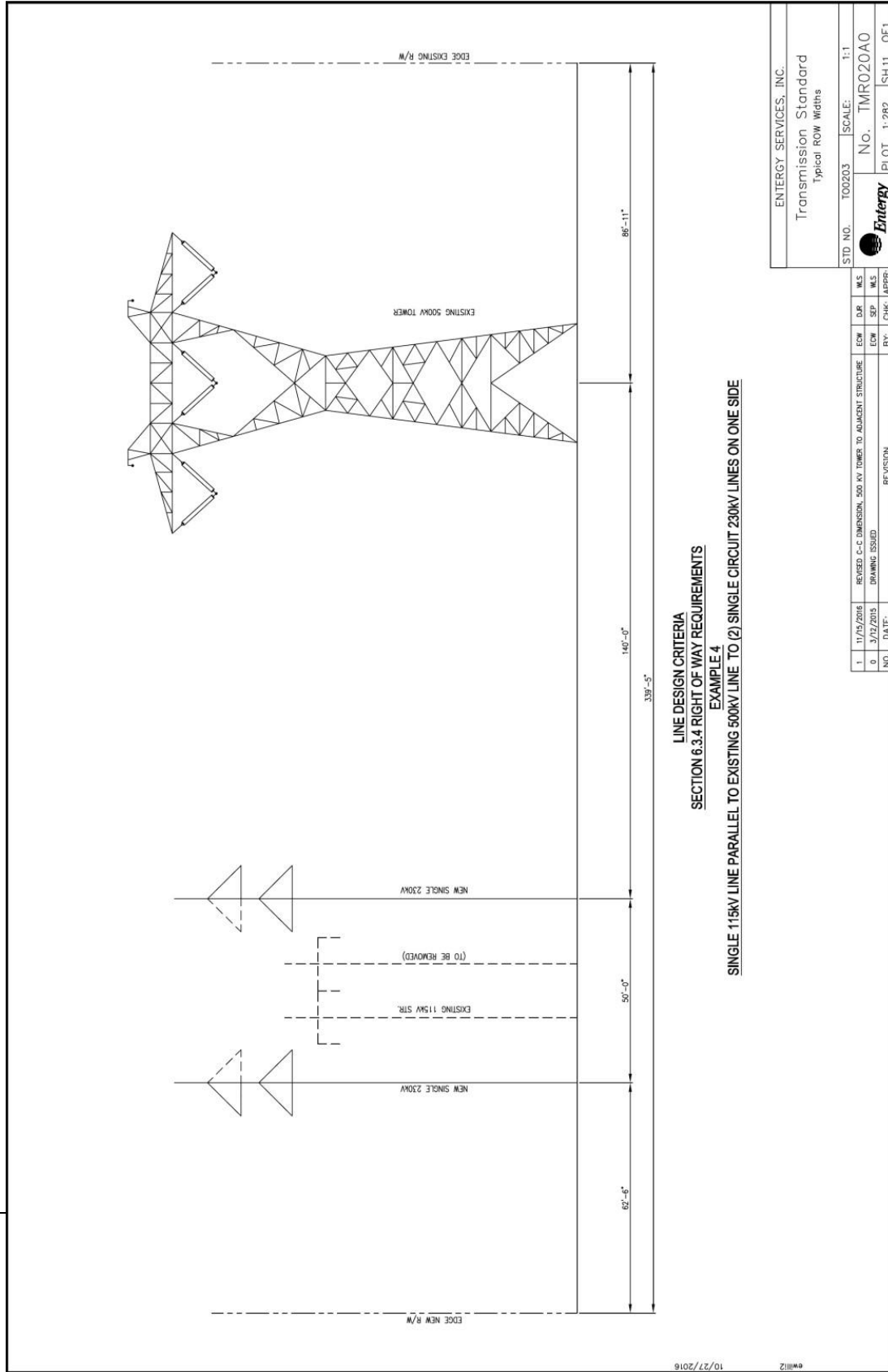




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ATTACHMENT 4: EXAMPLE ROW





ATTACHMENT 5: APPROVED VENDOR LIST

Class	Description	Qualifier	Preferred Manufacturer	Preferred Supplier	Other Approved Manufacturer(s)
Arresters	Arrester, Surge		Cooper	Eaton Cooper	Siemens, Hitachi Energy
Bolts	Bolts Anchor				Valmont, Threaded Fasteners
Bolts	Bolts Anchor cage for Substation Steel				Valmont, Threaded Fasteners (size limit)
Bus	Bus, Aluminum Pipe		Three D Metals	Three D Metals	AFL
Cable, Control	Control Cable -Shielded and Non-Shielded		Southwire	Southwire	Priority, Lake Cable, Service Wire, Prysmian
CCVT	CCVT	69kV - 500kV	Ritz - Lavonia, GA	Aertker	GE - Charleroi, PA, Itajuba, Brazil Trench - Toronto, Canada Hitachi Energy - Crystal Springs, MS Arteche - Tepeji Del Rio, Mexico (Sold through Hitachi)
Conductor	Cable, Aluminum	ACSS, ACSR	Prysmian	Aertker co	Southwire
Conductor	Cable, Copper (Not Control cable)			Stuart Irby	Copperweld /Alcoa
Conductor	Cable, Fiber	ADSS		Preferred Sales	AFL
Conductor	Cable, Fiber	OPT-GW		Preferred Sales	AFL
Conduit	Conduit & Accessories			Stuart Irby	Cantex, Carlon
Connector	Connectors line	ACSS		Preferred Sales	AFL
Connector	Connectors line (Fiber, OPGW, ACSR)	Fiber, OPGW, ACSR		Preferred Sales	AFL
Connector	Connectors, Trans. Line - Insulator Assemblies		Maclean Power Sys	Preferred Sales	
Connectors/Fittings	Connectors/Fittings -Substation			Stuart Irby	Any Approved Manufacturer
CT	CT	Slipover only		ITEC	ITEC, ABB Inc., Meramec
CT	CT	15kV - 34.5kV			ABB Inc, Ritz
CT	CT	230kV			GE - Charleroi, PA, Itajuba, Brazil Trench - Toronto, Canada Ritz - Waynesboro, GA. Arteche - Tepeji Del Rio, Mexico (Sold through Hitachi)
CT	CT	345kv - 500kV			GE - Charleroi, PA, Itajuba, Brazil Trench - Toronto, Canada Arteche - Tepeji Del Rio, Mexico (Sold through Hitachi)



ATTACHMENT 5: APPROVED VENDOR LIST

Class	Description	Qualifier	Preferred Manufacturer	Preferred Supplier	Other Approved Manufacturer(s)
CT	CT	69kv - 161kv			GE - Charleroi, PA, Itajuba, Brazil Trench - Toronto, Canada Hitachi Energy - Crystal Springs, MS Ritz - Waynesboro, GA Arteche - Tepeji Del Rio, Mexico (Sold through Hitachi)
CT	CT	High Accuracy Extended Range			GE - Charleroi, PA, Itajuba, Brazil Trench - Toronto, Canada Hitachi Energy - Crystal Springs, MS Ritz - Waynesboro, GA Arteche - Tepeji Del Rio, Mexico (Sold through Hitachi)
Fittings	Conductor Fittings Compression			Stuart Irby	AFL, Sefcor, Anderson, Hubell
Grounding	Below grade connectors	Weld	Cadweld		Thermoweld
Grounding	Below grade connectors	Swage			AFL DMC Power
Grounds Rods Clamps	Ground Rods, Clamps, & Anodes			Stuart Irby	Any Approved Manufacturer
Helical Piles	Foundation Piling				Hubbell, Cyntech
Insulators	Insulator, Station Post, Polymer	15kV - 230kV	Maclean Power Sys	Preferred Sales	Newell
Insulators	Insulator, Station Post, Porcelain	161kV (Porcelain)	Hubbell	Hubbell Power Systems	Victor, Lapp, NGK, Newell, Vanguard, PPC
Insulators	Insulator, Station Post, Porcelain	230kV (Porcelain) STANDARD STRENGTH	Hubbell	Hubbell Power Systems	Victor, Lapp, NGK, Newell, Vanguard, PPC
Insulators	Insulator, Station Post, Porcelain	230kV (Porcelain) HI / EXTRA HIGH STRENGTH			Hubbell, Victor, Lapp,NGK, Newell, Vanguard, PPC
Insulators	Insulator, Station Post, Porcelain	345/500kV (Porcelain) HI / EXTRA HIGH STRENGTH			Hubbell, Victor, Lapp,NGK, Newell, Vanguard, PPC
Insulators	Insulator, Station Post, Porcelain	69kV, 115kV, (Porcelain)	Hubbell	Hubbell Power Systems	Victor, Lapp, NGK, Newell, Vanguard, PPC
Insulators	Insulator, Station Post, Porcelain	34.5kV and below (Porcelain)	Vanguard	Preferred Sales	Victor, Lapp, NGK, Newell, PPC, Hubbell
Insulators	Insulator, Line, Polymer		Maclean Power Sys	Preferred Sales	
Insulators	Insulator, Line, Polymer	(Polymer Insulator Assembly)	Maclean Power Sys	Preferred Sales	
Insulators	Insulator, Line, Polymer	(Polymer Insulator Only)	Maclean Power Sys	Preferred Sales	Newell
Insulators	Insulator, Line, Polymer	Hardware Assembly Only	Maclean Power Sys	Preferred Sales	
Junction Box	Junction Boxes				MMR, Premier Control, SEL
Lighting	Substation Lighting	LED	Acuity	Ruffin & Associates	
Panel	Panel - Battery Switching				MMR, SEL, Premier Control



ATTACHMENT 5: APPROVED VENDOR LIST

Class	Description	Qualifier	Preferred Manufacturer	Preferred Supplier	Other Approved Manufacturer(s)
Panel	Panel - Breaker Line				MMR, SEL, Premier Control
Panel	Panel - Communication rack				MMR, SEL, Premier Control
Panel	Panel - Meter				MMR, SEL, Premier Control
Panel	Panel - AC & DC Cabinets				MMR, SEL, Premier Control, Peterson Panel
Panel	Panel - Bus Differential				MMR, SEL, Premier Control
Panel	Panel - Line Protection				MMR, SEL, Premier Control
Poles	Pole Caissons	T-Line - after approval	Valmont	Preferred Sales	
Poles	Pole, Steel	after approval	Valmont	Preferred Sales	
Poles	Pole, Concrete		Valmont	Preferred Sales	
Reactor	Reactor, Limiting				Coil Innovations - Eferding, Austria Trench - Toronto, Canada
Reactor	Reactor, Dry Type Shunt	Below 230kV			Coil Innovations - Eferding, Austria Trench - Toronto, Canada
Reactor	Reactor, Oil filled Shunt	Through 500kV			Hitachi – Varennes, Canada; Guarulhos, Brazil Mitsubishi – Ako, Japan Prolec-GE Waukesha – Canoas, Brazil Siemens – Jundiai, Brazil; Nuremburg, Germany; Weiz, Austria SMIT – Nijmegen, Netherlands
Relay	SEL cables	Cable & Fiber		Power Connection	SEL
Relay	SEL Relays	SEL Relay		Power Connection	SEL
RTU	ACS Cables	NTX cables		Ruffin & Associates	ACS (Automated Control Systems)
RTU	ACS RTU - Peripherals	NTX-U20 & Upgrades		Ruffin & Associates	ACS (Automated Control Systems)
RTU	GE Parts	Accessories & Cables			G.E. Grid Solutions
RTU	RTU	IO cabinet standard RTU			G.E. Grid Solutions
RTU	RTU - Kits & Parts	D400, D20, DNPIO Kits & Parts			G.E. Grid Solutions
Signs	Signs - General			Stuart Irby	Stuart Irby
Signs	Signs - Owner Substation Switchyard			Impco	Impco
Structure	Tapered Tubular	Fabrication and Design	Distran	Distran	Valmont
Structure	Standard Shape	Fabrication only (existing details)	Distran	Distran	Industrial Steel, Valmont
Structure	Standard Shape	Fabrication and Design	Distran	Distran	Industrial Steel, Valmont
Structure	Tapered Tubular	Fabrication only (existing details)	Distran	Distran	Valmont



ATTACHMENT 5: APPROVED VENDOR LIST

Class	Description	Qualifier	Preferred Manufacturer	Preferred Supplier	Other Approved Manufacturer(s)
Switch	Switch, Fuse (SMD style)	15 kV	S&C	Curtis Stout	
Switch	Switch, T-Line	Switch group operated 245kV and below		Southern Utility Sales Agency	SEECO
Switch	ASCO ATS (Automatic Transfer Switch)				Utility and Industrial Supply,LLC, WESCO
Switch	Switch, Disconnect	15kV - 34.5kV	Southern States	Preferred Sales	USCO, Royal
Switch	Switch, Disconnect, Hookstick	15kV - 34.5kV PBO up to 2000A XY-2A at 3000A	Southern States	Preferred Sales	USCO, Royal
Switch	Switch, Disconnect	115 & 230kV Air Break	Southern States	Preferred Sales	USCO, Pascor Atlantic, Royal
Switch	Switch, Disconnect	69kV - 230kV	Southern States	Preferred Sales	USCO, Pascor Atlantic, Royal
Switch	Switch, Disconnect	69kV Air Break	Southern States	Preferred Sales	USCO, Pascor Atlantic, Royal
Switch	Switch, Disconnect	345/500kV	Southern States	Preferred Sales	Pascor Atlantic
Switch/Motor Operators	Motor Operator	S&C MO	S&C	Curtis Stout	
Switch/Motor Operators	Motor Operator	Southern States MO	Southern States	Preferred Sales	
Trap	Trap, Line Carrier			Curtis Stout	Trench (No other supplier approved)
Trench			Concast	GHMR	Trenwa, Old Castle
Tuner	Tuner, Line Carrier			Curtis Stout	Trench



ATTACHMENT 6: OWNER LOADING DISTRICTS

State	County	Extreme Wind mph	NESC District			Extreme Ice inches	Entergy Load Case
			Light	Medium	Heavy		
AR	Arkansas	100		M		1	LC-2
AR	Ashley	100		M		1	LC-2
AR	Baxter	100			H	1	LC-1
AR	Benton	100			H	1	LC-1
AR	Boone	100			H	1	LC-1
AR	Bradley	100		M		1	LC-2
AR	Calhoun	100		M		1	LC-2
AR	Carroll	100			H	1	LC-1
AR	Chicot	100		M		1	LC-2
AR	Clark	100			H	1	LC-1
AR	Clay	100			H	1	LC-1
AR	Cleburne	100			H	1	LC-1
AR	Cleveland	100		M		1	LC-2
AR	Columbia	100		M		1	LC-2
AR	Conway	100			H	1	LC-1
AR	Craighead	100		M		1	LC-2
AR	Crawford	100			H	1	LC-1
AR	Crittenden	100		M		1	LC-2
AR	Cross	100		M		1	LC-2
AR	Dallas	100		M		1	LC-2
AR	Desha	100		M		1	LC-2
AR	Drew	100		M		1	LC-2
AR	Faulkner	100			H	1	LC-1
AR	Franklin	100			H	1	LC-1
AR	Fulton	100			H	1	LC-1
AR	Garland	100			H	1	LC-1
AR	Grant	100		M		1	LC-2
AR	Greene	100			H	1	LC-1
AR	Hempstead	100			H	1	LC-1
AR	Hot Spring	100			H	1	LC-1
AR	Howard	100			H	1	LC-1
AR	Independence	100			H	1	LC-1
AR	Izard	100			H	1	LC-1
AR	Jackson	100			H	1	LC-1
AR	Jefferson	100		M		1	LC-2



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ATTACHMENT 6: OWNER LOADING DISTRICTS

State	County	Extreme Wind mph	NESC District			Extreme Ice inches	Entergy Load Case
			Light	Medium	Heavy		
AR	Johnson	100			H	1	LC-1
AR	Lafayette	100		M		1	LC-2
AR	Lawrence	100			H	1	LC-1
AR	Lee	100		M		1	LC-2
AR	Lincoln	100		M		1	LC-2
AR	Little River	100			H	1	LC-1
AR	Logan	100			H	1	LC-1
AR	Lonoke	100		M		1	LC-2
AR	Madison	100			H	1	LC-1
AR	Marion	100			H	1	LC-1
AR	Miller	100		M		1	LC-2
AR	Mississippi	100		M		1	LC-2
AR	Monroe	100		M		1	LC-2
AR	Montgomery	100			H	1	LC-1
AR	Nevada	100		M		1	LC-2
AR	Newton	100			H	1	LC-1
AR	Ouachita	100		M		1	LC-2
AR	Perry	100			H	1	LC-1
AR	Phillips	100		M		1	LC-2
AR	Pike	100			H	1	LC-1
AR	Poinsett	100		M		1	LC-2
AR	Polk	100			H	1	LC-1
AR	Pope	100			H	1	LC-1
AR	Prairie	100		M		1	LC-2
AR	Pulaski	100			H	1	LC-1
AR	Randolph	100			H	1	LC-1
AR	St. Francis	100		M		1	LC-2
AR	Saline	100			H	1	LC-1
AR	Scott	100			H	1	LC-1
AR	Searcy	100			H	1	LC-1
AR	Sebastian	100			H	1	LC-1
AR	Sevier	100			H	1	LC-1
AR	Sharp	100			H	1	LC-1
AR	Stone	100			H	1	LC-1
AR	Union	100		M		1	LC-2
AR	Van Buren	100			H	1	LC-1
AR	Washington	100			H	1	LC-1
AR	White	100			H	1	LC-1
AR	Woodruff	100		M		1	LC-2
AR	Yell	100			H	1	LC-1
MO	Dunklin	100			H	1	LC-1
MO	New Madrid	100			H	1	LC-1
MO	Oregon	100			H	1	LC-1
MO	Pemiscot	100			H	1	LC-1
MO	Stoddard	100			H	1	LC-1
MO	Taney	100			H	1	LC-1



Entergy Texas, Inc.
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Technical Specification: ETI-CCCT
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ATTACHMENT 6: OWNER LOADING DISTRICTS

State	Parish	Extreme Wind mph	NESC District			Extreme Ice inches	Entergy Load Case
			Light	Medium	Heavy		
LA	Acadia	150	L			0.5	LC-3D
LA	Allen	125	L			0.5	LC-3B
LA	Ascension	150	L			0.5	LC-3D
LA	Assumption	150	L			0.5	LC-3D
LA	Avoyelles	110	L			0.5	LC-3F
LA	Beauregard	125	L			0.5	LC-3B
LA	Bienville	100		M		0.75	LC-2D
LA	Bossier	100		M		0.75	LC-2D
LA	Calcasieu	150	L			0.5	LC-3D
LA	Caldwell	100		M		0.75	LC-2D
LA	Cameron	150	L			0.5	LC-3D
LA	Catahoula	100	L			0.5	LC-3E
LA	Claiborne	100		M		0.75	LC-2D
LA	Concordia	100	L			0.5	LC-3E
LA	Desoto	100		M		0.75	LC-2D
LA	East Baton Rouge	150	L			0.5	LC-3D
LA	East Carrol	100		M		0.75	LC-2D
LA	East Feliciana	125	L			0.5	LC-3B
LA	Evangeline	125	L			0.5	LC-3B
LA	Franklin	100		M		0.75	LC-2D
LA	Grant	100	L			0.75	LC-2C
LA	Iberia	150	L			0.5	LC-3D
LA	Iberville	150	L			0.5	LC-3D
LA	Jackson	100		M		0.75	LC-2D
LA	Jefferson	150	L			0.5	LC-3D
LA	Jefferson Davis	150	L			0.5	LC-3D
LA	Lafayette	150	L			0.5	LC-3D
LA	Lafourche	150	L			0.5	LC-3D
LA	Lasalle	100	L			0.75	LC-3C
LA	Lincoln	100		M		0.75	LC-2D
LA	Livingston	150	L			0.5	LC-3D
LA	Madison	100	L			0.75	LC-3C
LA	Morehouse	100		M		0.75	LC-2D
LA	Natchitoches	100		M		0.75	LC-2D
LA	Orleans	150	L			0.5	LC-3D
LA	Ouachita	100		M		0.75	LC-2D
LA	Plaquemines	150	L			0.5	LC-3D
LA	Point Coupee	125	L			0.5	LC-3B
LA	Rapides	100	L			0.5	LC-3E
LA	Red River	100		M		0.75	LC-2D
LA	Richland	100		M		0.75	LC-2D
LA	Sabine	100		M		0.75	LC-2D
LA	St. Bernard	150	L			0.5	LC-3D
LA	St. Charles	150	L			0.5	LC-3D



ATTACHMENT 6: OWNER LOADING DISTRICTS

State	Parish	Extreme Wind mph	NESC District			Extreme Ice inches	Entergy Load Case
			Light	Medium	Heavy		
LA	St. Helena	125	L			0.5	LC-3B
LA	St. James	150	L			0.5	LC-3D
LA	St. John the Baptist	150	L			0.5	LC-3D
LA	St. Landry	125	L			0.5	LC-3B
LA	St. Martin, North	150	L			0.5	LC-3D
LA	St. Martin, South	150	L			0.5	LC-3D
LA	St. Mary	150	L			0.5	LC-3D
LA	St. Tammany	150	L			0.5	LC-3D
LA	Tangipahoa	150	L			0.5	LC-3D
LA	Tensas	100	L			0.5	LC-3E
LA	Terrebonne	150	L			0.5	LC-3D
LA	Union	100		M		0.75	LC-2D
LA	Vermillion	150	L			0.5	LC-3D
LA	Vernon	100	L			0.5	LC-3E
LA	Washington	125	L			0.5	LC-3B
LA	Webster	100		M		0.75	LC-2D
LA	West Baton Rouge	150	L			0.5	LC-3D
LA	West Carrol	100		M		0.75	LC-2D
LA	West Feliciana	125	L			0.5	LC-3B
LA	Winn	100		M		0.75	LC-2D



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State	County	Extreme Wind mph	NESC District			Extreme Ice inches	Entergy Load Case
			Light	Medium	Heavy		
MS	Adams	100	L			0.5	LC-3E
MS	Amite	110	L			0.5	LC-3F
MS	Attala	100	L			0.5	LC-3E
MS	Benton	100		M		1	LC-2
MS	Bolivar	100		M		1	LC-2
MS	Calhoun	100		M		1	LC-2
MS	Carrol	100		M		1	LC-2
MS	Chickasaw	100		M		1	LC-2
MS	Choctaw	100		M		1	LC-2
MS	Claiborne	100	L			0.5	LC-3E
MS	Clay	100		M		1	LC-2
MS	Coahoma	100		M		1	LC-2
MS	Copiah	100	L			0.5	LC-3E
MS	Covington	110	L			0.5	LC-3F
MS	Desoto	100		M		1	LC-2
MS	Franklin	100	L			0.5	LC-3E
MS	Grenada	100		M		1	LC-2
MS	Hinds	100	L			0.5	LC-3E
MS	Holmes	100		M		1	LC-2
MS	Humphreys	100		M		1	LC-2
MS	Issaquena	100	L			1	LC-3G
MS	Jefferson	100	L			0.5	LC-3E
MS	Jefferson Davis	110	L			0.5	LC-3F
MS	Lafayette	100		M		1	LC-2
MS	Lawrence	110	L			0.5	LC-3F
MS	Leake	100	L			0.5	LC-3E
MS	Leflore	100		M		1	LC-2
MS	Lincoln	110	L			0.5	LC-3F
MS	Madison	100	L			0.5	LC-3E
MS	Marion	110	L			0.5	LC-3F
MS	Marshall	100		M		1	LC-2
MS	Montgomery	100		M		1	LC-2
MS	Neshoba	100	L			0.5	LC-3E
MS	Newton	100	L			0.5	LC-3E
MS	Panola	100		M		1	LC-2
MS	Pike	110	L			0.5	LC-3F
MS	Ponotoc	100		M		1	LC-2
MS	Quitman	100		M		1	LC-2
MS	Rankin	100	L			0.5	LC-3E
MS	Scott	100	L			0.5	LC-3E
MS	Sharkey	100	L			0.75	LC-3C
MS	Simpson	100	L			0.5	LC-3E
MS	Smith	110	L			0.5	LC-3F



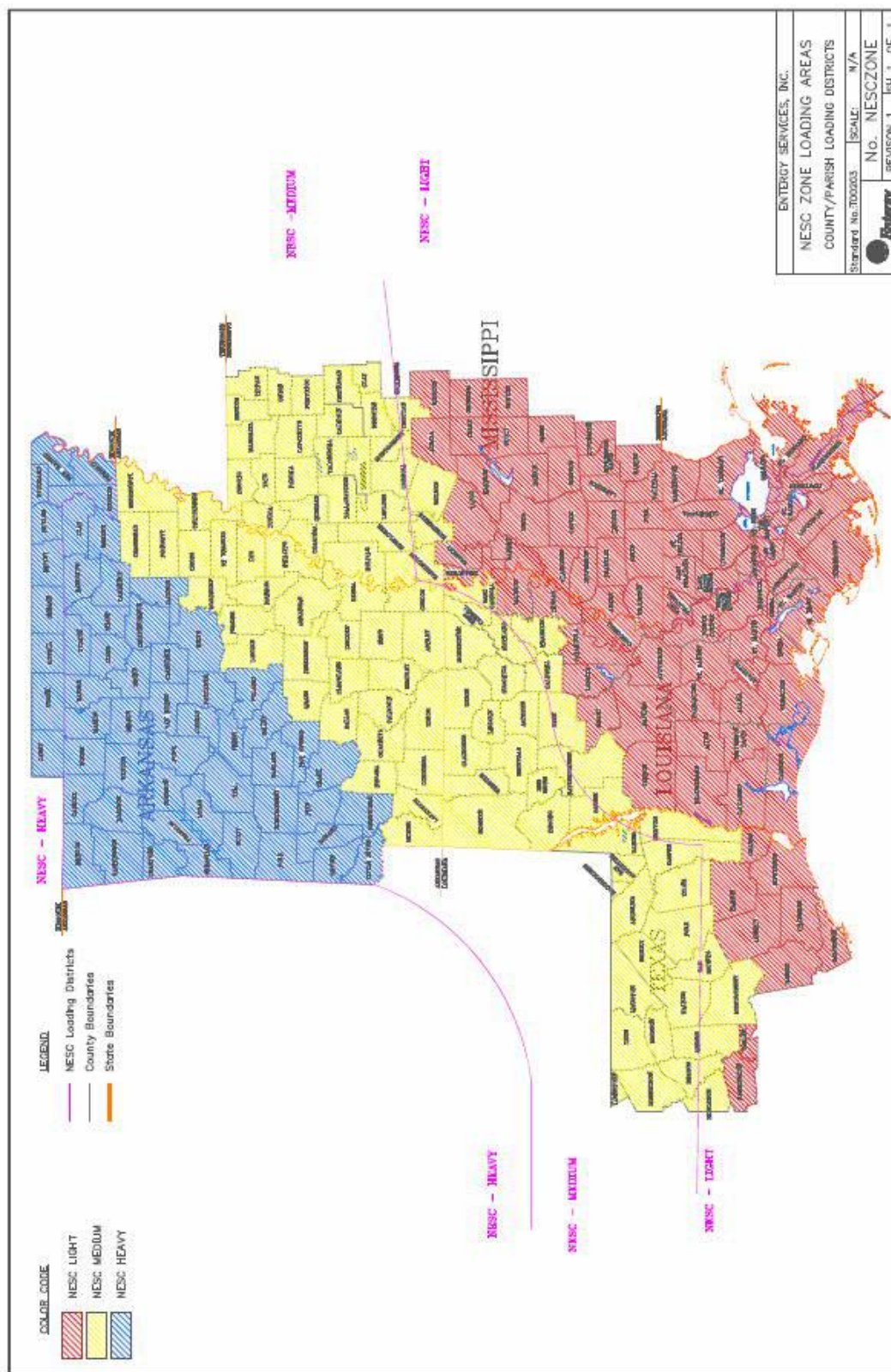
ATTACHMENT 6: OWNER LOADING DISTRICTS

State	County	Extreme Wind mph	NESC District			Extreme Ice inches	Entergy Load Case
			Light	Medium	Heavy		
MS	Sunflower	100		M		1	LC-2
MS	Tallahatchie	100		M		1	LC-2
MS	Tate	100		M		1	LC-2
MS	Tippah	100		M		1	LC-2
MS	Tunica	100		M		1	LC-2
MS	Union	100		M		1	LC-2
MS	Walthall	110	L			0.5	LC-3F
MS	Warren	100	L			0.5	LC-3E
MS	Washington	100		M		1	LC-2
MS	Webster	100		M		1	LC-2
MS	Wilkinson	110	L			0.5	LC-3F
MS	Winston	100	L			0.5	LC-3E
MS	Yalobusha	100		M		1	LC-2
MS	Yazoo	100	L			0.75	LC-3C

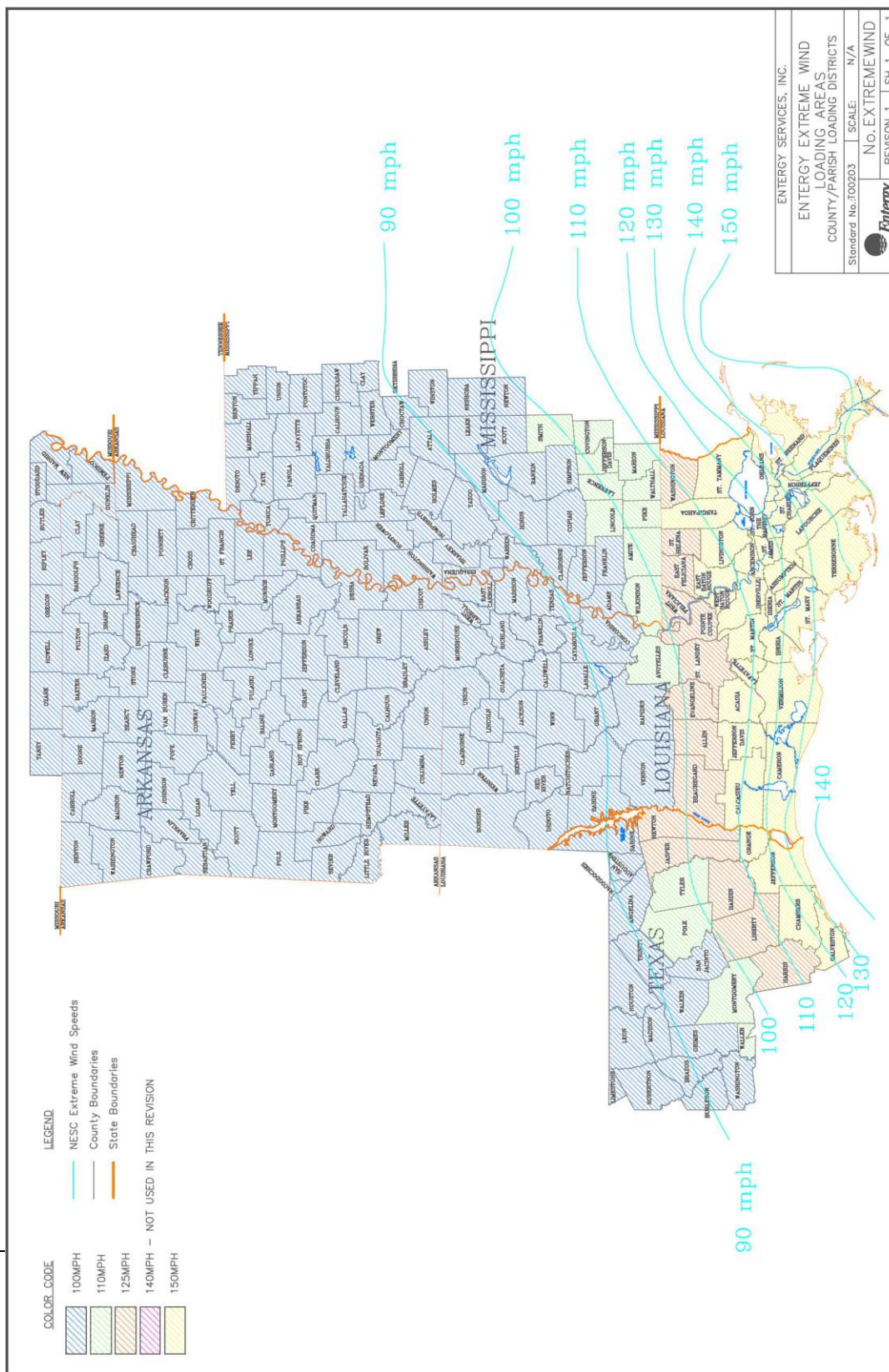
ATTACHMENT 6: OWNER LOADING DISTRICTS

State	County	Extreme Wind mph	NESC District			Extreme Ice inches	Entergy Load Case
			Light	Medium	Heavy		
TX	Angelina	100		M		0.75	LC-2D
TX	Brazos	100		M		0.75	LC-2D
TX	Burleson	100		M		0.5	LC-2B
TX	Chambers	150	L			0.5	LC-3D
TX	Galveston	150	L			0.5	LC-3D
TX	Grimes	100		M		0.75	LC-2D
TX	Hardin	125	L			0.5	LC-3B
TX	Harris	125	L			0.5	LC-3B
TX	Houston	100		M		0.75	LC-2D
TX	Jasper	125		M		0.5	LC-2C
TX	Jefferson	150	L			0.5	LC-3D
TX	Leon	100		M		0.75	LC-2D
TX	Liberty	125	L			0.5	LC-3B
TX	Limestone	100		M		0.75	LC-2D
TX	Madison	100		M		0.75	LC-2D
TX	Montgomery	110		M		0.5	LC-2A
TX	Nacogdoches	100		M		0.75	LC-2D
TX	Newton	125		M		0.5	LC-2C
TX	Orange	150	L			0.5	LC-3D
TX	Polk	110		M		0.75	LC-2E
TX	Robertson	100		M		0.75	LC-2D
TX	Sabine	100		M		0.75	LC-2D
TX	San Augustine	100		M		0.75	LC-2D
TX	San Jacinto	100		M		0.75	LC-2D
TX	Trinity	100		M		0.75	LC-2D
TX	Tyler	110		M		0.75	LC-2E
TX	Walker	100		M		0.75	LC-2D
TX	Waller	110	L			0.5	LC-3F
TX	Washington	100	L			0.5	LC-3E

ATTACHMENT 6: OWNER LOADING DISTRICTS



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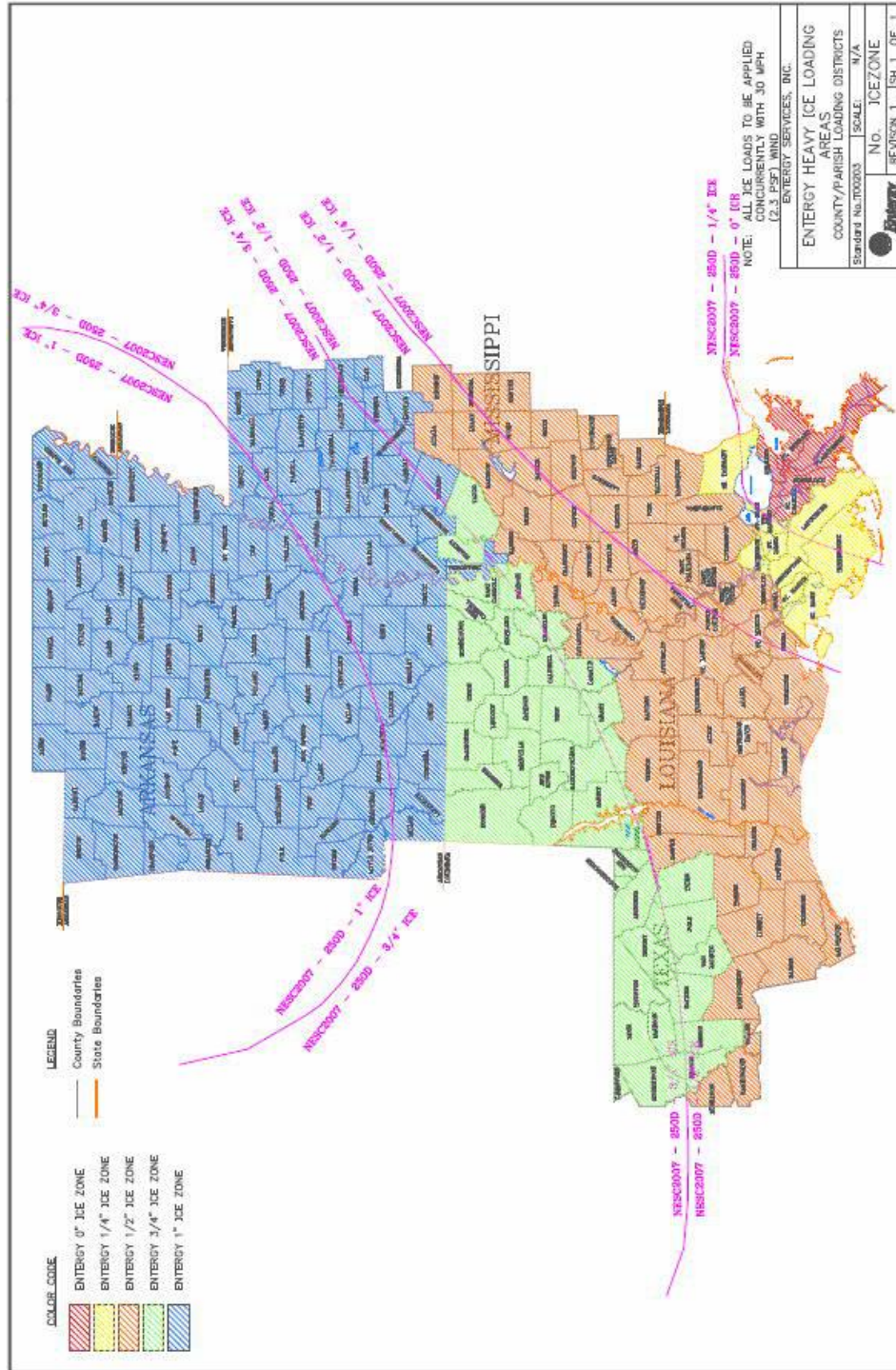
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***** END OF Section A.17*****