Appendix B-4
B-O-T Scope Book
2024 Request for Proposals
for
Combined-Cycle Combustion Turbine Resources
for

Entergy Services, LLC

Entergy CCCT Plant

Scope Book

January 27, 2025

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* Entergy's requirements for this Attachment are included in this scope book.
** Entergy's requirements for this Attachment are included in this scope book with Seller input.
*** Attachment to be inserted by Bidder as part of Proposal.

B-4.1 PROJECT SCOPE BOOK

This Appendix B-4 and its attachments form the Scope Book. This Scope Book describes certain requirements with respect to the Work. 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 described in Section 11 of Appendix B-4 (B-O-T Term Sheet) to this RFP).

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. This 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.

B-4.1.1 PROJECT DESCRIPTION

The Project will be located on a site in LRZ-9.

The Project will consist of a Commercially-Proven CCCT between 600 and 800 MW at Summer Conditions. Operating parameters will include a maximum heat rate of 7,000 Btu/kWh at full output without supplemental duct-firing (if included as part of the facility). The Project will be fully permitted, and the CTGs, STG and HRSGs will have the agreed upon equipment warranties.

The project will utilize natural gas as the only fuel. 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 Attachment A-4 (“Design Basis”).

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”:

The Project will be designed taking into consideration the following objectives:

- Ensure safe operations, maintainability, and construction.
- Achieve a thirty (30)-year life.
- Facilitate maintenance work and provide access to all equipment according to the Project Standard (including OSHA).
- 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 Appendix B-4.

Achieve specified requirements for Project output capacity, heat rate, reliability, emission limits, and noise limits.

Minimize adverse local community impacts.

Minimize changes throughout engineering, design, procurement, and construction.

B-4.2 SCOPE BOOK

B-4.2.1 KEY PERSONNEL CHART

B-4.2.1.1 The document entitled "Key Personnel Chart," attached hereto as Attachment A-1, is adopted and fully incorporated by reference as if it were reproduced in its entirety.

B-4.2.2 PROJECT EXECUTION PLAN REQUIREMENTS

B-4.2.2.1 The document entitled "Project Execution Plan Requirements," attached hereto as Attachment A-2, is adopted and fully incorporated by reference as if it were reproduced in its entirety.

B-4.2.3 PROJECT PERFORMANCE TESTS

B-4.2.3.1 The document entitled "Plant Performance Tests," attached hereto as Attachment A-3, is adopted and fully incorporated by reference as if it were reproduced in its entirety.

B-4.2.4 PROJECT REQUIREMENTS AND DESIGN CRITERIA

B-4.2.4.1 The document entitled "Project Requirements and Design Criteria," attached hereto as Attachment A-4, is adopted and fully incorporated by reference as if it were reproduced in its entirety.

B-4.2.5 CIVIL/STRUCTURAL/ARCHITECTURAL DESIGN

B-4.2.5.1 The document entitled "Civil/Structural/Architectural Design," attached hereto as Attachment A-5, is adopted and fully incorporated by reference as if it were reproduced in its entirety.

B-4.2.6 MECHANICAL DESIGN

B-4.2.6.1 The document entitled "Mechanical Design Criteria," attached hereto as Attachment A-6, is adopted and fully incorporated by reference as if it were reproduced in its entirety.

B-4.2.7 ELECTRICAL DESIGN

B-4.2.7.1 The document entitled "Electrical Design Criteria," attached hereto as Attachment A-7, is adopted and fully incorporated by reference as if it were reproduced in its entirety.

B-4.2.8 CONTROLS DESIGN

B-4.2.8.1 The document entitled "Controls Design Criteria," attached hereto as Attachment A-8, is adopted and fully incorporated by reference as if it were reproduced in its entirety.

B-4.2.9 BUILDING AND EQUIPMENT ENCLOSURE DESIGN CRITERIA

B-4.2.9.1 The document entitled "Building and Equipment Enclosure Design Criteria," attached hereto as Attachment A-9, is adopted and fully incorporated by reference as if it were reproduced in its entirety.

B-4.2.10 CONSTRUCTION REQUIREMENTS

B-4.2.10.1 The document entitled "Construction Requirements," attached hereto as Attachment A-10, is adopted and fully incorporated by reference as if it were reproduced in its entirety.

B-4.2.11 TERMINAL POINTS

B-4.2.11.1 The document entitled "Terminal Points," attached hereto as Attachment A-11, is adopted and fully incorporated by reference as if it were reproduced in its entirety.

B-4.2.12 DIVISION OF RESPONSIBILITY

B-4.2.12.1 The document entitled "Division of Responsibility," attached hereto as Attachment A-12, is adopted and fully incorporated by reference as if it were reproduced in its entirety.

B-4.2.13 EQUIPMENT LABELING AND SIGNAGE PROCEDURE

B-4.2.13.1 The document entitled "Equipment Labeling and Signage Procedure," attached hereto as Attachment A-13, is adopted and fully incorporated by reference as if it were reproduced in its entirety.

B-4.2.14 TRAINING

B-4.2.14.1 The document entitled "Training Procedure," attached hereto as Attachment A-14, is adopted and fully incorporated by reference as if it were reproduced in its entirety.

B-4.2.15 DRAWING SPECIFICATION

B-4.2.15.1 The document entitled "Drawing Specification," attached hereto as Attachment A-15, is adopted and fully incorporated by reference as if it were reproduced in its entirety.

B-4.2.16 APPROVED MANUFACTURERS LIST

B-4.2.16.1 The document entitled "Approved Manufacturers List," attached hereto as Attachment A-16, is adopted and fully incorporated by reference as if it were reproduced in its entirety.

B-4.2.17 FIRE PROTECTION

B-4.2.17.1 The document entitled “Fire Protection Requirements and Design Criteria,” attached hereto as Attachment A-20, is adopted and fully incorporated by reference as if it were reproduced in its entirety.

B-4.2.18 MAJOR TECHNICAL SPECIFICATIONS

The following major equipment technical specifications are adopted and fully incorporated by reference as if it were reproduced in its entirety:

B-4.2.18.1 Attachment A-17 – Combustions Turbine Generator Technical Specification

B-4.2.18.2 Attachment A-18 – HRSG Technical Specification

B-4.2.18.3 Attachment A-19 – Steam Turbine Generator Technical Specification

B-4.2.18.4 Attachment A-21 – GSU Transformer Specification

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 attachments 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 Appendix B-4 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. 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 ten (10) or fifteen (15) Business Day period, as applicable, such Engineering Materials shall be deemed approved. If Buyer provides comments within such ten (10) or 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 ten (10) or 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 have 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 Attachment A-16.

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 of the following organizations as listed in Attachment A-4 (Design Basis), 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 the 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 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 Attachment A-15. 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.4-1 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.4-1 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 Attachment A-10.

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 by 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 Attachment A-20 Fire Protection

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 to manage.

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 Attachment 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 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 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 Attachment A-4.

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 an 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 liming 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 Attachment A-5 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 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. See Attachment A-10 for additional requirements.

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 Attachment A-4 for acronyms, abbreviations, and definitions as used in the Scope Book and its attachments.

BOT Scope Book
Attachment A-1
Key Personnel Chart

Attachment to be inserted by Bidder as part of Proposal

BOT Scope Book
Attachment 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 Attachment A-2.

No modifications to the PEP are permitted without first providing the Owner a reasonable opportunity to review and comment on any proposed modifications, and the Seller shall give due consideration to any Owner'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 Owner will be reasonable and timely in any modification requests.

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

BOT Scope Book
Attachment A-3
Project Performance Tests

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A-3.1 PLANT PERFORMANCE GUARANTEES AND COMPLIANCE TESTING

A-3.1.1 Guarantees

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

A-3.1.1.1 Guaranteed Net Electrical Output and Guaranteed Net Plant Heat Rate

The performance guarantees listed in Table A-3.1 are subject to the Guarantee Test Conditions stated in this Attachment.

Table A-3.1 Performance Guarantees when firing 100% Natural Gas

Guaranteed Net Electrical Output	By Seller
Guaranteed Net Plant Heat Rate	By Seller

A-3.1.1.2

Performance Guarantees provided in this Attachment are based on the Guarantee Test Conditions shown in Table A-3.2 below. All Performance Test results shall be corrected for deviation from the Guarantee Test Conditions.

Table A-3.2 Guarantee Test Conditions

Conditions for Guarantees	Net Plant Performance
Ambient Dry Bulb Temperature (°F)	
Ambient Relative Humidity	
Evaporative Cooler Status	On
Duct Burner Status	On
Barometric Pressure (psia)	
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(s) Load	100% Load
CTG and STG Condition	New and Clean (1)
Auxiliary Power	By Seller

Conditions for Guarantees	Net Plant Performance
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 is 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 actual hours of the combustion turbine achieved 200 hours.
2. No tolerance will be applied prior to comparing the Performance Test results with the performance guarantee.

A-3.1.1.2.1 The performance guarantees stated in A-3.1.1 include the auxiliary consumption of equipment supplied by Seller as needed for steady state operation.

A-3.1.1.3 Guaranteed Emission Limits

A-3.1.1.3.1 Emissions guarantees shall be in accordance with the facility's air permit.

A-3.1.1.4 Emissions Guarantee Basis

A-3.1.1.4.1 The emissions guarantees provided in the facility's air permit are subject to the fuel properties in the Seller's fuel specification. If the sulfur content or fuel bound nitrogen content exceeds the value indicated in the Seller's fuel specification, the emissions guarantees shall be adjusted accordingly.

A-3.1.1.4.2 If part of project scope, 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-3.1.2 Mechanical Completion

A-3.1.2.1 Prior to initiating Performance Testing, the 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. The Seller must complete turnover, testing and Commissioning procedures, such as hydrostatic and pneumatic pressure tests, high pot tests, insulation resistance and continuity test, calibrations, clean-outs, and flushes, and completed system startup testing, back feed, and synchronizing in accordance with prudent industry practice and Buyer approved procedures.

A-3.2 Guarantee Test Conditions and Procedures

A-3.2.1 General

A-3.2.1.1 The Buyer shall assist the Seller in the coordination of the Performance Test requirements as defined in the Contract and this Appendix. Scheduling of the Performance Test shall be coordinated between the Buyer and Seller.

A-3.2.1.2 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-3.2.2 General Test Requirements

A-3.2.2.1 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-3.2.2.2 During all testing, the steam turbine inlet temperature and the combustion turbine control temperature shall not exceed the manufacturers recommended temperature for continuous long-term operation.

A-3.2.2.3 All the 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-3.2.2.4 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-3.2.2.5 The Project shall be operated during the Performance Test, the Reliability Test, the Turbine Run Back and Trip Test, the CTG Islanding Demonstration Test, the Plant Operating Startup Demonstration Test, and the Plant Operating Shutdown Demonstration Test by the Buyer's operating personnel under the technical direction of the Seller. Seller shall be responsible for all maintenance until Substantial Completion is achieved. Before the transfer of care, custody, and control of the Project to Buyer, Buyer's personnel shall be under the direction and control of Seller with respect to operating the Project. 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-3.2.2.6 The Turbine Run Back and Trip Testing may be performed either during the Reliability Test or separately, at the 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-3.2.2.7 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 the 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. The 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 the Buyer and the Seller.

A-3.2.2.8 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-3.2.2.9 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-3.2.2.10 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-3.2.2.11 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-3.2.3 Performance Test

A-3.2.3.1 The guaranteed Net Electrical Output and guaranteed Net Plant 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-3.2.3.2 The Net Electrical Output and Net Plant 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 Plant 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 Plant 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 that 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 the Seller's responsibility, will require that such evaluation period be repeated at Seller's cost (excluding fuel costs).

A-3.2.3.3 An individual evaluation period is considered consistent if the Net Electrical Output value, corrected to the Guarantee Test Conditions, is within one (1) percent of the average of all submitted evaluations; and, the Net Plant Heat Rate value, corrected to the Guarantee Test Conditions, is within two (2) percent of the average of all submitted evaluations.

A-3.2.3.4 The as-tested Net Electrical Output and Net Plant Heat Rate values determined during the Net Electrical Output and Net Plant 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-3.2.3.5 If the CTG supplier provides a new correction curve for the combustion turbine after the integrated Dry Low NOx (DLN) tuning at the site, it will be integrated in the Performance Test procedures subject to Buyer review and approval.

A-3.2.3.6 After the as-tested values for each of the Performance Test runs are determined, corrections to the as tested Net Electrical Output and Net Plant Heat Rate shall be performed by Seller for each test period in accordance with this Attachment 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-3.2.3.6.1 Generator power factor and frequency

A-3.2.3.6.2 Fuel composition, heating value and chemical and physical characteristics, including analysis.

A-3.2.3.6.3 Barometric pressure

A-3.2.3.6.4 Ambient relative humidity

A-3.2.3.6.5 Ambient dry bulb temperature

A-3.2.3.6.6 Degradation

A-3.2.3.6.7 Evaporative Cooler Status (On/Off)

A-3.2.3.6.8 Duct Burner Status (On/Off)

A-3.2.3.6.9 Cycle Leakage

A-3.2.3.6.10 Fuel gas temperature at supply point at the specified pressure

A-3.2.3.7 During the Net Electrical Output and Net Plant 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-3.2.4 Emissions Testing

A-3.2.4.1 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 LDEQ 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-3.2.4.2 Air Emissions Tests shall be conducted concurrently with the Net Electrical Output and Net Plant Heat Rate Tests as much as practical according to the Air Emissions Testing Procedure.

A-3.2.4.3 Seller shall meet guarantees, based on measurement at the HRSG stack.

A-3.2.4.4 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-3.2.4.5 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-3.2.4.5.1 EPA Method 20 or 7E shall be used to measure NOx.

A-3.2.4.5.2 EPA Method 10 shall be used to measure CO.

A-3.2.4.5.3 EPA Method 18 & 25A shall be used to measure total VOC emissions.

A-3.2.4.5.4 EPA Test Method CTM-027 shall be used to measure NH3 emissions.

A-3.2.4.5.5 EPA Test Method 323 or equivalent shall be used to measure H-CHO emissions.

A-3.2.4.5.6 EPA Test Method 201A/202 or equivalent shall be used to measure PM10 emissions.

A-3.2.4.5.7 EPA Test Method 9 shall be used to measure Opacity emissions.

A-3.2.4.6 Compliance with Guaranteed Emission Limits that can be continuously monitored are required during the Performance Test.

A-3.2.4.7 Before Final Acceptance, the Air Emissions Tests shall be repeated if directed by the LDEQ. 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-3.2.4.8 Air Emissions Testing shall demonstrate compliance with all emission limits defined in the facility’s air permit.

A-3.2.5 Measurement and Test Results

A-3.2.5.1 Calibration tests shall be made on all temporary test instruments prior to initiating the Net Electrical Output and Net Plant 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 the 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 the Seller's cost.

A-3.2.5.2 The Seller shall provide scaffolding (as required), material and labor for installation of test instrumentation, and removal of temporary instruments.

A-3.2.5.3 Within fourteen (14) days after receipt of the analysis of the test fuel, the 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-3.2.5.4 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-3.2.5.5 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-3.3 RELIABILITY TEST

A-3.3.1 Test Procedure

A-3.3.1.1 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-3.3.1.2 Any turbine trip caused by equipment or services under the control of the 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 during such period, the Reliability Test shall be rerun by Seller at no cost to Buyer other than fuel and Buyer labor costs.

A-3.3.1.3 The seven-day Reliability Test Measurement Period shall be one hundred sixty-eight (168) rolling hours with three hundred thirty-six (336) 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 that affect the safety and operation of the Project have been completed by the Seller.

A-3.3.2 Reliability Factor Calculation

A-3.3.2.1 The three-day Reliability Factor ("RF"), will be determined as follows:

RF= (A+ B + C) / (144) x 100%

Where:

A= The summation of those one 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 those one 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 those one 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 meets the utility dispatch requirements. The Project shall be considered at the demand load while it is controlling or ramping to the load demanded.

B = ∑ (n1 x NECF1 + n2 x NECF2 …ni x 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 = Actual Net Project Electrical Output / Demand

C = The summation of those one 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 the total 72 hours.

A-3.3.2.2 Maximum Limit shall be defined as the combustion turbine operating at base load and the steam turbine in operation with no bypass.

A-3.3.2.3 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-3.3.2.4 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-3.3.2.5 The plant shall be operated in accordance with the a dispatch schedule coordinated between Buyer, Seller, and with the approval of the transmission system operator.

A-3.3.2.6 Automatic Generation Control (AGC) will be in-service during the testing periods.

A-3.3.2.7 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-3.3.2.8 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, the 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-3.3.3 Conditions Applicable for the Reliability Test

A-3.3.3.1 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 the Buyer or its agents or its other Sellers and subcontractors (not including Seller's Subcontractors), 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-3.3.3.2 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 the 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-3.3.3.3 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 the Seller on a daily basis. Seller shall be entitled to inspect the operator log sheet.

A-3.3.3.4 Seller shall have a field representative present during performance of the Reliability Test.

A-3.3.3.5 The Buyer shall use all reasonable efforts to notify the 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-3.3.3.6 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-3.3.3.7 Within 45 days of completion of a successful Reliability Test, the 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-3.4 PROJECT DEMONSTRATION TEST

A-3.4.1 Load Demonstration Tests

A-3.4.1.1 The Seller shall demonstrate the following load carrying capability no later than 12 months after Substantial Completion.

A-3.4.1.1.1 The combustion turbine operating at manufacturer's minimum turndown load within emissions compliance and with steam turbine in operation.

A-3.4.1.1.2 Steam bypass operation with the combustion turbine operating at base load with steam turbine in full bypass and duct burners off.

A-3.4.1.2 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 that are in compliance with the Guaranteed Emission Limits herein, and all loops remain within the design operating parameters of the Plant.

A-3.4.2 Turbine Run Back and Trip Testing

A-3.4.2.1 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-3.4.2.2 The test scenarios to be demonstrated shall be conducted at the maximum Net Electrical Output and include:

A-3.4.2.2.1 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-3.4.2.2.2 Trip of one (1) boiler feedwater 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-3.4.2.2.3 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-3.4.2.2.4 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-3.4.3 CTG Islanding Mode Demonstration Test

A-3.4.3.1 The Seller shall perform an Islanding Mode Demonstration Test no later than 12 months after Substantial Completion. This test will demonstrate the CTG control capability for an Islanding Mode event. The Islanding Mode allows the CTG unit to continue operating in the event that the transmission grid (or bulk power system) is lost due to an outage (e.g. blackout). The test shall be considered successful if the event for islanding mode is accomplished and CTG is maintained operational for two (2) hours followed by synchronizing back to the transmission system. During this test, or during islanding mode operation, the emissions are not in compliance with the Guaranteed Emission Limits or Minimum Emission Compliance Limits (MECL)

A-3.4.4 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-3.4.4.1 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	Less than two-and-a-half (2.5) hours
Warm Startup	Less than four-and-a-half (4.5) hours
Cold Startup	Less than six-and-a-half (6.5) hours

A-3.4.4.2 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-3.4.5 Plant Operating Shutdown Demonstration Test

A-3.4.5.1 Seller shall define and demonstrate lx1 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-3.4.6 NERC Compliance Testing

A-3.4.6.1 Seller 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 the Buyer.

A-3.4.7 MISO Generation Verification Test Capacity (GVTC)

A-3.4.7.1 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-3.4.8 MISO Automatic Generation Control (AGC) Closed Loop Demonstration Test

A-3.4.8.1 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 ATTACHMENT A-3

BOT Scope Book
Attachment A-4
Project Requirements and Design Criteria

Table of Contents

A-4.1 PROJECT REQUIREMENTS

This section describes the scopes of work assigned to the respective Parties, the schedule for performance of the Project, the methods for establishment of detailed construction schedules, and the general requirements of the CCCT Project.

A-4.1.1 The Project is based on the use of air-cooled natural gas fired combustion turbine(s) with the associated heat recovery steam generator(s) with duct firing and an SCR, and one (1) steam turbine generator in a multi-shaft Combined Cycle Combustion Turbine (CCCT) configuration.

A-4.1.2 An air-cooled condenser will be used for steam cycle heat rejection and recovery of condensate. The Facility closed cooling water system will utilize an air-to-water radiator for heat rejection. Local heat rejection will be accomplished via dedicated fin-fan coolers.

A-4.1.3 The Project requires new Administration/Control, Demin/Wastewater Treatment, Steam/Water Sampling, Fire Pump, and Warehouse buildings. New Fire/Service Water and Demineralized Water tanks shall be field erected.

A-4.1.4 The Projects actual Heat Balance load cases be based on meteorological data specified in this attachment. The Seller will be responsible for providing revised heat balance load cases based on site data.

A-4.1.5 Redundancy shall be built into the Facility design. In general, the failure of a single piece of equipment should not cause a reduction in plant electric generation. 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.

A-4.1.6 The Project shall be designed for local operation as the primary operating method, with capability for remote operation.

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 the Buyer.

A-4.1.7 The Seller shall engineer, procure, design, build, construct, commission and test a complete, fully operational combined cycle generating plant in compliance with the contract requirements, applicable laws and permits. The scope is intended to include all work requirements for the Project except for those expressly stated herein as being completed by Buyer. Seller's complete scope of Work shall include the tasks identified in this specification. A summary of the Seller's scope of Work shall include, but is not to be limited to, the following.

A-4.1.8 Combustion turbine-generator (CTG) unit(s): unit shall be complete with all auxiliary equipment, accessories, and appurtenances (see Section A-17) 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-4.1.9 Heat recovery steam generator (HRSG) unit: three pressure, horizontal gas flow, reheat HRSG with duct firing system, selective catalytic reduction (SCR) system, NO_X/CO catalyst, exhaust stack and all necessary accessories and appurtenances (see Attachment A-18).

A-4.1.10 Steam turbine-generator (STG) unit: reheat, condensing side-exhaust steam turbine unit with all necessary accessories and appurtenances (see Attachment A-19). The OEM control system shall be provided for the STG.

A-4.1.11 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 Attachment A-21).

A-4.1.12 Steam condenser/condensate system: air 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-4.1.13 Closed Cooling water system: closed cooling water pumps, air cooled fin-fan heat exchangers, and associated chemical feed equipment.

A-4.1.14 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-4.1.15 Fuel gas supply system includes 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-4.1.16 Aqueous ammonia unloading, storage and distribution including all pumps and interconnecting piping and valves.

A-4.1.17 Raw water source shall be determined by Seller.

A-4.1.18 Potable Water source to be determined by Seller.

A-4.1.19 Balance of mechanical systems for a complete Project.

A-4.1.20 Seller shall provide all hydrogen and carbon dioxide interconnecting piping, valves, electrical and instrumentation.

A-4.1.21 Seller shall provide one (1) Carbon Dioxide Storage Tank along with necessary equipment as outlined in Section A-6.

A-4.1.22 Electrical systems, components, and equipment up to and including the connection to the Termination Points shall be provided, including but not limited to the following:

A-4.1.22.1 Dead-end structures at the GSUs for connection to high voltage transmission lines

A-4.1.22.2 Motorized disconnect and ground switches for both sides of owner supplied high voltage circuit breakers.

A-4.1.22.3 Generator circuit breakers and associated disconnects.

A-4.1.22.4 Generator Step Up and Auxiliary transformers.

A-4.1.22.5 MV/LV switchgear and motor control centers

A-4.1.22.6 Isolated phase bus duct with supports

A-4.1.22.7 Non-segregated bus or cable bus with supports

A-4.1.22.8 Protective relaying and metering

A-4.1.22.9 Lighting

A-4.1.22.10 Batteries, chargers, and Uninterruptible Power Supply (UPS)

A-4.1.22.11 Station Direct Current (DC) distribution system

A-4.1.22.12 Communications between the Facility Switchyard and DCS

A-4.1.22.13 Cathodic protection and grounding systems

A-4.1.22.14 Standby Diesel Generator

A-4.1.22.15 Balance of electrical systems for a complete Project

A-4.1.23 Control and instrumentation systems, components and equipment shall include, but not be limited to, the following:

A-4.1.23.1 Combustion Turbine Generator (CTG) control system

A-4.1.23.2 Steam Turbine Generator (STG) control system

A-4.1.23.3 HRSG direct reading drum level indicators

A-4.1.23.4 Continuous emissions monitoring system (CEMS)

A-4.1.23.5 Facility DCS, including all necessary supervisory, control and data acquisition systems.

A-4.1.23.6 I&C and metering equipment

A-4.1.23.7 Control room equipment including:

A-4.1.23.7.1 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), remote operation communications equipment, select control system servers, etc.

A-4.1.23.7.2 All hard-wired backup systems for CTG and STG emergency trip as required by code.

A-4.1.23.7.3 Main Fire Alarm Control Panel and interconnection with local panels and detectors

A-4.1.23.8 All Facility local instrumentation

A-4.1.23.9 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-4.1.23.10 Balance of I&C systems for a complete Project

A-4.1.24 Civil/Structural/Architectural Work shall include, but not be limited to, the following:

A-4.1.24.1 Project site preparation and surveying

A-4.1.24.2 Additional Geotechnical investigation(s) if required.

A-4.1.24.3 Excavation

A-4.1.24.4 Bedding and backfill.

A-4.1.24.5 Sanitary piping and lift stations

A-4.1.24.6 Storm and Plant drainage systems

A-4.1.24.7 Stormwater Layout Plan drawing to be provided by Seller.

A-4.1.24.8 Construction of all temporary roads and hard standings required within the temporary and permanent work areas, and of the permanent roads.

A-4.1.24.9 All piles (if required), rigid inclusions (if required), soil improvements (if required), reinforced concrete slabs and foundations for all Project components and buildings.

A-4.1.24.10 All necessary embedment's, anchor bolts, shear bars, and baseplates

A-4.1.24.11 Pre-engineered buildings, enclosures and HVAC required for compliance with interior temperature and humidity specifications.

A-4.1.24.12 Guard shack and electric power.

A-4.1.24.13 Architectural components and features for all buildings within the scope of supply

A-4.1.24.14 Steel structures including support steel, pipe racks, platforms, handrail, stairs, and ladders.

A-4.1.24.15 Concrete masonry walls.

A-4.1.24.16 Asphalt roads and area surfacing.

A-4.1.24.17 Fencing and gates.

A-4.1.24.18 Road for deliveries.

A-4.1.24.19 Repair of roads, transportation routes, infrastructure, public and private property, and areas on-site and off-site, damaged by the Seller directly or as a result of high usage and excessive shoulder use.

A-4.1.24.20 Balance of civil / structural systems to complete the Project.

A-4.1.24.21 The Process Wastewater discharge location and all required permitting.

A-4.1.25 Project Conditions

A-4.1.25.1 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-4.1.25.2 If Seller uncovers any unmarked or unknown facilities during excavation, Seller shall report findings to Owner and receive instructions before proceeding.

A-4.1.25.3 The Seller shall make a thorough 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-4.1.25.4 The 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. The Seller shall advise the 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-4.1.25.5 When excavated and/or exposed soil is thought to be contaminated, Contactor shall immediately notify the Buyer for resolution prior to proceeding.

A-4.1.26 Construction, Start-Up, and Commissioning Services:

A-4.1.26.1 Permitting and permitting support, 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-4.1.26.2 Distribution of construction power from low-side terminals of Seller's construction power transformer.

A-4.1.26.3 Construction power transformer 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, foundation, and containment (if required) to be provided by Seller.

A-4.1.26.4 Seller is responsible for supply of demineralized water to support start-up and commissioning functions. Rental of demineralizer trailers is acceptable.

A-4.1.26.5 All temporary facilities, services, and utilities for staff and construction, including office trailers, remote parking, secure remote laydown, equipment, and facilities. See Section A-10

A-4.1.26.6 Security for construction site

A-4.1.26.7 Temporary security fencing and gates including temporary fencing and gates that will become permanent.

A-4.1.26.8 Tie-ins as noted in Attachment A-11

A-4.1.26.9 Daily Project site clean-up through the Substantial Completion; waste disposal and other services through Final Acceptance

A-4.1.26.10 Maintenance of site safety

A-4.1.26.11 Transport, packing, protection, preservation, customs clearance, unloading handling and storage of materials and equipment, per manufacturer's recommendation and procedures.

A-4.1.26.12 Obtaining construction and transportation related licenses, permits, and authorizations, including those offsite

A-4.1.26.13 Painting and protective coatings, including field finish and touch-up painting.

A-4.1.26.14 Water treatment equipment and rentals needed to support the construction, startup, and commissioning through Substantial Completion.

A-4.1.26.15 Manufacture, fabrication, and factory testing and inspections.

A-4.1.26.16 On-site testing, inspections, and verifications

A-4.1.26.17 Electrical and plumbing connections for Buyer's temporary facilities (installed by Seller)

A-4.1.26.18 Removal of temporary works after main works are completed.

A-4.1.26.19 Operational and maintenance spare parts through the Substantial Completion

A-4.1.26.20 Special tools and equipment for testing and maintenance

A-4.1.26.21 All necessary lifting and handling equipment (including necessary hoists and lifting beams) for operation and maintenance.

A-4.1.26.22 Formal and structured operation and maintenance training services

A-4.1.26.23 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-4.1.26.24 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-4.1.26.25 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-4.1.26.26 Construction power transformer as required to support needs. Primary to be supplied from the local distribution system

A-4.1.27 Responsibilities of Buyer:

The services, equipment, system(s), and/or structures listed below shall be excluded from the Seller's Scope of Work and will be provided by Buyer/Others:

A-4.1.27.1 Securing environmental permits, easement approvals, letters of no objection, government approvals, and operating licenses that will be held by the Buyer. Seller 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-4.1.27.2 Buyer provided hydrogen tube trailers.

A-4.1.27.3 Delivery, supply, and management of fuel gas consumed in Commissioning, startup, and operations.

A-4.1.27.4 Buyer shall provide primary side wiring to the metering/dip pole for the construction power transformer.

A-4.1.27.5 Transmission interconnection studies.

A-4.1.27.6 Generator tie lines and any work within existing substations.

A-4.1.27.7 Spare parts for Buyer's inventory

A-4.1.27.8 Coordinating the work activities of Buyer working on Buyer's Site, whether or not related to this Project. NOTE: Seller will be required to participate in the Buyer's interface management program.

A-4.1.27.9 Water rights and consent, connection fees, and water supply metering for the permanent and construction supply of water to the site

A-4.1.27.10 Rights-of-way to the Facility Site

A-4.1.27.11 Furnish and install as part of the telephone/commination system (LAN) telecom racks, electronic equipment, and telephones; servers, switches, and routers; and network cabinet Ethernet and fiber patch cables within cabinets.

A-4.1.27.12 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-4.1.27.13 Buyer will provide Seller 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.

A-4.1.27.14 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. The Seller shall ensure that all buildings are equipped with the necessary space allocation needs, power supply, conduit, fiber, and power wiring to facilitate the Buyer's installation. The Seller shall supply and install camera poles, foundations, and conduits to these poles as necessary to accommodate the design.

A-4.1.27.15 The Buyer will provide fuel (natural gas, diesel for the permanent diesel generators and fire pump), water, ammonia, CO_2, H_2 and water treatment chemicals through Substantial Completion. The Seller will be responsible for greases, lube oils, hydraulic fluids, calibration gases, demin trailers, N_2, glycol, high voltage breaker SF6 gas, chemicals for the HRSG clean, analyzer reagents and other consumables through Substantial Completion.

A-4.1.28 Abbreviations

AC – Alternating Current

AGC — Automatic Generation Control

AMS — Asset Management 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

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

LNTP – Limited Notice to Proceed

LP – Low Pressure

LPS – Low pressure steam

MCC – Motor Control Center

MECL – Minimum Emission Compliant Load

MW – Megawatt

N2 – Nitrogen

NECF – Net Electrical Capacity Factor

NOx – Nitrogen Oxides

NTSM – Notice to Start Mobilization

OEM – Original Equipment Manufacturer

P&ID – Piping and Instrumentation Diagram

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

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-4.1.29 Definitions:

A-4.1.29.1 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-4.1.29.2 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 Attachment A-3 "Air Emissions Testing Procedures" are the Air Emissions Tests procedures to be developed by the Seller.

A-4.1.29.3 Baseline Schedule — The Level III CPM Project Schedule to be prepared by Seller, subject to Approval by Buyer.

A-4.1.29.4 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-4.1.29.5 Demonstration Test – The tests specified in Section Attachment A-3 to demonstrate the capability and response of the plant. The Demonstration Test consists of the separate and discrete tests that are defined as follows:

A-4.1.29.5.1 Load Demonstration Tests - The tests specified in Attachment A-3,

A-4.1.29.5.2 Turbine Run Back and Trip Testing - The tests specified in Attachment A-3,

A-4.1.29.5.3 CTG Islanding Mode Demonstration Test - The test specified in Attachment A-3,

A-4.1.29.5.4 Plant Operating Startup Demonstration Test - The test specified in Attachment A-3, A-4.1.29.5.5 Plant Operating Shutdown Demonstration Test - The test specified in Attachment A-3,

A-4.1.29.5.6 NERC Compliance Testing - The test specified in Attachment A-3,

A-4.1.29.5.7 MISO Generation Verification Test Capacity (GVTC) as specified in Attachment A-3,

A-4.1.29.5.8 MISO Automatic Generation Control (AGC) test as specified in Attachment A-3,

A-4.1.29.6 Full Notice to Proceed (FNTP) - Refer to BOT Term Sheet for definition.

A-4.1.29.7 Guaranteed Emission Limits – Refer to BOT Term Sheet for definition.

A-4.1.29.8 Guarantee Test Conditions - The conditions to which the as-tested Net Electrical Output and Net Plant Heat Rate values, determined during the Performance Test, shall be corrected.

A-4.1.29.9 Limited Notice to Proceed (LNTP) – Refer to BOT Term Sheet for definition.

A-4.1.29.10 Mechanical Completion – Refer to BOT Term Sheet for definition.

A-4.1.29.11 Net Electrical Output (NEO) - The net Project electrical output (kW) as measured at the high voltage side of the GSU transformers.

A-4.1.29.12 Net Plant Heat Rate (NPHR) - The net Project heat rate HHV (BTU/kWH) defined as the total fuel heat consumption (HHV) divided by the Net Electrical Output.

A-4.1.29.13 Notice to Start Mobilization (NTSM) – Refer to BOT Term Sheet for definition.

A-4.1.29.14 Performance Guarantee – The guaranteed Net Electrical Output and Net Plant Heat Rate, as specified in Attachment A-3.

A-4.1.29.15 Performance Test – The test to measure Net Electrical Output and Net Plant Heat Rate for purpose of correction to the Guarantee Test Conditions and comparison to the Performance Guarantee

A-4.1.29.16 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-4.1.29.17 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-4.1.29.18 Reliability Test - Refer to BOT Term Sheet for definition.

A-4.1.29.19 Reliability Factor (RF) — The calculated reliability factor used to determine the success of the Reliability Test.

A-4.1.29.20 Specifications — Documents providing a detailed and precise description of characteristics and features.

A-4.1.29.21 Start of Commissioning — Date of first turnover by Seller's construction department to Seller's commissioning department for Commissioning

A-4.1.29.22 Substantial Completion - Refer to BOT Term Sheet for definition.

A-4.1.29.23 Water Effluent Discharge Limits - Enforceable parameters that dictate 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-4.2 GENERAL REQUIREMENTS

A-4.2.1 Responsibilities following LNTP:

A-4.2.1.1 During the LNTP period, 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 early construction activities scheduled to follow FNTP.

A-4.2.1.2 Seller shall implement an enterprise collaboration software package and provide training and access to Buyer and parties designated by the 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-4.2.1.3 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-4.2.1.4 Seller shall commence all Engineering, construction planning, and permitting activities as necessary.

A-4.2.1.5 Seller may execute releases to Others, including the Major Equipment manufacturers for engineering, material orders and fabrication, as required to support delivery dates.

A-4.2.1.6 Access to the Site shall be granted by Buyer and Seller shall be allowed to mobilize to site, as necessary, to perform the following activities prior to receipt of NTSM:

A-4.2.1.6.1.a Perform any activities including, but not limited to: geotechnical, geophysical, and site survey work. The Buyer needs to approve activities prior to commencement.

A-4.2.1.7 Seller shall notify Buyer 30-days prior to the planned date of full mobilization. On receipt of a NTSM, Seller shall be permitted to commence full mobilization of construction personnel to the site and perform clearing and grubbing including tree removal and shredding. Seller shall also be released to begin all major site grading activities.

A-4.2.2 Seller is responsible for developing the construction and design basis arrangements for temporary facilities and the development of a Project laydown area drawing. The Project laydown area drawing shall be based on Plant Arrangement layouts. The Project laydown area drawings shall show fabrication/work areas, temporary parking areas, temporary facility trailers & buildings, temporary fencing and temporary equipment storage based on the conceptual arrangements Changes to the conceptual arrangements shall be mutually agreeable to both Seller and Buyer.

A-4.2.3 Seller is responsible for developing a Project Extents Drawing showing the extent of the Project Work Area. The Project Extents Drawing shall be based on Plant Arrangement Layout.

A-4.2.4 Operating Requirements

A-4.2.4.1 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 the Seller.

A-4.2.4.2 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-4.2.4.2.1 Two shifting operation where the Facility experiences daily startup and shutdown

A-4.2.4.2.2 Load following operation where the output of the Facility will vary significantly to provide regulation and other ancillary services.

A-4.2.4.2.3 Sporadic operation where the Facility may be shut down for extended periods, and upon startup, operate for extended periods.

A-4.2.4.3 The Facility shall be capable of operating in all of the above modes while maintaining compliance with the Guaranteed Emission Limits.

A-4.2.4.4 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-4.2.4.5 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-4.2.4.5.1 Starts per year:

No. of Cold Starts (for the CTG(s) and the STG): 10/year
Offline > 64 hours, including ambient rotor conditions

No. of Ambient Starts (for the CTG(S) and the STG):
10/year

No. of Warm Starts (for the CTG(s) and the STG): 40/year
Offline > 8 hours and < 64 hours

No. of Hot Starts (for the CTG(s) and the STG): 200/year
Offline < 8 hours

No of combustion turbine(s) starts (CT): 250/year

The HRSG shall accommodate quantity of starts, with HRSG starts defined based upon the HP drum conditions.

A-4.2.4.5.2 Hours of operation: up to 8,760 hrs./yr. for the CTG(s), HRSG(s) and STG

A-4.2.4.6 The Facility will be capable of operating without restriction during winter ambient and summer ambient conditions defined in this Attachment.

A-4.2.4.7 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(if supplied) in service under AGC in compliance with the Guaranteed Emission Limits herein.

A-4.2.4.8 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 provided by Seller.

A-4.2.4.9 Islanding 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 Attachment A-7.

A-4.2.5 Engineering and Design

A-4.2.5.1 Seller shall engineer and design the Project in accordance with this specification.

A-4.2.5.2 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-4.2.5.3 Overall facility design shall be optimized for the CTG exhaust gas conditions over the full range of operating conditions. Plant operation mode of 1x0, 1x1, and 2x1 (if applicable) with supplemental firing (if supplied) shall be controllable. This shall include optimization of the HRSG attemperators / desuperheaters.

A-4.2.5.4 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-4.2.5.5 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-4.2.5.6 Seller shall develop overall plant heat balances based upon the site conditions in this Attachment. Seller shall incorporate the CTG, HRSG and STG equipment thermal design characteristics into an overall Plant heat balance model.

A-4.2.5.6.1 Seller shall develop, at minimum, heat balance cases based upon the site conditions in this Attachment for minimum, average, and maximum temperatures and humidity, ISO conditions, MECL and Guarantee (97F / RH56%) 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-4.2.5.6.2 Seller shall include an allowance for up to 10 additional heat balance cases.

A-4.2.5.7 Seller shall develop and provide the following four (4) water balance cases based upon the site conditions in this Attachment:

A-4.2.5.7.1 Annual Average

A-4.2.5.7.2 Summer Average

A-4.2.5.7.3 Summer Extreme

A-4.2.5.7.4 Winter Extreme

A-4.2.5.8 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-4.2.5.9 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-4.2.5.10 All designs and Specifications prepared by Seller shall be consistent with Seller's warranty and the Project Performance requirements.

A-4.2.5.11 Project 3D Model

A-4.2.5.11.1 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-4.2.5.11.2 Seller shall schedule monthly 3D model reviews and provide notification to the Buyer so that the 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-4.2.5.11.3 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 the Buyer to review at all times. The 3D model shall reflect the actual design of the Facility.

A-4.2.5.12 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

A-4.2.5.13 The Seller's scope of work shall terminate at the interface points listed in Section A-11. The Buyer will be responsible for designing and installing any pipe, supports, and piping tie-in beyond the interface point. The Seller shall make all tie-in connections at the interface points.

A-4.2.5.14 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-4.2.5.15 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-4.2.5.15.1 Minimum clearance and equipment removal access:

A-4.2.5.15.2 Minimum clearance over walkways and platforms shall be 7'-6".

A-4.2.5.15.3 Minimum clearance under major interconnecting structures shall be 22 ft for truck and crane movement.

A-4.2.5.15.4 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-4.2.5.15.5 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 the Seller. The proposed layout must accommodate concurrent maintenance on the steam turbine and the combustion turbine with separate cranes.

A-4.2.5.16 Equipment, valves, instruments, testing devices and other mechanical components shall be designed and installed for ease of operation and maintenance.

A-4.2.5.17 Equipment or other items which contain PCBs (excluding batteries), lead, mercury, ceramic fiber, asbestos, or asbestos bearing materials are prohibited from use.

A-4.2.5.18 Seller shall prepare a complete set of System Descriptions. Each system description shall include the following content:

A-4.2.5.18.1 The design criteria and functions to be satisfied by the system.

A-4.2.5.18.2 A description of the system and its major equipment and components, and the performance characteristics.

A-4.2.5.18.3 A detailed description of system operating limitations and capacities, setpoints, consumables, and precautions which include startup, shutdown, and normal operations.

A-4.2.5.18.4 A description of system safety features and safety precautions for operation or maintenance required to prevent personnel injury.

A-4.2.5.18.5 A description of system boundaries.

A-4.2.5.19 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-4.2.6 Plant Identification, Numbering and Labelling Conventions

A-4.2.6.1 See Attachment A-13 for equipment, component, pipe, valve and instrumentation identification and numbering.

A-4.2.6.2 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 in the Seller's drawings.

A-4.2.6.3 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-4.2.7 Procurement

A-4.2.7.1 The systems, equipment and materials supplied by the Seller and Sub-Sellers 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-4.2.7.2 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 FNTP.

A-4.2.7.3 Seller's Procurement Plan shall apply to all procurement activities conducted by Seller to fulfill the terms of the specification.

A-4.2.7.4 The Procurement Plan shall be used during the engineering, construction, and Commissioning phases of the Project. Following the guidelines outlined in this Procurement Plan, the 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-4.2.7.5 Seller shall ensure that the specific requirements herein are included in the Seller's specifications and complied with by the selected manufacturer. Seller shall be responsible for obtaining the 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. The Buyer's concurrence or comments will be forwarded to the Seller within ten (10) Business Days of the date they are received by Buyer.

A-4.2.7.6 Packing, Handling and Shipping procedures shall describe how equipment, components and materials shall be secured and protected from adverse weather (including salt water intrusion) and transit conditions, including shock and vibration movements. This supplement specific shipping requirements outlined in throughout this specification.

A-4.2.7.7 Seller is responsible for the cost and arrangement of all equipment and material shipping, transportation, and delivery to the site.

A-4.2.7.8 Buyer reserves the right to attend tests of components, equipment, and controls (FAT) at the suppliers' manufacturing/assembly facilities.

A-4.2.7.9 Equipment that requires additional bracing for shipment should have the temporary bracing clearly identified.

A-4.2.8 Sourcing of Materials and Subcontracts

A-4.2.8.1 Steel from China shall not be used without Buyer approval.

A-4.2.8.2 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-4.2.8.3 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 utilize Approved Manufacturers List, Attachment A-16.

A-4.2.9 Lifting Beam and Lifting Facilities

A-4.2.9.1 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-4.2.9.2 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-4.2.10 Special Tools

A-4.2.10.1 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-4.2.11 Spare Parts

A-4.2.11.1 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-4.2.11.2 Seller shall provide startup and commissioning spare parts as part of its fixed Contract Price Work as required to achieve Substantial Completion.

A-4.2.11.3 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-4.2.12 DOCUMENT DELIVERABLES AND SUBMITTAL REQUIREMENTS

A-4.2.12.1 Seller's Master Drawing and Document List and Data Schedule (MDL)

A-4.2.12.1.1 Within four weeks after LNTP, the Seller shall provide Buyer with an initial MDL, complete including Seller’s subcontractors and supplier. 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-4.2.12.1.2 Seller or Supplier Name, including all Sub-contractors for the Project, and identified Equipment or Service Provided

A-4.2.12.1.3 Drawing or Document Number, OEM Drawing or Document Number, OEM Company Name, Title, and Revision, Unit Number, System Code, Drawing Type, and Discipline

A-4.2.12.1.4 Purpose of Submittal – For Buyer's Review, For Information, For Record

A-4.2.12.1.5 Drawing or Document First Submittal Scheduled Dates and Actual Dates

A-4.2.12.1.6 Drawing or Document Re-Submittal Scheduled Dates and Actual Dates.

A-4.2.12.1.7 The MDL shall individually list all submittals identified herein and in the referenced standards.

A-4.2.12.1.8 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, the 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-4.2.12.2 Submittals for Buyer Information, Review and Record (e.g., "as-built" drawings)

A-4.2.12.2.1 A complete list of submittals is presented in Table A.4-4.

A-4.2.13 Software Licenses

A-4.2.13.1 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-4.2.14 Format and Identification of Documents

A-4.2.14.1 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-4.2.14.2 Engineering document identification shall be in accordance with the project tagging procedure, see Attachment 13. Major Equipment identification will be per OEM tagging standards.

A-4.2.14.3 Final and For Record ("As-Built") drawings issued to Buyer for record purposes shall be in electronic formats.

A-4.2.14.4 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-4.2.15 Document Review Process

A-4.2.15.1 Following the initial release of an engineering document, Seller and its sub-Sellers 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-4.2.15.2 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 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 the Seller with one of the following status notations:

A-4.2.15.3 No exception taken: Proceed with fabrication or construction in accordance with the Contract.

A-4.2.15.4 Revise as noted and resubmit: Proceed in accordance with the contract after incorporating noted revisions.

A-4.2.15.5 Revise and resubmit: Does not meet contract requirements. Hold fabrication and/or construction.

A-4.2.15.6 For information only.

A-4.2.15.7 Buyer retains the right to review all documents.

A-4.2.15.8 After the Seller returns any written disposition on the Buyers comments, if there are still any unresolved comments the Buyer and Seller shall work together to resolve the comment(s) within (15) working days.

A-4.2.15.9 Any unresolved comments on any documents shall be resolved and updated prior to Substantial Completion.

A-4.3 GOVERNING CODES, STANDARDS AND REGULATIONS

A-4.3.1 Extent

A-4.3.1.1 In performing the Work, Seller shall comply with the codes and standards set forth herein (the “Codes and Standards”).

A-4.3.1.2 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-4.3.1.3 Publications of the nationally recognized organizations listed in this Attachment 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-4.3.1.4 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. The Seller shall provide a written position of any such conflict clarifications to the Buyer in writing.

A-4.3.1.5 Alternative international codes and standards may be used upon Buyer's approval. The Seller shall supply a hard copy or electronic copy, in English, of each alternative code of practice or design standard that is proposed by the 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 the Buyer.

A-4.3.2 Federal and State Codes

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
LDEQ	Louisiana Department of Environmental Quality

A-4.3.3 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 Sellers 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 protective relaying, event/disturbance recording, metering, and communication circuits related to the interface between the generators and the Bulk Electrical System (BES). The following NERC Reliability Standards shall include but not limited to: NERC-COM-001 NERC-EOP-004 NERC-EOP-012 NERC-FAC-002 NERC-FAC-008 NERC-PRC-002 NERC-PRC-005 NERC-PRC-019 NERC-PRC-023 NERC-PRC-024 NERC-PRC-025 NERC-PRC-026 NERC-PRC-027 NERC-MOD-032 NERC-TPL-007 NERC-VAR-002

A-4.4 SITE DESIGN DATA

A-4.4.1 This Section outlines the site conditions used as the basis for Facility Design

A-4.4.2 Site Location and Access

Project Location	At approximate coordinates: Completed by Seller
Main Access Road	Road Access: Rail: Provided by Seller

A-4.4.2.1 The governing code for all Work shall be the International Building Code (IBC) 2021. 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.

A-4.4.3 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.

A-4.4.4 In cases of conflict between the requirements of this Specification and any applicable codes, the more stringent of the requirements shall govern.

A-4.5 FACILITY DESIGN LIFE

A-4.5.1 The Facility shall have a design life of 30 years operation without distress due to cycling loads.

A-4.6 METEOROLOGICAL / WEATHER DATA

A-4.6.1 The table below lists the meteorological data to be completed by the Seller.

A-4.6.2 Table A-4.1 Meteorological Data

Parameter	Value	Units	Reference
Ambient Outside Dry Bulb Temperature (DBT):			
Maximum, Summer Extreme		ºF	ASHRAE (50-year max)
Summer		ºF	ASHRAE 0.4%
Annual Average		ºF	ASHRAE annual dry bulb average
Winter		ºF	ASHRAE 99.6%
Minimum, Winter Extreme		ºF	ASHRAE (50-year min)
Freeze Protection Design Temperature		ºF	
Relative Humidity (RH):			
Summer Extreme		%RH	ASHRAE (50-year max) DBT WB
Summer		%RH	ASHRAE (.4%) DBT MCWB
Annual Average		%RH	NCDC Weather Data, mean coincident to DBT
Winter		%RH	ASHRAE 99.6% DB, DP

Parameter	Value	Units	Reference
Winter Extreme		%RH	ASHRAE (50-year min) DB WB
Site Barometric Pressure:			
Pressure		psia	ASHRAE standard pressure at station elevation
Precipitation and Snow:			
Annual average rain, total		in.	ASHRAE Prec. Average
2-year, 24-hour storm		in.	NOAA Atlas 14
10-year, 24-hour storm		in.	NOAA Atlas 14
25-year, 24-hour storm		in.	NOAA Atlas 14
100-year, 24-hour storm		in.	NOAA Atlas 14

A-4.7 LOADING AND NATURAL PHENOMENA DESIGN DATA

A-4.7.1 Seismic Design Criteria

A-4.7.1.1 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 seismic design requirements of IBC 2021 and ASCE 7, using the following parameters:

A-4.7.1.2 Importance Factor (IE) = 1.25

A-4.7.1.3 Risk Category III

A-4.7.1.4 Seismic Design Category C

A-4.7.2 Wind Design Criteria

A-4.7.2.1 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 IBC 2021 and ASCE 7 using the following parameters:

A-4.7.2.2 Ultimate Wind Speed (V): Provided by Seller

A-4.7.2.3 Wind Exposure Category: C

A-4.7.2.4 Risk Category: III

A-4.7.2.5 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-4.7.2.6 Reduction in wind loads due to shielding effects of nearby or adjacent structures shall not be considered.

A-4.7.2.7 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-4.7.2.8 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-4.7.3 Snow Design Criteria

Structures shall be designed for snow loads in accordance with ASCE 7 using the following parameters:

A-4.7.3.1 Risk Category: III

A-4.7.4 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-4.7.4.1 Ice Thickness = 1.00 in

A-4.7.4.2 Ice Wind Gust Speed = 30 mph

A-4.7.4.3 Concurrent Ice Temperature = 15 F

A-4.8 FREEZE PROTECTION

A-4.8.1 Fluid temperature in pipe shall be maintained above 40°F (minimum, unless higher temperature is required due to fluid properties or process)

A-4.8.2 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-4.8.3 Time to freeze evaluation shall consider a maximum of 25% of pipe cross section freezing, and a 20-mph wind.

A-4.9 HVAC SYSTEM DESIGN

A-4.9.1 The table below lists the HVAC design parameters for various area types defined in Section A-9, Building and Equipment Enclosures.

Table A-4.2 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	140ºF
Minimum allowable indoor temperature	50ºF
General Facility Areas (Ventilated and Heated): Including Warehouse, Water Treatment Building, Fire Pump House Enclosure	
Maximum allowable indoor temperature	20ºF above ambient temperature
Minimum allowable indoor temperature	50ºF
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	75ºF
Minimum allowable indoor temperature	50ºF
Battery Rooms (Ventilated, Heated and Air Conditioned):	
Maximum allowable indoor temperature	80ºF
Minimum allowable indoor temperature	74ºF
Personnel Areas (Ventilated, Heated and Air Conditioned): Including Admin/Control Room Building, Guard Shack	
Maximum allowable indoor temperature	72ºF
Minimum allowable indoor temperature	70ºF
Personnel Areas (Ventilated, Heated and Air Conditioned): CEMS Enclosure	
Maximum allowable indoor temperature	75ºF
Minimum allowable indoor temperature	65ºF
Maximum allowable indoor relative humidity	60%
Minimum allowable indoor relative humidity	40%

Note 1: Listed numbers are for estimating purposes only.
Note 2: 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-4.10 FUEL GAS ANALYSIS

A-4.10.1 The fuel is pipeline quality natural gas with the following specifications:

Table A-4.3 Fuel Gas Properties

Fuel	Fuel Properties	Units	Design Range	
			Minimum	Maximum
Natural Gas	Temperature	ºF	Provided by Seller	Provided by Seller
	Pressure at fuel gas supplier interface point (station boundary)	psig	Provided by Seller	Provided by Seller

A-4.11 AMMONIA DESIGN DATA

A-4.11.1 29% Aqueous Ammonia solution will be provided for use in the SCR section of the HRSG.

A-4.12 MAKEUP / RAW WATER QUALITY

A-4.12.1 Water parameters are to be determined Seller based on Seller identified source(s).

A-4.13 FILTERED WATER QUALITY

A-4.13.1 Filtered water shall be provided for the CTG evaporative cooler while satisfying OEM requirements and limitations. Based on available water quality data, it is anticipated that the CTG evaporative cooler makeup supply will consist of 100% ultrafiltered water obtained from the UF product tank(s) of the demineralizer system.

A-4.14 POTABLE WATER SYSTEM

A-4.14.1 Potable water drinking water, safety showers, and eye wash stations.

A-4.15 NOISE LEVEL LIMITATIONS

A-4.15.1 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-18.

A-4.15.2 During any operating conditions, including, but not limited to, start-up and normal operation, the warranted maximum A-weighted sound level at Buyer's property boundaries, when measured in accordance with 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, based on far field noise study, the Seller shall provide adequate sound attenuation measures to meet good neighbor sound level goal of 63dBA at the Buyer 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.

A-4.15.3 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-4.16 CARBON CAPTURE AND SEQUESTRATION

A-4.16.1 The project shall have adequate space for future expansion of carbon capture facilities and should not be land-locked.

Table A.4-4

LIST OF SUBMITTALS

TECHNICAL & DOCUMENT SUBMITTAL REQUIREMENTS FOR CONTRACTOR AND MANUFACTURER						
Technical Document Type	For Review and Comment	For Information	For Record (" As-Built")	Prior to Substantial Completion	Prior to Final Acceptance	Comments
GENERAL:						
General Arrangement Drawings incl. OEM Equipment GA Drawings	X		X			
Site Arrangement Drawings	X		X			
3D Model File		X	X		X	Only deliverables that are as-built will be updated in the model
3D Model Owner Reviews Action Item (Comment Disposition) List	X					
Layout of Temporary Construction Facilities	X					
Permit Application Correspondence		X				Only as required for EPC Contractor Permits
Construction Lift Plans > 100 Tons per Contractor procedures	X					
Certificates of Completion from Equipment manufacturers (incl. CTG, HRSG & STG)		X		X		
Piping Material Inspection Receipts & Certifications		X		X		
Punch list items	X			X		

TECHNICAL & DOCUMENT SUBMITTAL REQUIREMENTS FOR CONTRACTOR AND MANUFACTURER						
Technical Document Type	For Review and Comment	For Information	For Record (" As-Built")	Prior to Substantial Completion	Prior to Final Acceptance	Comments
List of remaining startup spare parts		X		X		
List of warranties including contact information		X		X		
List of recommended spare parts		X		X		
Equipment calibration list		X		X		
System turnover documentation	X			X	X	Electronic versions will be available prior to Substantial Completion
Scoped Turnover Drawing Packages	X					
Native Engineering Deliverable drawing files		X			X	
Master Document List		X			X	As defined in section A-4
Complete Project Schedule (as defined in Section A.1)	X					-
Notice of Mechanical Completion		X		X		
Notice of Substantial Completion		X		X		
Notice of Final Acceptance		X			X	
Hazardous Area Classification Drawings	X		X			

TECHNICAL & DOCUMENT SUBMITTAL REQUIREMENTS FOR CONTRACTOR AND MANUFACTURER						
Technical Document Type	For Review and Comment	For Information	For Record (" As-Built")	Prior to Substantial Completion	Prior to Final Acceptance	Comments
Maintenance Crane Placement Drawings	X					Including crane placement, reach, capacity, soil conditions, and laydown areas. For future Owner use
Equipment Delivery Plan	X					
CIVIL / STRUCTURAL / ARCHITECTURAL:						
Geotechnical and Foundation Bearing Capacity and Settlement Design Criteria including deep foundations		X				
Civil/Structural/Architectural Design Criteria	X					
Barge Unloading Facility Design Criteria/Heavy Haul Route (As Applicable)	X					
Building Code and Life Safety Analysis		X				
Construction Storm Water calculations		X				
Post-Construction Storm Water calculations		X				

TECHNICAL & DOCUMENT SUBMITTAL REQUIREMENTS FOR CONTRACTOR AND MANUFACTURER						
Technical Document Type	For Review and Comment	For Information	For Record (" As-Built")	Prior to Substantial Completion	Prior to Final Acceptance	Comments
Independent Third Party Examination/Sampling/Testing Specification(s)	X					
Contractor and Independent Third Party Examination/Sample/Test Reports as requested		X				
Civil/Structural/Pre-Engineered Building Procurement Specifications		X				
Civil/Structural/Pre-Engineered Building Installation Specifications		X				
Concrete Mix Designs		X				
Concrete Test Result Reports		X				
Structural Steel Drawings		X	X			
Foundation Drawings		X	X			
Architectural Drawings, including Building Envelope and Interior Architectural Work	X		X			
Site Grading and Drainage Drawings (underground drains)	X		X			
MECHANICAL:						
Water Balance Diagrams	X		X			

TECHNICAL & DOCUMENT SUBMITTAL REQUIREMENTS FOR CONTRACTOR AND MANUFACTURER						
Technical Document Type	For Review and Comment	For Information	For Record (" As-Built")	Prior to Substantial Completion	Prior to Final Acceptance	Comments
Heat Balance Diagrams	X		X			
Piping and Instrumentation Diagrams (P&IDs)	X		X			
List of Critical Systems	X					
Interface Drawings to natural gas and other existing systems	X					
Plant Drains Plans	X		X			
Piping Isometrics		X	X			3D model will be used to perform review
Piping Class Sheets		X	X			
Underground Piping (isometric and orthographic format)		X	X			3D model will be used to perform review
Pipe Rack Plans and Sections		X				
Piping Stress Analyses (HP, CR, HR, LP Steam and BFP)		X				
Pipe Support Drawings		X	X			
Mechanical Equipment List		X	X			
Piping Line List		X	X			
Valve List		X	X			
Safety Relief Valve lists and settings		X	X			

TECHNICAL & DOCUMENT SUBMITTAL REQUIREMENTS FOR CONTRACTOR AND MANUFACTURER						
Technical Document Type	For Review and Comment	For Information	For Record (" As-Built")	Prior to Substantial Completion	Prior to Final Acceptance	Comments
ASME Pressure Vessel certifications		X	X			
Welding WPS and PQR Documentation		X				
FIRE PROTECTION:						Refer to Section A-20 for more details
Underground Fire Protection Piping		X	X			3D model will be used to perform review
Fire Hydrant Layout and Coverage Drawing	X		X			3D model will be used to perform review
Fire Protection Design Basis (or Master Plan)	X		X			
NFPA 850 Design Basis Document	X		X			
Building and Fire Codes and Life Safety Compliance Review Report	X		X			
Hazardous Area Classification Evaluation Drawings	X		X			
Portable Fire Extinguisher Location Drawings	X		X			
Fire Suppression System Layout/Piping Drawings	X		X			
Hydraulic Calculations for all Fire Suppression Systems	X		X			

TECHNICAL & DOCUMENT SUBMITTAL REQUIREMENTS FOR CONTRACTOR AND MANUFACTURER						
Technical Document Type	For Review and Comment	For Information	For Record (" As-Built")	Prior to Substantial Completion	Prior to Final Acceptance	Comments
Fire pump Manufacturer's Performance Curves		X	X			
ELECTRICAL:						
Main One-Line Diagrams	X		X			
Three-Line Diagrams	X		X			
Key Diagrams	X		X			
Overall Relay and Metering Single Line Diagrams	X					
Load Flow Calculation		X				
Short Circuit Calculation		X				
Motor Starting Calculation		X				
Electrical Grounding Calculations		X				
GSU and UAT Sizing Calculations	X					
GCB Transient Recovery Voltage (TRV) Calculation	X					
All Electrical Logic and Flow Diagrams	X					
Zone of Protection Diagram	X					

TECHNICAL & DOCUMENT SUBMITTAL REQUIREMENTS FOR CONTRACTOR AND MANUFACTURER						
Technical Document Type	For Review and Comment	For Information	For Record (" As-Built")	Prior to Substantial Completion	Prior to Final Acceptance	Comments
Protective Relaying Settings and Coordination Study	X		X			
Protective Relaying Schematic Diagrams	X		X			
Protective relay settings list	X			X		
ETAP model files (.OTI and associated files)		X	X			As-built limited to Major Equipment as-commissioned changes
Electrical Grounding Drawings		X	X			
Underground Ductbank and Manhole Drawings		X	X			
Cable Tray Drawings		X				
Cable Tabulations (in Excel or Access format)		X				
Electrical Wiring Diagrams		X	X			
Electrical Master Schematic Diagrams		X	X			
Arc Flash Study	X			X		
Battery & UPS Sizing Calculations	X					
Electrical Equipment Lists	X					
Electrical Load List	X		X			

TECHNICAL & DOCUMENT SUBMITTAL REQUIREMENTS FOR CONTRACTOR AND MANUFACTURER						
Technical Document Type	For Review and Comment	For Information	For Record (" As-Built")	Prior to Substantial Completion	Prior to Final Acceptance	Comments
Battery Load Test Report		X				
INSTRUMENTATION AND CONTROLS:						
Control Logic Diagrams		X				
DCS Cabinet Drawings		X				
Complete Control System Architecture Diagram with all data links	X					
DCS, STG and CTG Graphics and Displays	X					
Instrument List		X				
Instrument Datasheets in ISA format and Calibration Certificates		X				
Instrument Location Drawings		X				
Instrument Installation Detail Drawings	X					
Instrument Wiring Diagrams		X	X			
Distributed Control System (DCS) I/O List	X		X			
Turbine Control System (TCS) I/O list	X		X			

TECHNICAL & DOCUMENT SUBMITTAL REQUIREMENTS FOR CONTRACTOR AND MANUFACTURER						
Technical Document Type	For Review and Comment	For Information	For Record (" As-Built")	Prior to Substantial Completion	Prior to Final Acceptance	Comments
Instrument Loop Diagrams		X				
FAT Procedure - DCS (FAT) (Prior to DCS energization or shipment)	X					
DCS and Controllers (GTG and Remote System Controllers) FAT Procedures	X					Prior to the FAT date
DCS and Controllers (GTG and Remote System Controllers) FAT Acceptance Test Results		X				
EQUIPMENT SPECIFICATIONS & DATA SHEETS:						
Gas Turbine Generators	X					
Steam Turbine Generators	X					
Heat Recovery Steam Generators (including the SCR and ammonia delivery and injection system)	X					
Ammonia Storage and Forwarding System	X					
Generator Step Up Transformer	X					
Unit Auxiliary Transformer	X					
Medium Voltage Switchgear	X					

TECHNICAL & DOCUMENT SUBMITTAL REQUIREMENTS FOR CONTRACTOR AND MANUFACTURER						
Technical Document Type	For Review and Comment	For Information	For Record (" As-Built")	Prior to Substantial Completion	Prior to Final Acceptance	Comments
Demin Water Treatment System	X					
CEMS	X					
Sample Panel and Analyzers	X					
Distributed Control System	X					
Feedwater Pumps	X					
Air Cooled Condenser	X					
Condensate Pumps	X					
Dual Purpose Catalyst	X					
Fuel Gas Compressors (if required)	X					If required
All Specifications not listed above		X				
SYSTEM DESCRIPTIONS:						
Plant Control Philosophy	X					
Makeup Process Water Treatment System	X					
Demineralized Water System	X					
Condensate System	X					
Feedwater System	X					
High Pressure (Main) Steam System	X					

TECHNICAL & DOCUMENT SUBMITTAL REQUIREMENTS FOR CONTRACTOR AND MANUFACTURER						
Technical Document Type	For Review and Comment	For Information	For Record (" As-Built")	Prior to Substantial Completion	Prior to Final Acceptance	Comments
Cold Reheat System	X					
Intermediate Pressure Steam System	X					
Hot Reheat System	X					
Low Pressure Steam System	X					
Auxiliary Steam System	X					
Ammonia Storage and Forwarding System	X					
Chemical Feed Systems	X					
Closed Cooling Water System	X					
Raw Water Makeup and Treatment System	X					
Service Water System	X					
Potable Water System	X					
Fuel Gas System	X					
Fire Protection System	X					
Fire Detection System	X					
Instrument and Service Air Systems	X					
Compressed Gas Systems	X					
Plant Drains System	X					

TECHNICAL & DOCUMENT SUBMITTAL REQUIREMENTS FOR CONTRACTOR AND MANUFACTURER						
Technical Document Type	For Review and Comment	For Information	For Record (" As-Built")	Prior to Substantial Completion	Prior to Final Acceptance	Comments
Waste/Oily Water Collection and Treatment System	X					
Storm Water Drainage	X					
Sanitary Waste and Treatment System	X					
High Voltage System	X					
125 Volt DC Distribution	X					
Medium Voltage Distribution	X					
Low Voltage Distribution	X					
Essential AC Power Distribution	X					
Control System Descriptions	X					
Distributed Control System (DCS)	X					
Islanding Mode Operation Descriptions (if required)	X					If required
System Operating Procedures	X					
Draft Site specific Plant Operating Procedures	X			X		
Final Site-specific Plant Operating Procedures	X				X	
SCR System	X					

TECHNICAL & DOCUMENT SUBMITTAL REQUIREMENTS FOR CONTRACTOR AND MANUFACTURER						
Technical Document Type	For Review and Comment	For Information	For Record (" As-Built")	Prior to Substantial Completion	Prior to Final Acceptance	Comments
OTHER:						
O&M Manuals (Draft & Final)	X			X		Two (2) hard copies for final and electronic format
Emissions Performance and Correction Curves	X				X	
Emissions Certification for equipment not tested in the field		X				
Catalyst Unloading and Loading Procedure	X					
Catalyst Seal Drawings		X				
Project Performance and Emissions Guarantee Test Procedures	X					
Reliability Test Procedure	X					
Project Performance Test results	X				X	
Project performance curves	X				X	
Overall Plant Performance Correction Curves	X				X	
Gas Turbine Generator Performance Correction Curves	X				X	
Project Reliability Test results	X				X	

TECHNICAL & DOCUMENT SUBMITTAL REQUIREMENTS FOR CONTRACTOR AND MANUFACTURER						
Technical Document Type	For Review and Comment	For Information	For Record (" As-Built")	Prior to Substantial Completion	Prior to Final Acceptance	Comments
Project Demonstration Test results	X				X	
Operators and maintenance personnel training records		X			X	
CEMS QA/QC Program		X				
Catalyst Module Drawings		X				Including test coupon location

END OF ATTACHMENT A-4

BOT Scope Book
Attachment A-5
Civil/Structural/Architectural Requirements and Design Criteria

Table of Contents

A-5.1 GENERAL

A-5.1.1 This Attachment defines the minimum requirements for construction materials and design requirements for structures, foundations, buildings and civil sitework. This Attachment indicates specific information for the design of structures, foundations, and site development Work required for services to engineer, procure, and construct the Facility.

A-5.2 SCOPE OF WORK

A-5.2.1 The scope of Work is summarized in this Attachment and elsewhere in the BOT Scope Book.

A-5.2.2 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-5.2.3 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-5.2.4 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 application.

A-5.2.5 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-5.2.6 Acceptance of Work by the third-party Testing Service shall not relieve the Seller in any manner from full responsibility for the Work.

A-5.2.7 The Seller shall perform and require its Subcontractors to perform sufficient testing and inspections to ensure that the products supplied satisfy specifications.

A-5.2.8 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-5.2.9 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-5.2.10 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-5.2.11 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-5.2.12 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-5.2.13 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-5.3 DESIGN PHILOSOPHY, REFERENCE CODES AND STANDARDS

A-5.3.1 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-5.3.2 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-5.3.3 Foundations

A-5.3.3.1 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-5.3.3.2 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-5.3.3.3 Foundations shall be designed and sized to meet the specific site soil conditions and minimize the potential for differential settlement.

A-5.3.4 At Seller 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-5.3.5 Grade Slabs

A-5.3.5.1 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-5.3.5.2 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-5.3.6 Access Requirements

A-5.3.6.1 Galleries and platforms shall be provided to access all equipment, valves, components, and I&C devices.

A-5.3.6.2 Access shall be in accordance with Attachment A-06 and as otherwise specified herein.

A-5.3.6.3 Adequate space shall be provided for pull-space room and space for maintenance of the items being accessed.

A-5.3.6.4 Adequate space shall be provided to service control valves including their operators.

A-5.3.6.5 Adequate space shall be provided within enclosures, as well as removable enclosure panels, to allow for equipment removal.

A-5.3.6.5.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-5.3.6.6 Walkway gallery platforms shall be located to provide access to all valves, equipment, etc. requiring access as specified herein. Tie-ins to the HRSG stair towers shall be provided.

A-5.3.6.7 Provide ramps at minor differences in floor elevations to facilitate cart access.

A-5.3.6.8 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-5.3.6.9 Concrete-filled pan treads shall be used in enclosed stairwells provided as required means of egress from enclosed buildings/structures.

A-5.3.6.10 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-5.3.7 Consideration of the Effects of Settlement

A-5.3.7.1 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-5.3.7.2 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-5.3.7.3 The settlements, both total and differential, and their effects, shall satisfy the equipment manufacturer's requirements for settlement limits.

A-5.3.8 Architectural

A-5.3.8.1 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 Plans 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-5.3.9 Maintenance Crane Requirements

A-5.3.9.1 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-5.3.10 Design Codes, Standards, Laws and Ordinances

A-5.3.10.1 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-5.3.10.2 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-5.3.10.3 Federal

A-5.3.10.3.a Title 29, Code of Federal Regulations (CFR), Part 1910, Occupational Safety and Health Standards.

A-5.3.10.3.b Title 40, CFR Attachment 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-5.3.10.4 State

A-5.3.10.4.a Louisiana Department of Transportation & Development (DOTD), Standard Specifications for Road and Bridge Construction, along with applicable Special Provisions and Reference Specifications, as last revised.

A-5.3.10.4.b Occupational Safety and Health Act (OSHA)

A-5.3.10.4.c Louisiana Department of Environmental Quality (LDEQ)

A-5.3.10.4.d Accessibility Code (ADA)

A-5.3.10.5 Local County Code(s), as required.

A-5.3.10.6 Industry Codes and Standards

A-5.3.10.6.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-5.3.10.6.a.1 Specifications for materials shall follow the standard specifications of the ASTM International (ASTM) and the American National Standards Institute (ANSI).

A-5.3.10.6.a.2 Field and laboratory testing procedures for materials shall follow standard ASTM specifications.

A-5.3.10.6.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-5.3.10.6.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-5.3.10.6.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-5.3.10.6.a.6 Welding procedures and qualifications for welders shall follow the recommended practices and codes of the American Welding Society (AWS).

A-5.3.10.6.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-5.3.10.6.a.8 Fabrication and erection of grating shall follow applicable standards of the National Association of Architectural Metals Manufacturers (NAAMM).

A-5.3.10.6.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-5.3.10.6.a.10 Plumbing shall conform to the International Plumbing Code IPC.

A-5.3.10.6.a.11 Design of roof coverings shall conform to the requirements of the National Fire Protection Association (NFPA).

A-5.3.10.6.a.12 Design of roadways shall conform to the Project state's Department of Transportation Standard and Specifications.

A-5.3.10.6.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-5.3.10.6.a.14 Product certifications shall be UL listed.

A-5.3.10.6.b The latest revision of the following Codes and Industry Standards shall be used:

A-5.3.10.6.b.1 IBC, International Building Code with all Errata.

A-5.3.10.6.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-5.3.10.6.b.3 American Iron and Steel Institute (AISI) "North American Specification for the Design of Cold-Formed Steel Structural Members"

A-5.3.10.6.b.4 Association for Iron & Steel Technology (AIST) - Technical Report 13: Guide for the Design and Construction of Mill Buildings

A-5.3.10.6.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-5.3.10.6.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-5.3.10.6.b.7 Concrete Reinforced Steel Institute (CRSI), Design Handbook

A-5.3.10.6.b.8 Precast/Prestressed Concrete Institute, PCI Design Handbook Precast and Prestressed Concrete

A-5.3.10.6.b.9 Masonry Designers Guide

A-5.3.10.6.b.10 American Society of Civil Engineers (ASCE)

- ASCE/SEI (ASCE) 7, Minimum Design Loads for Buildings and Other Structures

A-5.3.10.6.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-forced Welded and Seamless Carbon Steel Structural Tubing in rounds and Shapes”
- ASTM A572 “Standard Specification for High Strength, Low Alloy Columbian-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 Allow-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-5.3.10.6.b.12 NAAMM Manual – Metal Bar Grating Manual

A-5.3.10.6.b.13 SDI Manual of Construction with Steel Deck

A-5.3.10.6.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-5.3.10.6.b.15 Aluminum Association, “Aluminum Design Manual”

A-5.3.10.6.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-5.3.10.6.b.17 American Association of State Highway and Transportation Officials (AASHTO) - A Policy on Geometric Design of Highways and Streets

A-5.3.10.6.b.18 Manual on Uniform Traffic Control Devices (MUTCD), Federal Highway Administration (FHA)

A-5.3.10.6.b.19 Asphalt Institute - The Asphalt Handbook (MS-4)

A-5.3.10.6.b.20 Heating, Ventilating, and Air Conditioning Guide by American Society of Heating, Refrigeration, and Air Conditioning engineers (ASHRAE)

A-5.3.10.6.b.21 International Energy Conservation Code (IECC)

A-5.3.10.6.b.22 National Fire Protection Association (NFPA) Standards

A-5.3.10.6.b.23 International Association of Plumbing and Mechanical Officials

A-5.3.10.6.b.24 American Society of Nondestructive Testing Recommended Practice (ASNT-TC-lA)

A-5.3.10.6.b.25 International Organization for Standardization (ISO) 10816-1 “Evaluation of Machine Vibration by Measurements on Non-Rotating Parts”

A-5.3.10.6.b.26 CMAA, Crane Manufacture Association of America

A-5.4 ARCHITECTURAL REQUIREMENTS

A-5.4.1 General architectural requirements including code references are including in Attachment A-5.

A-5.4.2 See Attachment A-5 Surface Preparation and Protective Coatings) for protective coatings of structural steel for buildings, enclosures and canopies.

A-5.4.2.1 All building metal siding, roofing, trim, and accessories with painted finish colors will be selected by Buyer from the manufacturer’s standard colors.

A-5.4.2.2 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-5.4.2.3 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-5.4.2.4 Interior, exterior and emergency lighting at all buildings, enclosures and canopies shall be LED lighting as specified in Attachment A-7, Electrical Requirements and Design Criteria.

A-5.4.2.5 As a minimum, provide buildings and equipment enclosures as indicated in Attachment A-9, Building and Equipment Enclosure Requirements, with heating, cooling and ventilation systems as indicated.

A-5.4.3 Pre-Engineered Buildings

A-5.4.3.1 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-5.4.3.2 In general, materials and installation of architectural systems or components shall be as follows:

A-5.4.3.2.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-5 for more information.

A-5.4.3.2.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-5.4.3.2.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-5.4.3.2.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-5.4.3.2.e Fire Exits: Fire exits shall be provided at outside walls as required by code. Exit signs shall be provided. 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-5.4.3.2.f Doors: Doors and frames shall be insulated hollow metal type with weather seals and BHMA Grade 1 hardware. Doors and frames shall be Level 3, Extra Heavy Duty types, and 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 door locations shall be provided with electrified access hardware in accordance with NERC CIP requirements.

A-5.4.3.2.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-5.4.3.2.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-5.4.3.2.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-5.4.3.2.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-5.4.3.2.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-5.4.3.2.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-5.4.3.2.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" Attachments 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-5.4.3.3 Architectural Finishes:

A-5.4.3.3.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*	SAT
	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	Raised Access Flooring System set into the recessed slab, 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 (Wall assemblies and finishes to be installed up to roof at exposed to structure areas)

A-5.4.3.4 Plastic laminate casework, solid surface countertops, toilet room partitions and toilet accessories shall meet IBC and ADA requirements.

A-5.4.3.5 Unless noted office furniture, appliances, cubical walls, and security hardware required in each building will be furnished and installed by Buyer.

A-5.4.3.6 Control Room furniture including operator stations shall be furnished and installed by Seller.

A-5.5 MATERIALS

A-5.5.1 All material for the items listed below shall be new and shall be certified to be in accordance with the applicable specification. Evidence of certification shall be on file in the Seller's office and furnished to Buyer upon request.

A-5.5.2 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-5.5.3 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 Attachments	ASTM A500 Grade B
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.l 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
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, GR 60 or ASTM A706 (fy = 60,000 psi)

- Anchor Rods:

Standard:	
Rods	ASTM F1554 Gr 36
Nuts	ASTM A563 heavy hex, Zinc-Coated, ASTM Al53 Class C
Washers	ASTM F436, Zinc-Coated, ASTM A153 Class C
High Strength:	
Rods	ASTM F1554 Gr 55 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 Al08

• Guardrail/Handrail	ASTM A500 Grade B, 1-1/2” nominal diameter schedule 40 pipe. Hot-dipped galvanized.
• Toe (Guard) Plate	ASTM A36 ¼” 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, ¼” minimum thickness, Hot-dipped galvanized

A-5.6 STRUCTURAL LOADS AND LOAD COMBINATIONS

A-5.6.1 General:

A-5.6.1.1 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 Attachment A-4)
- 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 7-10 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-5.6.2 Dead Load:

A-5.6.2.1 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-5.6.3 Live Load:

A-5.6.3.1 General:

A-5.6.3.1.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-5.6.3.1.b The live load to be used is the greater of that specified in ASCE 7-10, 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

Location	Live Load	Remarks
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. 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.

b. 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.

c. Equipment loads shall be used when they exceed the live load stated. Equipment and minimum uniform live loads will not be applied simultaneously.

d. Equipment removal loads shall be considered.

e. 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-5.6.3.2 Live Load Reduction

A-5.6.3.2.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-5.6.3.3 Live Load Posting and Drawing Notation

A-5.6.3.3.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-5.6.4 Wind Load

A-5.6.4.1 General

A-5.6.4.1.a Design wind pressures shall be determined in accordance with the provisions and design parameters indicated in Attachment A-4 of this document.

A-5.6.5 Seismic Load

A-5.6.5.1 General

A-5.6.5.1.a Seismic loads shall be determined in accordance with the provisions and design parameters indicated in Attachment A-4 of this document.

A-5.6.5.1.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-5.6.5.1.c In addition, Architectural, Mechanical, and Electrical components shall be designed and constructed to resist seismic forces determined in accordance with ASCE 7.

A-5.6.6 Soil and Hydrostatic Pressure Loads

A-5.6.6.1 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-5.6.6.2 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-5.6.7 Excursion Loads

A-5.6.7.1 Excursion conditions (i.e., unusual, or infrequent loadings) shall be considered as a separate loading condition beyond the normal operating load(s).

A-5.6.8 Temporary Load

A-5.6.8.1 Provision shall be made for temporary loads arising from the installation of the heavy machinery and equipment.

A-5.6.9 Equipment Load

A-5.6.9.1 Static and dynamic equipment loads shall be as specified on the Manufacturer's drawings.

A-5.6.10 Impact Load

A-5.6.10.1 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-5.6.11 Vibratory, Thermal and Friction Loads

A-5.6.11.1 These loads shall be included in the design and shall include loads as specified by the equipment manufacturers.

A-5.6.12 Load Combinations

A-5.6.12.1 Loads shall be applied and combined in accordance with load combinations given in ASCE 7, and as described herein.

A-5.6.12.2 Load combinations include normal operating, test, excursion, and severe environmental loading conditions, with separate combinations for extraordinary events as given by ASCE 7.

A-5.7 CIVIL DESIGN

A-5.7.1 Nominal Site Grade:

A-5.7.1.1 Top of Concrete: Elevation 6" higher than the Nominal Finish Grade Elevation"

A-5.7.1.2 Nominal Finish Site Grade: Elevation to be higher than a 500-year Flood Site Elevation (high point)

A-5.7.1.3 Plant Coordinate System:

A-5.7.1.3.a All horizontal survey control shall be established to the Louisiana State Plane Coordinate System (NAD 1983, West Zone). Vertical control shall be set to North American Vertical Datum of 1988 (NAVD 1988).

A-5.7.1.3.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-5.7.2 Description of Civil Site Development Scope

A-5.7.2.1 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 pond 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-5.7.3 Reference Documents

A-5.7.3.1 The design and construction of this Facility shall be in accordance with all Applicable Laws.

A-5.7.3.2 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-5.7.4 Excavation and Backfill

A-5.7.4.1 Quality Assurance

A-5.7.4.1.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-5.7.4.1.b Seller shall perform existing utility identification using geophysical and hydrovac techniques for all excavations within and outside power block area.

A-5.7.4.2 Project Conditions

A-5.7.4.2.a See Attachment A-04 for general project conditions.

A-5.7.4.3 Soil Materials

A-5.7.4.3.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-5.7.4.3.b 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-5.7.4.3.c 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-5.7.4.3.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-5.7.4.4 Storage of Soil Materials

A-5.7.4.4.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-5.7.4.4.b Stockpile soil materials away from edge of wetlands and excavations per OSHA regulations.

A-5.7.4.5 Excavation

A-5.7.4.5.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-5.7.4.5.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-5.7.4.5.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-5.7.4.5.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-5.7.4.5.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-5.7.4.6 Subgrade Preparation

A-5.7.4.6.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-5.7.4.6.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-5.7.4.6.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-5.7.4.6.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-5.7.4.6.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-5.7.4.7 Fill and Backfill General Placement Requirements

A-5.7.4.7.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-5.7.4.7.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-5.7.4.7.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-5.7.4.7.d Material shall not be placed upon a porous, wet, spongy, or frozen surfaces, nor shall frozen material be incorporated into the materials.

A-5.7.4.7.e Materials placed by dumping in piles or windows shall be spread uniformly before being compacted.

A-5.7.4.7.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-5.7.4.7.g Material placed against concrete shall not be done until concrete has attained sufficient strength that backfilling will not cause damage.

A-5.7.4.7.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-5.7.4.7.i Each lift of material placed shall extend the entire length and width of the area being filled when practicable.

A-5.7.4.7.j Compaction methods, equipment, and loose lift thickness shall be included in the detailed specifications.

A-5.7.4.8 Moisture Control of Soil Materials

A-5.7.4.8.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-5.7.4.8.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-5.7.4.8.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-5.7.4.9 Compaction of Soil Materials

A-5.7.4.9.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-5.7.4.10 Grading

A-5.7.4.10.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-5.7.4.10.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-5.7.4.10.c Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross Attachments, lines, and elevations as required.

A-5.7.4.10.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-5.7.4.10.e The high point of finished grade shall be set at 6 inches below the top of concrete foundation elevations.

A-5.7.4.10.f Slope grades to direct water away from buildings and to prevent ponding.

A-5.7.4.10.g The maximum permanent slope, without supplemental stabilization through mechanical means, to be provided shall be 3H:1V, unless otherwise approved by Buyer.

A-5.7.4.10.h Where approved by Buyer, permanent slopes steeper than 3H:1V and higher than 4 feet shall be numerically evaluated for stability.

A-5.7.4.10.i Permanent slopes cut into natural or existing soils shall be numerically evaluated for stability.

A-5.7.4.10.j Slope stability analyses shall consider all appropriate loading conditions such as, but not limited to surcharge traffic, structures, and seismic acceleration.

A-5.7.4.10.k The minimum safety factor for slopes immediately after construction is 1.3.

A-5.7.4.10.l The minimum safety factor for slopes for long term stability is 1.5.

A-5.7.4.10.m The minimum safety factor for slopes subjected to seismic acceleration is 1.1.

A-5.7.4.10.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-5.7.4.10.o Finished area surfacing material shall be approved by Buyer.

A-5.7.4.11 Field Quality Control

A-5.7.4.11.a The density of in-place soils shall be tested by ASTM D6938, ASTM D1556, or ASTM D2167.

A-5.7.4.11.b The moisture content of in-place soils shall be determined in accordance with ASTM D6938 or ASTM D2216.

A-5.7.4.11.c Loose lift thicknesses shall be measured and monitored by the third-party Testing Service.

A-5.7.4.11.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-5.7.4.11.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-5.7.4.12 Clean-Up

A-5.7.4.12.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-5.7.4.13 Disposal of Excavated Material

A-5.7.4.13.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-5.7.5 Dewatering

A-5.7.5.1 Performance Requirements

A-5.7.5.1.a Seller shall review the geotechnical information and determine the appropriate dewatering system for the Work to meet the performance requirements.

A-5.7.5.1.b Seller shall maintain all excavations in a dry condition to facilitate quality construction and backfill activities.

A-5.7.5.1.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-5.7.5.1.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-5.7.5.1.e Accomplish dewatering without damaging structures and improvements adjacent to excavation.

A-5.7.5.1.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-5.7.5.1.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-5.7.5.1.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-5.7.5.1.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-5.7.5.1.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-5.7.5.1.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-5.7.5.1.l 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-5.7.5.2 Dewatering System

A-5.7.5.2.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-5.7.5.2.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-5.7.5.2.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-5.7.5.2.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-5.7.5.2.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 Louisiana Department of Environmental Quality (LDEQ).

A-5.7.5.2.f Notify Buyer immediately of and promptly repair damages to adjacent structures, facilities and/or improvements caused by dewatering operations.

A-5.7.5.3 Control of Water

A-5.7.5.3.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-5.7.5.3.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 Louisiana Department of Environmental Quality (LDEQ).

A-5.7.5.3.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-5.7.6 Protection of Structures and Utilities

A-5.7.6.1 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-5.7.6.2 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-5.7.6.3 Compact fill adjacent to structures to a density equivalent to that of the surrounding fill by hand-tamping or hand-power tampers.

A-5.7.6.4 Do not operate heavy equipment within 2 feet of any structure.

A-5.7.6.5 Do not operate heavy vibratory compactors within 5 feet of any structure.

A-5.7.6.6 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-5.7.7 Grading and Drainage

A-5.7.7.1 General

A-5.7.7.1.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-5.7.7.1.b Drainage shall be designed to discharge non-contact stormwater to the appropriate, regulated outfalls as specified in the approved NPDES 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-5.7.7.1.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-5.7.7.1.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-5.7.7.2 Erosion Control

A-5.7.7.2.a Proper temporary erosion control measures including but not limited to the use of silt fences, sandbags and seeding shall be employed during construction to control erosion of embankments, temporary material stockpile(s), and to limit sediment runoff.

A-5.7.7.2.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-5.7.7.2.c All necessary permitting for pre- and post-construction stormwater management must be obtained by Seller before start of construction activities.

A-5.7.7.3 Stormwater Drainage System

A-5.7.7.3.a A stormwater drainage system consisting of catch basins and underground piping shall collect stormwater runoff in the power block area. All storm water discharge from the power block area shall meet the requirements of the applicable state and parish ordinances and shall be acceptable by the Buyer.

A-5.7.7.3.b Stormwater runoff from the construction laydown and parking areas shall follow state and local stormwater management criteria, including the LDEQ requirements for Stormwater Discharge for Construction Activities for five acres or more. 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 shall be assumed to be at elevation 6, pending further survey.

A-5.7.7.3.c Materials

A-5.7.7.3.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-5.7.7.3.c.2 Storm sewer manholes and catch basins shall be precast reinforced concrete structures, designed for HS20 traffic load with a minimum of 10% impact factor. Manholes and catch basins shall have a cast iron frame and removable solid or grate cover.

A-5.7.7.4 Roof Drains

A-5.7.7.4.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-5.7.8 Oil Containment Requirements

A-5.7.8.1 Oil Containment

A-5.7.8.1.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-5.7.8.2 Oily Water System

A-5.7.8.2.a An oily water system shall be provided to collect discharges from all areas which have potential for oil contamination.

A-5.7.8.2.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-5.7.8.2.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-5.7.8.2.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-5.7.8.2.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-5.7.8.2.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-5.7.8.2.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-5.7.9 Truck Unloading Containment

A-5.7.9.1 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-5.7.9.2 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-5.7.10 Post indicator valves may be painted with a system-unique color code as directed by Buyer.

A-5.7.11 Sanitary Sewage System

A-5.7.11.1 Sanitary sewage discharge from new facilities shall be routed to a lift station and pumped to the local municipal sewer system.

A-5.7.11.2 Seller shall tie into the Municipal Sanitary Sewer line at a manhole outside the Facility boundary. Details are to be provided by Seller as listed on Attachment A-11 Terminal Points.

A-5.7.11.3 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-5.7.11.3.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 a 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-5.7.11.3.b Two 100 percent submersible grinder pumps rated for sewage duty with hydraulic sealing flanges, each connected to a discharge elbow mounted in the bottom of the wet well.

A-5.7.11.3.c Each pump shall be furnished with two stainless steel guide rails with support brackets and a stainless-steel lifting chain.

A-5.7.11.3.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-5.7.11.3.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-5.7.11.3.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-5.7.11.3.g The enclosure shall include pump motor running lights and for each pump and local alarm lights for pump failure and high water.

A-5.7.11.3.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-5.7.11.4 Force main piping, if required, shall be pressure rated high density polyethylene with fusion welded joints.

A-5.7.11.5 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-5.7.12 Sanitary Sewage Flows

A-5.7.12.1 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-5.7.12.2 The system shall consider 21 full time employees per day to support operation of the combined cycle site.

A-5.7.13 Parking and Paving

A-5.7.13.1 Permanent Parking

A-5.7.13.1.a The permanent parking areas shall be paved with asphalt. All parking stalls shall be laid out in a 90-degree pattern with painted striping and concrete wheelstops.

A-5.7.13.1.b The total number of parking stalls shall be 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-5.7.13.2 Paving

A-5.7.13.2.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-5.7.13.2.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-5.7.13.2.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-5.7.13.2.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 Louisiana Department of Transportation and Development DOTD Standard Specifications.

A-5.7.13.2.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-5.7.13.2.f Driveways at the rolling doors of all buildings shall be a minimum 8-inch-thick reinforced concrete pavement to accommodate HS20/HL-93 trucks and forklifts.

A-5.7.13.2.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. An accessible route from the ADA parking to any accessible building shall be provided using paved areas and sidewalks with ADA curb cuts and slope requirements.

A-5.7.13.2.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-5.7.13.2.i Seller shall provide information to support detailed traffic impact study to be performed by Buyer.

A-5.7.14 Fences and Gates

A-5.7.14.1 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-5.7.14.2 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-5.7.14.3 Where possible, permanent fencing shall be installed in lieu of providing temporary fencing.

A-5.7.14.4 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 Attachment A-8 for additional physical security requirements.

A-5.7.14.5 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-5.7.14.6 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 pipeline posts shall be 10'-0" center to center.

A-5.7.14.7 Swing gates shall be internally braced against sagging and furnished with hinges, latches, stops, keepers, etc.

A-5.7.14.8 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-5.7.14.9 Fence Grounding Requirements

A-5.7.14.9.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-5.7.14.9.b Fences shall be isolated per Buyer's isolation criteria.

A-5.7.15 ALTA/ACSM Land Title Survey – Not Used

A-5.7.16 Equipment Delivery Plan

A-5.7.16.1 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-5.7.17 Construction Laydown

A-5.7.17.1 Laydown areas may be left with the improved stone surfacing.

A-5.8 STEEL DESIGN

A-5.8.1 General

A-5.8.1.1 This Attachment covers the design of structural steel for buildings and other structures.

A-5.8.1.2 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-5.8.1.3 Cold-formed steel components shall conform to the American Iron and Steel Institute specifications for structural members.

A-5.8.2 Deflections

A-5.8.2.1 The maximum lateral deflection of a structure at height H (above the base) shall not exceed 0.005 x H.

A-5.9 FOUNDATION DESIGN

A-5.9.1 General

A-5.9.1.1 This specification covers the design of all reinforced concrete structures, foundations, ground floor slabs, and yard structures.

A-5.9.1.2 Reinforced concrete structures, foundations and ground floor slabs shall be designed by the ultimate strength method in accordance with ACI 318.

A-5.9.1.3 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-5.9.1.4 Foundations for settlement sensitive equipment and structures 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-5.9.1.5 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-5.9.1.6 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-5.9.1.7 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-5.9.1.8 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-5.9.1.9 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-5.9.1.10 Structural concrete shall be designed to minimize ponding on structural foundations.

A-5.9.2 Rotating Equipment Foundations

A-5.9.2.1 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 Attachment.

A-5.9.2.2 For soil supported foundations the ratio of machine concrete foundation mass to equipment mass shall be at least 3:1.

A-5.9.2.3 Equipment foundations shall extend a minimum of 6 in. all around beyond the edge of the equipment.

A-5.9.2.4 The CT, ST 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-5.9.3 Factors of Stability

A-5.9.3.1 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-5.9.3.2 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-5.9.3.3 Other minimum factors of safety for foundations shall be as follows:

A-5.9.3.3.a Sliding, Uplift, and Buoyancy (normal groundwater) shall be 1.5.

A-5.9.3.3.b Buoyancy (flood groundwater) shall be 1.1.

A-5.9.3.4 The minimum factor of safety for retaining structures during service conditions for overturning and sliding shall be 2.0 and 1.5, respectively.

A-5.9.3.5 Passive bearing pressure shall not be considered in the calculation of the stabilizing moment for factor of stability against overturning.

A-5.9.4 Miscellaneous Requirements

A-5.9.4.1 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-5.9.4.2 Tank foundations shall be designed in accordance with all tank vendor requirements.

A-5.9.4.3 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-5.9.5 Additional Requirements for Foundations of Vibratory Equipment

A-5.9.5.1 Foundations for vibrating equipment shall meet design requirements specified by the equipment manufacturer and industry standards and be designed to limit vibrations.

A-5.9.5.2 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-5.9.5.3 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-5.10 GEOTECHNICAL DESIGN

A-5.10.1 General

A-5.10.1.1 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-5.10.1.2 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-5.10.1.3 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-5.10.1.4 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-5.10.1.5 Allowable capacities for deep foundation elements shall be determined using approved methods in accordance with IBC and industry standards.

A-5.10.1.6 Allowable capacities for deep foundation elements shall take into account effects of pile groups, where appropriate.

A-5.10.1.7 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-5.10.1.8 If applicable, installation of deep foundation elements shall not impact the continued operation of the existing plant facilities.

A-5.10.1.9 Pile foundations, if used, shall be tested in accordance with ASTM Standards D1143, D3689, D3966, D4945 and D5882 and IBC requirements.

A-5.10.2 Groundwater

A-5.10.2.1 The groundwater conditions at the time of the geotechnical exploration for the site shall be depicted in the Geotechnical Report, which is provided by the Seller.

A-5.10.2.2 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-5.10.3 Subsurface Data and Geotechnical Design

A-5.10.3.1 Geotechnical input and parameters for use in design shall be determined by the Seller from the preliminary geotechnical memo. The design will be updated to reflect a detailed geotechnical investigation performed by Seller.

A-5.11 DESIGN AND WORKMANSHIP

A-5.11.1 Structural Steel – Fabrication

A-5.11.1.1 General

A-5.11.1.1.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-5.11.1.2 Design of Connections

A-5.11.1.2.a All connections shall be developed in accordance with ANSI/AISC 360-10 and AISC Manual except as otherwise indicated herein.

A-5.11.1.2.b Connection angles, connection plates and gusset plates shall be 3/8 in. thick, minimum.

A-5.11.1.2.c When beams are coped, all re-entrant corners will be shaped, notch-free, to a radius of approximately ½ in.

A-5.11.1.3 Fabrication Quality

A-5.11.1.3.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-5.11.1.4 High-Strength Bolts

A-5.11.1.4.a General

A-5.11.1.4.a.1 The use of high-strength bolts shall conform to the RCSC Specification.

A-5.11.1.4.a.2 Welding of or to high-strength bolts is prohibited.

A-5.11.1.5 Structural Steel Stair Stringers

A-5.11.1.5.a Stairs shall be constructed of channel stringers.

A-5.11.1.5.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-5.11.1.5.c All stairs' stringers shall be hot-dipped galvanized in accordance with ASTM A123.

A-5.11.1.6 Guardrail/Handrail

A-5.11.1.6.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-5.11.1.6.b Pipe rails shall be made with complete penetration groove welded connections, without fittings. Bends shall be smooth without miters, kinks, or collapsed wall Attachments, 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-5.11.1.6.c All guardrails/handrails and accessories shall be hot-dipped galvanized in accordance with ASTM A123.

A-5.11.1.6.d Handrails shall conform to the requirement of OSHA, including requirement for guardrail in addition to graspable handrail at stairs.

A-5.11.1.7 Ladders and Ladder Cages

A-5.11.1.7.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-5.11.1.7.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-5.11.1.7.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-5.11.1.7.d All ladders and accessories shall be coated per the requirements specified herein.

A-5.11.1.8 Swing Gates

A-5.11.1.8.a Self-closing gates shall be provided at the top of all ladders.

A-5.11.1.8.b Swing gates for ladders, platforms and similar uses shall be manufactured, prefabricated, self-closing gates.

A-5.11.1.8.c Swing gates shall be coated per the requirements specified herein.

A-5.11.1.9 Grating and Stair Treads

A-5.11.1.9.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-5.11.1.9.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-5.11.1.10 Checkered Floor Plate

A-5.11.1.10.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-5.11.2 Structural Steel - Erection

A-5.11.2.1 General

A-5.11.2.1.a This Attachment covers the erection of structural steel for buildings and other structures.

A-5.11.2.1.b The fabrication and erection tolerances shall conform to those specified in the AISC Steel Construction Manual.

A-5.11.2.1.c Erection shall comply with the provisions of the codes, specifications, and standards listed in this attachment, except where more stringent requirements are shown or specified.

A-5.11.2.1.d All base plates shall be grouted with non-shrink grout as noted.

A-5.11.2.2 Delivery, Storage, and Handling

A-5.11.2.2.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-5.11.2.2.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-5.11.2.3 Materials

A-5.11.2.3.a Materials shall conform to the requirements specified herein.

A-5.11.2.4 Erection

A-5.11.2.4.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-5.11.2.4.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-5.11.2.4.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-5.11.2.4.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-5.11.2.4.e Level and plumb individual members of structure within specified AISC tolerances.

A-5.11.2.4.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-5.11.2.4.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-5.11.2.4.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-5.11.2.4.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-5.11.2.5 Quality Control

A-5.11.2.5.a Field-Bolted Connections: Inspect in accordance with AISC and RCSC specifications.

A-5.11.2.5.b Field Welding: Inspect and test during erection of structural steel as specified herein.

A-5.11.3 Steel Floor Deck

A-5.11.3.1 Deck General

A-5.11.3.1.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-5.11.3.2 Steel Deck Design

A-5.11.3.2.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-5.11.3.2.b Floor decking can be designed as floor formwork, but the composite deck properties shall not be utilized for design.

A-5.11.3.3 Deck Fabrication

A-5.11.3.3.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-5.11.3.3.b Deck Openings: Unframed openings and all skew cutting shall be cut and reinforced, if necessary, in the field.

A-5.11.3.4 Deck Welding

A-5.11.3.4.a All field welding, shop welding, weld procedures and weld qualification shall be in accordance with AWS Dl .3.

A-5.11.3.4.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-5.11.3.4.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 Dl .3.

A-5.11.3.5 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-5.11.4 Reinforced Concrete

A-5.11.4.1 General

A-5.11.4.1.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-5.11.4.1.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-5.11.4.2 Materials

A-5.11.4.2.a Materials shall conform to the requirements specified herein and shall conform to the additional requirements indicated below. Redi-Mix Concrete shall comply with ASTM C94.

A-5.11.4.2.b Cement type shall be in accordance with ACI requirements and appropriate for soil conditions as documented in the geotechnical report.

A-5.11.4.2.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-5.11.4.2.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-5.11.4.2.e Admixtures: Non-Chloride type only. The use of calcium chloride is not permitted.

A-5.11.4.2.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-5.11.4.2.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-5.11.4.2.h Bonding Agent: Polyvinyl acetate or acrylic base.

A-5.11.4.2.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-5.11.4.3 Proportioning and Designing Mixes

A-5.11.4.3.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-5.11.4.3.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-5.11.4.3.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-5.11.4.4 Admixtures

A-5.11.4.4.a Use admixtures as required for placement, workability, and durability. Admixtures shall be used in strict compliance with manufacturer's directions.

A-5.11.4.4.b Admixtures shall be submitted for Buyer approval as part of the concrete mix design submittal.

A-5.11.4.4.c The use of calcium chloride admixtures is prohibited.

A-5.11.4.5 Concrete Mixing

A-5.11.4.5.a Ready-Mixed Concrete: Comply with requirements of ASTM C 94, and as specified.

A-5.11.4.6 Formwork

A-5.11.4.6.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-5.11.4.7 Fabricating and Placing Reinforcement

A-5.11.4.7.a Fabricate reinforcement in accordance with ACI 315.

A-5.11.4.7.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-5.11.4.8 Joints

A-5.11.4.8.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-5.11.4.8.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-5.11.4.9 Installing Embedded Items

A-5.11.4.9.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-5.11.4.10 Concrete Placement

A-5.11.4.10.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-5.11.4.10.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. Do not drop concrete freely for more than 5 feet. Use a hopper and drop chute where drops are greater than 5 feet.

A-5.11.4.10.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-5.11.4.10.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-5.11.4.10.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 158°F.
- The maximum allowable difference between the center and surface temperature of mass concrete section shall be 35°F.
- 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 Attachment.
- Forms shall be left in place for a minimum of 7 days.

A-5.11.4.11 Finishing Concrete

A-5.11.4.11.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-5.11.4.11.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-5.11.4.11.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-5.11.4.12 Quality Control Testing During Construction

A-5.11.4.12.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-5.11.4.12.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-5.11.4.12.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 Attachment A-5. 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-5.11.5 Anchorage to Concrete

A-5.11.5.1 Cast-in-Place Anchorage

A-5.11.5.1.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-5.11.5.1.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-5.11.5.1.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-5.11.5.1.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-5.11.5.2 Post-Installed Anchorage

A-5.11.5.2.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-5.11.5.2.b Installation of post-installed anchorage shall conform to anchor manufacturer's instructions and requirements.

A-5.11.6 Concrete Masonry Unit

A-5.11.6.1 General

A-5.11.6.1.a Comply with the provisions of the following codes, specifications and standards listed in Attachment A-5, 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-5.11.6.2 Materials

A-5.11.6.2.a Materials shall conform to the requirements specified in Attachment A-5 herein and shall conform to the additional requirements indicated below.

A-5.11.6.2.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-5.11.6.2.c Tie Bar Anchors: Steel, ASTM A82, hot-dipped galvanized after fabrication with minimum size of 3/16 in. diameter.

A-5.11.6.2.d Corrugated Metal Ties: Steel, 16-gauge, 7/8 in. wide, ASTM A36, A1008 or A109, hot-dipped galvanized per ASTM A153.

A-5.11.6.2.e Dovetail Anchors: Steel, ASTM A1008 or A109, hot-dipped galvanized per ASTM A153.

A-5.11.6.3 Construction:

A-5.11.6.3.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-5.11.6.3.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-5.11.6.3.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-5.11.6.3.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-5.11.6.4 Cold Weather Construction

A-5.11.6.4.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-5.11.6.5 Hot Weather Construction:

A-5.11.6.5.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-5.12 STRUCTURAL WELDING

A-5.12.1 General

A-5.12.1.1 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-5.12.1.2 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-5.12.1.3 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-5.12.1.4 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-5.12.1.5 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-5.12.2 Weld Filler Metal Control

A-5.12.2.1 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-5.12.3 Inspection and Repair of Welds

A-5.12.3.1 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-5.12.3.2 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-5.12.3.3 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-5.13 SURFACE PREPARATION AND PROTECTIVE COATINGS

A-5.13.1 General

A-5.13.1.1.a Coatings shall have a minimum design life of 20 years without recoating.

A-5.13.1.1.b Coatings shall comply with the locally adopted EPA Volatile Organic Compound (V.O.C.) limits.

A-5.13.1.1.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-5.13.1.1.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-5.13.1.1.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-5.13.1.1.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-5.13.1 Coating Application

A-5.13.1.1.a Coatings shall be applied in accordance with the requirements of SSPC PAl, supplemented by requirements of the coating manufacturer and application requirements of this specification.

A-5.13.1.1.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-5.13.1.1.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-5.13.1.1.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-5.13.1.1.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-5.13.1.1.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-5.13.1.1.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-5.13.1.1.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-5.13.1.1.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-5.13.1.1.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-5.13.1.1.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-5.13.1.1.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-5.13.1.1.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.

A-5.13.1.1.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-5.13.2 Standard Coating System

A-5.13.2.1 General

A-5.13.2.1.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-5.13.2.1.b Coating systems shall comply with Table 1 of this attachment.

A-5.13.2.1.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-5.13.2.1.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-5.13.2.2 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-5.13.3 Film Thickness Test

A-5.13.3.1 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-5.13.4 Hot-Dip Galvanizing

A-5.13.4.1 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-5.13.4.2 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-5.13.4.3 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-5.13.4.4 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-5.13.4.5 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-5.13.4.6 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-5.13.4.7 Seller shall insure 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-5.13.4.8 Seller shall coat materials with safety colors as specified in this Attachment.

A-5.13.5 Hot-Dip Galvanizing Touch-Up and Repair:

A-5.13.5.1 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-5.13.5.2 The use of zinc-based solders or metallizing by zinc spray for touch-up and repairs is not permitted.

A-5.13.5.3 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-5.13.6 Safety Color Code Coating

A-5.13.6.1 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-5.13.6.2 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-5.13.7 Coating and Finish Systems

A-5.13.7.1 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. All surfaces of exterior (outdoor) metals	Per coating manufacturer's requirements.	Hot-dipped galvanized per ASTM A123.
d. Milled, embedded, contact and welded surfaces, etc.	None (unless otherwise indicated).	No painting – milled surfaces protected with lacquer.
e. Safety color coat on surfaces of indoor metals	Per coating manufacturer's recommendations.	1 or 2 - coat epoxy system
f. 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.
g. 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.
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
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

ITEM	SURFACE PREPARATION	COATING SYSTEM
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

Approved Subcontractors	Primer	DFT
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

Acceptable Subcontractors	**Touch-up**	**DFT (mils)**
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

Acceptable Subcontractors	Touch-up	DFT
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

Acceptable Subcontractors	**Sealer**	**DFT**
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

Acceptable Subcontractors	**Finish**	**DFT**
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

Acceptable Subcontractors	**Primer**	**DFT**
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

Acceptable Subcontractors	**Finish**	**DFT**
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:

Location	**Coating System**
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 - Ceilcote 695 by Ceilcote
Containment Area Outside Surfaces of Walls-40 mils DFT	- Protecto Coat 800 by Dudick - Flakeline 232 by Ceilcote

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

Acceptable Subcontractors	**Sealer**	**DFT**
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
Acceptable Subcontractors	**Intermediate**	**DFT**
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
Acceptable Subcontractors	**Finish**	**DFT**
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

Acceptable Subcontractors	**Surfacer**	**DFT**
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
Devoe-International	Devran 126	10-15
Sigma-PPG	Novoguard Caulk	15-20

Acceptable Subcontractors	**Intermediate**	**DFT**
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
Devoe-International	Devran 224HS	4-8
Sigma-PPG	Sigmacover TCP	5-7
Ameron-PPG	395 FD	4-5

END OF ATTACHMENT A-5

BOT Scope Book

Attachment A-6

Mechanical Requirements and Design Criteria

Table of Contents

A-6.1 GENERAL

A-6.1.1 This Attachment 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-6.1.2 It is Seller's responsibility to ensure that all of the specification requirements herein are incorporated into engineering and design. The 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-6.1.3 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 of this specification, the term "alloy steel" shall be synonymous with "low or intermediate alloy steel" which are steels with 1.25% > chromium > 9% (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-6.1.4 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 Owner approval.

A-6.1.5 All Facility systems shall include connections necessary to accommodate startup and commissioning activities including, but not limited to flushing and cleaning.

A-6.1.6 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 Attachment A-9.

A-6.1.7 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-6.1.8 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-6.1.9 Clearance Requirements:

A-6.1.9.1. Good design practice shall be followed to optimize clearance between piping, equipment and passageways for operation and maintenance.

A-6.1.9.2. For the entire Facility, the Seller shall maintain minimum horizontal and vertical clearances outlined in Attachment A-5.

A-6.1.9.3. Adequate space shall be provided to service control valves including their operators.

A-6.1.9.4. Adequate space shall be provided within enclosures, as well as removable enclosure panels, to allow for equipment removal.

A-6.1.9.5. Clearances shall be reflected in the 3D model to demonstrate that the appropriate clearances have been provided. This is subject to review by Owner for approval.

A-6.2 APPLICABLE CODES AND STANDARDS

A-6.2.1 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 Owner for the Owner's consideration other institutions and/or organizations, if the Seller can demonstrate the proposed alternate(s) are technically equivalent to or more stringent.

A-6.2.2 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-6.2.3 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 which shall govern the Work.

A-6.3 EQUIPMENT NUMBERING AND LABELING

A-6.3.1 Numbering of instrument and control devices shall be in accordance with ANSI/ISA-S5.1.

A-6.3.2 Seller shall develop with the Owner a project specific numbering system derived from the Buyer Project Numbering Guideline, as specified in attachment A-13 Numbering Procedures

A-6.4 STEAM SYSTEMS

A-6.4.1 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 Systems)

A-6.4.2 Auxiliary steam system, may include a natural gas fired or electric auxiliary boiler if necessary to meet the proposed plant startup times

A-6.4.3 Final (exit) stage attemperators shall be provided with the HP and HR Steam Systems at the HRSG interface.

A-6.5 STEAM TURBINE BYPASS SYSTEM

A-6.5.1 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-6.5.2 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-6.5.3 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-6.6 STEAM DRAINS AND WATER INDUCTION PREVENTION SYSTEM

A-6.6.1 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-6.6.2 Drain pots shall be provided as recommended by ASME B&PVC, Attachment 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-6.6.3 Automatically operated drain valves shall be used throughout the steam piping system drains (i.e., drain pots), to prevent condensate accumulation. No operator’s action shall be required to initiate the drain systems. A temperature element should be added downstream of the drain valve for the main cycle steam systems.

A-6.6.4 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-6.6.5 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-6.6.6 The Blowdown Tank and Steam Drains Tank shall feature an automated quench water system for temperature control.

A-6.6.7 Condensate from the Blowdown Tank shall ultimately be routed to the wastewater sump.

A-6.6.8 Condensate collected in the Steam Drains Tank(s) shall be routed to the Condensate Collection Tank of the Air-Cooled Condenser.

A-6.6.9 Combination of different pressure steam system drains into common drain headers / manifolds is prohibited.

A-6.6.10 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-6.7 FEEDWATER SYSTEM

A-6.7.1 A high-pressure feedwater system shall connect the HRSG LP drum to the HP HRSG economizer and other systems as required to support CTG operation. An intermediate pressure feedwater system shall connect the boiler feedwater pumps to the IP economizer and to the fuel gas performance heater. Feedwater is also used as attemperation water.

A-6.7.2 The system shall be designed to minimize flow disturbances and pressure drops, as well as prevent excessive loads on the interconnected equipment including HRSG, boiler feedwater pumps and economizer headers.

A-6.7.3 Two (2) 100% fixed speed motor-driven boiler feedwater pumps shall be provided for each HRSG. Refer to Attachment A-7 for motor requirements.

A-6.7.4 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-6.7.5 The boiler feedwater pumps shall be segmented ring, multiple stage pumps in accordance with Hydraulic Institute Standards.

A-6.7.6 The pump lube oil system shall be equipped with oil sampling connections.

A-6.7.7 Each pump shall be provided with a minimum recirculation control valve.

A-6.7.8 A warmup 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 the pump manufacturer.

A-6.7.9 Pumps and skid mounted items are to be constructed so that bearings, seals, and balance drum may be accessed without removing the pump.

A-6.7.10 Pressure pulsations are designed to be below 3% of total pump head.

A-6.7.11 The pumps shall utilize a vibration monitoring system. Refer to Attachment A-8 for vibration instrumentation requirements.

A-6.7.12 Each pump and driver shall operate in dynamic balance as a unit without excessive vibration, as defined by the Hydraulic Institute.

A-6.7.13 Maximum pump operating speed (full speed) shall not exceed 5,500 rpm. The impeller specific speed shall not exceed 1,700 rpm.

A-6.7.14 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 the throwing of oil and to prevent contamination of the oil from moisture or dirt.

A-6.7.15 The thrust bearing shall be of the double acting Kingsbury adjustable type or Owner approved equal. Thrust bearings shall positively prevent contact of rotating and stationary pump parts in the axial direction.

A-6.7.16 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-6.7.17 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-6.8 CONDENSATE SYSTEM

A-6.8.1 The condensate system shall transfer condensate from the ACC condensate collection tank to the HRSG low-pressure (LP) economizers.

A-6.8.2 The condensate system shall include three (3) 50% capacity motor driven vertical can type condensate pumps. Refer to Attachment A-7 for motor requirements.

A-6.8.3 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-6.8.4 The pumps and system shall be sized for the maximum condensate flow and head requirements of the system.

A-6.8.5 All operating scenarios shall be considered in determining the maximum design, full range of ambient conditions, full steam bypass, startup, and trip conditions.

A-6.8.6 Two (2) x 100% capacity heat exchangers shall provide cooling to prevent excessive temperature rise in the air-cooled condenser and steam turbine back-end.

A-6.8.6.1. The heat exchangers shall cool Condensate System water (for curtain spray, casing spray, etc. as required) with water from the Closed Cooling Water System.

A-6.8.6.2. The heat exchanger shall be sized to handle the startup flow for the Combustion Turbine Unit, through Full Speed No Load (FSNL).

A-6.8.6.3. Heat exchangers shall be able to pass through the maximum expected flow associated with normal system operation, rather than bypassing. There is no heat transfer expected during this normal operating condition.

A-6.8.6.4. Heat exchanger pressure drop limit shall be 10 psid for startup and normal operation for Condensate Water (hot side).

A-6.8.6.5. Exchangers shall conform to Attachment VIII, Division 1, of the ASME Boiler and Pressure Vessel Code, the seventh edition of the TEMA (1) Standards Class R and HEI Standard for Power Plant Heat Exchangers, except where the requirements herein are more stringent.

A-6.8.6.6. Heat exchanger design shall include 10% excess margin for fouling, greater than the maximum expected operating condition for heat transfer performance.

A-6.8.7 Two (2) x 100% capacity iron filters will be provided as part of the condensate system.

A-6.9 AIR COOLED CONDENSER AND ACCESSORIES

A-6.9.1 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-6.9.1.1. 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-6.9.2 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. 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-6.9.3 The ACC shall be of the W-frame type, elevated sufficiently for proper air inlet distribution. Jacking bolts shall be provided to permit proper alignment of bundle tube sheets for purposes of seal welding.

A-6.9.4 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-6.9.5 The ACC shall be designed for full vacuum and a positive pressure of 7.25 psig per requirements of HEI.

A-6.9.6 The ACC shall be designed to allow freeze-proof 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-6.9.7 A reverse buckling rupture disc type pressure relief device for each isolatable condenser Attachment shall be provided.

A-6.9.8 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-6.9.9 Fans:

A-6.9.9.1. Fan blades shall be constructed of fiberglass reinforced polyester (FRP). Fan blades shall be interchangeable. A fan guard shall be provided below each fan. 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. A mechanical brake shall be provided to prevent fan rotation during maintenance.

A-6.9.9.2. 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. 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-6.9.10 Steam Duct:

A-6.9.10.1. 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-6.9.10.2. 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.

A-6.9.10.3. The steam duct shall be designed for full vacuum and for a pressure of 7.5 psig per requirements of HEI, with a maximum steam temperature of 250ºF.

A-6.9.10.4. At locations where the steam duct will exit the building and penetrate sidings, a steel flange or other suitable provision shall be made for sealing and flashing the siding to the duct.

A-6.9.10.5. Steam Duct Drain Pot:

A-6.9.10.5.a. 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. The Seller shall provide freeze protection, as required, during plant shutdown.

A-6.9.11 Turbine Exhaust Neck:

A-6.9.11.1. 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-6.9.12 Condensate Collection Tank:

A-6.9.12.1. The tank shall be designed in accordance with the requirements of the Boiler and Pressure Vessel Code, Attachment VIII if required by governing codes or per the Seller's design.

A-6.9.12.2. The condensate collection tank shall be of the horizontal storage type located below the ACC.

A-6.9.12.3. The condensate outlet from the condenser condensate collection tank shall be provided with anti-vortexing devices, with an internal lip height of 3 inches to prevent the carryover of solids into the condensate.

A-6.9.12.4. 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-6.9.12.5. 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-6.9.12.6. 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-6.9.13 Air Ejector System:

A-6.9.13.1. The ejection equipment capacity shall as a minimum conform to the applicable standards of HEI.

A-6.9.13.2. Four (4) 33% electric motor-driven liquid ring vacuum pumps shall be provided for hogging operation. Materials of construction shall be as follows:

A-6.9.13.2.a. Cast steel housing.

A-6.9.13.2.b. Stainless steel internals

A-6.9.13.2.c. Mechanical cartridge type seals

A-6.9.13.3. Two (2) 100% Steam Jet Air Ejector (SJAE) shall be used for holding operation.

A-6.9.14 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 owner-approved equivalent.

A-6.9.15 Automatic Fin Cleaning System:

A-6.9.15.1. 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-6.9.16 Expansion Joints:

A-6.9.16.1. 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-6.9.16.2. 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, Attachment C.

A-6.9.16.3. Provisions shall be made to protect the expansion joint from direct impingement of any incoming steam by use of stainless-steel impingement shields.

A-6.10 RAW & MAKEUP WATER SYSTEM

A-6.10.1 The plant's raw water system will deliver raw water to the water treatment equipment, where it is treated for Facility use.

A-6.10.2 A sodium hypochlorite feed system shall be provided at the Fire Water / Service Water Storage Tank to mitigate concerns with biofouling.

A-6.11 DEMINERALIZED WATER TREATMENT SYSTEM

A-6.11.1 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. Temporary lease/rental systems (i.e. trailer systems) are not acceptable.

A-6.11.2 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-6.11.3 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-6.11.4 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 Owner will provide chemical totes for all chemicals used within the treatment system.

A-6.11.5 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-6.11.6 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 316 stainless steel except where material compatibility requires use of CPVC.

A-6.11.7 Two (2) x 100% UF backwash pumps and air scour blowers (if applicable), shall be furnished.

A-6.11.8 UF and RO cleaning waste shall be neutralized in-situ prior to discharge.

A-6.11.9 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-6.11.10 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-6.11.11 Seller shall supply a Demineralized Water storage tank with capacity of 250,000 gallons (min.). Tank shall include provisions to protect against contamination due to air leakage.

A-6.11.12 All tanks and chemical storage areas to be located to be accessible by trucks.

A-6.11.13 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-6.11.14 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-6.11.14.1. 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-6.11.15 Demineralized water quality shall be in accordance with the following:

Parameter	Units	Limit
Sodium	ppb Na	< 2
Chloride	ppb Cl	< 2
Sulfate	ppb SO4	< 2
Silica	ppb SiO2	< 10
Conductivity	uS/cm @ 77ºF	< 0.1
TOC	ppb TOC	< 100

A-6.12 CLOSED COOLING WATER SYSTEM

A-6.12.1 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-6.12.2 Closed cooling water shall be a propylene glycol and water mixture. Glycol percentage will be determined based on ambient design conditions.

A-6.12.3 The pumps shall be capable of supplying cooling water under all operating conditions while meeting all equipment water temperature requirements of the proposed design.

A-6.12.4 This system, including equipment, shall be designed based on Minimum Emissions Compliant Load through full operating conditions including maximum ambient conditions.

A-6.12.5 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-6.12.6 Individual closed cooling water equipment users shall be capable of being isolated without interruption of said system.

A-6.12.7 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-6.12.8 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-6.12.9 One (1) x 100% air-cooled heat exchanger shall provide cooling to the closed cooling water system.

A-6.12.9.1. Heat exchanger design shall allow sufficient margin for fouling. The design heat duty shall be full duct firing condition plus 10%.

A-6.12.9.2. Heat exchanger shall be capable of handling the maximum expected heat requirements with 10% of the tubes plugged.

A-6.12.9.3. 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-6.12.10 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-6.12.11 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 the Owner.

A-6.12.12 Air Cooled (Fin-Fan) Heat Exchangers

A-6.12.12.1. 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 a margin for 10% future capacity. Isolation of each cell from the CCW supply without affecting operation shall be provided.

A-6.12.12.2. 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-6.13 CYCLE CHEMICAL FEED SYSTEMS

A-6.13.1 Cycle chemical feed systems shall be provided for the addition of ammonia into the condensate system and oxygen (O_2) into the feedwater system.

A-6.13.2 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-6.13.3 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-6.13.4 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-6.13.5 Any chemical containment walls shall be 45” or less in height (therefore does not require confined space classification).

A-6.13.6 O_2 injection shall be based on supply from external O_2 bottles (bottles supplied by Owner).

A-6.13.7 The O_2 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-6.13.8 O_2 level in the feedwater shall be monitored by the DCS, using an analysis element. Adjustment of the O_2 injection rates will be manual.

A-6.14 WATER AND STEAM SAMPLING SYSTEM

A-6.14.1 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-6.14.2 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	
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-6.14.3 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-6.14.3.1. Furniture consisting of cabinets, countertops, working surface shall be provided and included in the water lab.

A-6.14.4 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-6.14.5 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-6.14.6 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-6.14.7 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-6.14.8 Each sample stream shall include a total flow rotameter.

A-6.14.9 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-6.14.10 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-6.14.11 Samples shall be analyzed, and the information shall be displayed on local instruments and sent to the main DCS for trending and alarm.

A-6.14.12 Cooling water for the primary sample coolers shall be provided from the closed cooling water system.

A-6.14.13 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-6.14.14 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 Attachment that shall contain an annunciator, various transmitters, indicators, and inputs to the control system.

A-6.14.15 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-6.14.16 Sample panels shall feature valves and quick connect fittings so that analyzers can be connected to alternate sample sources.

A-6.14.17 Sampling tubing shall be sized to have a velocity of approximately 6 ft/sec.

A-6.14.18 Sample piping/tubing shall be seamless ASTM SA213 TP316/316L.

A-6.14.19 The sample panel shall be centrally located to limit tubing runs from the source to the panel to < 300 feet.

A-6.14.20 Sample lines shall be provided with Swagelok type quick disconnect fittings constructed of 316 stainless steel.

A-6.14.21 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-6.14.22 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
	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	

Analysis Parameter	Sample Application	Make	Model
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-6.15 SERVICE WATER SYTEM

A-6.15.1 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-6.15.2 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 the Fire Protection and Service Water tank.

A-6.15.3 Each service water hose station shall feature a standard ¾" hose coupling and isolation valve.

A-6.15.4 All outdoor service water hose stations 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-6.16 FUEL GAS CONDITIONING AND DELIVERY SYSTEM

A-6.16.1 Owner receives supply of natural gas from its gas transporters at the onsite gas yards. Gas pressure and constituents are provided in Attachment A-4.

A-6.16.2 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-6.16.3 The natural gas system shall be designed per ASME B31.1 or B31.3, as dictated by the CTG manufacturer.

A-6.16.4 The gas supplier will provide shut-off and overpressure protection at the gas yard interface connection for its supplied equipment. The Seller shall provide shut-off and overprotection equipment for its supplied equipment.

A-6.16.5 Seller shall supply a total fuel gas flow meter on the fuel gas supply line.

A-6.16.6 Seller shall supply any fuel gas conditioning equipment required to meet the needs of the CTG 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. The CTG shall be equipped with a dedicated flow measuring device conforming to AGA-7, Measurement of Natural Gas by Turbine Meters.

A-6.16.6.1. Startup dew point heaters shall be equipped with low NOx burners with a maximum of 0.04 lb NOx/MMBtu.

A-6.16.7 All fuel gas conditioning equipment shall include a minimum flow margin of 10%.

A-6.16.8 Fuel gas sample points shall be provided throughout the system for Owner use.

A-6.16.9 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-6.16.10 The natural gas drains tanks shall be double wall and installed above ground to accommodate regular maintenance and inspections. Each tank shall feature interstitial (annular space), leak detection capability as well as level indicating transmitter.

A-6.16.11 Fuel gas vents shall be routed to the highest steel structure and to a safe location, away from personnel areas, mutually agreed with Owner.

A-6.16.12 Appropriate hazardous area designation is required for any leak or vent source per NFPA 497.

A-6.16.13 Contactor shall provide chromatograph with hydrocarbon dewpoint measurement capability.

A-6.17 CTG INLET EVAPORATIVE COOLING SYSTEM

A-6.17.1 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-6.17.2 Quality of the makeup water supply to the system shall be coordinated with and approved by the CTG manufacturer.

A-6.17.3 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-6.18 SUMP PUMPS

A-6.18.1 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-6.18.2 Sump pumps in oil drain areas shall be designed for pumping oil and shall be non-emulsion and non-shear design.

A-6.18.3 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-6.18.4 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 Owner approval. Owner will not accept pumps that require maintenance cycles with less than 60-day durations.

A-6.19 TANKS & PRESSURE VESSELS

A-6.19.1 Double wall tanks shall meet the EPA Guidance SPCC Guidance for Regional Inspection.

A-6.19.2 Atmospheric pressure, field erected, outdoor, steel water tanks shall be designed in accordance with AWWA D100 (welded tanks) or AWWA D103 (bolted tanks).

A-6.19.3 Pressurized tanks with an internal design pressure greater than 15 psig shall be designed in accordance with ASME B&PVC.

A-6.19.4 Pressure vessels shall be designed, fabricated, stamped, tested, and documented to ASME VIII standards and in accordance with state and local requirements.

A-6.19.5 Pressure vessels shall include the following features and appurtenances:

A-6.19.5.1. Process, vent, and drain connections for startup, operation, and maintenance.

A-6.19.5.2. 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-6.19.5.3. Shop-installed insulation clips spaced not greater than 18 inches on center, or shop installed insulation support rings, for vessels requiring insulation.

A-6.19.5.4. Relief valves in accordance with the applicable codes

A-6.19.6 Carbon steel tanks shall have a minimum corrosion allowance of 1/16 in.

A-6.19.7 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-6.19.8 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 documenting the vapor pressure exemption. This shall be verified during permitting efforts, to ensure tanks comply with all authority requirements.

A-6.19.9 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-6.20 PUMPS

A-6.20.1 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-6.20.2 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-6.20.3 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-6.20.4 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-6.20.5 In sizing of the pumps, consideration shall be given to the possibility and effect of driver overspeed, and pump run out.

A-6.20.6 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**
Condensate Pumps	10% margin on the Normal Flow	0% margin on the calculated head	NPSHA ≥ NPSHR +1.5ft 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 >= NPSHR + 20ft 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 ≥ NPSHR + 3ft 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 ≥ NPSHR + 3ft 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 *(1-0.2) ≥ NPSHR [equivalent to NPSHA ≥ NPSHR * 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-6.20.7 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-6.20.8 Unless otherwise stated, all pumps shall be furnished with all necessary vents, drains, leak-offs, and gauges.

A-6.20.9 All pumps shall use cartridge type mechanical seals.

A-6.20.10 Piping systems connected to the suction and discharge connections of the pumps shall be designed based on the manufacturer's allowable nozzle loads.

A-6.20.11 Motors shall be furnished and mounted by the Seller on a common baseplate in accordance with the motor identified in electrical attachment of this specification. All motors shall be air cooled.

A-6.20.12 Pumps with seal drains shall have seal drains directed to the oil-water separator funnel drains without effluent running across the floor.

A-6.20.13 Pumps shall be equipped with gauges to indicate the discharge and suction pressure. Process tappings for these gauges shall be into piping and not into pump nozzles. Major Equipment supplier's pump drawings 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-6.20.14 Fire protection pumps, drivers, and controllers shall be UL listed for their intended class of service.

A-6.20.15 Centrifugal Pumps (Horizontal & Vertical):

A-6.20.15.1. 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 pumps 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 suppliers may utilize standard coupling designs for centrifugal pumps.

A-6.20.15.2. Minimum flow/recirculation lines from a pump's discharge to a pump suction line are not acceptable for centrifugal pumps.

A-6.20.15.3. 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-6.20.15.4. 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-6.20.15.5. 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-6.20.15.6. 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-6.20.15.7. 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-6.20.15.8. Additional pump requirements are included in the condensate system, feedwater system, and cooling water system attachments.

A-6.20.15.9. Shop Testing (BFP, Condensate, Cooling Water, all Fire Protection Pumps, Demineralized Water Pumps, and Service Water Pumps):

A-6.20.15.9.a. All pumps shall be subjected to a hydrostatic pressure test in accordance with HI Standards, or NFPA for fire protection system pumps.

A-6.20.15.9.b. A shop performance test with tolerances per ANSI/HI 14.6 Grade 1U shall be performed.

A-6.20.15.9.c. An NPSHR test, vibration test and sound level test shall be performed with the shop performance test.

A-6.20.15.9.d. The shop performance test of developed head, efficiency, brake horsepower and NPSHR vs. flow shall be performed at design operating speed.

A-6.20.15.9.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-6.20.15.9.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-6.20.15.9.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 the Owner.

A-6.20.15.9.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-6.20.15.9.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-6.20.16 Positive Displacement Pumps:

A-6.20.16.1. All positive displacement pumps shall be of the horizontal screw, piston, or gear type.

A-6.20.16.2. 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-6.20.16.3. 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-6.20.16.4. Unless specified otherwise, mechanical seals shall be used exclusively. Ample space shall be provided for seal maintenance.

A-6.21 INSTRUMENT AND SERVICE (COMPRESSED) AIR SYSTEMS

A-6.21.1 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-6.21.2 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-6.21.2.1. 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-6.21.2.2. 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 -40ºF. A dewpoint meter shall be provided with each dryer including local indication and DCS signal.

A-6.21.3 An air receiver shall be provided for combined instrument and service air system. The air receiver shall be designed per ASME B&PVC Attachment 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 switchovers, 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-6.21.3.1. One (1) x 100% air receiver shall be provided for the Instrument Air/Service Air System with 1,550-gallon capacity (minimum).

A-6.21.3.2. Additional remote receivers shall be provided, if required, to reduce air compressor loading due to sudden large air demands.

A-6.21.4 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 Owner.

A-6.21.5 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-6.21.6 Air shutoff valves shall be provided at each compressed air user.

A-6.21.6.1. 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-6.21.7 Header branch lines shall be taken off from the top of the air header. Minimum branch line size is ½”.

A-6.21.8 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-6.21.9 Redundant pneumatic devices shall be piped to the air header with separate branch lines.

A-6.21.10 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. The 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-6.22 AMMONIA SYSTEM

A-6.22.1 Ammonia supplied to the HRSG SCR system shall be from the Seller supplied and installed 29% aqueous ammonia storage facility.

A-6.22.2 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-6.22.3 The ammonia storage tank(s) containment walls shall be 45" or less in height (therefore does not require confined space classification).

A-6.22.4 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-6.22.5 Ammonia leak detection system shall be provided at locations mutually agreed with the Owner.

A-6.22.6 Ammonia storage tank shall be designed to prevent venting of ammonia.

A-6.23 BULK GAS SYSTEMS

A-6.23.1 Nitrogen Gas

A-6.23.1.1. 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-6.23.1.2. 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-6.23.1.3. Flexible hoses shall be of a non-degradable material and U/V resistant.

A-6.23.1.4. Seller shall determine the quantity of nitrogen gas and the amount of storage area required.

A-6.23.1.5. Nitrogen gas bottles will be provided by the Owner after Substantial Completion.

A-6.23.2 Hydrogen and Carbon Dioxide Gas

A-6.23.2.1. Gas Storage:

A-6.23.2.1.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-6.23.2.1.b. Refer to Attachment A.6.19 for Tanks and Pressure Vessels requirements.

A-6.23.2.2. Seller shall provide equipment, piping, instrumentation, and valving (including relief valves and control valves), to accommodate interconnection between Owner supplied bulk storage equipment and the STG and CTG interfaces.

A-6.23.2.3. Each system shall utilize double block and bleed valves and removable spool pieces upstream of the CTG and STG manufacturer piping interface points.

A-6.23.2.4. Each system shall utilize total flow meters to monitor and record gas usage. These instruments shall be tied into the Facility DCS.

A-6.23.2.5. Hydrogen System Design Criteria:

A-6.23.2.5.a. Pressure shall be as required by the CTG(s) and the STG, per the respective manufacturer's requirements.

A-6.23.2.5.b. Flow shall be as required to purge and fill the CTG(s) and the STG, 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-6.23.2.5.c. Volume shall be as required to supply one (1) complete purge and fill quantity, at a minimum, for the CTG(s) and the STG, per the respective manufacturer's requirements.

A-6.23.2.5.d. Owner shall supply one (1) hydrogen tube trailer.

A-6.23.2.6. Carbon Dioxide System Design Criteria:

A-6.23.2.6.a. Pressure shall be as required by the CTG(s) and the STG, per the respective manufacturer's requirements.

A-6.23.2.6.b. Flow shall be as required to purge the CTG(s) and the STG, per the respective manufacturer's requirements. System shall be capable of simultaneous flow to the CTG(s) and the STG.

A-6.23.2.6.c. Volume shall be as required to supply two (2) complete purge quantities for the CTG(s) and the STG, per the respective manufacturer's requirements.

A-6.23.2.6.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-6.24 POTABLE WATER

A-6.24.1 Seller shall tie into the potable water line at the location identified in Attachment A.11 The Seller shall provide the hardware required to make the permanent connection. 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-6.24.2 The potable water system shall comply with local plumbing codes. Seller shall coordinate with local municipality for making the potable water connection if municipal water is used.

A-6.24.3 Anti-scald, tepid water and freeze protection provisions shall be included in the system design.

A-6.24.4 Eyewash and/or shower station shall be provided as follows:

A-6.24.4.1. Each eyewash and shower shall be provided with a flow switch and alarm indication in the BOP DCS when the system is used.

A-6.24.4.2. Design, quantity, location and accessibility of safety showers and eyewashes shall comply with ANSI Z358.1 and OSHA safety requirements.

A-6.24.4.3. 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
- 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-6.25 HEATING, VENTILATION, AND AIR CONDITIONING

A-6.25.1 All buildings shall be provided with electrical heating, ventilation and/or air conditioning systems (HVAC) as specified herein. The Seller shall be responsible for the complete engineering and design of the HVAC systems, in accordance with ASHRAE, other relevant standards and local jurisdictions.

A-6.25.2 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 and shall be N-1 redundant. Each individual room/area or unit shall be complete with dedicated controls that can be adjusted by the room users.

A-6.25.2.1. Control system(s) shall be redundant to eliminate single points of failure.

A-6.25.3 Explosion resistant construction and appropriate ventilation shall be used in all battery rooms where hydrogen may be developed or released.

A-6.25.4 Refer to the site design criteria in Attachment A-4, 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-6.26 PIPING

A-6.26.1 In general, and unless specified otherwise, the design of all pipes, bends and fittings shall comply with ASME B&PVC, Attachment I, or ASME B31.1, as applicable.

A-6.26.2 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 Owner for resolution:

ASME Attachment I
ASME B31.1 - 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-6.26.3 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 Owner 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-6.26.4 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 Owner for record.

A-6.26.5 Engineering and design of piping systems shall account for field pressure testing requirements.

A-6.26.6 Threaded pipe connections are only permitted on drains that are atmospheric at both ends such as pump base plate drains, silencer drains, etc.

A-6.26.7 Victaulic Grooved Pipe may be used at Sellers discretion for a pressure class of 150, low temperature water service.

A-6.26.8 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)
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)
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-6.26.9 Pump suction piping velocity shall not exceed 4 fps if there is suction lift.

A-6.26.10 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 Potable Water Piping	2”
Underground Fire Protection Piping	Refer to Fire Protection Design Criteria
Underground Drain Line Headers	4”

Application	Minimum Nominal Pipe Size
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-6.26.11 Piping and Instrumentation Diagrams (P&IDs):

A-6.26.11.1. 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-6.26.11.2. Maximum operating and design, temperature, and pressure conditions shall be defined on the P&IDs.

A-6.26.11.3. All valves including instrument root valves, regardless of size, shall be shown on the P&IDs.

A-6.26.11.4. To the greatest extent possible, the P&ID shall depict the actual physical system installation.

A-6.26.12 Pipeline List and Documentation:

A-6.26.12.1. 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-6.26.12.2. The material requirements for each pipeline class specification shall be further defined on Piping Class Sheets.

A-6.26.12.2.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-6.26.12.3. The Pipeline List and Piping Class Sheets (BOP only) shall be regularly submitted to the Owner, as engineering and design progresses, for review and ultimately submitted for record upon completion of the project.

A-6.26.13 Pipe Isometric Drawings:

A-6.26.13.1. Drawings shall include bills of materials and specific design requirements.

A-6.26.13.2. Drawings shall incorporate any and all necessary equipment interfaces.

A-6.26.13.3. Locations, types, and tags of pipe supports shall be incorporated with piping isometric drawings.

A-6.26.13.4. Vents and drains shall be included and shown.

A-6.26.14 Pipe Support Drawings:

A-6.26.14.1. Drawings shall locate each engineered hanger and include support details for all piping.

A-6.26.14.2. Composite drawings with bills of materials and specific design requirements of each type of support shall be submitted to the Owner.

A-6.26.15 Design Pressure:

A-6.26.15.1. The piping system design pressure shall equal the design pressure of its associated equipment with allowance for static head and friction loss.

A-6.26.15.2. 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-6.26.15.3. 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-6.26.15.4. 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-6.26.16 Design Temperature:

A-6.26.16.1. The piping system design temperature shall equal the most severe temperature condition expected during normal and/or upset operating conditions plus additional margin of 10ºF (5ºF for steam piping systems).

A-6.26.17 Stress Analysis and Support:

A-6.26.17.1. Stress analysis shall be performed on those piping systems required by code and standard engineering practices. This analysis shall include temperature conditions over 300ºF and dead weight load conditions, as well as wind and other occasional loading, as required.

A-6.26.17.2. 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-6.26.17.3. Calculations of thermal expansion shall be based on an ambient temperature of 70ºF.

A-6.26.17.4. Expansion bends or loops shall be provided where required for thermal expansion.

A-6.26.17.5. 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-6.26.17.6. Design of pipe supports shall consider the design pressure, weight, operating temperature, and fluid dynamic loads.

A-6.26.17.7. Design of all supports for steam piping shall account for hydrostatic test loads.

A-6.26.17.8. 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-6.26.17.9. Insulated piping shall include the insulation weight when calculating dead load.

A-6.26.17.10. Piping shall be adequately supported throughout the various operating conditions (cold through hot), with no noticeable sagging between supports.

A-6.26.17.11. Seller is allowed to use B-line type material (uni-strut type material is not allowed) to support cold small bore piping systems.

A-6.26.18 Pipe Schedule and Wall Thickness:

A-6.26.18.1. Pipe wall thickness shall be dictated by ASME B31.1.

A-6.26.18.2. 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-6.26.18.3. The ASTM manufacturing tolerances shall be subtracted from the nominal thickness when calculating minimum wall thickness.

A-6.26.18.4. 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-6.26.19 Pipe Sloping:

A-6.26.19.1. 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-6.26.20 Piping Materials:

Service / Piping System	Material	
	Aboveground	**Underground**
Ammonia	ASTM A 312 Grade TP 304	HDPE
Auxiliary Steam	ASTM Al06 Grade B	N/A
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

Service / Piping System	Material	
	Aboveground	Underground
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 Al06 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 Al06 Grade B	ASTM Al06 Grade B
Instrument Air Tubing	ASTM A312 Grade TP316	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
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

Service / Piping System	Material	
	Aboveground	Underground
Raw Water	ASTM A106 Grade B	HDPE

A-6.26.20.1. Plastic PVC/CPVC piping is prohibited. Some applications may consider this pipe material but only with Owner approval and based on technical justification including QA/QC provisions.

A-6.26.20.2. Press-fit piping materials, including fittings and components, are prohibited.

A-6.26.21 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-6.26.22 Critical Piping:

A-6.26.22.1. 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-6.26.22.2. Positive material identification is required for all alloy pipe, flanges, and fittings.

A-6.26.23 Fuel Gas Piping

A-6.26.23.1. 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-6.26.23.2. The piping shall include spool pieces at each end and appropriate bending radius to accommodate pigging.

A-6.26.23.3. Piping shall include connections for chromatographic gas analysis.

A-6.26.23.4. Electrical potential test stations are to be installed along the underground pipeline route.

A-6.26.23.5. 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-6.26.24 Branch Connections:

A-6.26.24.1. The use of direct pipe insertion (branch to run) connections on any steam or feedwater lines is prohibited.

A-6.26.25 Pipe Sleeves:

A-6.26.25.1. 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-6.26.26 Dissimilar Metal Joints:

A-6.26.26.1. 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-6.26.27 Vents and Drains:

A-6.26.27.1. 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 the Owner.

A-6.26.27.2. 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-6.26.27.3. 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-6.26.27.4. Skid mounted drains and vents shall be provided with the equipment, as required, including isolation valves.

A-6.26.27.5. The CTG water wash system drains shall be drained directly to a dedicated sump.

A-6.26.27.6. Vents and drains shall be provided with isolation valves.

A-6.26.27.7. Drain connections shall be provided near all control valves, between the inlet isolation valve and the control valve.

A-6.26.27.8. 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-6.26.27.9. 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-6.26.27.10. Vents shall feature rain caps, except in high point locations. The owner shall review and approve vent cap locations.

A-6.26.28 Sample and Test Connections:

A-6.26.28.1. All lube oil sampling locations shall be confirmed by the Owner.

A-6.26.28.2. 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-6.26.29 Root Connections:

A-6.26.29.1. Root connections on horizontal or sloping lines shall not be located below the center of the line.

A-6.26.29.2. The following root connection guidelines shall also be observed:

A-6.26.29.2.a. Connections for service on steam and condensable vapors or wet gas shall be taken from the top or side of pipe.

A-6.26.29.2.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-6.26.29.2.c. Connections for service on dry gases shall be taken from top of pipe.

A-6.26.30 Fabrication and Installation:

A-6.26.30.1. 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-6.26.30.2. All piping, valves and other mechanical components shall be new and clean.

A-6.26.30.3. General Piping Requirements:

A-6.26.30.3.a. Piping shall be installed in a neat and workmanlike manner while maintaining cleanliness requirements (in the shop and field).

A-6.26.30.3.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-6.26.30.3.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-6.26.30.3.d. All high-pressure drainpipes 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-6.26.30.3.e. All drainpipes 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 or ACC condensate collection tank. All drainpipes shall be free draining towards the discharge ends and freeze protected if not free draining. Headers or manifolds for drainpipes are only allowed where the drain connections are at a blowdown tank or ACC Condensate collection tank.

A-6.26.30.3.f. Jointing of High-Pressure Steam, Feedwater, Drain and Blowdown Piping:

A-6.26.30.3.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 welded 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-6.26.30.3.g. Steam, Water, Drain and Air Services:

A-6.26.30.3.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 Owner.

A-6.26.30.3.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-6.26.30.3.i. Oil and Gas Services:

A-6.26.30.3.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-6.26.30.3.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-6.26.30.3.k. Final installation of piping systems shall satisfy the clearance requirements herein.

A-6.26.30.3.l. Drain piping, including instrument tubing, shall be properly installed to ensure drainage, where applicable.

A-6.26.30.3.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-6.26.30.3.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. The Seller shall tighten valve stuffing boxes or replace packing, as required, to correct leaks during testing.

A-6.26.30.3.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-6.26.30.3.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-6.26.30.3.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 Owner, prior commencing of cleaning. For limited Attachments 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-6.26.30.3.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-6.26.30.4. Welding:

A-6.26.30.4.a. Welding of piping shall be in accordance with the applicable requirements of the governing codes, drawings, and supplements.

A-6.26.30.4.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-6.26.30.4.c. Qualification of welding procedures to be used and qualification of welders and welding operators shall comply with the latest requirements of Attachment IX of ASME B&PVC and ASME B31.1.

A-6.26.30.4.d. Seller shall conduct the tests required to qualify his welding procedures and shall conduct performance qualifications of welders and welding operators who apply these procedures. All performance qualifications shall be conducted on-site unless otherwise approved by the Owner. Procedures or qualification of procedures or welders by organizations other than the Seller is not acceptable.

A-6.26.30.4.e. Welding procedures shall identify appropriate qualification code and the corresponding construction code for all work.

A-6.26.30.4.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-6.26.30.4.g. Each welder/welding operator shall be qualified by the Seller. WPQ certified by Seller shall not be acceptable.

A-6.26.30.4.h. Alternate Welding Processes: Alternate welding procedures will be considered if complete WPS and PQR are approved by the Owner.

A-6.26.30.4.i. For field welds, the root pass and one fill pass shall be made with the Gas Metal Arc Welding (GMAW) process.

A-6.26.30.4.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-6.26.30.4.k. All temporary welded attachments shall be removed so as to not damage base material.

A-6.26.30.4.l. Temporary welded attachments shall be removed, and surface inspections performed using MT or PT in the affected area.

A-6.26.30.4.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-6.26.30.4.n. Purge will be performed where required by qualified welding procedures.

A-6.26.30.5. Inspection and Testing:

A-6.26.30.5.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-6.26.30.5.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 Owner 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-6.26.30.5.c. The following systems shall be pneumatically tested in accordance with ASME B31.1:

- Lube Oil

A-6.26.30.5.d. Upon Owner 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-6.26.30.5.e. Leak testing of HDPE pipe shall be in accordance with ASTM F2164.

A-6.26.31 Underground Piping:

A-6.26.31.1. Special consideration shall be given to the 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-6.26.31.2. 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 Attachment A-07 for additional cathodic protection system requirements.

A-6.26.31.3. Gravity drains slopes and turns shall be properly designed and routed.

A-6.26.31.4. 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-6.26.31.5. 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-6.26.31.6. 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 of similar device.

A-6.26.31.7. 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-6.26.31.8. Underground Piping Materials:

A-6.26.31.8.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-6.26.31.8.b. Drain lines may consist of cast iron, ductile iron, or HDPE.

A-6.26.31.8.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 Owner approval and based on technical justification including QA/QC provisions. If PVC/CPVC is approved by the Owner, the material shall be in accordance with ASTM D1784 and ASTM D2664.

A-6.26.31.1. 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-6.27 PIPE SUPPORTS

A-6.27.1 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-6.27.2 Pipe supports shall be designed in accordance with ASME B31.1, AISC and MSS code requirements.

A-6.27.3 Construction materials of pipe supports including guides, restraints and anchors shall be in accordance with ASME B31.1.

A-6.27.4 Pipe support materials shall include corrosion protection.

A-6.27.5 All clips, lugs, plates, saddles, etc. welded to piping shall be of the same material as the piping to which they connect.

A-6.27.6 Areas subject to sliding conditions between piping and supports shall feature a sacrificial material to protect against wear.

A-6.28 INSULATION

A-6.28.1 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-6.28.2 Insulation shall be provided, as required on hot surfaces, to limit the outside lagging surface temperature to 140ºF or less at all operating conditions and site max ambient temperature (based on 3 mph wind speed).

A-6.28.3 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-6.28.3.1. Anti-sweat insulation shall be applied where minimum operating fluid temperature is anticipated to be 60°F or below.

A-6.28.3.2. Protrusions or attachments shall be insulated for a minimum of 12" from the surface of the pipe / equipment insulation.

A-6.28.4 Insulation Materials:

A-6.28.4.1. 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-6.28.4.2. Mineral Wool and E-Glass Fiber (ESLIN or equivalent) insulation materials are acceptable for all but HRSG and anti-sweat applications, as follows:

A-6.28.4.2.a. BOP systems: Mineral Wool for temperatures up to and including 350°F (ASTM C547 Type I)

A-6.28.4.2.b. BOP systems: E-Glass Fiber for temperatures greater than 350°F

A-6.28.4.2.c. Major Equipment supplier systems: Mineral Fiber (ASTM C547 Type II Gr. A) for piping up to 1200°F.

A-6.28.4.2.d. Major Equipment supplier systems: High Temperature Fiber Blankets (ASTM C892 Type III Gr. 12) for temperatures above 1200°F

A-6.28.4.3. 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-6.28.4.4. 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-6.28.5 Lagging Material and Thickness:

A-6.28.5.1. Ductwork, Breaching, Drums, and field erected tanks: 0.036” embossed, box ribbed aluminum, weather-proofed appropriately.

A-6.28.5.2. Piping and Equipment: 0.016” embossed aluminum

A-6.28.5.3. Valves and Fittings: 0.016” embossed aluminum

A-6.28.5.4. Anti-sweat insulation: Metal jacket (OEM Armacell approved or technically equivalent)

A-6.28.6 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 suppliers may utilize their standard insulation designs.

A-6.28.7 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-6.28.8 In addition to the specified insulation, personnel protection insulation shall be provided for the following:

A-6.28.8.1. 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-6.28.8.2. Alternately, OSHA compliant personnel protection via shields may be utilized but only with Owner approval.

A-6.28.8.3. 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 steam traps.

A-6.28.9 Freeze Prevention:

A-6.28.9.1. All outdoor piping and equipment subject to freezing shall be provided with freeze protection including insulation and heat tracing.

A-6.28.9.1.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-6.28.9.1.b. Time to freeze evaluation shall consider a maximum of 25% of pipe cross section freezing, and a 20-mph wind.

A-6.28.9.2. All outdoor instruments sensing tubing shall be heat traced and insulated.

A-6.28.9.3. 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-6.28.9.4. 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-6.28.9.5. 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-6.28.9.6. Refer to Attachment A-7, Electrical Design Criteria for additional heat tracing design conditions and requirements.

A-6.28.9.7. Insulation and lagging shall extend 12 inches below grade at all ground penetrations.

A-6.28.10 Fire Protection Freeze Prevention:

A-6.28.10.1. Where subject to potential freezing conditions, Dry Pipe fire protection water systems shall be used.

A-6.28.10.2. 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-6.29 VALVES (EXCLUDES STEAM TURBINE STOP & GOVERNOR VALVES)

A-6.29.1 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-6.29.2 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 valve bodies shall be of forged material in sizes 2" and smaller. Steel valve bodies 2½" and larger may be forged or cast. Cast iron body valves may only be used for wastewater systems.

A-6.29.3 A coating shall be applied to carbon steel valves to protect against corrosion.

A-6.29.4 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 200ºF or pressures greater than 500 psig, For contract purposes, double block and bleed valves for the Project are based on an assessment of Buyer requirements considering the final design configuration.

A-6.29.5 For systems with conditions less than 300°F temperature and class 300 rating:

A-6.29.5.1. High performance butterfly valves are preferred for large-bore piping systems (> 2" NPS)

A-6.29.5.2. Ball valves are preferred for small-bore piping (≤ 2" NPS), including drains.

A-6.29.5.3. For systems with higher operating conditions, gate valves shall be used for isolation and drain connections. Major Equipment suppliers may utilize globe valves per their standard design.

A-6.29.6 Globe valves shall be used for vents and where flow throttling is required.

A-6.29.7 Bypass valves shall not be installed around trip valves that close to protect equipment or prevent a hazardous situation.

A-6.29.8 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-6.29.9 All gate valves greater than 2” nominal diameter shall be of the full-port gate type and when in the fully open position, the bore of the valve shall not be obstructed by any part of the gate.

A-6.29.10 With the exception of control valves, valves shall match their respective pipeline size (except for applications requiring a different size).

A-6.29.11 Check valves may be smaller than their pipeline size contingent upon acceptable system hydraulic calculations (by Seller), to ensure proper functionality.

A-6.29.11.1. 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. The 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-6.29.12 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-6.29.13 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-6.29.14 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-6.29.15 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-6.29.16 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-6.29.17 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-6.29.18 Ductile iron material shall be limited to a system design pressure of 350 psig and a design temperature of 400°F.

A-6.29.19 Bronze and brass materials shall be limited to a system design pressure of 350 psig and a design temperature of 200°F.

A-6.29.20 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. The 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-6.29.21 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-6.29.22 Valves shall be fitted with limit switches where required for interlocking purposes.

A-6.29.23 Valves shall feature handwheel extensions and other special features, as required, to allow for valve operability by Facility personnel.

A-6.29.24 Valves utilized for containment drains shall feature locking capability as well as post indicators to check valve position.

A-6.29.25 Valves for HP Steam, Feed water, Drain and Other High Pressure, High Temperature Services:

A-6.29.25.1. 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 with covers and glands of approved construction.

A-6.29.25.2. 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-6.29.25.3. 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 owner.

A-6.29.26 Valves for LP Steam, Water, Drain and Air Services:

A-6.29.26.1. 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 forged steel or cast-iron bodies; valves of 2-inch nominal bore and under shall have bodies of 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-6.29.27 Valves for Fuel Gas Services:

A-6.29.27.1. 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 suppliers may supply valves per their standard design.

A-6.29.27.2. 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 suppliers 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-6.29.27.3. 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-6.29.27.4. No aluminum or zinc alloys or similar low melting material shall be included in their construction.

A-6.29.27.5. 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 suppliers may supply valves per their standard design.

A-6.29.27.6. All valves shall incorporate sliding sealing surfaces such that further movement of the closing part is provided after gas shut-off.

A-6.29.27.7. All valves shall provide reliable tight shut-off and be capable of easy operation after long periods in one position.

A-6.29.27.8. 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-6.29.28 Valves for Oil Services:

A-6.29.28.1. 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-6.29.29 Safety and Relief Valves:

A-6.29.29.1. Safety and relief valves shall be provided on all pressure vessels where required by ASME B&PVC, Attachment I or Attachment 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-6.29.29.2. 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-6.29.29.3. All safety and relief valve types shall be direct, spring-loaded angle body with flanged inlet and outlet piping interfaces, unless specified otherwise.

A-6.29.29.4. 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-6.29.29.5. Water or oil valve type shall be liquid relief with slow action opening / closing.

A-6.29.29.6. 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-6.29.29.7. 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-6.29.29.8. Isolating valves shall not be installed on either the inlet nor outlet of safety valve piping.

A-6.29.29.9. 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-6.29.30 Pressure Reducing Valves and Control Valves:

A-6.29.30.1. 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-6.29.30.2. 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-6.29.30.3. 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-6.29.30.4. 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-6.29.30.5. Control valves shall be pneumatic, hydraulically, or motor operated modulating valves. On/off service valves shall be pneumatic, hydraulic, or motor-operated.

A-6.29.30.6. 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-6.29.30.7. 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-6.29.30.8. Self-actuated regulators may be used for local control in services where a variation above or below the set point is not objectionable.

A-6.29.30.9. 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-6.29.30.10. All integrally mounted instrumentation (positioners, regulators, etc.) shall be designed to operate with an air pressure range between 80 psig and 125 psig.

A-6.29.30.11. 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-6.29.30.12. 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-6.29.30.13. Steam turbine bypass control valves shall be designed as a combination modulating and stop valve.

A-6.29.30.14. Cast iron bodies for control valves are prohibited.

A-6.29.30.15. Block and bypass valves shall be provided around control valves only when:

A-6.29.30.15.a. Maintenance of the valve would prevent Facility operation.

A-6.29.30.15.b. Valve failure would require Facility shutdown.

A-6.29.30.16. 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-6.29.31 Vent Valves:

A-6.29.31.1. 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-6.29.32 Valve Operators:

A-6.29.32.1. 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-6.29.32.2. 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-6.29.32.3. Seller shall comply with the following guideline for providing powered or manual valve operators:

A-6.29.32.3.a. Maintenance isolation valves shall have manual operators.

A-6.29.32.3.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-6.29.32.3.c. Valves (other than check valves) that are required to change position to perform an automatic safety function shall be power operated.

A-6.29.32.4. 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-6.29.32.5. Air operated, double acting valves shall include manual override, air cylinder bypass capability (i.e., handwheel, lever, jacking pump), for manual operation.

A-6.29.32.6. Motor operators shall be provided for valves requiring tight shut off and for automatic valves where instrument air is not available.

A-6.29.32.7. 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-6.29.32.8. 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-6.29.33 Valve Mounted Accessories

A-6.29.33.1. 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-6.29.33.2. 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-6.29.33.3. 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-6.29.34 Fire Protection System Valves:

A-6.29.34.1. Valve design, materials and classification specified by the applicable NFPA standard and shall include UL Listing for their intended service class.

A-6.30 PAINTING / COATING

A-6.30.1 Engineered Equipment shall be supplied with Vendors standard paint system, finish paint touch-up shall be provided by Seller / Vendor.

A-6.30.2 Painting of safety signs, labels, and tags, as well as identification and location of fire extinguishers, first aid kits, traffic aisleways and trip hazards, shall comply with ANSI/NEMA Z535.1 for safety colors.

A-6.30.3 Piping:

A-6.30.3.1. Unless indicated otherwise, piping shall be color coded per the table below.

SERVICE	COLOR	FEDERAL COLOR CODE
FIRE PROTECTION SYSTEM	SAFETY RED	21105
CARBON DIOXIDE-CO2, NITROGEN	SAFETY ORANGE	22544
FUEL GAS and HYDROGEN	SAFETY YELLOW	23655
OIL	SAFETY BROWN	33434
POTABLE, COOLING, BOILER FEED, CONDENSATE, AND OTHER WATER	SAFETY GREEN	34090
STEAM	CRIMSON RED	30076
COMPRESSED AIR	SAFETY BLUE	35180
PROCESS WATER TREATING CHEMICALS	SAFETY PURPLE	37100
PLANT USAGE (Note 1)	SAFETY WHITE	37925
PLANT SERVICE WATER	SAFETY GRAY	36173
AQUEOUS NH3>19%	SAFETY WHITE	37925

A-6.30.3.2. 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-6.30.4 Aluminum lagging and insulation covering shall not be painted.

A-6.30.5 Dangerous parts of equipment or energized equipment as defined in ANSI 253.1 shall be identified and coated Safety Yellow.

A-6.30.6 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-6.30.7 Attachment A-23 contains additional painting / coating requirements for the Fire Protection System.

A-6.31 PROTECTION FOR SHIPMENT

A-6.31.1 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 ATTACHMENT A-6

BOT Scope Book
Attachment A-7
Electrical Requirements and Design Criteria

Table of Contents

A-7.1 ELECTRICAL SYSTEMS AND EQUIPMENT

A-7.1.1 This Attachment 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-7.1.2 In general, the electrical systems and equipment described in this Attachment 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-7.1.3 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-7.1.4 The failure of any single major piece of electrical equipment, with the exception of the Generator Step-Up (GSU) Transformer, Generator Breakers, Isolated Phase Bus Duct, and disconnect switches shall not cause a loaded generator to trip.

A-7.1.5 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 Buyers power grid.

A-7.1.6 Plant auxiliary electrical system shall automatically switch between the normal auxiliary source and the backup or secondary source without relying on operator action to maintaining the Unit online. Buses required for safe shutdown shall automatically energize without operator action to transfer or energize buses or loads.

A-7.1.7 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-7.1.8 The electrical design criteria shall be used by the Seller during the procurement of all sub-specifications to avoid different subcontractors receiving different electrical requirements.

A-7.1.9 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-7.1.1 Vendor supplied equipment is delivered on site and instruments are pre calibrated at factory and calibration records shall be provided.

A-7.2 HAZARDOUS AREA CLASSIFICATION

A-7.2.1 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-7.2.2 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-7.3 GENERATION SYSTEM

A-7.3.1 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-7.3.2 Seller to provide power and communication to Combustion Turbine and Steam Turbine Remote Monitoring Systems.

A-7.3.3 Generators

A-7.3.3.1. The generator for the combustion turbine and steam turbine will be in accordance with the enclosed combustion and steam turbine generator specifications, Attachments A.17 and A.19 respectively.

A-7.3.3.2. Generator voltage shall be OEM standard.

A-7.3.4 The combustion turbine generator shall have the ability to automatically operate in Island Mode. CTG separation from the grid and activation of Island Mode shall be on an Buyer approved element set in the relaying scheme of the operating Facility without operator intervention. 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).

A-7.3.5 The STG will trip during an islanding event based on its standard relay settings which shall conform to the grid code requirements. As a result of the STG trip, the process systems required (e.g., Steam Bypass system, ACC, etc.) for the islanded Heat Recovery Steam Generator (HRSG) to dump steam to the condenser will continue to operate.

A-7.3.6 Grid Interconnect Standards Requirements:

A-7.3.6.1. Seller shall meet all NERC requirements 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-7.3.7 In Islanding Mode operation, the CTG will automatically maintain frequency at 60Hz by the CT controller. Any change in load altering the islanding CTG's frequency shall be compensated for by the control unit.

A-7.3.8 Once the transmission grid has been restored after unit Islanding, the Operators will re synchronize the unit to the grid using normal procedure and synch controls in the CTG control system.

A-7.4 HIGH VOLTAGE SYSTEM

A-7.4.1 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 Attachments of this specification.

A-7.4.2 High Voltage System:

Facility HV system consists of the below equipment provided by the Seller:

- Potential Transformers (PT) and Current Transformers (CT) accuracy shall meet ANSI C12.1 metering accuracy for use with Buyers revenue metering.
- Surge Arrestors
- Gas Insulated Circuit breakers
- Current transformers (CT)
- HV motor disconnects and grounding switches on both sides of the breaker.
- Dead End Structures – For each generator, including structure foundation and installation for GSUs to Transmission Line Tower connections.
- Buyer provided RTU cabinet and revenue meters to be installed in the Main PDC

A-7.4.3 Seller's scope for the HV conductors and OPGW wire will end at the Seller supplied Dead End structures. Seller shall be responsible for the procurement, installation, and termination of the HV conductors from the Dead-End structures, to the disconnect switches, HV circuit breakers and GSU HV bushings and all PTs and CTs.

A-7.4.4 The Seller's Facility protection system design engineer shall interface with the Buyer's Transmission to ensure that selective coordination and inter-trips are NERC compliant.

A-7.4.5 At the time of Facility design, Seller shall obtain current transmission system planning data with respect to transmission system capacity.

A-7.4.6 High voltage breakers ratings shall provide capacities including maximum fault currents (single line to ground or 3-phase to ground as applicable), X/R rations, and system maximum MVA and Thevenin impedances. Breaker shall include design margin.

A-7.4.7 Grounding Disconnect switches shall be provide on both the upstream and downstream side of the HV breakers.

A-7.4.8 PTs and CTs to be provided by Seller for all protection and control including for Buyer's 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-7.4.8.1. 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 Buyer. The Seller shall also be responsible for Facility side line protection relay settings and will coordinate with Buyer 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-7.4.8.2. Line protection relays shall, at a minimum, display voltage and current reading on the HV transmission lines.

A-7.5 ISOLATED PHASE BUS DUCT

A-7.5.1 It shall be the responsibility of the Seller to design, manufacture, test, deliver, and install isolated phase bus duct (IPBD) for each generator, as described below.

A-7.5.2 IPBD shall be provided between the generator and generator breaker for both the combustion and steam turbine generator units and between the generator's breaker and the GSUs. A section of tap bus shall be provided to connect each UAT. Removable links shall be provided in the tee-off connections to the UATs to allow continued operation of the associated generator in the event that a UAT is required to be out of service for maintenance. The disconnect links shall preferably be arranged so that they may be used for grounding the UAT side of the connections and the arrangement shall incorporate barriers to prevent access to the live connections after the transformer has been disconnected and the generator returned to service. The links shall be arranged so that the main relay protection can be retained during an outage of the particular UAT. A section of tap bus shall also be provided, as required, for the generator excitation system and bus neutral grounding.

A-7.5.3 All generator IPBD 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-7.5.4 Each section of IPBD shall be self-cooled, isolated phase bus construction.

A-7.5.5 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-7.5.5.1. Isolated Phase Bus Duct (IPBD) General

A-7.5.5.1.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-7.5.5.1.b. The isolated phase bus duct shall interconnect the following Equipment:

- Turbine Generators (including the excitation transformer)
- Generator Circuit Breakers
- UATs

- GSU Transformers
- Excitation Transformers

A-7.5.5.1.c. 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, GCBs and GSUs.

A-7.5.5.1.d. 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-7.5.5.1.e. 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-7.5.5.1.f. The Steam Turbine Generator IPBD shall also be provided with IPBD taps to feed the VT/SA cubicle or UAT as required by Sellers proposed design.

A-7.6 GENERATOR STEP-UP TRANSFORMERS

A-7.6.1 Refer to Attachment A.21 GSU Transformer Specification.

A-7.7 GENERATOR CIRCUIT BREAKER

A-7.7.1 The generator circuit breaker (GCB) shall be SF_6 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 for each. Access to SF_6 gauges and lockout mechanisms, and control panels shall be on the same side of the generator circuit breakers.

A-7.7.2 GCBs shall be sized with a continuous rating which exceeds the maximum generator output current by a minimum 10% at all ambient conditions.

A-7.7.3 Tripping logic and control power circuit shall be independent with two redundant trip coils. GCBs shall each have its own independent breaker failure relay protection scheme.

A-7.7.4 GCBs shall be designed for operation within the TRV values for faults on either side of the breaker.

A-7.7.5 Disconnect and Ground Switches

A-7.7.5.1.a. Each 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-7.7.5.2. Grounding and disconnect switches shall be rated for both the continuous current rating and the short time rating of the installed system. Switches shall be interlocked to preclude energization with a ground switch closed.

A-7.8 UNIT AUXILIARY TRANSFORMERS (UATs)

A-7.8.1 The UAT 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-7.8.2 A minimum of two (2) UATs shall be installed for auxiliary power. In the case of a 2x1 CCGT the UATs shall be connected at the CTG IPBDs.

A-7.8.3 The transformers maximum rating shall be such that the loss of one auxiliary transformer shall not limit station generation capacity. Each UAT's rating shall include margin above the maximum Facility initial design requirement.

A-7.8.4 Each unit auxiliary transformer 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-7.8.5 The maximum (hottest spot) winding temperature rise above ambient temperature shall not exceed 80ºC 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 ºC in IEEE Std. C57.12.00.

A-7.8.6 UATs shall have +/-2 – 2 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-7.8.6.1. 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-7.8.7 Angular Displacement: The transformers shall have a standard phase relationship per IEEE Standard C57.116.

A-7.8.8 Impedance at the rated connections shall be based on the Seller's design base with an IEEE standard ± 7.5% design tolerance. BIL, sound level, and voltage connections shall be in accordance with ANSI, IEEE, and NEMA standards.

A-7.8.9 Control Devices and Small Wiring

A-7.8.10 Control relays, breakers, contactors, etc., shall be furnished in a NEMA 4 enclosures for outdoor cabinet.

A-7.8.11 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.

A-7.8.12 Short Circuit Capability

A-7.8.12.1. The transformers 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-7.8.12.1.a. Short circuit values shall be determined during design using ETAP analysis by the Seller.

A-7.8.12.2. 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-7.8.13 Thermal Connections and Bushings

A-7.8.13.1. 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-7.8.14 Bushing Current Transformers: The CT quantities and ratios shall be determined by Seller. Bushing 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 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-7.8.15 Project/Site Condition

A-7.8.15.1. Refer to Attachment A-4 – Project Requirements and Design Criteria

A-7.8.15.2. Transformers shall be suitable for outdoor location.

A-7.8.16 Each transformer shall be provided with the following accessories:

A-7.8.16.1. Winding temperature indicator

A-7.8.16.2. Surge Protection

A-7.8.16.3. Liquid temperature indicator

A-7.8.16.4. Seller shall provide dry contact outputs for alarm status to BOP DCS

A-7.8.16.5. Fiber Optic Temperature Monitoring Sensors

A-7.8.16.5.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-7.8.16.6. 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-7.8.16.7. 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-7.8.16.8. 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-7.8.16.9. 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-7.8.16.10. Transformers shall have online dissolved gas monitoring using a Vaisala OPT-100.

A-7.8.16.11. 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 Entergy shall be provided with the transformer.

A-7.8.17 Transformer Losses and Auxiliary Power Requirements

A-7.8.17.1. The load losses, efficiency and regulation shall be corrected to a reference temperature according to IEEE C57.12.00.

A-7.9 SYSTEM RELAYING

A-7.9.1 Generator Step Up transformer to Buyer 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 lines 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 Buyer regarding manufacturer type for relays and interface devices. Wiring from the existing switchyard circuit breakers to the existing switchyard differential relay panels shall be performed by Buyer.

A-7.9.2 Generator Protective Relaying

A-7.9.2.1. See Attachment A.17 and Attachment A.19.

A-7.9.3 Generator Bus and Transformer Protective Relaying

A-7.9.3.1. 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.

- Differential (87B)
- Neutral over voltage (59N)

A-7.9.4 Generator Step Up Transformer Protective Relaying

A-7.9.4.1. The following generator step up transformer relays and protection schemes shall be provided:

- Generator Step Up Transformer, generator breaker, and generator bus zone differential relaying.
- Fault pressure relaying, two devices with either device alarming, and two-out-of-two logic to trip
- Mechanical fault pressure relief device
- Lockout relay for generator step up transformer, generator bus, and unit auxiliary transformer trip.
- Transformer shall be protected by transformer differential relays, primary and backup. Primary relay shall be SEL 487 and backup shall be Beckwith M3311A.

A-7.9.5 Auxiliary System Relaying

A-7.9.5.1. The auxiliary system relaying design shall be based on C37.102 and included references.

A-7.9.5.2. The auxiliary system shall be protected as listed and described below:

- Unit auxiliary transformers shall be protected by transformer differential relays, primary and backup. Primary relay shall be SEL 487 and backup shall be Beckwith M3311A.

- Fault pressure relaying, with both alarm and trip
- Unit auxiliary transformers shall be low resistance grounded and provide alarm and trip
- Lockout relay for generator step up transformer, generator bus and unit auxiliary transformer trip
- Unit auxiliary transformers shall have instantaneous and over current protection, as well as differential protection
- Medium-voltage bus supply and tie breakers shall have over current relays.
- Bus transfer synchro-check relaying
- Medium-voltage bus differential
- Unit substation (load center) transformers shall be provided with differential protection.
- Motors greater than 3000 HP shall be provided with differential protection.

A-7.9.6 Lockout Relay Actions

A-7.9.6.1. 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 UATs shall also have independent lockout relays.

A-7.9.6.2. All protective relays shall be provided with external targets to show relay operation to assist operator in determining which relays have operated.

A-7.9.6.3. Protective relaying as described above not provided by generator OEM shall be installed in a protective relay panel(s) provided by Seller.

A-7.9.6.3.a. Protective Relay Panel General

A-7.9.6.3.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 Beckwith relays. 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-7.10 AUXILIARY POWER SYSTEM

A-7.10.1 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.
Essential Power –	480V ESS (high resistance grounded), 120 VAC UPS (grounded), 125 VDC (ungrounded)

A-7.10.2 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-7.10.3 The auxiliary power system shall be designed to accommodate a minimum 10% future load growth.

A-7.11 POWER DISTRIBUTION CENTER (PDC) BUILDINGS

A-7.11.1 Prefabricated PDC shall contain major electrical distribution equipment including but not limited to MV SWGR, LV SWGR, MCC, Operating Facility DCS cabinets, relay and metering cabinets, AC, DC, and UPS distribution systems at the approval of the Buyers requirements. PDCs shall also include:

- Fire Detection
- Redundant HVAC system (N-1)
- Dedicated climate-controlled battery room
- Interconnecting wire between internal components (coiled during shipping splits)
- Platform and stairways for all access and switchgear maintenance and access to all HVAC equipment located at the exterior of the PDC.
- Remote racking capabilities for LV and MV Switchgear (SWGR) breakers
- Sealed conduits top to bottom to prevent rodents from damaging equipment.
- Reserved space to accommodate two (2) 24”x36”x72” cabinets for Buyer’s locker storage
- Reserved space to permanently store all special tools for operating and testing of the equipment housed in the PDC
- Reserved space and floor/wall openings to accommodate the following: a) Seller provided cabinets - “RTU”, 36”x36”x96” and two “Revenue Metering Panel”, 36”x36”x96”, b) LAN Cabinets, c) Seller shall provide power and communication cabling and conduits to the reserved space.
- Redundant exhaust fans with fan running status switches located in Battery Room.

A-7.12 BALANCE OF PLANT NON-SEGREGATED PHASE BUS DUCT / CABLE BUS

A-7.12.1 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-7.12.2 Seller shall design, procure, test, deliver, and erect cable bus to interconnect the UATs with the 6900 V switchgear and the Standby Diesel Generator to the 480V Essential bus. 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-7.12.3 Space Heaters

A-7.12.3.1. Outdoor bus duct sections shall be furnished with space heaters to prevent condensation of moisture within the bus duct. Space heaters shall be thermostatically controlled.

A-7.12.3.2. 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-7.13 ARC FLASH

A-7.13.1 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-7.13.2 Maximum cal/cm sq for all MV Switchgear, MV MCC, and Low Voltage System equipment (MCCs, distribution panels, switchboards, panelboards, etc.) shall be less than 8 cal/cm sq. 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 accepted by Buyer. This requirement applies to BOP and OEM packaged equipment. Also, this requirement applies to all AC and DC systems with the exception of the battery terminals and main switchboard disconnect switch.

A-7.13.3 Arc flash analysis shall be performed using ETAP.

A-7.14 MEDIUM-VOLTAGE SYSTEM

A-7.14.1 Medium Voltage Requirements General

A-7.14.1.1. 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 two 3-winding Unit Auxiliary Transformers, and 6900-volt switchgear lineups supplied by the UATs.

A-7.14.1.2. 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-7.14.1.3. 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-7.14.2 Medium Voltage System Configuration

A-7.14.2.1. The Medium Voltage Switchgear and Medium Voltage MCC shall be hard coupled together. The medium-voltage system shall consist of a low resistance grounded system powered through Unit Auxiliary Transformers.

A-7.14.2.2. The medium-voltage system provides power to large motors and load center transformers. Relay protection shall be as specified in this Attachment. 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-7.14.3 Medium Voltage 6900V Switchgear and Motor Controllers

A-7.14.3.1. 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-7.14.3.2. 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-7.14.3.3. MV switchgear/MCC shall be utilized to feed motors greater than 250 HP, CTG starting system, and load center transformers.

A-7.14.3.4. 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-7.14.3.5. Equipment to 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-7.14.3.5.a. MV motor contactors shall be non-latching type with integrally mounted fuses.

A-7.14.3.5.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-7.14.3.5.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-7.14.3.5.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-7.14.3.5.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-7.14.3.5.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-7.14.3.5.b.5 All auxiliary switches shall be wired to a terminal board on the fixed portion of the switchgear.

A-7.14.3.5.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-7.14.3.5.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-7.14.3.5.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-7.14.3.5.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-7.14.3.5.b.10 The MV switchgear enclosure shall have Infra-Red (IR) inspection windows.

A-7.14.3.5.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 and main breaker for the bus differential protection.

A-7.15 LOW VOLTAGE 480 VOLT SYSTEM

A-7.15.1 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-7.15.2 The low-voltage system consists of a 480V high resistance grounded system powered from the 6.9 kV – 480V transformers.

A-7.16 480V SWITCHGEAR

A-7.16.1 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-7.16.2 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-7.16.3 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-7.16.4 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-7.16.5 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-7.16.6 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-7.16.7 Metering shall consist of a voltmeter and ammeter on each 480 V bus. Voltmeter and ammeter shall be monitored by DCS.

A-7.16.8 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-7.16.9 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.

A-7.16.10 The Switchgear main breakers shall include a pad lockable switch and blue LED Armed Status Indicating Light.

A-7.16.11 Seller shall provide a minimum of one spare breaker and one spare cubicle in each 480LV Switchgear lineup. 480V switchgear shall be capable of adding additional vertical sections.

A-7.16.12 Low Voltage 480 Volt System Protection

A-7.16.12.1. 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-7.16.12.2. The 480V system shall be a high resistance grounded. A ground detection scheme shall be provided to alarm when a ground fault is detected.

A-7.16.12.3. 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-7.16.13 Low Voltage Switchgear Transformers

A-7.16.13.1. 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-7.16.13.2. 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 (± 2 x 2.5%). Dry type transformers shall be designed for a 115 degrees C temperature rise and constructed with full capacity taps (± 2 x 2.5%).

A-7.16.13.3. The transformer windings and all bus material shall be copper.

A-7.16.13.4. 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-7.16.13.5. 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-7.16.13.6. 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-7.16.13.7. 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-7.16.13.8. 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 for Buyer's use.

A-7.16.13.9. 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-7.16.13.10. 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-7.16.13.11. 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-7.16.13.12. Instruments and Meters

A-7.16.13.12.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-7.16.13.12.b. Meter potential coils shall be 120-volt, 60 Hz. Meter current coils shall be 5 amperes.

A-7.16.13.12.c. Indicating meters shall be 1 percent accuracy, 4 –1/2-inch square switchboard type, with taut band suspension.

A-7.16.13.12.d. Equipment on each panel shall be arranged with a maximum amount of space allowed for possible future additions.

A-7.16.13.13. Instrument Transformers

A-7.16.13.13.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-7.16.13.13.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-7.16.13.13.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-7.16.13.13.d. The accuracy rating of current transformers shall be as shown in ANSI/IEEE Standard C37.20.1.

A-7.16.13.13.e. All instrument transformers shall be grounded directly to the ground bus, not to the housing.

A-7.17 480V MOTOR CONTROL CENTER (MCC)

A-7.17.1 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-7.17.2 Enclosures shall be NEMA 12 for indoor applications. All 480V MCCs shall be located indoors.

A-7.17.3 OEM provided distribution equipment (motor control centers) shall have a withstand rating of 65kAIC on the 480V main bus.

A-7.17.4 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-7.17.5 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.

A-7.17.6 The short circuit withstand capability of the combination of starters and circuit breakers shall equal or exceed 65,000 rms symmetrical amperes in accordance with UL508.

A-7.17.7 Space Heaters:

A-7.17.7.1. 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-7.17.7.2. Space heater capacity shall be as required to maintain the compartment and section internal temperature above the dewpoint.

A-7.17.8 Utility and lighting transformers or panels shall not be located within MCCs.

A-7.17.9 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-7.17.10 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-7.17.11 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-7.17.12 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-7.18 DISTRIBUTION PANELS

A-7.18.1 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-7.18.2 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-7.19 ESSENTIAL SERVICE AC AND DC SYSTEMS

A-7.19.1 General Requirements for Essential Service System

A-7.19.1.1. The Seller shall design, manufacture, test, deliver, and install an essential service AC and DC systems, as described below:

A-7.19.1.2. 480V AC Essential Bus (SWGR/MCC)

- 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 Shutdown loads for Turbines
- Battery Charger AC supply system
- UPS Supply – AC input

A-7.19.1.3. 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-7.19.2 UPS System

A-7.19.2.1. 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 Bus. UPS shall also provide power requirements for safe emergency shutdown.

A-7.19.2.2. 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-7.19.2.3. 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 UPS shall be 208/120V AC three phase sized to accommodate all loads with a 20% design margin. 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-7.20 DC SYSTEM

A-7.20.1 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-7.20.2 A DC system shall be supplied with each CTG sized to provide total DC power requirements of each individual turbine generator see Attachment A.17. The STG DC loads shall be powered from the common balance of plant Essential-Service DC System.

A-7.20.3 Battery room floor shall be treated with an acid-resistant floor sealant. Batteries shall be rated by industry standards on the basis of a nominal 24-hour average temperature of corresponding to the battery room minimum design temperature. Battery Room exhaust 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. Battery room exhaust vent fans show be monitored for loss of air flow and an hydrogen gas detector shall be installed and hardwired to DCS for monitoring/alarm.

A-7.20.4 Batteries

A-7.20.4.1. Batteries General

A-7.20.4.1.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 as describe in this Attachment A-7.20.1. Each combustion turbine shall have its own dedicated battery and UPS, see Attachment A.17.

A-7.20.4.1.b. Batteries shall be designed to maintain a 2-hour duty cycle.

A-7.20.4.1.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.

A-7.20.4.1.d. Batteries shall be load tested based on recommendations from the OEM on approved factory testing methods and IEEE standards.

A-7.20.4.2. Specification for 125V DC Batteries

A-7.20.4.2.a. 125 VDC Batteries Specification General

A-7.20.4.2.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-7.20.4.2.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-7.20.4.2.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-7.20.4.2.a.4 Battery run down testing, load test and documented results shall be performed by the Seller and test reports provided to the Buyer.

A-7.20.4.2.a.5 Battery service life shall be 20 years.

A-7.20.5 Battery Chargers Specification

A-7.20.5.1. General

A-7.20.5.1.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-7.20.5.1.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 adjustable equalizing and float voltage and shall include standard alarms, meters, controls, paralleling circuit abilities and filtering to allow battery elimination under steady state.

A-7.20.6 125V DC Distribution Panel Specification General

A-7.20.6.1. 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 BOP 125 VDC battery and battery chargers.

A-7.20.6.2. 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-7.20.6.2.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-7.21 DC MOTOR CONTROLS

A-7.21.1 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-7.21.2 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-7.22 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A-7.22.1 Specifications for the Uninterruptible Power Supply

A-7.22.1.1. Uninterruptible Power Supply System (UPS) Specification General

A-7.22.1.1.a. One (1) UPS system is to be furnished by Seller. The UPS system shall be supplied with 20% spare capacity above calculated requirements.

A-7.22.2 Each power supply shall consist of an Integrated UPS System three phase 208/120 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.

A-7.22.3 Distribution Panelboard

A-7.22.3.1. Panelboards shall be rated 120VAC, single-phase, two-wire, or 208/120, three-phase, four-wire, as required to support power distribution as designed by th Seller. Distribution panelboard shall include main breaker and neutral buses. The rating of the main bus and interconnections at the UPS shall be equal to the rated continuous full load current of the inverter without exceeding 65°C rise. The main bus shall have a minimum interrupting rating of 10 kA.

A-7.22.3.2. The panelboard(s) shall have forty-two (42), single pole, thirty (30) ampere frame, branch circuit devices.

A-7.22.3.3. The 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 panelboard shall be flush mounted within a freestanding enclosure that matches and is aligned on a common base with the other UPS System panels. Also, the same requirements apply to UPS distribution sub-panels.

A-7.22.3.4. The panelboard shall be UL-listed and conform to the latest issues of the National Electric Code and NEMA Panelboard Standard PB 1

A-7.23 MOTORS

A-7.23.1 General Requirements for Motors

A-7.23.2 The Seller shall design, manufacture, test, deliver, and install all motors to comply with the following criteria.

A-7.23.2.1. All AC motors shall be designed for direct across the line starting 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. Softstart or VFDs may be used in other process application 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-7.23.2.2. All motors supplied by VFDs shall be inverter rated.

A-7.23.2.3. Single terminal box shall be provided for the motor leads. Motor pigtails shall be supplied with Raychem or 3M kits for motor connections.

A-7.23.3 Medium Voltage Motors

A-7.23.3.1. MV Motors shall be provided as follows: MV motors shall be in accordance with ANSI C50.41

A-7.23.3.2. 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 torque:	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	Provide partial discharge monitoring in accordance with ANSI C50.41.
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.
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 3500 vibration monitoring equipment with exception of ECA compressor motor which is monitored in the Turbine Control System.

A-7.23.4 Low-Voltage Motors

A-7.23.4.1. 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 Attachment A-4.
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 by 480VAC, 3 phase.

A-7.23.4.2. 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-7.23.5 Additional Motor Requirements:

A-7.23.5.1. Motors shall be rated on a continuous duty basis.

A-7.23.5.2. 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-7.23.5.3. 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-7.23.5.4. 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-7.23.5.5. DC motors shall be designed for continuous operation at any voltage between ±10% of nominal voltage without exceeding permitted temperatures and without injurious sparking at the commutator.

A-7.23.5.6. All enclosures shall be corrosion resistant and provided with galvanized screens over all openings to prevent debris and animals from entering.

A-7.23.5.7. Hazardous location specified motors shall meet NFPA 70 and UL 674 for the specified class, division, and group.

A-7.24 COMMUNICATIONS

A-7.24.1 Seller shall furnish and install the communications system as described below.

A-7.24.2 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-7.24.3 Network and server cabinets shall be electrically insulated from their mounting surface.

A-7.24.4 Voice over Internet Protocol (VOIP) telephone shall be single-mode fiber cables. Fiber terminations shall not be made in Junction Boxes.

A-7.24.5 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-7.24.6 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. Orange fiber inner duct shall be utilized when fiber optic cable where conduit is not being used.

A-7.24.7 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. Buyer shall provide the voltage and amperage ratings for the circuits.

A-7.25 GROUNDING AND LIGHTNING PROTECTION SYSTEM

A-7.25.1 Grounding

A-7.25.1.1. 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-7.25.1.2. 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-7.25.1.3. 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-7.25.1.4. 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-7.25.1.5. 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-7.25.1.6. 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-7.25.1.7. 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). In the Facility area, grounding conductors shall be brought through the ground slab and weld connected to the building steel and selected Equipment. The grounding pigtails shall not be run exposed over finished concrete slabs.

A-7.25.2 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-7.25.3 Major building and 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-7.25.4 MV motors and transformers shall have 2 #4/0 grid stub ups, pigtails, 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-7.25.5 Fencing under HV transmission lines and adjacent to transformers (areas susceptible to high fault currents) shall be connected to the grounding system. 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-7.25.6 Underground duct bank installation shall include at least 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-7.25.7 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. The sizing of the jumpers shall be as required by the NEC for the tray application.

A-7.25.8 Cable trays shall be connected to the ground grid at each end and at 50-foot intervals. Trays shall be rated as an earth return path. Where dissimilar metals are in contact, measures shall be taken to mitigate galvanic reaction.

A-7.25.9 Non-metallic flexible conduit shall have a ground wire bridging from last rigid conduit/tray to the equipment.

A-7.25.9.1. Individual equipment grounding shall be as follows:

A-7.25.9.1.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-7.25.9.1.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-7.25.9.1.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-7.25.9.1.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-7.25.9.1.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-7.25.9.1.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-7.25.9.2. Grounding materials shall be as follows:

A-7.25.9.2.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-7.25.9.2.b. Ground rods shall be copper-clad and shall be installed throughout the project including CTG and STG areas, PDCs, Control Room, GSU/ UAT / HV equipment areas connected to the facility ground grid.

A-7.25.9.2.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-7.25.9.2.d. Ground protection calculations shall be based on actual measured soil conditions including project fill material.

A-7.25.9.2.e. Cable shall be soft-drawn copper with Class B stranding.

A-7.25.9.2.f. Exothermic welds shall use molds, cartridges, and materials as manufactured by Cadweld.

A-7.25.9.2.g. Clamps, connectors, and other hardware used with the grounding system shall be made of copper.

A-7.25.10 Lightning Protection

A-7.25.10.1. 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-7.25.10.2. 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-7.25.10.3. The air terminals shall be connected together with copper cable and connected to the Facility ground grid with copper down conductors.

A-7.25.10.4. 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-7.26 LIGHTING

A-7.26.1 All lighting fixtures for the Facility shall be LED type including roadway.

A-7.26.2 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-7.26.2.1. Control rooms shall be maintained at 30 foot-candles from bottom of drop ceiling to top of finished floor.

A-7.26.2.2. Lighting intensities shall be appropriate for each area of the facility and the work functions to be performed in the area.

A-7.26.3 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-7.26.4 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-7.26.5 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-7.26.6 INDOOR

A-7.26.6.1. 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-7.26.7 OUTDOOR

A-7.26.7.1. 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.

A-7.26.7.2. Outdoor lighting shall comply with dark sky initiative.

A-7.26.8 Emergency

A-7.26.8.1. 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-7.26.8.2. 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-7.26.9 Receptacles

A-7.26.9.1. 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-7.26.9.2. 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-7.26.9.3. 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-7.27 CABLE AND RACEWAY SYSTEMS

A-7.27.1 Materials of Construction

A-7.27.2 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 Vendor’s standard cable must be installed in which case the Vendor cable will be accepted after evaluated by Buyer for site installation. 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-7.27.2.1. All cables shall meet UL 1685 and the IEEE 1202 flame exposure standard and tests.

A-7.27.3 Cable Service Classifications

A-7.27.4 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-7.27.5 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-7.27.6 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	300 V 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-7.27.7 Medium Voltage Cable (Service Level J and H)

A-7.27.7.1. 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-7.27.8 Low Voltage Power Cable (Service Level L and K)

A-7.27.8.1. 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-7.27.8.2. 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-7.27.8.3. 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-7.27.8.4. 600 Volt control cable shall be used for 120VAC and 125 VDC circuits unless otherwise specified.

A-7.27.8.5. Cables completely within an occupied building such as a control room shall be low smoke, flame retardant.

A-7.27.8.6. Above ground lighting cable may utilize Teck cable.

A-7.27.9 Control Cable (Service Level C)

A-7.27.9.1. 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-7.27.9.2. Color coding shall be per NEC.

A-7.27.10 Instrument Cable (Service Level X)

A-7.27.10.1. 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-7.27.10.2. Shrink tube should be installed on shield wires of all instrument wiring at termination points.

A-7.27.11 Communication Cable (Service Level X)

A-7.27.11.1. Phones, Ethernet, and Network Switches

A-7.27.11.1.a. Telecom cables shall be low smoke zero halogen, Cat 6e, XLPE jacketed cable.

A-7.27.12 Fiber Optic (Service Level Z)

A-7.27.12.1. Unless otherwise approved by Buyer, armored single mode fiber cable shall be used in telecommunication systems.

A-7.27.12.2. 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-7.27.12.3. 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-7.27.12.4. Fiber optic cables shall not occupy the same raceway as other cable services; in ductbank these shall be routed in separate conduit cells; in cable tray, they shall be routed with dividers.

A-7.27.13 COAXIAL SIGNAL CABLE (Service Level X with Exceptions)

A-7.27.13.1. 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-7.27.14 AMPACITY/CABLE SIZING

A-7.27.14.1. 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-7.27.14.2. 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-7.27.14.3. 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-7.27.14.4. Derating of cable due to installation in the various types of raceways shall be in accordance with IEEE 835, and NEC.

A-7.27.14.5. Underground cable derating calculations shall be performed using actual measured soil conditions.

A-7.27.14.6. 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-7.27.14.7. Terminating control wiring for relays and other terminations should be made using ring lugs only. Ferrules are also used in terminations.

A-7.28 RACEWAY SYSTEM REQUIREMENTS

A-7.28.1 All raceways, cable tray, cable trench, conduit, and ductbank shall be tagged or labeled and listed in the raceway schedule.

A-7.28.2 All Seller installed cables shall have cable tags (ferrules) or identifiers, per the Sellers wiring diagrams. All Individual wires shall be labeled with tags (ferrules) as identifiers.

A-7.29 CABLE TRAY

A-7.29.1.1. The Seller shall design, furnish, and install a cable tray system as required for a complete installation.

A-7.29.1.2. The cable tray system shall be designed, fabricated, and installed in accordance with the latest edition of NEMA Standard Publication No. VE-l - Cable Tray Systems, load/span class designation NEMA Class 20C.

A-7.29.1.3. All metallic cable tray shall be rated as a earth return path.

A-7.29.1.4. Aluminum ladder type tray shall be used unless required otherwise by a specific Supplier. Tray inside the PDCs shall be manufacturer’s standard.

A-7.29.1.5. 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-7.29.2 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-7.30 JUNCTION BOXES

A-7.30.1 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-7.31 CONDUITS, DUCTBANKS, AND MANHOLES

A-7.31.1 The Seller shall furnish and install all conduit required for the Facility in accordance with this Attachment. 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-7.31.2 All conduits shall be sized in accordance with the number and total area of cables that they contain using the National Electric Code.

A-7.31.3 All outdoor exposed conduits shall be rigid galvanized steel.

A-7.31.4 All outdoor exposed conduits shall have low point conduit drains.

A-7.31.5 All underground conduit, with the exception of vertical risers and vertical elbows, will be Schedule 40 PVC.

A-7.31.6 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-7.31.7 Seller shall furnish raceways for Seller located telephone, LAN, PA, and communication circuits.

A-7.31.8 PVC conduits shall be Schedule 40 for use in concrete encased duct banks. The conduits shall be supported by prefabricated spacers.

A-7.31.9 Ductbanks shall provide for additional separation of the control and instrumentation cables routed though 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-7.31.10 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-7.31.11 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-7.31.12 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-7.31.13 All duct banks terminating at manholes shall have a minimum slope of 0.25 percent and arranged to drain toward manholes.

A-7.31.14 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-7.31.15 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-7.31.16 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-7.31.16.1.a. Seller shall provide all electrical conduit and fittings, built in, concealed or a part of the concrete work.

A-7.31.16.1.b. 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-7.31.16.1.c. Conduit terminations to motors and equipment subject to vibration shall be made with flexible conduit and maximum of 6 feet length.

A-7.31.16.1.d. Conduit in hazardous areas shall be supplied with fittings and seals suitable for the hazard encountered.

A-7.32 HEAT TRACING

A-7.32.1 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 Attachment A-4 freeze protection temperature and wind requirements.

A-7.32.2 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-7.32.3 The heat tracing system shall consist of self-limiting resistance type or mineral insulated type cables when higher exposure temperature ratings are required.

A-7.32.4 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-7.32.5 All equipment shall be capable of being operated at ± 10 percent of rated voltage without damage.

A-7.32.6 The heat trace system shall be designed from off-the-shelf components to ensure availability.

A-7.32.7 Heat trace sensors.

A-7.32.7.1. Electric heat tracing for freeze protection shall be controlled by ambient air temperature sensors, each sensor shall energize the heat tracing circuits.

A-7.32.7.1.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-7.32.7.1.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-7.32.7.1.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-7.32.7.1.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-7.32.7.2. Electric heat trace to maintain process piping temperatures shall be controlled by individual line sensing RTDs.

A-7.32.8 Electric heat tracing located on skid packages shall be the responsibility of the skid vendors. A feeder cable shall be provided by the Seller shall be connected to the vendor provided skid mounted junction box for heat tract power.

A-7.32.9 Heat Trace Panels and Alarms.

A-7.32.9.1. 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-7.32.9.2. 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-7.32.9.3. Heat Trace panels shall have audible and visible alarms and shall transmit all monitored parameter information and alarm information to the DCS.

A-7.32.9.3.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-7.32.9.3.b. DCS screens shall be developed to display temperature, current, etc. readings by heat trace panel.

A-7.32.9.3.c. Transmitter sensor temperatures shall be brought into the DCS screens and alarming shall include setpoints as described in this Attachment.

A-7.32.10 The installation of the heater shall not require the use of heat transfer cement or compounds in any form.

A-7.32.11 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-7.32.12 As-built Heat Tracing drawings shall show the approximate location of heaters, thermostats and any other equipment installed.

A-7.32.13 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-7.32.14 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-7.32.15 Where heat trace circuits are installed at ground penetrations, the heat trace shall extend 12 inches below grade.

A-7.32.16 Refer to Attachment A-6 for insulation requirements for heat trace and freeze protection system.

A-7.33 CATHODIC PROTECTION

A-7.33.1 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-7.33.2 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-7.33.3 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-7.33.4 Chromium plated parts shall not be used in any damp or corrosive atmosphere.

A-7.33.5 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-7.33.6 All external steel screw fixings shall be supplied in the hot dipped spun galvanized condition, stainless steel, or sherardized with passivation treatment.

A-7.33.7 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-7.33.8 After the system is operational, it shall be verified by a final corrosion surveyor/inspector.

A-7.34 EMERGENCY DIESEL GENERATOR (EDG)

A-7.34.1 Codes and Standards:

A-7.34.1.1. NEMA MG 1, “Motors and Generators”

A-7.34.1.2. IEEE 115 – Test Procedures for Synchronous Machines

A-7.34.1.3. IEEE 126 – Recommended Specifications for Speed Governing of Internal Combustion Engine – Generator Units

A-7.34.1.4. NFPA 110 – Standards for Emergency and Standby Power Systems

A-7.34.2 General Requirements:

A-7.34.2.1. Seller shall furnish, deliver, and install complete and ready for operation an 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-7.34.2.2. 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 2000 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-7.34.2.3. 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-7.34.2.4. 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-7.34.2.5. Lube oil leak detector switches shall be provided on the EDG and fuel oil module.

A-7.34.2.6. Final ratings and operational philosophy shall be determined during detailed design with approval with the Buyer.

A-7.35 CALCULATIONS

A-7.35.1 Seller shall use the latest version of ETAP.

A-7.35.2 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-7.35.3 Cable pull tension calculations shall be performed for conduits exceed 360 degrees of total bends or pulls in excess of 1000 feet.

A-7.36 ON-SITE STORAGE OF EQUIPMENT CARE

A-7.36.1 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-7.36.2 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 ATTACHMENT A-7

BOT Scope Book

Attachment A-8

Instrumentation and Control Requirements and Design Criteria

Table of Contents

A-8.1 INTRODUCTION

A-8.1.1 The purpose of this document is to define the Project Design Criteria for instrumentation, including selection, installation, and testing.

A-8.2 Scope of supply

A-8.2.1 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. Any equipment from vendors/manufacturers which are not listed in the Approved Manufacturers List must be approved by the Buyer.

A-8.2.2 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-8.2.2.1 Systems to be controlled directly by the Facility DCS shall include, but not be limited to, the following:

A-8.2.2.1.a Heat Recovery Steam Generator auxiliaries control

A-8.2.2.1.b Unit load control

A-8.2.2.1.c Steam bypass system

A-8.2.2.1.d Steam temperature control

A-8.2.2.1.e Feed water control

A-8.2.2.1.f Condensate control

A-8.2.2.1.g Cooling water systems

A-8.2.2.1.h Make up water control.

A-8.2.2.1.i Chemical injection control

A-8.2.2.1.j Selective catalytic converter and auxiliaries control

A-8.2.2.1.k Steam turbine auxiliaries not controlled directly by the steam turbine control system.

A-8.2.2.1.l Combustion turbine auxiliaries not controlled directly by the combustion turbine control system.

A-8.2.2.1.m Plant auxiliary power system

A-8.2.2.1.n Balance of plant equipment

A-8.2.2.2 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 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-8.2.2.2.a Steam turbine

A-8.2.2.2.b Combustion turbines

A-8.2.2.2.c Water treatment

A-8.2.2.2.d Air compressors

A-8.2.2.2.e Standby Diesel generator

A-8.2.2.2.f Electrical switchyard

A-8.2.2.2.g Skid mounted systems controlled by a PLC or dedicated controller as approved by Buyer.

A-8.2.2.2.h Generation Management System (GMS)

A-8.2.2.3 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. The data link shall be discussed during detail design stage.

A-8.2.2.3.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. The Seller shall implement the agreed upon scheme for providing communication protocol break as required by Buyer.

A-8.2.2.3.b Protective relaying and metering

A-8.2.2.3.c Gas chromatograph and metering station

A-8.2.2.3.d Generator Step-Up and Unit Auxiliary Transformers

A-8.2.3 The extent of supply described shall consist of, but not be limited to, the following:

A-8.2.3.1 Complete control hardware and software, instrumentation, monitoring, and alarm equipment packages for all plant equipment being supplied, including all local control, electrical room, and Control Room consoles, plus engineering consoles for all control systems.

A-8.2.3.2 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-8.2.3.3 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 one control scheme.

A-8.2.3.4 Redundant network communications links between the Facility DCS and all plant equipment control computer systems.

A-8.2.3.5 All instrumentation as described in the control system design requirements of this Attachment including pressure, differential pressure, temperature, level, flow using gauges, transmitters, switches, all associated instrument taps, tubing, pipework, valves, manifolds, thermowells, local panels and racks.

A-8.2.3.6 Instrumentation suitable for performance metering and monitoring, for the display and logging of actual and integrated plant parameters, and for the processing of data to produce calculated data such as individual unit efficiencies.

A-8.2.3.7 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-8.2.3.8 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-8.2.3.9 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-8.2.3.10 Factory acceptance testing and inspection of all systems.

A-8.2.3.11 Facility erection, installation, and commissioning.

A-8.3 NERC CIP – Physical Security and Cybersecurity

A-8.3.1 The Facility physical security shall include cameras, card readers, intercom, fencing, gates, etc.

A-8.3.1.1 The Buyer shall supply specifications of hardware and software during the Project design phase, as necessary for the Seller's detailed design.

A-8.3.1.2 The Buyer shall be responsible for the supply and installation of all cameras, intercom, cabling, and video security system servers and monitors required.

A-8.3.1.3 The Seller shall supply and install camera poles and foundations necessary to accommodate the security camera design.

A-8.3.1.4 The Buyer shall be responsible for the supply and installation of the badge readers, cabling, and security system servers and software required.

A-8.3.1.5 The Seller shall ensure that all buildings are equipped with the necessary power supply, conduit, fiber, and power wiring to facilitate the installation.

A-8.3.1.6 Attachment A-9 identifies security requirements (cameras, card readers, etc.) for building exterior and interior doors, respectively.

A-8.3.1.7 In addition to the cameras for doors and gates as described in the cross-referenced Attachments above, exterior cameras shall be strategically placed around the Facility to provide visual coverage of the entire perimeter and primary drive ways 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-8.3.1.8 All security devices, badge readers, electronic lock, door sounders and cameras, shall be powered by the UPS power system.

A-8.3.2 This Attachment 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.

The design will comply with the latest North American Electric Reliability Corporation (NERC) Critical Infrastructure Protection (CIP) standards.

A-8.3.2.1 External vendor access to control systems, for example, packaged systems supplied with a PLC control system (compressors, water treatment, etc.), shall be prohibited, unless approved by Buyer.

A-8.4 Instrumentation & Control System Requirements

A-8.4.1 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-8.4.2 Basis of Design

A-8.4.2.1 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 or controls required to make a complete system.

A-8.4.2.2 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 hazards. Instruments will be protected from extremes of temperature and other adverse conditions.

A-8.4.2.3 Instrument, control, and sampling tubing systems will be designed, fabricated, and tested in accordance with ASME B31.1.

A-8.4.2.4 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-8.4.2.5 Instrument wetted parts will be compatible with the fluid to which they are exposed.

A-8.4.2.6 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-8.4.2.6.a CT(s) Emergency Stop

A-8.4.2.6.b ST Emergency Stop

A-8.4.2.6.c Fuel Gas Emergency Stop (one pushbutton to shut main fuel trip valve(s))

A-8.4.2.7 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-8.4.2.8 Redundancy of control instruments should be provided as follows:

A-8.4.2.8.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-8.4.2.8.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-8.4.2.8.c Non-critical parameters may utilize single process measurements.

A-8.4.2.8.d Additional required trip inputs will be documented during initial P&ID review.

A-8.4.2.8.e First out trips shall be captured in DCS historian or TCS historian (If available).

A-8.4.3 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, alarm panels, or paper chart recorders for operation of the plant. 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-8.4.4 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-8.4.5 The Facility shall include semi-automatic start-up sequencing with manual override programmed in the Facility DCS. Once the CTG has started, the Operating 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 the steam turbine bypass systems, managing steam temperature, and establishing condenser vacuum. Once all STG permissives are met, the STG shall be started.

A-8.4.6 The operating staff of the Facility will be kept to a minimum. Therefore, a high level of automation and reliability is required.

A-8.4.7 The main objectives of the control and instrumentation scheme shall be as follows:

A-8.4.7.1 To provide safe, efficient, and reliable operation of the Facility in accordance with all applicable codes and standards.

A-8.4.7.2 To give a high level of automatic control incorporating synchronizing, ramp loading, unloading, start-up and shutdown to minimize operator manning levels.

A-8.4.7.3 To reduce start-up and shutdown sequence times to an optimum using thermal stress management.

A-8.4.7.4 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-8.4.7.5 To standardize instrumentation and control equipment where practicable to reduce spare parts requirements.

A-8.4.7.6 To eliminate unnecessary interfaces.

A-8.4.7.7 To minimize installation, testing and commissioning time.

A-8.4.7.8 To minimize maintenance downtime.

A-8.4.7.9 To minimize staff training requirements.

A-8.4.8 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-8.4.9 The Facility DCS and local controls shall be designed such that operation of plant equipment shall not be possible from local and remote control units simultaneously. The DCS shall display the local/remote control status of the equipment.

A-8.4.10 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-8.4.11 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-8.4.12 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-8.4.13 The failsafe condition shall be set for all discrete I/O.

A-8.4.14 Fully open/closed limit switches shall be provided when required for control sequence purposes.

A-8.4.15 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-8.4.16 Profibus, Foundation Fieldbus, and wireless communications/protocols shall not be installed on instruments and valves required for control.

A-8.4.17 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-8.4.18 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-8.4.19 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-8.4.20 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 (see Attachment A-7 for detailed DC voltage requirements). Insulation of coils shall permit continuous operation at a temperature of 130°C.

A-8.4.21 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-8.4.22 Mercury encapsulated switches shall not be used.

A-8.4.23 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. The Project site has unique grounding issues as described in Attachment A-06.

A-8.5 Facility distributed control system (DCS)

A-8.5.1 A fully integrated Facility DCS shall be an Emerson Ovation system with an Embedded Simulation system (Digital Twin). 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-8.5.2 Facility DCS Hardware

A-8.5.2.1 The Facility DCS shall be provided with spare capacity, (in percentage of total capacity) after factory acceptance test (FAT) and prior to shipment to Project site as follows:

A-8.5.2.1.a Control Processors: 50% of total processing capacity per module

A-8.5.2.1.b Power Supplies: 25% of full capacity for the rack

A-8.5.2.1.c Cabinet Spare Rack Slots: 20%

A-8.5.2.1.d I/O: 20% by wired I/O type at each I/O and remote I/O location.

A-8.5.2.1.e System Communications: 70% (maximum design throughput 30%)

A-8.5.2.2 All workstations, HMIs, engineering stations, historians, etc. shall be rack mounted server class machines with KVM extenders or thinclients, to allow the keyboards, monitors, and mice to be located elsewhere in the room. The supplied DCS system shall also be provided with control room speakers to provide the ability for audible alarms.

A-8.5.2.3 Communication Network

A-8.5.2.3.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 Attachment A-7). 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-8.5.2.3.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, for example communications protocol, data compression, error detection and data display application software for use on the interface control systems.

A-8.5.2.3.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 troubleshooting. 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-8.5.2.3.d The redundant data highways must be physically separated from each other (see Attachment A-7).

A-8.5.2.3.e Communication networking to the switchyard shall be fiber-optic cable.

A-8.5.2.3.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-8.5.2.4 Processors and Cabinets

A-8.5.2.4.a The Facility DCS shall be divided into subsystems. The number of subsystems shall be agreed to by the 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-8.5.2.4.b The system shall be designed to have a functionally and geographically distributed architecture utilizing several 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/closed loop control functions.

A-8.5.2.4.c All necessary hardware for marshalling and terminating incoming/outgoing plant cabling shall be provided, including gland plates, glands, terminal blocks, barriers, isolation devices, labeling and wiring. All equipment shall be designed to operate in hazardous areas where necessary.

A-8.5.2.4.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-8.5.2.4.e The maximum scan time for digital signals shall be 100 milliseconds and 250 milliseconds for analog signals.

A-8.5.2.4.f Comprehensive system diagnostics shall be incorporated to assist in maintenance and troubleshooting. 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-8.5.2.4.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-8.5.2.4.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-8.5.2.5 Facility DCS Inputs and Outputs (I/O)

A-8.5.2.5.a Comprehensive system diagnostics shall be incorporated to assist in maintenance and troubleshooting. 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-8.5.2.5.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 occur a minimum of one millisecond apart and print them in their proper sequence when they are opening and closing.

A-8.5.2.5.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-8.5.2.5.d Inputs, outputs, and other connections shall meet the surge withstand requirements of ANSI C37.90a. The Subcontractor 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-8.5.2.5.e For the Facility DCS I/O, compression type terminations shall be acceptable. Spring type termination is not acceptable. Excluding thermocouples, all I/O cables at the field end shall be terminated using crimped-on, ring-tongue lugs except where (per 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-8.5.2.6 Control of Starters, Motor Operated Valves, and Solenoid Valves

A-8.5.2.6.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-8.5.2.6.b Open, closed, and trip power status, relay status, tripped status, phase voltage, phase current, watts, vars, trip coil status, and heartbeat signal to confirm communication.

A-8.5.2.6.c Switchgear Motors and Breakers (if necessary) shall have the following hard wired I/O: DI: Stopped/Opened, Running/Closed, Trip Power Available, Close Power Available, DO: Stop/Trip, Start/Close

A-8.5.2.6.d Motor Control Center (MCC) Starters and Contactors shall have the following hard wired I/O: DI: Running, Stopped, Power available, DO: Start

A-8.5.2.6.e Motor Operated Valves shall have the following hard wired I/O: DI: Not Full Open, Not Full Closed, Torque Switch Open, Torque Switch Closed, Power available/no overload, DO: Open, Close

A-8.5.2.6.f Solenoid Operated Valves shall have the following hard wired I/O: DI: Full Open, Full Closed, Power available, DO: Open (energize to open only) or Close (energize to close only)

A-8.5.2.7 Facility DCS Power

A-8.5.2.7.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-8.5.2.7.b 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. 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 troubleshooting.

A-8.5.2.8 Workstation and Human Machine Interface (HMI)

A-8.5.2.8.a The Control Room shall have the Facility DCS operator HMIs, located on a control console/desk. The console/desk shall be as approved by the Buyer. The three (3) operator HMIs 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. The large screen 75-inch (minimum) LCD or LED monitor shall be provided and mounted from the ceiling in the Control Room. 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-8.5.2.8.b 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 a 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.

A-8.5.2.8.c The Facility DCS shall include an Enterprise Data Server, Database Server, and Asset Management Suite (AMS) workstations on the engineering console/desk. Each of these servers shall be provided with one high resolution 24-inch (minimum) LCD or LED screen except the AMS server which shall be provided with two (2) high resolution 24-inch (minimum) LCD or LED screens. All these rack mounted servers shall be provided with keyboards and mice.

A-8.5.2.8.d The AMS system software license (with ValveLink SNAP-ON) shall be licensed for up to 400 AMS Devices and 100 ValveLink Devices.

A-8.5.2.8.e The Seller shall solicit and use the 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-8.5.2.8.f 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:

A-8.5.2.8.f.1 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-8.5.2.8.g 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. The Buyer will specify the location of the remote drum level indicators.

A-8.5.2.9 Printers

A-8.5.2.9.a The Facility DCS Subcontractor 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-8.5.2.10 Data Historian, Historical Storage Retrieval (HSR)

A-8.5.2.10.a The purpose of the HSR system shall be to have available detailed information at long intervals, after events have occurred. 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-8.5.2.10.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-8.5.2.10.c The historian shall be completed and configured at the plant site before the unit startup.

A-8.5.2.10.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, independent of all other software functions.

A-8.5.2.11 Control System Interfaces

A-8.5.2.11.a The Facility DCS will provide the required hardware and software to bring all plant control system packages into one operator interface scheme. The control system interfaces shall include, but are not limited to, the interfaces as listed in this Attachment A-8.2.2.The operator shall have supervisory control and the ability to monitor and control these interfaced systems from the Facility DCS consoles in the Control Room.

A-8.5.2.11.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-8.5.2.11.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 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, or alarm acknowledgement capabilities.

A-8.5.2.11.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-8.5.2.11.e The Seller shall supply OSIsoft Plant Information (PI) system software.

A-8.5.2.11.f Automatic Generation Control (AGC)

A-8.5.2.11.f.1 The AGC load demand signal shall be received by plant Facility DCS through a Remote Terminal Unit (RTU). RTU shall be SEL model. The plant Facility DCS shall generate CTG's load demand signals for each CTG.

A-8.5.2.11.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 Buyer's CIP requirements. Communication protocol shall be dictated by the Buyer.

A-8.5.2.11.f.3 In addition, telecom circuits shall also interface with the RTU.

A-8.5.2.11.f.4 The RTU interface details shall be provided during the detail design stage.

A-8.5.2.12 Control System Fault Tolerance

A-8.5.2.12.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 Attachment.

A-8.5.2.12.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-8.5.2.13 Embedded Simulator (Digital Twin)

A-8.5.2.13.a The Facility DCS shall include a high-fidelity simulation system using embedded Ovation-based models. The Emerson Ovation Digital Twin Embedded Simulator shall be a combination of physical models, empirical models, and simplified models.

A-8.5.2.13.b The Embedded Simulator shall be supplied complete with the appropriate server, management workstation, network switches, color printer, three (3) dual 24" screen thin client workstations, and two (2) quad 24" screen thin client workstations, at a minimum.

A-8.5.2.13.b.1 In addition to this hardware, the simulator shall include virtual machines to function as the database server, domain controller, engineering station, virtual controller host, operator workstation, model server, instructor station, and anti-virus workstation. All applicable software licenses shall be provided to the Buyer.

A-8.5.2.13.c Additional instrumentation for the sole purpose of the digital twin is not required.

A-8.5.3 Facility DCS Software

A-8.5.3.1 The Facility DCS shall include the following major software components, in the latest versions supplied by the Facility DCS Subcontractor:

A-8.5.3.1.a High level regulatory control-oriented languages for control and monitoring function development, with full documenting and printing capabilities.

A-8.5.3.1.b High level Boolean diagram-oriented language for development of discrete control logic functions with full documenting and printing capabilities.

A-8.5.3.1.c High level graphic generation language for HMI graphic display development, with full documenting and printing capabilities.

A-8.5.3.1.d High level log generation language for development of log report formats.

A-8.5.3.1.e All software to provide the functions described and control, communications, and scheduling within the Facility DCS.

A-8.5.3.1.f System database for identification of all process and calculated variables and for definition of the system attributes associated with each variable.

A-8.5.3.1.g Windows based operator/engineering consoles.

A-8.5.3.1.h Microsoft Excel on the engineering consoles.

A-8.5.3.1.i Performance and optimization software based on the plant thermodynamic model for use in the unit start-up.

A-8.5.3.1.j Anti-virus software.

A-8.5.3.2 Configuration

A-8.5.3.2.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-8.5.3.2.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-8.5.3.2.b.1 CTG start-ups through synchronization

A-8.5.3.2.b.2 STG start-ups through synchronization

A-8.5.3.2.c The Facility DCS shall be capable of:

A-8.5.3.2.c.1 Providing automatic and manual control of individual drives, such as a pump, motor operated valve, solenoid valve, etc., and systems with bump less transfer (manual-auto-manual).

A-8.5.3.2.c.2 Automatic start-up including permissive checks at the individual drive level.

A-8.5.3.2.c.3 Sequencing a group of drives to an optimized program of plant operation.

A-8.5.3.2.c.4 Sequencing functional groups to provide full automatic plant operation.

A-8.5.3.2.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-8.5.3.2.c.6 Automatic speed and load control.

A-8.5.3.2.c.7 Automatic steam temperature control.

A-8.5.3.2.c.8 Automatic sequencing of setpoints for the steam bypass system pressure control.

A-8.5.3.2.d The operator interface software shall enable the operator to carry out the necessary actions in a safe and efficient manner. At minimum, the following are included aspects:

A-8.5.3.2.d.1 Software structured in such a way to provide a hierarchy of control from automatic sequential plant start-up through to manual control of an individual piece of equipment.

A-8.5.3.2.d.2 All software and hardwired permissives and overrides shall be indicated and visible to the operator during manual intervention by the operator (sequence initiation and individual device control under normal and failure conditions).

A-8.5.3.2.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-8.5.3.2.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-8.5.3.2.e Mechanical equipment on standby status shall automatically start upon a trip of the operating equipment.

A-8.5.3.3 Graphics

A-8.5.3.3.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-8.5.3.3.b Graphics shall be a combination of animated P&ID symbols, text, pop up face plates, bar graphs and trend graphs.

A-8.5.3.3.b.1 Face plates include manual/auto stations, set point stations, start/stop controls, and permissive and interlock displays.

A-8.5.3.3.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-8.5.3.3.c Graphic sketches shall be supplied for the Buyer's review and comment before they are configured. As a result of the Buyers 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 the 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-8.5.3.3.d In addition, the Seller shall configure up to 10 Buyer-defined graphics.

A-8.5.3.3.e Graphics colors shall be used consistently throughout all graphics. The following minimum standards shall apply:

A-8.5.3.3.e.1 Green shall depict valves closed and electrical drives (circuit breakers, contactors, switches, etc.) open, off, or de-energized.

A-8.5.3.3.e.2 Red shall depict valves open and electrical drives closed, on, or energized.

A-8.5.3.3.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-8.5.3.3.e.4 White or cyan shall be used for changing process values.

A-8.5.3.3.e.5 The remaining color shall be used for text that does not change.

A-8.5.3.3.f All drives and remotely controlled valves shall have their positions displayed and confirmed on the operator interfaces.

A-8.5.3.3.g Facility DCS controlled regulating valves shall provide actual position indication in “percent open” to the operator in the CR.

A-8.5.3.3.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-8.5.3.3.i The operator shall have the ability to present real-time 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. Multiple trends of real-time or historical data from the data logger or archives shall be possible to compare on the same display.

A-8.5.3.3.j All graphics shall have their name displayed on the graphics.

A-8.5.3.3.k A logical hierarchy shall be developed by the Seller to aid in navigating from graphic to graphic.

A-8.5.3.4 Alarm Management

A-8.5.3.4.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 advisory 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.

A-8.5.3.4.b Each of the major control systems (TCS and DCS) shall utilize its vendor’s standard alarm management system.

A-8.5.3.4.c A hierarchical alarm system shall be implemented with 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/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).

Priority Level	Priority Definition	Alarm Definition
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.
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-8.5.3.4.d 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. The following shall apply to operator process alarms generated from analog input signals only, and are distinguished from alarms used for control action:

A-8.5.3.4.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-8.5.3.4.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 permits, start/stops, trips, runbacks, etc. Use of these algorithms solely to generate an alarm from an analog point shall be avoided or greatly limited, since the DCS analog database typically has embedded alarm set points for each analog record.

A-8.5.3.4.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 trip, runback, permissive (not met), etc.

A-8.5.3.4.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-8.5.3.4.f Equipment not in service or tagged out shall have their alarms deactivated.

A-8.5.3.4.g System failures shall be alarmed and logged in the alarm capture computer.

A-8.5.3.5 Reporting

A-8.5.3.5.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 so these logs, alarm records, and daily reports shall be made available through the Facility DCS displays.

A-8.5.3.5.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-8.5.3.5.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-8.5.3.5.d Facility DCS Shall indicate run times for each CTG, STG, and all motors 480 Volt and higher.

A-8.5.3.5.e The historian 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-8.5.3.6 Plant Performance Monitoring System

A-8.5.3.6.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-8.5.3.6.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 data diode provided by the Buyer.

A-8.5.4 Testing: Factory Acceptance, Start-up, and Commissioning

A-8.5.4.1 In addition to the manufacturer's production tests, the Seller shall carry out routine tests on completed Equipment. The 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 testing, control loop testing, fail over testing (communication and power), and voltage withstand and insulation testing. Where Equipment is intended to operate together, the complete assembly shall be tested to demonstrate that the interconnected pieces are compatible.

A-8.5.4.2 A factory acceptance test shall be performed by the Seller. The Seller shall include all Equipment necessary for full testing to cover both at factory and at Project site. All Facility DCS functions, inputs and outputs and ranges of the same, 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 tests 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-8.5.4.3 From the various factory equipment/components tests, evidence shall be provided to prove that the Equipment meets the requirements of this specification and is sufficiently reliable to justify delivery 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-8.5.4.4 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-8.5.4.5 The Facility DCS equipment shall conform to, and tests 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-8.5.4.6 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-8.5.4.6.a Testing of all workstation or PLC facilities without connection to workstations in the new Control Room.

A-8.5.4.6.b Testing of data communications to workstations shall be established for each workstation or PLC.

A-8.5.4.6.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-8.5.4.6.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-8.5.4.6.e A Facility DCS workstation designated by the Seller solely for Buyers 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-8.5.4.6.f Data communication and interfaces between Facility DCS and proprietary control equipment as listed in the Control System Interfaces section shall be demonstrated.

A-8.5.4.6.g Full working communication between the BOP Facility DCS, CEMS, Gas Yards, RTU, and the AGC interfaces, established by the Seller and the Buyer.

A-8.6 Combustion Turbine Generator (CTG) controls

Instruments and controls that are supplied as part of the CTG package will be provided in accordance with Subcontractor’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-8.6.1 General TCS Requirements

A-8.6.1.1 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. NFPA 85 HRSG purge and CTG to HRSG interlock requirements must be satisfied by the TCS.

A-8.6.1.2 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-8.6.1.3 The TCS shall provide for the automatic and semi-automatic starting, synchronizing, loading, and shutting down of a single 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-8.6.2 CTG Controls

A-8.6.2.1 Consisting of the manufacturer's normal complement of equipment, the control and instrumentation package for each Unit shall include, but not be limited to, the following:

A-8.6.2.1.a Governor controls, droop selection, MW load control, and exhaust temperature limiting. Droop control shall be active in M mode or AGC mode so that the CTG responds to system frequency changes during these modes. See Attachment A-17.

A-8.6.2.1.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. The Buyer shall review and approve all trip systems that do not have 2oo3 voting.

A-8.6.2.1.c Sequence controls and interlocks (e.g., pre-start checks, start-up auto-synchronizing, load run-up, shut-down, etc.).

A-8.6.2.1.d Comprehensive machine condition monitoring and supervisory equipment.

A-8.6.2.1.e Control and instrumentation for auxiliary systems.

A-8.6.2.1.f Local and remote alarms on the operator workstation.

A-8.6.2.1.g Generator control and instrumentation, including electrical protection.

A-8.6.2.1.h Fire and gas detection systems.

A-8.6.2.2 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 45º and 135º angles of the horizontal plane), phase reference, bearing pad temperatures, thrust bearing to shaft position, thrust bearing temperature.

A-8.6.2.3 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-8.6.2.4 The CTG supervisory system shall be fully compatible with the Bently System 1, or equivalent, condition monitoring analysis system installed in the Control Room.

A-8.6.2.5 TCS shall be provided with a network printer in the Control Room and in each local control package.

A-8.6.2.6 Emergency stop push buttons shall be mounted on the trip panel installed in the Control Room.

A-8.6.2.7 Refer to Attachment A-17 for additional instrumentation and controls requirements for the CTGs.

A-8.7 Heat Recovery Steam Generator (HRSG) Controls

A-8.7.1 General HRSG Control Requirements

A-8.7.1.1 The Seller shall supply all control, protection, and instrumentation for the safe, reliable, and efficient operation of the HRSG. All 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-8.7.1.2 All control 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-8.7.2 HRSG Controls

A-8.7.2.1 The control and instrumentation package shall include, but not be limited to, the following:

A-8.7.2.1.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-8.7.2.1.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-8.7.2.1.c Economizer inlet temperature (economizer recirc) control.

A-8.7.2.1.d Automatic continuous blowdown monitoring and control.

A-8.7.2.1.e Emergency tripping and protection systems.

A-8.7.2.1.f Sequence control and safety interlocks.

A-8.7.2.1.g Controls and instrumentation for auxiliary systems.

A-8.7.2.1.h Local and remote alarms.

A-8.7.2.2 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-8.7.2.3 Refer to Attachment A-18 for additional instrumentation and controls requirements for HRSG.

A-8.8 Steam Turbine Generator (STG) Controls

A-8.8.1 General STG Control Requirements

A-8.8.1.1 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-8.8.1.2 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-8.8.1.3 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-8.8.2 STG Controls

A-8.8.2.1 The control system shall include the following features:

A-8.8.2.1.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-8.8.2.1.a.1 All necessary pre-start checks to ensure minimum conditions for auto run-up initiation are satisfied.

A-8.8.2.1.a.2 Selection of run-up rate (cold, warm, and hot).

A-8.8.2.1.a.3 Turning after steam turbine shutdown.

A-8.8.2.2 Governor System

A-8.8.2.2.a The turbine governor shall include the following features:

A-8.8.2.2.a.1 Electro-hydraulic control system

A-8.8.2.2.a.2 Triplex, high-integrity speed monitoring channels for separate turbine control and over-speed protection.

A-8.8.2.2.a.3 Comprehensive self-diagnostic fault detection features.

A-8.8.2.2.a.4 On-load testing of all turbine steam admission valves shall be provided.

A-8.8.2.3 A Bently Nevada turbine supervisory instrumentation (TSI) system.

A-8.8.2.3.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 pushbuttons shall be installed on the trip panel in the Control Room.

A-8.8.2.4 Miscellaneous Turbine Auxiliary Systems

A-8.8.2.4.a The control of the principal turbine drains after the stop valves shall be included.

A-8.8.2.4.b Separate control groups shall provide monitoring, regulating and sequence controlling of all plant functions associated with the turbine oil systems, vacuum and gland sealing systems, condensate, cooling, and all auxiliary systems.

A-8.8.2.4.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-8.8.2.4.d The TCS shall be capable of printing on a networked printer in the Control Room.

A-8.8.2.4.e Refer to Attachment A-19 for additional instrumentation and controls requirements for the STG.

A-8.9 Balance Of Plant (BOP) Controls

A-8.9.1 General BOP Control Requirements

A-8.9.1.1 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 pumps, 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 provided for the main plant process systems.

A-8.9.1.2 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-8.9.1.2.a Steam systems (Steam supply, steam bypass system etc.)

A-8.9.1.2.b Water systems (service and demineralized)

A-8.9.1.2.c Water treatment system

A-8.9.1.2.d Generator cooling systems for combustion turbine generators and steam turbine generators

A-8.9.1.2.e Combustion Turbine inlet chiller system

A-8.9.1.2.f Condensate system

A-8.9.1.2.g Compressed air systems

A-8.9.1.2.h Fire protection system

A-8.9.1.2.i Gas detection system

A-8.9.1.2.j Hydrogen seal system (if supplied)

A-8.9.1.2.k Fuel gas system

A-8.9.1.2.l Condenser systems

A-8.9.1.2.m Independent coolers to cool plant auxiliaries

A-8.9.1.2.n Feedwater system

A-8.9.1.2.o Chemical feed systems

A-8.9.1.2.p New wastewater systems

A-8.9.1.3 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-8.9.1.3.a The Seller 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-8.9.1.4 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-8.9.1.5 The demineralized water storage tanks shall have level monitoring and inlet flow totalizers reporting in the Facility DCS.

A-8.9.1.6 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-8.9.1.7 The fuel gas systems shall be designed by the Seller for implementation in the plant Facility DCS system.

A-8.9.1.8 The feedwater system, open loop cooling water system, chemical treatment system and wastewater 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-8.9.1.9 Local systems such as sump pumps, oil water separators, and eye wash stations shall be locally controlled with status alarms wired back to the Facility DCS.

A-8.10 Requirements For Instrumentation

A-8.10.1 Instrumentation General

A-8.10.1.1 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-8.10.1.2 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-8.10.2 BOP Control and Instrumentation Signal Levels

A-8.10.2.1 The following signal levels shall be used for instrumentation and control valve actuating (other signals to the Engineer'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	48 VDC, 125 VDC and 120 VAC wetting voltages
d.	Solenoids	120 VAC/ 125 VDC

A-8.10.3 Field Mounted Instruments

A-8.10.3.1 Unless otherwise specified or approved by Buyer, all parameters (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-8.10.3.2 All field mounted electrical equipment shall be weatherproof to NEMA Type 4 or equivalent and suitable for the local ambient weather conditions.

A-8.10.3.3 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-8.10.3.4 All transmitters shall be of the indicating type or equipped with separately mounted local indicators, except transmitters in the CTG enclosure. All transmitters shall be provided with test connections and instrument isolating valve manifolds (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-8.10.3.5 Unless required by code, transmitters shall be used to the greatest extent possible in place of process type switches.

A-8.10.3.6 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 types shall be provided with isolation valves and two-valve manifolds, and float-type level switches shall be provided with isolation valves.

A-8.10.3.7 Instruments shall be grounded at the source end only, not at both ends. The cable shield shall be isolated at the instrument end.

A-8.10.4 Flow Instruments

A-8.10.4.1 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-8.10.4.2 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-8.10.4.3 Orifice plates shall be made of a material suitable for the service application.

A-8.10.4.4 The orifice beta ratio (d/D) shall be between 0.4 and 0.75 for flow control measurements.

A-8.10.4.5 Orifice meter accuracy shall conform to ASME MFC-3M specifications.

A-8.10.4.6 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-8.10.4.7 Positive displacement type meters shall be used for measuring oil flow.

A-8.10.4.8 Flow meters employing alternative measurement principles may be utilized for appropriate applications subject to the approval of the 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-8.10.4.9 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-8.10.4.10 Flowmeters for the fuel gas flow measurements for the CTGs shall meet the requirements of the EPA. A manufacturer’s calibration certificate shall be provided that shows that the flow meter meets the accuracy requirements of the EPA.

A-8.10.4.11 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-8.10.5 Level Instruments

A-8.10.5.1 Level measuring devices may be of 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 the Buyer, each measuring instrument shall be removable without the vessel or other instruments being taken out of service.

A-8.10.5.2 Level gauges shall be of the reflex type made from stainless steel bar, 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-8.10.5.3 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-8.10.5.4 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 (paddle, capacitance, sonic, etc.) when float/displacer type switches are not suitable for the application.

A-8.10.5.5 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-8.10.5.6 Float switches shall be glandless with magnetic coupling.

A-8.10.6 Pressure and Differential Pressure Instruments

A-8.10.6.1 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 ±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-8.10.6.2 Transmitters shall be used whenever possible in place of process type switches (pressure, level, flow, etc.) for all system applications.

A-8.10.6.3 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., except for CTG and STG packages. Pressure indicators on pump headers shall be provided with snubbers and shall be glycerol filled.

A-8.10.6.4 Pressure gauges shall have a weatherproof case, a solid front with blowout back, an accuracy within ±0.5% (±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-8.10.6.5 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 ±1.0% (±2.0% for TCS) full-scale indication (both up and down) or better with no leak-through.

A-8.10.6.6 Differential pressure instruments shall be capable of taking full line pressure on one side only, without damage or loss of calibration.

A-8.10.6.7 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-8.10.6.8 Pressure instruments exposed to possible vacuum shall be protected for full vacuum.

A-8.10.6.9 Diaphragm seals shall be used for slurries, corrosive fluids, and for very viscous liquids.

A-8.10.6.10 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-8.10.6.11 Siphons shall be used for pressure instruments on steam service unless a liquid filled sensing line is used.

A-8.10.6.12 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-8.10.7 Temperature Instruments

A-8.10.7.1 The method of temperature measurement to be employed shall be selected for each particular application, bearing in mind requirements for accuracy and reliability.

A-8.10.7.2 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-8.10.7.3 Thermocouple extension wire will have the same characteristics as the thermocouple. Connections shall be made to avoid cold junctions.

A-8.10.7.4 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-8.10.7.5 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-8.10.7.6 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-8.10.7.7 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.), apart from 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-8.10.7.8 All fluid system temperature sensors shall be equipped with thermowells. Thermowell 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-8.10.7.9 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-8.10.7.10 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-8.10.7.11 Sensing elements for air, inert gas, and radiant temperature measurements shall be complete with a suitable protective sheath. For steam, water, and hazardous applications, thermowells shall be utilized.

A-8.10.7.12 No temperature measuring system shall use mercury as its sensing medium.

A-8.10.7.13 Thermocouples and RTDs shall be wired directly to the Facility DCS and shall not use temperature transmitters.

A-8.10.8 Analyzers

A-8.10.8.1 Measuring instruments monitoring chemical or physical properties of process fluids and substances may be installed either directly in the process line, vessel, or at a distance and connected by means of sampling systems.

A-8.10.8.2 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-8.10.8.3 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-8.10.8.4 Sensors shall be of rugged 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-8.10.9 All instrument tagging shall agree with the approved project tagging procedure and shall be read in English units. Instrument tags shall be stainless steel and either screwed into instrument or attached to instrument by stainless steel wire.

A-8.11 Instrument Installation Requirements

A-8.11.1 Installation Responsibility

The Seller shall be responsible for the installation of all instruments furnished by the Seller as well as the Seller's sub-vendors.

A-8.11.2 General

A-8.11.2.1 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 at fixed platform level.
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-8.11.2.2 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 ultraviolent exposure and shall be provided with heaters.

A-8.11.2.3 Instrument enclosures and racks shall be designed to facilitate instrument calibration and maintenance. Local instruments shall be easily read without dismantling equipment.

A-8.11.2.4 If required, analytical detector systems mounted outdoors shall be installed in noncombustible, corrosion resistant, weatherproof enclosures.

A-8.11.2.5 The sensor and analyzer shall, where possible, be mounted near the sample point and shall be properly protected from the environment.

A-8.11.2.6 Analyzers may be installed in analyzer houses near the measuring points in-field. The temperature inside the analyzer houses shall be controlled to ensure adequate ambient condition.

A-8.11.2.7 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-8.11.2.8 In-line instruments shall be located where they shall be accessible for maintenance and servicing.

A-8.11.2.9 Instruments not mounted inline shall be located where they shall be accessible from platforms or grades. Indicating instruments shall face forward toward the normal operating area and shall be within reading distance and in the line of sight.

A-8.11.2.10 Instruments shall be mounted level and plumb, rigidly supported, and in such a manner as to provide protection from heat, shock and vibration; accessible for maintenance; and free from interference with piping, conduit, and equipment.

A-8.11.2.11 Tubing shall be installed in a neat, workmanlike manner, being properly sloped, and showing no sign of crumpling, bending with 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 manifold installations shall be in accordance with ASME B31.1, “Power Piping”.

A-8.11.2.12 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. The alarm can be wired into a heat trace panel alarm circuit.

A-8.11.2.13 Instrument tubing shall not be welded and shall be ½ inch minimum size.

A-8.11.3 Classified Areas

A-8.11.3.1 Hazardous location classes will be as per NFPA No. 70.

A-8.11.3.2 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 in a hazardous area, the design shall incorporate appropriate methods of protection.

A-8.11.3.3 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-8.11.3.4 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-8.11.3.5 If intrinsically safe systems are specified, the electronic instruments shall be certified by the appropriate agency when used with approved current limiting device.

A-8.11.3.6 All instrumentation and control devices shall be suitable for the environment where they will be located.

A-8.11.4 Personnel Protection

A-8.11.4.1 Consideration shall be given to personnel protection during the normal operation of field instruments.

A-8.11.4.2 Process sensing lines above 140°F during normal operation and readily accessible to personnel shall be provided with means to prevent direct contact in readily accessible areas.

A-8.11.5 Process Tap Connections

A-8.11.5.1 Connection to the process system shall be in accordance with each particular application. Connections shall be in accordance with the applicable Codes, piping line specifications, 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-8.11.6 Process Connection Orientation

A-8.11.6.1 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-8.11.6.2 Temperature connections shall typically be located on the top of the pipe. Temperature connections can also be located on the side or at 45º between the side and top of the pipe.

A-8.11.6.3 Level connections – varies depending upon type detector.

A-8.11.7 Pressure connections

A-8.11.7.1 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 750ºF. Connection size shall be 1" for other applications.

A-8.11.8 Flow Connections

A-8.11.8.1 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-8.11.8.2 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-8.11.8.3 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-8.11.9 Level connections

A-8.11.9.1 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-8.11.10 Instrument Sensing Lines

A-8.11.10.1 Instrument Sensing Line Material

A-8.11.10.1.a 316 stainless steel tubing, compression fittings, welded 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 900F or greater. Swagelok compression fittings shall be utilized for all other applications.

A-8.11.10.1.b Tubing wall thickness shall be determined for each installation application in accordance with ASME 931.0 based on average wall thickness.

A-8.11.10.1.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:

A-8.11.10.1.d ASTM A213 Dual Rated Grade TP316/316L, carbon content ≤0.0354% average wall, Rockwell Hardness shall not exceed 90Rb for applications of < 1,000°F.

A-8.11.10.1.e ASTM A213 TP316H for applications of > or = 1,000°F, Rockwell hardness shall not exceed 95Rb.

A-8.11.10.1.f Seamless Stainless Steel

A-8.11.10.1.g Cold Drawn Fully Annealed

A-8.11.10.1.h 20 ft. Lengths or Longer

A-8.11.10.1.i All fittings shall be ASTM A213 316/316L for application of < 1,000°F or ASTM A213 316H for applications of > or = 1,000°F.

A-8.11.10.2 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. The minimum bending radius of instrument sensing line tubing shall be three times the tube outside diameter.

A-8.11.11 Instrument Sensing Line Configuration

A-8.11.11.1 Sensing Line Routing

A-8.11.11.1.a Instrument sensing lines shall be routed as directly as practical from the process rout valve to the instrument.

A-8.11.11.1.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-8.11.11.1.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 are to have double isolation vent valves for venting while filling the condensate pot, not welded plugs.

A-8.11.11.1.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 ½ 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-8.11.11.1.b.3 Instrument primary piping for steam, liquid pressure, flow, and/or 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-8.11.11.1.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-8.11.11.1.b.5 Primary piping instrument taps shall not be located on the bottom of the pipeline.

A-8.11.11.1.b.6 Redundant transmitters and switches shall be provided with separate process connections.

A-8.11.11.1.b.7 All instruments and gauges shall have independent process connections.

A-8.11.11.2 Sensing Line Support

a. Support of tubing shall be adequate to assure that the tubing is not overstressed and to prevent sagging.
b. The preferred method of routing and supporting tubing is in tube tray.

A-8.11.12 Remotely Mounted Instruments

A-8.11.12.1 Control devices for high temperature applications or equipment in inaccessible areas shall be mounted remotely.

A-8.11.13 Freeze Protection

A-8.11.13.1 For steam or water services subject to freezing at the Project defined conditions, the following shall apply:

A-8.11.13.1.a All outdoor instrument sensing lines shall be electrically heat traced and insulated (see Attachment A-6).

A-8.11.13.1.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-8.11.13.1.c For heat traced sensing lines, heat trace cable is to be adequately rated for all process temperature conditions.

A-8.11.13.1.d Refer to Attachment A-7 for additional heat tracing design conditions and requirements.

A-8.11.14 Calibration

A-8.11.14.1 Instruments shall be calibrated or shall meet specified tolerances as defined below. Calibration and test equipment shall be traceable to the 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.) shall 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 shall 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-8.11.14.2 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-8.11.15 Pressure Testing

A-8.11.15.1 Instrument air supply lines shall be pressurized to instrument air system pressure and checked for leaks using a leak detection liquid surfactant.

A-8.11.15.2 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-8.11.15.3 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-8.11.15.4 Other sensing lines may be tested during initial service.

A-8.12 Continuous emissions monitoring system (CEMS)

A-8.12.1 General Technical Requirements

A-8.12.1.1 Required Measurements: The 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: (a) NOx volumetric concentration; (b) O2 percent; (c) CO volumetric concentration; (d) NH_3 slip and produce all required data logging and reporting as required by the Air Permit.

A-8.12.1.2 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-8.12.1.3 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-8.12.1.4 The CEMS shall be installed as an extractive system, if required by the Air Permit.

A-8.12.1.5 For NOx, O2, CO, and NH_3 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-8.12.1.5.a For a O_2 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 $\pm$ 1.0 percent O_2, determined by relative accuracy test audit (RATA) These requirements shall be included in the Seller's operator manuals and maintenance/instruction books.

A-8.12.1.5.b The NH3 concentration in the CTG Stack shall be tested or calculated according to one of the methods listed below:

A-8.12.1.5.b.1 Install, calibrate, maintain, and operate a CEMS to measure and record the concentrations of NH3.

A-8.12.1.5.b.2 Install and operate a second NO_X CEMS probe located between the duct burners and the SCR, upstream of the stack NO_X CEMS, which may be used in association with the SCR efficiency and NH3 injection rate to estimate NH3 slip.

A-8.12.1.5.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-8.12.1.5.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 O_2) of the span value, determined separately for pollutants in units of ppm and %, by calibration gas injection in accordance with Seller's operator manuals and maintenance/instruction books.

A-8.12.1.6 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 Air Permit.

A-8.12.1.7 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-8.12.1.8 The probe and all other surfaces which come into contact with the flue gas or calibration gas stream shall be glass, heavy wall 316 stainless steel, or another appropriate material.

A-8.12.1.9 All necessary tubing and hardware required for a complete installation shall be provided by the Seller.

A-8.12.1.10 The Seller shall provide controls, instrumentation, and alarms for maintenance, testing and unattended operation of the CEMS.

A-8.12.1.10.a CEMS certification shall be provided by the Seller.

A-8.12.1.10.b Each analyzer shall provide 4-20 mA hardwired outputs to the ESC 8864 Data Loggers.

A-8.12.1.10.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-8.12.1.10.d The Data Logger shall provide one independent output for each NO_x, CO, O_2, and NH_3 slip analysis. Each of the outputs shall be an isolated 4-20 mA VDC linear, analog signal capable of driving a 600-Ω (minimum) load. Individual output for each channel shall be provided.

A-8.12.1.10.e The analyzers shall measure in units:

A-8.12.1.10.e.1 NOx – ppm

A-8.12.1.10.e.2 CO – ppm

A-8.12.1.10.e.3 O_2 – %

A-8.12.1.10.e.4 NH_3 – ppm

A-8.12.1.11 The Seller shall furnish any other analyzer as called for in the operating permit for this Facility.

A-8.12.1.12 Analyzers shall be provided in accordance with the following criteria:

A-8.12.1.12.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-8.12.1.12.b Analyzers shall be scaled per EPA guidelines to measure the range of concentrations specified herein. Auto range selection capability is required.

A-8.12.1.12.c Each analyzer shall be designed for ease of manual calibration and adjustment.

A-8.12.1.12.d Each analyzer shall include a panel meter for display of monitoring data.

A-8.12.1.13 Data Acquisition and Handling System (DAHS)

A-8.12.1.13.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. The Seller shall provide the Buyer with the software, configuration, licenses, activation codes, etc. for the ESC Stack Vision software.

A-8.12.1.13.b The Data Loggers shall be connected to the Plant LAN to communicate with the DAHS server.

A-8.12.2 CEMS Enclosure

A-8.12.2.1 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. The Seller shall furnish fully redundant heating, ventilation, and air conditioning equipment for personnel comfort and equipment protection. The 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-8.12.2.2 Gas cylinders shall be enclosed in a rigid frame rack with a protective rain hood, be convenient for cylinder change out, and be mounted outside the CEMS enclosure.

A-8.12.2.3 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-8.12.2.4 The Seller shall configure the shelter so that all penetrations are on the side of the shelter closest to the stack.

A-8.12.2.5 CEMS Power Supply:

A-8.12.2.5.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 the Seller:

A-8.12.2.5.b 480V auto-transfer switch

A-8.12.2.5.c 480V to 208/120-volt transformer

A-8.12.2.5.d Heating, ventilating and air conditioning equipment.

A-8.12.2.5.e Lighting and power receptacles

A-8.12.2.5.f Power distribution panels, which shall have an interrupting capacity of 65,000 rms symmetrical.

A-8.12.2.5.g The Facility UPS electrical power supply, which shall be used for the CEMS analyzers, controllers, monitors, controls, instrumentation, and other monitoring accessory equipment.

A-8.12.2.5.h All electrical protection equipment and accessories, distribution panels, circuit breakers, etc., which shall be provided by the Seller.

A-8.12.2.6 Heating, Ventilation and Air Conditioning (HVAC):

A-8.12.2.6.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-8.12.2.6.b HVAC shall be provided to maintain the shelter's inside temperature between 68ºF and 75ºF, and 50% relative humidity the year round, with or without the inside equipment running (see Attachment A.9 for ambient weather condition requirements).

A-8.12.3 FACTORY ACCEPTANCE TESTING

A-8.12.3.1 The 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 O_2 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-8.13 Vibration Monitoring System

A-8.13.1 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-8.13.2 Vibration monitoring shall be provided for select rotating equipment deemed critical to the operational process as listed below:

- Steam Turbine/Generator
- Boiler Feed Pumps
- Combustion Turbine/Generator
- ACC Fans

A-8.13.3 Each lineup of critical equipment referenced in the previous paragraph, except ACC Fans, shall be supplied with Alta Solutions AS-7000 (preferred) or Bently Nevada 3500 (acceptable) vibration monitoring system. The ACC Fans shall be supplied with vibration sensors/transmitters, which shall be wired to the DCS.

A-8.13.4 Axial displacement shall be monitored if recommended by the equipment Subcontractor. If axial displacement is monitored, two probes shall be provided in accordance with API-670.

A-8.13.5 Each bearing shall be monitored in both the x and y directions (at 45^{o} and 135^{o} angles of the horizontal plane) and a Keyphasor will be included for each lineup.

A-8.13.6 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-8.13.7 Vibration monitoring input tagging shall be descriptive to facilitate operator identification of input equipment identity.

A-8.13.8 HRSG Ammonia Dilution (SCR) Fans bearings to be provided with vibration transducers and temperature measurements which shall be connected to Facility DCS.

A-8.13.9 The vibration monitoring package shall be perpetual, royalty free package.

A-8.13.10 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-8.14 Weather Station

Seller shall furnish and install a weather station to monitor ambient temperature, relative humidity, rain gauge, and wind gauge. These measurements shall be fed to Facility DCS and shall be available to plant operator through HMI displays.

END OF ATTACHMENT A-8

BOT Scope Book

Attachment A-9

Building and Enclosure Requirements and Design Criteria

Table of Contents

A-9.1 GENERAL

A-9.1.1 This Attachment 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-9.1.1 The final number of buildings, structures, and PDCs, and the size determination of all 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-9.1.2 Structural requirements for buildings and equipment enclosures including code references, materials, loads, and finishes are included in Attachment A-5.

A-9.1.3 Architectural requirements including code references, materials, finishes, and performance ratings are included in Attachment A-5.

A-9.1.4 Prefabricated structures, where used, shall comply with state building code requirements, including industrialized building requirements, where applicable.

A-9.1.5 Pre-engineered building, prefabricated 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 piping, conduit, and cable tray.

A-9.1.6 Mechanical and electrical equipment enclosures shall be provided for weather protection and/or for noise abatement.

A-9.1.7 Provide exterior insulated window assemblies for all occupied rooms with exterior walls.

A-9.1.8 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 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 Attachment A-8 for additional physical security requirements.

A-9.1.9 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 Attachment A-8 for additional physical security requirements.

A-9.1.10 Building and equipment enclosure HVAC system design requirements are included in Attachment A-4.

A-9.1.11 Seller to Provide Building Arrangement Drawings of all Buildings and Enclosures listed in this Attachment. 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-9.2 BUILDING AND EQUIPMENT ENCLOSURES

A-9.2.1 Control/Administration Building:

A-9.2.1.1 The building shall be a pre-engineered building with HVAC system. The building area shall be as specified per Table .A-9.2-1. 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.

A-9.2.1.2 Raised access floor systems will be provided as indicated in the Architectural Finishes schedule in A-5. Loading criteria for the access flooring is included in A-5. 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 Electrical Design Criteria for cable requirements. Coordinate locations network, power, and communication receptacles with Buyer for projectors, screens, and additional Buyer provided furniture. Provide additional blocking and support for wall mounted screens and panels. Buyer shall review and approve layout of building.

A-9.2.1.3 The building shall be designed to meet ADA requirements. Provide shower/floor drain in each toilet/ shower room.

A-9.2.1.4 The control room shall have windows looking toward the power block area. Workstations shall not be located in DCS Network Rooms.

A-9.2.1.5 Building shall have fire protection and fire detection. See Attachment A-20.

Table A-9.2-1 Control Administration

Room	Ext. Access	Sq FT	Count	Total Sq Ft	Notes
Overal 80 x 100		**8000**			
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.
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	App. 17%
Total Admin Building				**8000**	

*Building Arrangement Drawings (To Be Provided by Seller)

A-9.2.2 Warehouse and Maintenance:

A-9.2.2.1 Warehouse and Maintenance 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-9.2-2The building will have an eave height of 25'-0" minimum.

A-9.2.2.2 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.

A-9.2.2.3 Building shall have fire protection and fire detection – See Attachment A-20.

Table A-9.2-2 Warehouse and Maintenance

Room	Ext. Access	Sq. Ft.	Count	Total Sq Ft	Notes
Warehouse Overall 80x115		**9200**			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	
Warehouse Bathroom		120	1	120	
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				**9200**	

*Building Arrangement Drawings (To Be Provided by Seller)

A-9.2.3

A-9.2.4 Water Treatment Building:

A-9.2.4.1 Water Treatment Building shall be a pre-engineered building provided with heating and ventilation system. Separate enclosed electrical room shall have an independent heating and ventilation system.

Table A-9.2-3 Water Treatment Building

Exterior Access	Room	Area (SF)	Notes
Yes	Water Treatment	*	
Yes	Electrical	*	Minimum 2 egress doors, one door sized for equipment access

* Determined by Seller. Building Arrangement Drawings (To Be Provided by Seller)

A-9.2.5 HIP Steam Turbine enclosure and enclosure between LP Steam Turbine and Generator (See Attachment A-19):

Pre-engineered enclosure. Provide ventilation system.

A-9.2.6 Steam Turbine/Generator Excitation Equipment Enclosure:

Pre-engineered or pre-fabricated enclosures. Vendor supplied enclosure. Provide heating, cooling, and ventilation system.

A-9.2.7 Combustion Turbine/Generator Enclosure with noise walls (for nearfield noise compliance).

Pre-engineered enclosure. Vendor supplied enclosure Provide ventilation system.

A-9.2.8 Combustion Turbine/Generator Auxiliary Equipment Enclosure

Pre-engineered or pre-fabricated enclosures. Provide heating and ventilation system.

A-9.2.9 Steam Water Sample Enclosures

Pre-engineered or pre-fabricated enclosure. Provide heating, cooling, and ventilation system. Provide one enclosure at the STG area.

A-9.2.10 CEMS Enclosure(s):

Pre-engineered or prefabricated enclosure. Provide heating, cooling, and ventilation system.

A-9.2.11 Fire Pump House Enclosure:

Pre-engineered or pre-fabricated enclosure. Vendor supplied enclosure. Provide heating and ventilation system.

A-9.2.12 Diesel Generator Enclosure:

Pre-manufactured enclosure. Vendor supplied enclosure. Provide heating and ventilation system.

A-9.2.13 Combustion Turbine/ Generator Excitation Enclosure:

Pre-engineered or pre-fabricated enclosures. Vendor supplied enclosure. Provide heating, cooling, and ventilation system.

A-9.2.14 Combustion Turbine Control Package Enclosure:

Pre-engineered or pre-fabricated enclosures. Vendor supplied enclosure. Provide heating, cooling, and ventilation system.

A-9.2.15 PDC Buildings:

Pre-engineered or pre-fabricated enclosures. Provide heating, cooling, and ventilation system. Provide, as a minimum, one main PDC, HRSG(s) PDC, one ACC PDC, and one CCW PDC. Additional PDCs as required by Seller's design.

A-9.2.16 Closed Cooling Water Pump and Heat Exchanger Shelter:

Roof canopy only above equipment area, shelter can be pre-engineered or custom designed.

A-9.2.17 ST Lube Oil Unit Shelter:

Roof canopy only above equipment area, shelter can be pre-engineered or custom designed.

A-9.2.18 Guard Shack:

Pre-fabricated enclosure. Provide heating, cooling, and ventilation system.

A-9.2.19 Ammonia Tank and Pump Sunshades

As required

A-9.3 CRANES AND HOISTS:

At a minimum cranes and hoists shall be provided as indicated:

A-9.3.1 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.

A-9.3.2 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.

A-9.3.3 Monorails required for HRSG, combustion turbines and other equipment shall be as indicated in the respective equipment procurement specifications.

END OF ATTACHMENT A-9

BOT Scope Book
Attachment A-10
Construction Requirements

Table of Contents

A-10.1 CONSTRUCTION CONSIDERATIONS

A-10.1.1 Seller shall provide construction services in accordance with the Seller Project Execution Plan and this Specification.

A-10.1.2 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, each Subcontractor must also adhere to all Seller established EH&S Plan requirements. Safety plans shall include major events, but not limited to hurricanes and tornado. The safety plan shall include support of annual drills.

A-10.1.3 Construction execution along with environmental site planning participation between Buyer and Seller is essential and will be ongoing throughout Project execution. Upon initiation of the Project, construction execution will be an integral part of overall planning.

A-10.1.4 A layout drawing of temporary construction facilities/offices, laydown yards, security, and parking, shall be an attachment to the construction execution plan.

A-10.1.5 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-10.1.6 Source of construction water shall be determined and arranged by Seller.

A-10.1.7 Construction Constraints:

The Seller shall design and install a new process discharge for the project. Seller is not able to release at the new process discharge outfall until permit is completed.

A-10.2 ENVIRONMENTAL REQUIREMENTS

A-10.2.1 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 who shall reach agreement with the Buyer, local Government Authorities, and the local sewage company with regard to the detailed methods of disposal.

A-10.2.2 Buyer will obtain a new NPDES 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. The Seller is responsible for providing Water Balances.

A-10.2.3 The Seller shall dispose of above ground and underground flushing and testing water offsite. The Seller shall dispose the boiler hydro discharge water offsite.

A-10.2.4 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 shall 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 LPDES.

A-10.2.5 The Seller shall not commence construction activity prior to receipt of the written notification of approval of permit coverage by the Buyer.

A-10.3 HAZARDOUS MATERIALS AND HAZARDOUS WASTE

A-10.3.1 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-10.3.2 Seller shall comply with applicable Law, Contract requirements, and Buyer's policy requirements concerning the removal and disposal of all hazardous material/waste.

A-10.3.3 Removal, transport, and disposal of hazardous materials, including asbestos, are the responsibility of the Buyer.

A-10.3.4 Disturbance of and exposure to asbestos, lead, and all other hazardous materials involves certain health, safety, and environmental risks.

A-10.3.5 Seller shall abide by all Buyer's hazardous materials and waste requirements and policies.

A-10.3.6 Asbestos and Lead Awareness:

A-10.3.7 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-10.3.8 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-10.4 DISPOSAL

A-10.4.1 Disposal of all waste resulting from the Work shall be per applicable Law.

A-10.5 TRAFFIC, NOISE, DUST, OVER-SPRAY ABATEMENT AND MITIGATION MEASURES; OTHER RESTRICTIONS DURING CONSTRUCTION

A-10.5.1 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-10.5.2 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-10.5.3 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-10.5.4 Contract shall provide any necessary improvements to the site access roads to facilitate their work and deliveries.

A-10.6 SELLER PARKING

A-10.6.1 Seller parking of vehicles shall be restricted to the Seller Parking Area as approved by the Buyer. Seller is responsible for maintaining the Seller Parking Area.

A-10.6.2 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-10.7 TEMPORARY FACILITIES

A-10.7.1 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 trailers and a double wide trailer to site for Buyer use during construction. Seller shall supply power and water to Buyers trailers.

A-10.7.2 Seller shall provide all required temporary facilities needed by the Seller for the duration of the Project

A-10.7.3 Seller shall provide temporary potable bathrooms and hand washing stations for all construction personnel. Seller shall service, clean, pump out and dispose as necessary.

A-10.7.4 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-10.7.5 Seller shall install and supply internet and associated fiber installation to bring the internet to the Seller's 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-10.7.6 Seller shall provide space and power connection (cable, conduit, etc.) for six (6) connex for Buyer Equipment storage.

A-10.8 NOISE ABATEMENT

A-10.8.1 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-10.9 TURNOVER WALKDOWNS

A-10.9.1 Seller shall conduct and lead construction to commissioning and commissioning to Buyer completion system walkdowns as a presentation of the system for acceptance by the Buyer.

A-10.9.2 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-10.9.3 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-10.9.4 For equipment, components and materials damaged during the construction process, see requirements for remedy and resolution in Agreement Terms and Conditions.

A-10.10 MASTER DEFICIENCY LIST (PUNCHLIST)

A-10.10.1 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-10.10.2 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-10.10.3 Priority A: Must be completed prior to acceptance of Mechanical Completion.

A-10.10.4 Priority B: Must be completed prior to acceptance of Substantial Completion.

A-10.10.5 Priority C: Must be completed prior to Final Acceptance.

A-10.10.6 Priority D Other - commercial / Buyer requested items.

A-10.10.7 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-10.11 CONSTRUCTION TURNOVER (CTO) DOCUMENTATION

A-10.11.1 Seller will scope drawings to define system turnover boundaries and will include Drawings and Engineering Lists.

A-10.11.2 Seller shall document all construction checkout, quality assurance/quality control and testing results.

A-10.11.3 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.B.1	Pile / Pier Installation Reports (if self-performed)
2.B.2	Pile / Pier Installation Reports (if subcontracted)
B	Special Inspection Reports (3rd Party)
2.C.1	Special Inspection Reports (if applicable)
C	Material Test Report's
2.D.1	Material Test Reports (Steel or Rebar)
D	Concrete Placement & Batch Tickets
2.E.1	Concrete Placement Form
2.E.2	Batch Ticket Reports
E	Compressive Strength Results
2.F.1	Compressive Test Result Log
2.F.2	Compressive Test Result Form (28 Day results)
F	As-built Information
2.G.1	As-built Information

Section 3	RETAINING WALLS – As Applicable
A	Installation Reports
3.B.1	Pile / Pier Installation Reports (if self-performed)
3.B.2	Pile / Pier Installation Reports (if subcontracted)
B	Special Inspection Reports (3rd Party)
3.C.1	Special Inspection Reports (if applicable)
C	Material Test Report's
3.D.1	Material Test Reports (Steel or Rebar)
D	Proof Test Reports
3.E.1	Proof Test Reports
E	Concrete Placement & Batch Tickets
3.F.1	Concrete Placement Form
3.F.2	Batch Ticket Reports
F	Compressive Strength Results
3.G.1	Compressive Test Result Log
3.G.2	Compressive Test Result Form (28 Day results)
G	As-built Information
3.H.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-10.12 SYSTEM TURNOVER PACKAGEs (STPs) DOCUMENTATION

A-10.12.1 Seller shall combine completed CTO documentation organized by system with their STPs for submittal to the Buyer.

A-10.12.2 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-10.12.3 Seller shall provide NERC FAC-008 supporting information documentation 60 days prior to back-feed.

A-10.12.4 Seller shall provide testing documentation for batteries/relays/PTs/CTs testing utilizing NERC nomenclature and parameters.

A-10.12.5 All documentation shall be reviewed and accepted by Buyer prior to acceptance of the system by Buyer.

A-10.12.6 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 (Form) (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	Office 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	FIELD COMMISSIONING REPORTS
	Description
A	Vendor and Seller 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-10.13 CONSTRUCTION STARTUP, TESTING AND CHECKOUT, AND COMMISSIONING TESTS

A-10.13.1 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-10.13.1.1.a 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-10.13.1.1.b The testing shall be performed by the Seller in coordination with the suppliers or in accordance with supplier instructions and under Buyer reviewed test procedures administered by the Seller.

A-10.13.1.1.c The Seller shall provide the means for the Buyer to access, observe and visually confirm proper operation of all equipment and systems.

A-10.13.1.1.d 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-10.13.2 The Seller shall provide functional testing and initial operation of all components, equipment, and systems.

A-10.13.2.1.a 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-10.13.2.1.b 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-10.13.2.1.c 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-10.13.3 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-10.13.4 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-10.13.5 Seller shall identify requirements for fuel gas and provide daily usage to the Buyer through Substantial Completion.

A-10.14 QUALITY ASSURANCE & QUALITY CONTROL (QA/QC)

A-10.14.1 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-10.14.2 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-10.14.3 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, whether performed in its or its Subcontractors' facilities.

A-10.14.4 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-10.14.4.1 Welding Procedure Specifications (WPS) and the corresponding Procedure Qualification Records (PQR).

A-10.14.4.2 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-10.14.4.3 Cleaning, painting, storage, packaging, and shipping procedures. Seller shall attach the Safety Data Sheets (SDS) with all painting/coating procedures.

A-10.14.4.4 Nondestructive examination (NDE) procedures.

A-10.14.4.5 Other special processes and procedures, such as heat-treating, pipe bending, flushing, etc.

A-10.14.4.6 Welder certification records and continuity logs shall be made available to Buyer upon request.

A-10.14.5 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-10.14.6 Quality documents, such as but not limited to the ones listed below, shall be submitted as required by Buyer for review and acceptance:

A-10.14.6.1 Material certifications, including filler metal certifications.

A-10.14.6.2 Inspection check sheets and nondestructive examination records.

A-10.14.6.3 Test records including construction and installation records.

A-10.14.6.4 Manufacturer's data reports (Form-U), material safety data sheets, etc.

A-10.14.6.5 Copies of all deviation reports/non-conformance reports and dispositioning records.

A-10.14.6.6 Non-Conformance procedure

A-10.14.6.7 Certificate of conformance.

A-10.14.7 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-10.14.8 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-10.14.9 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-10.15 OPERATION AND MAINTENANCE TRAINING

A-10.15.1 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 the start of Commissioning. Training that is not able to be completed by the 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-10.15.2 The objective of the Training Program is to train the Buyer's personnel to be qualified 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 to be limited to the following:

- System Descriptions and Control Narratives
- Piping and Instrument Diagrams (P&ID) and Electrical One Lines
- Seller 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-10.15.3 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-10.15.4 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 Wastewater Treatment – Oily Water Separation
- Fuel Gas Supply System
- Ammonia Storage and Supply
- Ammonia Dilution Fans and SCR
- HRSG
- 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 Operation
- Combustion Turbine Maintenance
- Combustion Turbine Hands-on Control System
- Combustion Turbine Generator
- Combustion Turbine 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 Operation
- Steam Turbine Maintenance

- Steam Turbine Hands-on Control System
- Steam Turbine Generator
- Steam Turbine 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 –Hands-on Operation
- DCS –Hands-on Data Acquisition
- DCS –Hands-on Logic Building
- DCS –Hands-on Graphics Building
- DCS –Hands-on Troubleshooting
- DCS –Hands-on AMS Device Manger and ValveLink™
- Integrated Startup and Shutdown

A-10.16 SYSTEM OPERATING PROCEDURES

A-10.16.1 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
- Ambient Startup Procedure 1x1
- Shutdown Procedure 1x1
- Emergency Shutdown 1x1
- Islanding
- 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 (MV) Electrical Switching
- 480V (LV) Electrical Switching
- 6900V (MV)Racking (Remote & Manual)
- 480V (LV) 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 Valve Calibration
- Combustion Turbine IGV 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
- 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 ATTACHMENT A-10

BOT Scope Book
Attachment A-11
Terminal Points

Attachment to be inserted by Bidder as part of Proposal

BOT Scope Book
Attachment A-12
Division of Responsibilities

Attachment to be inserted by Bidder as part of Proposal

BOT Scope Book
Attachment A-13
Equipment Labeling and Signage Procedure

Table of Contents

1.0 PURPOSE

This procedure provides numbering conventions to be used for equipment and documents on Capital Projects New Generation projects. This is a guidance document. The EPC contractors should prepare a project specific number procedure for the project based on this standard guideline.

2.0 SCOPE and APPLICABILITY

This procedure generally applies to Balance of Plant (BOP) equipment and document numbering. In general, BOP vendor supplied equipment will follow the equipment numbering and functional description conventions herein, and the BOP vendor drawing numbering will follow the BOP vendor's standard numbering conventions.

The following exceptions and clarifications for substation (transmission) equipment, Major Equipment (CTGs, HRSGs and STG), and BOP vendor supplied equipment.

2.1 Transmission

Substation circuit breakers, disconnects, transformers, busses, devices, etc. in the GSU high voltage area will follow the guidance in this document. Substation equipment in the point of interconnection switchyard will follow Entergy Transmission standards and numbering will be assigned by Entergy Transmission Engineering.

2.2 Major Equipment Suppliers (Power Island Equipment)

The CTG and STG equipment numbering will follow the Original Equipment Manufacturer

(OEM) standard plant identification numbering system. Mitsubishi will incorporate the Entergy Unit numbering, north/south, west/east, and top/bottom equipment numbering requirements herein. The Major Equipment drawing numbering and functional description conventions will follow the OEM's standard drawing numbering and functional description conventions. The equipment numbering requirements in this procedure will apply to the HRSGs.

3.0 NUMBERING

3.1 General Numbering Conventions

The following is the general philosophy for numbering plant equipment, components, I/O points, documents and files.

3.1.1 Alphabetic characters A, B, C, etc., shall be used for parallel or redundant equipment numbering suffixes. Parallel or redundant equipment shall be numbered from Plant North to South, and from Plant West to East, with North/South taking precedence over West/East. When equipment is in the same plant northing and easting coordinates at different elevations, Top shall take precedence over Bottom.

3.1.2 Equipment functional descriptions must be unique and capable of clearly describing a particular device or piece of equipment without the use of additional information. The equipment number will serve as additional information for independent verification but must not be relied upon as the sole means of identification.

3.1.3 Where complete functional descriptions cannot be shown due to size limitations, abbreviations may be used. Abbreviations shall be clear and consistent throughout the project. An index of functional description abbreviations shall be added to applicable project lists.

3.1.4 Functional descriptions shall be developed for equipment that appears on the mechanical or electrical equipment lists, I/O points, and drawings with assigned numbers using the following guidelines. The functional descriptions will be included in the applicable equipment and drawing lists.

3.1.5 Names shall be based on the natural hierarchy of the plant components, beginning with the generating unit number, major train, or subdivision if applicable, followed by the description.

3.1.6 Subcomponents will carry the descriptor for the parent component, then supplemented as required to describe the subcomponent.

3.1.7 Characters for designations, as part of the name, shall use alternating numeric and alpha characters as required to work through the parent, child and, if required, grandchild designations, beginning with a numeric character for the generating unit number.

3.1.8 For parallel or redundant equipment description names, equipment shall be named with the same suffix as its equipment number (A, B, C, etc.).

3.1.9 The CTG and STG equipment functional descriptions will follow the OEM’s standard functional description convention while other equipment vendors will follow the functional description convention herein.

Other components that do not appear on the mechanical or electrical equipment lists may use simplified descriptions.

3.2 Convention and Numbering Rules

If the numbering segment of an equipment number or document number is alphabetical, the values from Section 4 shall be followed, and the entire field does not need to be filled. Alphabetic examples:

3.2.1 Valve code is listed as VVV but may be filled by V or any of the three-character valve codes.

3.2.2 A, B, C, etc. character indicating redundant equipment shall be omitted if no redundant equipment is present. The alphabetic letters I, O, Q, or X, shall not be used to indicate redundant equipment.

3.2.3 If the numbering segment of an equipment number or document number is numeric and there is no expressly intended value to fill the required number of fields, add a leading zero(s) except as indicated below and within this procedure. Numeric examples:

3.2.3.1 Unique number sequence XXXX may be filled by 1234 or 0001 rather than 1234 or 1.

3.2.3.2 A revision ZZ may be filled by 1 rather than 01.

3.2.3.3 A sheet may be Sheet 1 rather than Sheet 01.

3.2.3.4 Sheets are not included as part of document numbers but shall appear, if used, on documents, drawings, and lists. Filenames shall include sheet numbers per Section 3.

3.3 Equipment Numbering

3.3.1 Equipment, Specialty, and Pipe Support Numbers

This section applies to all equipment not explicitly covered by other Sections. Motors shall carry the same sequential number as the driven equipment.

Format: AA-BBB-EEE-XXXXY
Where:

AA = Unit number (See Table 5-2).

BBB = System code (See Table 5-4).

EEE = Equipment code (See Table 5-5).

XXXX = Unique numeric identifier assigned sequentially to groups defined by the preceding number attributes. Leading zeros shall be kept.

Y = Optional (blank if not used) sequential letter for parallel or duplicate equipment (A, B, C, etc.).

Equipment Number and Functional Description Examples:

1A-FWS-P-0001A (Unit 1A Feedwater Pump A)

1C-CNM-T-0001 (Unit 1C Steam Turbine Vacuum Drains Tank)

3.3.2 Pipeline Number

Format: AA-BBB-XXXXYZ
Where:

AA = Unit number (See Table 5-2).

BBB = System code (See Table 5-4).

XXXX = Unique numeric identifier assigned sequentially to groups defined by the preceding number attributes. Leading zeros shall be kept.

Y = Optional sequential letter for parallel flow paths (A, B, C, etc.).
Z = Optional sequential letter for changes in pipe within the same flow path (A, B, C,etc.).

Pipeline Number Examples:

1A-FWS-0002AB (Unit 1A Feedwater Pump A Suction Second Pipe Segment)

1C-CRS-0001 (Unit 1C Cold Reheat)

Line sizes will be shown along with pipeline numbers on drawing tags but are not part of the actual pipeline number.

3.3.3 Manual Valve Number

Format: AA-BBB-V-XXXXY
Where:

AA = Unit number (See Table 5-2).

BBB = System code (See Table 5-4).

V = Manual Valve

XXXX = Unique numeric identifier assigned sequentially to groups defined by the preceding number attributes. Leading zeros shall be kept.

Y = Optional (blank if not used) sequential letter for parallel or duplicate valves (A, B, C, etc.).

Valve Number Examples:

1A-FWS-V-0002A (Unit 1A Feedwater Attemperating Water Supply)

1C-CNM-RV-0001 (Unit 1C Condensate Level Transmitter Root Valve)

3.3.4 Control and Actuated Valves

Format: AA-BBB-VVV-XXXX
Where:

AA = Unit number (See Table 5-2).

BBB = System code (See Table 5-4).

VVV = Control and Actuated Valve Type (See Table 5-10)

XXXX = Unique numeric identifier tag number blocks assigned sequentially to groups defined by the Plant Unit Number (See Table 5-12).

Valve Number Examples:

1A-FWS-MOV-5101 (Unit 1A Feedwater Pump Discharge Motor Operated Valve)

1C-CNM-FCV-5342 (Unit 1C Condensate Flow Control Valve)

10-FPS-LCV-5001 (Fire Protection Tank Level Control Valve)

3.3.5 Instrument and Control Device Number

Instruments that are part of valves, equipment, dampers, etc., share the same sequential number as its parent component, wherever possible.

Format: AA-BBB-EEEE-XXXXY
Where:

AA = Unit number (See Table 5-2).

BBB = System code (See Table 5-4).

EEEE = Instrument identifier (See Table 5-7).

XXXX = Unique numeric identifier assigned sequentially to groups defined by the preceding number attributes. Leading zeros shall be kept.

Y = Optional sequential letter for parallel or duplicate devices (A, B, C, etc.).

Instrument and Control Device Number Examples:

1A-FWS-FIT-0002A (Unit 1A Feedwater Pump A Flow Indicating Transmitter A)

1C-CNM-LIT-0001 (Unit 1C Condensate Level Indicating Transmitter)

3.3.6 DCS I/O Tag Number

Input/Output (I/O) tagging for equipment and instrumentation will use the equipment/instrument tag as the base of the I/O tag, including dashes. A suffix will be added to denote the I/O function.

Format: AA-BBB-EEEE-XXXX-YYY
Where:

AA-BBB-EEEE-XXXX = Associated equipment/instrument code including unit number.

YYY = I/O Function Suffix (See Table 5-8).

I/O Tag Number Examples:

1A-FWS-P-0001A-ZA (Unit 1A Feedwater Pump A Running)

1C-CNM-LIT-0001 (Unit 1C Condensate Level)

1C-CNM-LIT-0001-LA (Unit 1C Condensate Level Low Alarm)

3.3.7 Cable Numbers

Format: AA-BBB-XXXXYZZ
Where:

AA = Unit number (See Table 5-2).

BBB = System code (See Table 5-4).

XXXX = Unique numeric identifier assigned sequentially assigned. Restart at 0001 for change in preceding number attributes.

Y = Electrical Service Code (See Table 5-9).

ZZ = Cable Sequence Number (11 thru 99).

Cable Number Examples:

1A-FWS-0001M11 (Unit 1A Feedwater System Medium Voltage Power Cable 11 on Schematic Diagram OCT-1A-ES-FWS-0001)

10-CCW-0002C15 (Unit 10 Closed Cooling Water System Control Cable 15 on Schematic Diagram OCT-10- ES-CCW-0002)

3.3.8 Raceway Number

Format: AARRSXXXXYY
Where:

AA = Unit number (See Table 5-2).
RR = Raceway code (See Table 5-11)
S = Service code (See Table 5-9).

XXXX = Designator numeric.

YY = Optional (blank if not used) alphabetical letters (A, B, C, etc.).

Raceway Number Examples:

1ATC0002 (Unit 1A Cable Tray 600 V Control)

1CTL0005 (Unit 1C Cable Tray 600 V Power)

3.4 <u>Document Numbering</u>

3.4.1 Default Document Number

Format: PPP-AA-CC-BBB-XXXX
Where:

PPP = Plant identifier (See Table 5-1).

AA = Unit number (See Table 5-2).

CC = Engineering discipline and description (See Table 5-3).

BBB = System code (See Table 5-4) for system documents or FFF = plant area (See Table 5-6) for physical- oriented documents.

XXXX = Unique numeric identifier assigned sequentially to groups defined by the preceding number attributes except as noted in Section 2.3.1.1. Leading zeros shall be kept.

Note: It is preferred to not use sheet numbers; but if needed, drawing sheet numbers may be used. The sheet number shall not be part of the drawing number. Sheet number format shall be “Sheet 1”, “Sheet 2”, “Sheet 3”, etc. Do not use “Sheet 1 of 2”, etc.

Examples:

OCT-10-GA-000-0001 (OCAPS Unit 10 General Site Plan)

OCT-1C-MC-CRS-0001 (OCAPS Unit 1C Cold Reheat System Calculation)

3.4.2 Isometric Document Number

XXXX unique identifiers shall follow the same XXXXYZ as the pipeline on the isometric. The Z character, where applicable, is not part of the isometric drawing number.

Examples:

OCT-1A-FWS-0002A (OCAPS Unit 1A Feedwater Pump A Suction Isometric)

OCT-1C-CRS-0001 (OCAPS Unit 1C Cold Reheat Isometric)

3.4.3 Document Revisions

Revisions are not included as part of document numbers but shall appear on documents, drawings, and lists. Alphabetic letters “A” through “Z” shall be used for preliminary, comment, and bid (except specifications) revisions (except for I, O, Q, or X, which shall not be used). The first revision of a non-preliminary document shall be numeric “0” for documents released for bid (specifications), construction, fabrication, permit, or purchase”. Subsequent revisions shall be “1” through “99”. Leading zeros shall be omitted for numeric revisions.

4.0 FILE NAMING

4.1 Document And Drawing Deliverable File Naming

Format: DOCUMENTNUMBER SH YY REV ZZ.FILETYPE
Where:

DOCUMENTNUMBER = Document number (See Section 2.3).

SH = Optional sheet (SH).

YY = Optional sheet number (See Section 2.3).
REV = Revision (REV).

ZZ = Revision number (See Section 2.1).
FILETYPE = File type (Such as PDF)

Examples:

OCT-10-GA-000-0001 REV 0.PDF (OCAPS Unit 10 Common General Site Plan Rev 00)

OCT-1A-FWS-0002A SH 1 REV A.PDF (OCAPS Unit 1A Feedwater Pump A Suction Isometric Sheet 1 Rev A)

5.0 TAG ID CODES

The following tables provide the valid codes for use on the formatted tags/numbers detailed in previous sections.

Table 5-1 – PPP = Plant Identifier

Plant Code	Plant Code Description
XXX	Three letter identifier for the plant – provided by Entergy.

Table 5-2 – AA = Unit Number

Unit Code	Unit Code Description
10	Not Applicable or Common to Project Site
1A	Unit 1A Combustion Turbine/HRSG)
1B	Unit 1B Second Combustion Turbine/HRSG (if used, i.e., for 2x1 CCCT)
1C	Steam Turbine
Unit Code	**Unit Code Description**
Note:	Documents which are common to Unit 1A and 1B are to use "1A". A note should then be added to the document indicating that it applies to both 1A and 1B. Tags that are common to Unit 1A and 1B are to use "1A

Table 5-3 – CC = Engineering Discipline

Discipline Code	Discipline Code Description
Architectural	
AA	PLANS, SECTIONS, ELEVATIONS

AD	DETAILS
AE	EVALUATIONS, STUDIES, AND REPORTS
AI	INDEX, SYMBOLS, LISTS, NOTE, ETC.
AS	SCHEDULES
Civil	
CC	CIVIL CALCULATIONS
CE	EVALUATIONS, STUDIES, AND REPORTS
CI	INDEX, SYMBOLS, LISTS, NOTES, ETC.
CP	PLAN & PROFILE
CR	ROADS
CS	CIVIL SURVEY
CU	UTILITIES (SEWERS, DRAINS, STORM WATER)
CY	PLANS, PONDS, EARTHWORK, SITE SURFACING
ELECTRICAL	
EA	ELECTRICAL EQUIPMENT ARRANGEMENT/INSTALLATION DRAWINGS
EB	CABLE TRAY LAYOUTS (RACEWAY, EXPOSED CONDUIT)
EC	ELECTRICAL CALCULATIONS
ED	DESIGN SHEETS, ELECTRICAL CONSTRUCTION FACILITIES (SKETCHES, DESIGN)
EE	EVALUATION, STUDIES, AND REPORTS
EF	FIRE PROTECTION
EG	GROUNDING PLANS, LIGHTNING PROTECTION, MISC.
EU	ELECTRICAL UNDERGROUND AND PLANS, UNDERGROUND & EMBEDDED CONDUIT, DUCT BANKS AND MANHOLES
EI	INDEX, SYMBOLS, NOTES, CABLE TABULATION, LISTS, LEGENDS AND STANDARDS
EJ	CATHODIC PROTECTION
EL	LIGHTING PLANS AND DETAILS
EM	ALL ONE LINE DIAGRAMS, THREE LINE DIAGRAMS AND PHASING AND SYNCHRONIZING DIAGRAMS
ES	SCHEMATICS AND WIRING
EY	ELECTRICAL SYSTEM DESCRIPTIONS
EZ	NETWORK COMMUNICATIONS, PHONES, AND INTERNET
FIRE PROTECTION	
FP	EVALUATIONS, STUDIES, AND REPORTS

Discipline Code	**Discipline Code Description**
GENERAL PURPOSE	
GA	ARRANGEMENTS (MAJOR EQUIPMENT, PROPERTY, SITE, PLANT LAYOUT)

GC	GENERAL CALCULATIONS
GD	DESIGN CRITERIA
GE	EVALUATIONS, STUDIES, AND REPORTS
GM	COMPOSITE DRAWINGS
GG	GEOLOGY
GI	GENERAL, INDEX, SYMBOLS, LISTS, NOTE, ETC.
INSTRUMENTATION	
JA	INSTRUMENT LOCATIONS, CONTROL AND COMPUTER ARRANGEMENTS, LOGIC ROOM ARRANGEMENTS
JC	CONTROL LOGIC NARRATIVES, LOGIC DIAGRAMS, LOGIC MACROS
JD	INSTRUMENT INSTALLATION DETAILS
JE	EVALUATIONS, STUDIES, AND REPORTS
JI	INDEX, SYMBOLS, LISTS, NOTES, ETC.
JN	CONTROL NETWORK ARCHITECTURE DRAWINGS
JS	INSTRUMENT DATA SHEETS
MECHANICAL	
MA	MECHANICAL EQUIPMENT LOCATION DRAWINGS
MC	MECHANICAL CALCULATIONS
MD	MATERIALS HANDLING
ME	EVALUATIONS, STUDIES, AND REPORTS
MF	FLOW DIAGRAMS, P&IDS, INCLUDING SYMBOLS AND PFD/P&ID INDEX
MH	PIPE SUPPORTS
MI	INDEX, SYMBOLS, LISTS, NOTES, ETC.
MM	HVAC, INCLUDING DUCTWORK AND SCHEDULES
MP	PIPING (DOES NOT APPLY TO ISOMETRICS)
MS	SYSTEM DESCRIPTIONS
MT	MECHANICAL TOOLED PARTS
MV	MECHANICAL EQUIPMENT (VENDOR DRAWINGS)
PLANNING/PERMITTING	
P	GENERAL PLANNING/PERMITTING
PC	PLANNING/PERMITTING CALCULATIONS
PE	EVALUATIONS, STUDIES, AND REPORTS
STRUCTURAL	
SC	STRUCTURAL CALCULATIONS
SE	EVALUATIONS, STUDIES, AND REPORTS
SF	CONCRETE (FOUNDATIONS)
SG	GENERAL AND MICELLANEOUS DRAWINGS, DETAILS
SI	INDEX, NOTES, ETC.
SP	PLASTIC

SS	STEEL
SW	WOOD

Table 5-4 – BBB = System

System Code	System Code Description
AFS	AQUEOUS AMMONIA
AIC	AIR INLET COOLING SYSTEM
ARC	CONDENSER VACUUM SYSTEM
ASF	AUXILIARY STEAM SYSTEM
BYS	BATTERY – 125V – STATION
CCW	CLOSED COOLING WATER SYSTEM
CEM	CONTINUOUS EMISSIONS MONITORING SYSTEM (CEMS)
CNC	CONDENSATE - CHEMICAL TREATMENT
CNM	CONDENSATE SYSTEM
COR	COMMUNICATION – PORTABLE RADIO
COT	COMMUNICATION - TELEPHONE SYSTEM
CRS	COLD REHEAT SYSTEM
CTS	COMBUSTION TURBINE SYSTEM
CTV	COMMUNICATIONS – CLOSED TV
CUS	STORM WATER SYSTEM
CWC	CIRCULATING WATER CHEMICAL TREATMENT
CWS	CIRCULATING WATER - SYSTEM
DCM	MISC CONTROLS/COMPUTERS
DCS	DISTRIBUTED CONTROL SYSTEM
DEM	PLANT DRAINS
DFS	DIESEL FUEL SYSTEM
DGS	DIESEL GENERATOR SYSTEM
DWS	POTABLE WATER SYSTEM
EHC	ELECTRO - HYDRAULIC CONTROL SYSTEM (STG)
ESE	480V OR 208/120V ESSENTIAL POWER
ESF	120V OR 120/208V UPS POWER
ESG	125VDC ELECTRICAL
ESH	120/240V OR 208/120V NON-ESSENTIAL POWER - PROCESS
ESL	208/120V NON-ESSENTIAL POWER - LIGHTING
ESP	ELECTRICAL SYSTEM PROTECTION
ESY	480/277V NON-ESSENTIAL POWER - LIGHTING
EXS	GENERATOR EXCITATION SYSTEM
FGS	FUEL GAS SYSTEM
FPS	FIRE PROTECTION, DETECTION, AND ALARM SYSTEM
FWS	FEEDWATER SYSTEM
GCH	GAS -HYDROGEN SYSTEM
GDL	GROUNDING AND LIGHTNING PROTECTION

GMS	GENERATOR, MAIN-SYSTEM
GOX	OXYGEN INJECTION SYSTEM
GNO	GAS – CARBON DIOXIDE SYSTEM
GSC	GAS – CARBON DIOXIDE SYSTEM
HRS	HOT REHEAT SYSTEM
HTS	HEAT TRACING – SYSTEM
HVA	HEATING AND VENTILATING SYSTEM
HVC	AIR CONDITIONING SYSTEM
IAS	INSTRUMENT AIR SYSTEM
System Code	**System Code Description**
IPS	INTERMEDIATE PRESSURE STEAM
LAN	LOCAL AREA NETWORK
LAV	LIGHTING, AIRCRAFT WARNING
LPS	LOW PRESSURE STEAM SYSTEM
LTG	LIGHTING
MBL	HRSG (BOILER) BLOWDOWN
MBS	HEAT RECOVERY STEAM GENERATOR (HRSG)
MHS	MAT HANDLING (CRANES, HOISTS, ETC)
MSS	HIGH PRESSURE STEAM SYSTEM
NBS	NITROGEN BLANKETING SYSTEM
NJS	480 V SYSTEM
NOS	6900 V SYSTEM
NPS	13.8 KV SYSTEM
NQS	21 KV SYSTEM
OWS	OIL-WATER SEPARATION SYSTEM
PCS	CATHODIC PROTECTION SYSTEM
RWC	RAW WATER CHEMICAL TREATMENT
RWS	RAW WATER SYSTEM
SDS	STEAM DRAINS SYSTEM
SEC	PLANT SECURITY
SFC	STATIC FREQUENCY CONVERTER
SLB	STEAM LINE BLOW-OUT SYSTEM
SSS	SAMPLING SYSTEM
STC	STEAM TURBINE SYSTEM
SWC	SERVICE WATER CHEMICAL TREATMENT
SWS	SERVICE WATER SYSTEM
TSW	SANITARY WASTE SYSTEM
UFS	ULTRAFILTRATION SYSTEM
WPS	WELDING POWER RECEPTACLES
WTD	DEMINERALIZED WATER SYSTEM
WWT	WASTEWATER SYSTEM

YVA	138 KV SYSTEM
YWA	230 KV SYSTEM
ZZZ	MISCELLANEOUS
000	GENERAL. FOR USE ON GENERAL SYSTEM DRAWINGS SUCH AS P&ID SYMBOL SHEETS.

Table 5-5 – EEE = Equipment, Piping Specialty, and Pipe Support Code

Equipment Code	Equipment Code Description
ACD	AIR VOLUME TANK
ACU	AIR CONDITIONER
AF	AFTER FILTER
BAT	BATTERY
BKR	BREAKER
BL	BLENDER
BLW	BLOWER
CAB	CABINET
CDU	CONDENSING UNIT (HVAC)
CHGR	CHARGER
CHL	CHILLER
CLT	COOLING TOWER
CND	CONDENSER
COM	COMPRESSOR
CP	AUXILARY (CONTROL) PANEL
CRN	CRANE HOIST
CYC	HYDROCYCLONE
DEMN	DEMINERALIZER
DRV	DRIVE - VFD
DRY	DRYER
DSW	DISCONNECT SWITCH
ENC	ENCLOSURE
EDU	EDUCTOR
EFN	EXHAUST FAN
EDG	EMERGENCY DIESEL GENERATOR
ENG	ENGINE
ESP	ELECTRICAL EQUIPMENT SPECIALTIES (NOT OTHERWISE COVERED BY THIS LIST)
FDR	FEEDER
FLT	FILTER
FN	FAN
FOPP	FIBER OPTIC PATCH PANEL

FX	FIRE EXTINGUISHER
GE	GENERAL EQUIPMENT
GEN	GENERATOR
HEX	HEAT EXCHANGER
H	HEATER
HOP	HOPPER
HRSG	HEAT RECOVER STEAM GENERATOR
HYD	HYDRANT
IPB	ISOPHASE BUS DUCT
JB	JUNCTION BOX - WELD RECEPT
LVR	LOUVER
M	MOTOR
MCC	MOTOR CONTROL CENTER
MEL	MIST ELIMINATOR
MFD	PIPING MANIFOLD
MH	PIPE SUPPORTING ELEMENTS INCLUDING HANGERS, SUPPORTS, SNUBBERS, RESTRAINTS, ETC.
MHO	MANHOLE
MXR	MIXER
MSP	MECHANICAL SPECIALTIES (NOT OTHERWISE COVERED BY THIS LIST)
OWS	OIL WATER SEPARATOR
P	PUMP
PF	PRE-FILTER
Equipment Code	**Equipment Code Description**
PSP	PIPING SPECIALTIES (TRAPS, HOSES, EXPANSION JOINTS, RESTRICTION ORIFICES, Y-PATTERN OR
PDC	POWER DISTRIBUTION CENTER
PNL	PANELS (ELECTRICAL, DISTRIBUTION, FIRE DETECTION, ETC.)
RAK	RACK
RLY	RELAY
SCL	COOLER (STEAM)
SCR	SCREEN
SCRP	SCRAPER
SKD	SKID
SLR	SILENCER
SLU	SANITARY LIFT STATION
SMP	SAMPLE PANEL
SSP	OIL ACCUMULATOR
ST	STEAM TURBINE
STN	STRAINER
SUM	SUMP

SWG	SWITCHGEAR
SWR	SAFETY EYEWASH/SHOWER
T	TANK
TGR	TURNING GEAR
TRP	STEAM TRAP
UHE	UNIT HEATER (AREA HEATER)
UPS	UPS
VAC	VACUUM CONVEYOR
VAV	TERMINAL UNIT (HVAC)
VPR	VAPORIZER
WR	WELD RECEPT
XFM	TRANSFORMER

Table 5-6 – FFF = Plant Area Code

Plant Area Code	Plant Area Code Description
000	GENERAL
001	NORTH YARD
002	EAST YARD
003	SOUTH YARD
004	WEST YARD
100	POWER BLOCK UNDERGROUND
111	HRSG A ABOVEGROUND
121	HRSG B ABOVEGROUND
151	MAIN PIPE RACK
152	HRSG A FINGER RACK
153	HRSG B FINGER RACK
201	STG GROUND FLOOR
202	STG MEZZANINE
203	STG OPERATING FLOOR
321	STG GSU TRANSFORMER
322	CTG A GSU TRANSFORMER
323	CTG B GSU TRANSFORMER
411	CTG A ABOVEGROUND

421	CTG B ABOVEGROUND
510	COOLING TOWER UNDERGROUND
511	COOLING TOWER ABOVEGROUND
530	WATER TREATMENT UNDERGROUND
531	WATER TREATMENT ABOVEGROUND
600	ADMIN/CONTROL/WAREHOUSE UNDERGROUND
601	ADMIN/CONTROL/WAREHOUSE ABOVEGROUND
700	SUBSTATION
900	FUEL GAS YARD UNDERGROUND
901	FUEL GAS YARD ABOVEGROUND

Table 5-7 – EEEE = Instrument Identifier Code

Instrument Identifier Code				
	First Letter		**Succeeding Letters**	
	Variable	**Modifier**	**Function**	**Modifier**
A	ANALYSIS, ANALYZER		ALARM	
B	BURNER FLAME		CLOSE, STOP, DECREASE	OFF
C	CONDUCTIVITY	COMPUTER	CONTROL	CLOSE
D	DENSITY OR SPECIFIC GRAVITY			
E	VOLTAGE		SENSOR, ELEMENT	
F	FLOW, FLOW RATE	RATIO (FRACTION)	FORWARD	FAIL
G	GAUGING		GLASS, GAUGE, GATE	
H	HAND			HIGH
I	CURRENT		INDICATE, INDICATING, INDICATOR	
J	POWER		SCAN	
K	TIME	TIME RATE OF CHANGE	CONTROL STATION	

L	LEVEL		LIGHT	LOW
M	MOISTURE, HUMIDITY	MANUAL	MOMENTARY, MOTOR	MIDDLE, INTERMEDIATE
Instrument Identifier Code				
	First Letter		**Succeeding Letters**	
	Variable	**Modifier**	**Function**	**Modifier**
N	INTRUSION			ON, OPERATE, RUNNING
O			ORIFICE	OPEN
P	PRESSURE, VACUUM		POINT (TEST CONNECTION), PUMP	
Q	QUANTITY	INTEGRATE, TOTALIZE	INTEGRATE, TOTALIZE	
R	RADIOACTIVITY		RECORD, PRINT, REVERSE	RUN
S	SPEED, FREQUENCY, MOTION			
T	TEMPERATURE		TRANSMIT, TRANSMITTER	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION		VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE, TORQUE			
X	UNCLASSIFIED	X-AXIS	UNCLASSIFIED	UNCLASSIFIED
Y	EVENT STATUS	Y-AXIS	RELAY, COMPUTE	
Z	POSITION, DIMENSION			

Table 5-8 – JJJJJ = DCS Hardwired I/O Signal Identifier Suffix

I/O Suffix	I/O Type	I/O Description
AI	AI	ANALOG INPUT - GENERAL
ST	AI	SPEED FEEDBACK
TE	AI	TEMPERATURE INPUT

ZT	AI	VALVE POSITION FEEDBACK
AO	AO	ANALOG OUTPUT - GENERAL
FY	AO	OUTPUT DEMAND – FLOW CONTROL
LY	AO	OUTPUT DEMAND – LEVEL CONTROL
PY	AO	OUTPUT DEMAND – PRESSURE CONTROL
SY	AO	OUTPUT DEMAND – SPEED CONTROL
TY	AO	OUTPUT DEMAND – TEMPERATURE CONTROL

I/O Suffix	I/O Type	I/O Description
AUT	DI	AUTO
BKR	DI	BRAKER (RACKED IN)
DI	DI	DIGITAL INPUT - GENERAL
FLT	DI	FAULT
LA	DI	LOW ALARM
LLA	DI	LOW-LOW ALARM
LOC	DI	LOCAL
HA	DI	HIGH ALARM
HHA	DI	HIGH-HIGH ALARM
MNL	DI	MANUAL
NML	DI	NORMAL
ON	DI	ONLINE
PWR	DI	POWER
RDY	DI	READY
RLY	DI	RELAY
RMT	DI	REMOTE
TRL	DI	TROUBLE
TRP	DI	TRIPPED
ZA	DI	RUNNING, ON
ZB	DI	STOPPED, OFF
ZSC	DI	VALVE POSITION – FULLY CLOSED
ZSO	DI	VALVE POSITION – FULLY OPENED
XA	DI	GENERAL ALARM
XS	DI	GENERAL STATUS
DO	DO	DIGITAL OUTPUT - GENERAL
MVA	DO	MOV OPEN COMMAND

MVB	DO	MOV CLOSE COMMAND
SVA	DO	SOV OPEN COMMAND
SVB	DO	SOV CLOSE COMMAND
YA	DO	EQUIPMENT ENERGIZE COMMAND (EQUIPMENT START CMD, BREAKER CLOSE CMD)
YAR	DO	EQUIPMENT ENERGIZE REQUEST (EQUIPMENT START REQUEST, BREAKER CLOSE REQUEST)
YB	DO	EQUIPMENT DE-ENERGIZE COMMAND (EQUIPMENT STOP CMD, BREAKER OPEN CMD)
YBR	DO	EQUIPMENT DE-ENERGIZE REQUEST (EQUIPMENT STOP REQUEST, BREAKER OPEN REQUEST)

Table 5-9 – S = Electrical Service Code

Service Code Identification	Service Code Description	Circuit Voltage
H	25kV Power	21kV
M	5kV Power 8kV Power 15kV Power	4.16kV 6.9kV 13.8kV
L	600V Power	120VAC, 208VAC, 240VAC 480VAC, 125VDC
C	600V Control	120VAC or 125VDC
K	300V Control, Instrument, RTD, Thermocouple, and Communication	Max 50V
X	Fiber Optic	N/A

Table 5-10 – VVV = Valve Type

Type of Work Code	Type of Work Code Description
HOV	HYDRAULICALLY OPERATED VALVE
FCV	FLOW CONTROL VALVE
LCV	LEVEL CONTROL VALVE
MOV	MOTOR OPERATED VALVE
PCV	PRESSURE CONTROL VALVE
PIV	POST INDICATING VALVE
PRV	PRESSURE REGULATING VALVE
RV	ROOT VALVE
SOV	SOLENOID OPERATED VALVE
SRV	SAFETY OR RELIEF VALVE
TCV	TEMPERATURE CONTROL VALVE

V	VALVES (ALL OTHERS)

Table 5-11 – R = Raceway Codes

Raceway Code	Raceway Code Description
T	CABLE TRAY
C	CONDUIT
D	DUCT
PB	PULL BOX
MH	MANHOLE
HH	HANDHOLE
TT	TRENCH

Table 5-12 – XXXX = Sequential Number Block Assignments

Unit Code	Sequential Number Block Assignments
10	5000 - 5099
1A	5100 - 5199
1B	5200 - 5299
1C	5300 - 5399

END OF ATTACHMENT A-13

BOT Scope Book
Attachment A-14
Training Procedure

Attachment to be inserted by Bidder as part of Proposal

BOT Scope Book
Attachment A-15
Drawing Specification

Attachment to be inserted by Bidder as part of Proposal

BOT Scope Book

Attachment A-16

Approved Manufacturers List

Approved list of manufacturers is subject to change prior to execution of a final Agreement.

Equipment	Approved Supplier	Clarifications or Restrictions
Actuators (Motor Operated Valves)	Auma	
Actuators (Motor Operated Valves)	Betis	
Actuators (Motor Operated Valves)	EIM	
Actuators (Motor Operated Valves)	Limitorque	
Actuators (Motor Operated Valves)	Rotork	
Actuators (Motor Operated Valves)	Universal Valve	
Air Cooled Heat Exchangers (Fin Fan Cooler)	Alfa Laval	
Air Cooled Heat Exchangers (Fin Fan Cooler)	GEA	
Air Cooled Heat Exchangers (Fin Fan Cooler)	Hayden Industries	
Air Cooled Heat Exchangers (Fin Fan Cooler)	Marley	
Air Cooled Heat Exchangers (Fin Fan Cooler)	SPX Cooling Technologies	
Aqueous Ammonia System	Aether.dbs	
Aqueous Ammonia System	Chemithon	
Aqueous Ammonia System	Global Chem Feed	
Aqueous Ammonia System	Integrated Flow Solution	
Aqueous Ammonia System	Johnson March Systems, Inc.	
Aqueous Ammonia System	Vector Systems, Inc.	
Aqueous Ammonia System	Wahlco	
Attemperators (HP and HRH Desuperheaters)	Control Components Inc. (CCI)	
Attemperators (HP and HRH Desuperheaters)	Fisher	
Attemperators (HP and HRH Desuperheaters)	KOSO	
Attemperators (HP and HRH Desuperheaters)	Schutte & Koerting	
Auxiliary Cooling Tower	ATS	
Auxiliary Cooling Tower	Evapco	
Auxiliary Cooling Tower	Evaptech	
Auxiliary Cooling Tower	Hamon / Research Cottrell	
Auxiliary Cooling Tower	International Cooling System	
Auxiliary Cooling Tower	Research Cottrell Cooling	

Equipment	Approved Supplier	Clarifications or Restrictions
Auxiliary Cooling Tower	SPX-Marley	
Batteries, Chargers	See UPS System	
Bus, lso-Phase	Alfa Standard	
Bus, lso-Phase	Alstom	
Bus, lso-Phase	AZZ Calvert	
Bus, lso-Phase	Crown Electric	
Bus, lso-Phase	GE	
Bus, lso-Phase	Hitachi	
Bus, lso-Phase	Techibus (formerly ABB)	
Bus, Non-segregated Phase	ABB	
Bus, Non-segregated Phase	AZZ Calvert	
Bus, Non-segregated Phase	Cape Electric	
Bus, Non-segregated Phase	Cutler-Hammer (Eaton)	
Bus, Non-segregated Phase	GE	
Bus, Non-segregated Phase	Square D	
Bus, Non-segregated Phase	Techibus (formerly ABB)	
Cathodic Protection	Accurate Corrosion Control	
Cathodic Protection	BK Corrosion	
Cathodic Protection	Corrpro	
Cathodic Protection	JDH Corrosion Consultants	
Cathodic Protection	Matcor	
Chemical Feed Pumps	Global Chem Feed	
Chemical Feed Pumps	Johnson March Systems, Inc.	
Chemical Feed Pumps	Milton Roy/LMI	
Chemical Feed Pumps	Prominent	
Chemical Feed Pumps	Pulsafeeder	
Chemical Feed Pumps	Reetex	
Chemical Feed Pumps	Sigma	
Chemical Feed Pumps	US Water	
Chillers	Carrier	
Chillers	Stellar	
Chillers	Trane	
Chillers	Turbine Air Systems	
Chillers	York	
Chromatograph	ABB	
Chromatograph	AC Systems Integration	
Chromatograph	Agilent Technologies	
Chromatograph	Daniel	

Equipment	Approved Supplier	Clarifications or Restrictions
Chromatograph	Rosemount Analytical (Emerson)	
Chromatograph	Siemens	
Chromatograph	Yokogawa	
Circuit Breakers, 138 kV and 345 kV	ABB	
Circuit Breakers, 138 kV and 345 kV	GE	
Circuit Breakers, 138 kV and 345 kV	Hitachi HVB, Inc.	
Circuit Breakers, 138 kV and 345 kV	Mitsubishi	
Circuit Breakers, 138 kV and 345 kV	Siemens	
Circuit Breakers, Generator	ABB	
Circuit Breakers, Generator	GE	
Circuit Breakers, Generator	Hitachi	
Circuit Breakers, Generator	Siemens	
Coatings	Ameron	
Coatings	Carboline	
Coatings	PPG	
Coatings	Sherwin Williams	
Coatings	Thenec	
Communications Equipment	Gai-tronics	
Communications Equipment	Motorola	
Communications Equipment	RFIP, Inc.	
Compressors, Air-Screw Type Oil-less Rotary	Atlas Copco	
Compressors, Air-Screw Type Oil-less Rotary	Gardner Denver	
Compressors, Air-Screw Type Oil-less Rotary	Ingersoll-Rand	
Compressors, Air-Screw Type Oil-less Rotary	Kaeser Compressors	
Compressors, Air-Screw Type Oil-less Rotary	Kobelco	
Compressors, Air-Screw Type Oil-less Rotary	Sullair	
Compressors, Gas	Atlas Copco Comptec, LLC	
Compressors, Gas	Siemens Energy	
Compressors, Gas	Solar Turbines International Co.	
Concrete	Local read-mix company(ies)	To be mutually agreed upon by EPC Contractor and Owner
Condenser	American Exchanger Services	
Condenser	Foster Wheeler	
Condenser	Godrej	
Condenser	Holtec	
Condenser	Maarky Thermal Systems	
Condenser	SPG	

Equipment	Approved Supplier	Clarifications or Restrictions
Condenser	TEI	
Continuous Emissions Monitoring (CEMS)	Altech	
Continuous Emissions Monitoring (CEMS)	Cemtek Environmental	
Continuous Emissions Monitoring (CEMS)	Cherokee Instruments	
Continuous Emissions Monitoring (CEMS)	Custom Instrumentation Services (CISCO)	
Continuous Emissions Monitoring (CEMS)	ESC (Environmental Systems Corporation)	
Continuous Emissions Monitoring (CEMS)	MSI	
Continuous Emissions Monitoring (CEMS)	Spectrum Systems	
Continuous Emissions Monitoring (CEMS)	Teledyne - Monitor Labs	
Continuous Emissions Monitoring (CEMS)	Thermo Environmental (CEMS Analyzers)	
Control Drives - Electric	ABB	
Control Drives - Electric	Beck	
Control Drives - Electric	Universal Valve	
Couplings	Falk	
Couplings	Kap-Flex	
Couplings	Rexnord	
Couplings	Thomas	
Couplings	Zurn	
Cranes	Accent Sales & Service Co.	
Cranes	ACCO	
Cranes	American Crane	
Cranes	CRS Crane Systems	
Cranes	Demag	
Cranes	Ederer	
Cranes	Kone	
Cranes	Kranco	
Cranes	Mid-Atlantic Crane & Equip.	
Cranes	P&H	
Cranes	Terex Services	
Cranes	Virginia Crane	
Cranes	Whiting	
DCS (Distributed Control Systems)	Emerson Process Management	Ovation System
Drives, Variable Speed Fluid Coupling	Howden Power	
Drives, Variable Speed Fluid Coupling	Philadelphia Gear	
Drives, Variable Speed Fluid Coupling	Voith	
Duct Burner Flame Scanners	Coen	

Equipment	Approved Supplier	Clarifications or Restrictions
Duct Burner Flame Scanners	Forney	
Duct Expansion Joints	Bachmann	
Duct Expansion Joints	Cembell Industries	
Duct Expansion Joints	Flexonics - Pathway Div	
Duct Expansion Joints	Frenzelilt	
Duct Expansion Joints	KE Burgmann (IAFD)	
Duct Expansion Joints	PAPCO Industries	
Expansion Joints, Non-Metallic	Mercer Rubber	
Expansion Joints, Non-Metallic	Norflex	
Expansion Joints, Non-Metallic	Pathway	
Expansion Joints, Non-Metallic	Proco	
Expansion Joints, Non-Metallic	RM Industrial Products	
Fans	Baron	
Fans	Chicago Blower	
Fans	Clarage	
Fans	Howden	
Fans	Robinson	
Fans	TLT- Babcock	
Filters, Slurry, Vacuum Dewatering	Eimco Water Technologies	
Filters, Slurry, Vacuum Dewatering	Komline Sanderson	
Fire Detection Systems	ANSUL	
Fire Detection Systems	Chemetron	
Fire Detection Systems	Cybercat	
Fire Detection Systems	Fenwal	
Fire Detection Systems	Fike	
Fire Detection Systems	Gamewell	
Fire Detection Systems	Honeywell - Notifier	
Fire Detection Systems	Kidde	
Fire Detection Systems	Protectowire	
Fire Detection Systems	Siemens - Cerberus Pyrotronics	
Fire Detection Systems	Simplex Grinnell	
Fire Protection Systems	American Fire Technologies	
Fire Protection Systems	Continental	
Fire Protection Systems	FE Moran	
Fire Protection Systems	Janus Fire Systems	
Fire Protection Systems	Shambaugh and Sons	
Fire Protection Systems	VFP Fire Systems	
Fire Protection Systems	Wayman Fire Protection	

Equipment	**Approved Supplier**	**Clarifications or Restrictions**
Fire Protection Systems	Wolverine Fire Protection	
Fittings, Compression Type, Tube	Cumberland Valve and Fitting	
Fittings, Compression Type, Tube	James C. White	
Fittings, Compression Type, Tube	O'Brien Corporation	
Fittings, Compression Type, Tube	Parker	
Fittings, Compression Type, Tube	Swagelok	
Fuel Gas Electric Startup Heaters	Aether.dbs	
Fuel Gas Electric Startup Heaters	Chromalox	
Fuel Gas Electric Startup Heaters	Envirosep	
Fuel Gas Electric Startup Heaters	Gastech	
Fuel Gas Electric Startup Heaters	Gaumer	
Fuel Gas Electric Startup Heaters	Integrated Flow Solutions	
Fuel Gas Electric Startup Heaters	Sigma Thermal	
Fuel Gas Electric Startup Heaters	Texas Systems & Controls, Inc.	
Fuel Gas Electric Startup Heaters	Watlow	
Fuel Gas Separator/Filter	Aether.dbs	
Fuel Gas Separator/Filter	Anderson	
Fuel Gas Separator/Filter	Control Center LLC	
Fuel Gas Separator/Filter	Gastech	
Fuel Gas Separator/Filter	Gaumer Process	
Fuel Gas Separator/Filter	Integrated Flow Solution	
Fuel Gas Separator/Filter	Mitten Manufacturing	
Fuel Gas Separator/Filter	PECO (The Blythe Company)	
Fuel Gas Separator/Filter	Peerless Manufacturing Co.	
Fuel Gas Separator/Filter	Texas Systems & Controls, Inc.	
Fuel Gas Startup Heaters, Water Bath	Aether.dbs	
Fuel Gas Startup Heaters, Water Bath	Gastech	
Fuel Gas Startup Heaters, Water Bath	Heat Exchanger Design	
Fuel Gas Startup Heaters, Water Bath	Newpoint Therma	
Fuel Gas Startup Heaters, Water Bath	Sigma Thermal	
Fuel Gas Startup Heaters, Water Bath	Thermal Engineering International (TEI)	
Grating and Stair Tread	American Grating	
Grating and Stair Tread	Carolina Grating Co.	
Grating and Stair Tread	Fisher & Ludlow	
Grating and Stair Tread	IKG Industries	
Grating and Stair Tread	Klemp Corp	
Grating and Stair Tread	Ohio Gratings	

Equipment	Approved Supplier	Clarifications or Restrictions
Grating and Stair Tread	Seasafe, Inc.	
Grout, Cementitious	Chemrex MBT Embeco	
Grout, Cementitious	Five Star	
Grout, Cementitious	Masterflow	
Grout, Cementitious	Unisorb Industrial Grout	
Grout, Epoxy	Chemrex MBT Masterflow	
Grout, Epoxy	Five Star	
Heat Exchangers, Plate & Frame	Alfa Laval	
Heat Exchangers, Plate & Frame	API Heat Transfer	
Heat Exchangers, Plate & Frame	APV	
Heat Exchangers, Plate & Frame	Cembell Industries	
Heat Exchangers, Plate & Frame	GEA/PHE	
Heat Exchangers, Plate & Frame	Graham	
Heat Exchangers, Plate & Frame	ITT Standard	
Heat Exchangers, Plate & Frame	Mueller	
Heat Exchangers, Plate & Frame	SPX Heat Transfer, Inc.	
Heat Exchangers, Plate & Frame	Tranter	
Heat Exchangers, Plate & Frame	Tranter PHE	
Heat Exchangers, Plate & Frame	Viex/GEA	
Heat Exchangers, Plate & Frame	Yuba	
Heat Exchangers, Shell & Tube	Atlas Industries	
Heat Exchangers, Shell & Tube	Doyle & Roth	
Heat Exchangers, Shell & Tube	Holtec	
Heat Exchangers, Shell & Tube	ITT Standard	
Heat Exchangers, Shell & Tube	Manning & Lewis	
Heat Exchangers, Shell & Tube	SPX Heat Transfer, Inc.	
Heat Exchangers, Shell & Tube	Steele	
Heat Exchangers, Shell & Tube	Struthers - TEI	
Heat Exchangers, Shell & Tube	Thermal Engineering International (TEI)	
Heat Exchangers, Shell & Tube	Yuba	
Heat Recovery Steam Generator (HRSG)	John Cockerill (CMI)	
Heat Recovery Steam Generator (HRSG)	NEM	
Heat Recovery Steam Generator (HRSG)	Nooter/Eriksen	
Heat Recovery Steam Generator (HRSG)	Vogt Power	
Heat Tracing	Bartec	
Heat Tracing	Chromalox	
Heat Tracing	Nelson	

Equipment	Approved Supplier	Clarifications or Restrictions
Heat Tracing	Newtron Heat Trace	
Heat Tracing	Thermon	
Heat Tracing	Tracer Construction, LLC	
Heat Tracing	Tyco/Raychem HTS	
Instrument Flow Nozzles	Daniel Industries	
Instrument Flow Nozzles	Fluidic Techniques	
Instrument Flow Nozzles	Triad Measurement	
Instrument Panels	Harlo	
Instrument Panels	Hatch Inc.	
Instrument Panels	Honeywell	
Instrument Panels	Johnson Controls	
Instrument Panels	Mercury Co.	
Instrument Panels	Southern Instruments	
Instrumentation - Misc Valves & Fittings	Cumberland Valve and Fitting	
Instrumentation - Misc Valves & Fittings	James C. White	
Instrumentation - Misc Valves & Fittings	Kaw Valve and Fitting	
Instrumentation - Misc Valves & Fittings	O'Brien Corporation	
Instrumentation - Misc Valves & Fittings	Rosemount Analytical (Emerson)	
Instrumentation - Misc Valves & Fittings	Swagelok	
Instruments, Flow Element, Orifice Plates	Daniel Industries	
Instruments, Flow Element, Orifice Plates	Emerson Process Management	
Instruments, Flow Element, Orifice Plates	Endress & Hauser	
Instruments, Flow Element, Orifice Plates	Fluidic Techniques	
Instruments, Flow Element, Orifice Plates	FTI Industries	
Instruments, Flow Element, Orifice Plates	Primary Flow Signal, Inc.	
Instruments, Flow Element, Orifice Plates	Schneider Electric (Foxboro)	
Instruments, Flow Element, Orifice Plates	Triad Measurement	
Instruments, Flow Element, Orifice Plates	Yokogawa	
Instruments, Flow Switch and Indicator type	John H. Carter	
Instruments, Flow Switch and Indicator type	Magnetrol	
Instruments, Flow Switch and Indicator type	UFM (Universal Flow Monitors)	
Lighting Fixtures	Appleton	
Lighting Fixtures	Cooper-Crouse Hinds	
Lighting Fixtures	GE	
Lighting Fixtures	Holophane-Petrolux	
Lighting Fixtures	Lithonia	

Equipment	**Approved Supplier**	**Clarifications or Restrictions**
Lightning Protection	A/C Lightning Protection	
Lightning Protection	Harger Lightning Protection	
Lightning Protection	Lightning Elimination Consultants	
Lightning Protection	VFC/Lightning Protection Systems	
Limit Switches	GO (Proximity type)	
Limit Switches	John H. Carter	
Limit Switches	Magnetrol	
Limit Switches	Namco Controls	
Limit Switches	Pepperill & Fuchs (Proximity type)	
Limit Switches	Pinnacle Controls	
Limit Switches	Snap-Lock (Mechanical type)	
Limit Switches	SOR	
Linings, alloy	Haynes lnt'I	
Linings, alloy	Rolled Alloy Corp	
Linings, alloy	Special Metals Corp	
Linings, alloy	VDM	
Linings, clad	Dupont	
Linings, clad	Industeel	
Linings, clad	Lukens Steel	
Linings, clad	Rocky Mountain Fabricators	
Linings, rubber	ARDCO	
Linings, rubber	Goodrich	
Linings, rubber	Goodyear	
Linings, tile	Stebbins	
MCCs (MV) and Switchgear	ABB	
MCCs (MV) and Switchgear	Cutler-Hammer (Eaton)	
MCCs (MV) and Switchgear	GE	
MCCs (MV) and Switchgear	M&I Electric	
MCCs (MV) and Switchgear	POWERCON	
MCCs (MV) and Switchgear	Siemens	
MCCs (MV) and Switchgear	Southern Power	
MCCs 480VAC (Low Voltage) and Switchgear	ABB	
MCCs 480VAC (Low Voltage) and Switchgear	Allen-Bradley	
MCCs 480VAC (Low Voltage) and Switchgear	Cutler-Hammer (Eaton)	
MCCs 480VAC (Low Voltage) and Switchgear	GE	
MCCs 480VAC (Low Voltage) and Switchgear	M&I Electric	

Equipment	Approved Supplier	Clarifications or Restrictions
MCCs 480VAC (Low Voltage) and Switchgear	Southern Power	
Monitors, Vibration	Alta Solutions	
Monitors, Vibration	Bentley-Nevada (GE)	
Motors, Medium Voltage	ABB	
Motors, Medium Voltage	Electric Machinery	
Motors, Medium Voltage	GE	
Motors, Medium Voltage	Hyundai	
Motors, Medium Voltage	Siemens	
Motors, Medium Voltage	TECO-Westinghouse	
Motors, Medium Voltage	Toshiba	
Motors, Medium Voltage	US Electrical	
Motors, Medium Voltage	WEG Industries	
Oil Water Separators	Great Lake International	
Oil Water Separators	Highland Tank	
Oil Water Separators	McTighe Industrial	
Oil Water Separators	PS International	
PDCs, Power Distribution Centers Bldgs	ABB	
PDCs, Power Distribution Centers Bldgs	Cape Electric/Graybar	
PDCs, Power Distribution Centers Bldgs	Crown Technical Systems	
PDCs, Power Distribution Centers Bldgs	ESS Metron	
PDCs, Power Distribution Centers Bldgs	Kiewit Off Shore (KOS)	
PDCs, Power Distribution Centers Bldgs	M&I Electric	
PDCs, Power Distribution Centers Bldgs	Point Eight	
PDCs, Power Distribution Centers Bldgs	Volta	
Pipe Supports	Anvil International	
Pipe Supports	Bergen Power	
Pipe Supports	Lisega	
Pipe Supports	Piping Technologies and Products	
Protective Relays	ABB	
Protective Relays	Alstom	
Protective Relays	Basler	
Protective Relays	Beckwith	
Protective Relays	GE	
Protective Relays	SEL (Schweitzer Engineering Laboratories)	
Protective Relays	Siemens	
Protective Relays	Toshiba	

Equipment	Approved Supplier	Clarifications or Restrictions
Pumps, Boiler Feed	Flowserve	
Pumps, Boiler Feed	KSB	
Pumps, Boiler Feed	Sulzer Pumps	
Pumps, Boiler Feed	Torishima	
Pumps, Circulating Water	Flowserve	
Pumps, Circulating Water	Flygt-Xylem	
Pumps, Circulating Water	Goulds	
Pumps, Circulating Water	Hyundai	
Pumps, Circulating Water	KSB	
Pumps, Circulating Water	Sulzer Pumps	
Pumps, Circulating Water	Torishima	
Pumps, Condensate	Flowserve	
Pumps, Condensate	Goulds	
Pumps, Condensate	Hyundai	
Pumps, Condensate	KSB	
Pumps, Condensate	Sulzer Pumps	
Pumps, Condensate	Torishima	
Pumps, Fire Protection	Aurora	
Pumps, Fire Protection	Caterpillar	
Pumps, Fire Protection	Cummins	
Pumps, Fire Protection	Engines	
Pumps, Fire Protection	Fairbanks Morse Controllers	
Pumps, Fire Protection	John Deere	
Pumps, Fire Protection	Patterson	
Pumps, Fire Protection	Peerless	
Pumps, Fire Protection	Ruhrpumpen	
Pumps, Fire Protection	SPP Pumps	
Pumps, Fire Protection	Xlyem-Flowtronix	
Reinforcing Steel (Rebar) - Fabricated	Ambassador Steel	
Reinforcing Steel (Rebar) - Fabricated	Barker Steel	
Reinforcing Steel (Rebar) - Fabricated	CMC Rebar	
Reinforcing Steel (Rebar) - Fabricated	Gerdau	
Reinforcing Steel (Rebar) - Fabricated	Gerdau Ameristeel	
Reinforcing Steel (Rebar) - Fabricated	Harris Rebar	
Reinforcing Steel (Rebar) - Fabricated	JMN Rebar Installation	
Reinforcing Steel (Rebar) - Fabricated	LB Construction Enterprises	
Reinforcing Steel (Rebar) - Fabricated	RESCO	
Reinforcing Steel (Rebar) - Fabricated	SMI	

Equipment	Approved Supplier	Clarifications or Restrictions
Reinforcing Steel (Rebar) - Fabricated	Tie Steel	
Reinforcing Steel (Rebar) - Fabricated	Whaley Constructors, LLC	
Relay Panel OEMs	Control Center LLC	
Relay Panel OEMs	Crown Technical Systems	
Relay Panel OEMs	Electrical Power Products	
Relay Panel OEMs	Keystone Electrical	
Relay Panel OEMs	SEL (Schweitzer Engineering Laboratories)	
Relay Panel OEMs	Western Control Systems	
RTDs, Instruments	Gulf Sensors	
RTDs, Instruments	Johnson March Systems, Inc.	
RTDs, Instruments	Minco	
RTDs, Instruments	Rosemount Analytical (Emerson)	
RTDs, Instruments	Temp-Pro	
Sampling Systems	Johnson March Systems, Inc.	
Sampling Systems	Sentry	
Sampling Systems	Waters Equipment	
Selective Catalyst Reduction (SCR) System, Air Cooled	Mitsubishi Power	For simple cycle CTs.
Selective Catalyst Reduction (SCR) System, Air Cooled	Nooter/Erikson	For simple cycle CTs.
Selective Catalyst Reduction (SCR), Catalyst	Cormatech	
Selective Catalyst Reduction (SCR), Catalyst	Umicore	
Standby Diesel Generator	Caterpillar	
Standby Diesel Generator	Cooper Power Systems	
Standby Diesel Generator	Cummins	
Standby Diesel Generator	Detroit Diesel	
Standby Diesel Generator	Kohler	
Standby Diesel Generator	Western Engine	
Steam Bypass and Desuperheater Valves	See Valves, Severe Service Control Valves	
Steam Traps	Armstrong	
Steam Traps	Bestobell Steam Traps	
Steam Traps	Spirax Sarco USA	
Steam Traps	Yarway Corp.	
Strainers	Armstrong	
Strainers	Eaton Hayward	
Strainers	Fluid Engineering	

Equipment	**Approved Supplier**	**Clarifications or Restrictions**
Strainers	Hellan	
Strainers	Islip Flow Controls	
Strainers	Midstates/Midco Supply Co.	
Strainers	Mueller	
Strainers	Spirax Sarco USA	
Strainers	Sure Flow Equipment Inc.	
Strainers	Wolseley/Ferguson	
Strainers	Yarway Corp.	
Strainers, Automatic Backwash	Fluid Engineering	
Strainers, Automatic Backwash	Hellan	
Strainers, Automatic Backwash	R.P. Adams	
Strainers, Automatic Backwash	Sure Flow Equipment Inc.	
Structural Steel	AFCO	
Structural Steel	Blum Enterprises	
Structural Steel	Cives	
Structural Steel	Hirschfeld	
Structural Steel	Merril Iron	
Structural Steel	Pax Fab	
Structural Steel	Paxton Vierling	
Structural Steel	Paxton Vierling	
Structural Steel	Qualico	
Structural Steel	Schuff Steel Company	
Structural Steel	SteelFab	
Structural Steel	Structural Steel Services	
Tanks, Field Erected	Caldwell Tanks	
Tanks, Field Erected	Chattanooga Boiler and Tank	
Tanks, Field Erected	Fisher Tank	
Tanks, Field Erected	National Steel Erectors	
Tanks, Field Erected	Pittsburgh Tank	
Tanks, Field Erected	Tank Connections	
Tanks, Shop Fabricated Steel	Accelerated	
Tanks, Shop Fabricated Steel	Arrow Tank	
Tanks, Shop Fabricated Steel	Cembell Industries	
Tanks, Shop Fabricated Steel	CH Murphy	
Tanks, Shop Fabricated Steel	Chattanooga Boiler and Tank	
Tanks, Shop Fabricated Steel	Dixie Southern (Triple S&P)	
Tanks, Shop Fabricated Steel	Highland Tank	
Tanks, Shop Fabricated Steel	Modern Welding	

Equipment	Approved Supplier	Clarifications or Restrictions
Tanks, Shop Fabricated Steel	PDM	
Tanks, Shop Fabricated Steel	RECO	
Tanks, Shop Fabricated Steel	Tampa Tank	
Tanks, Shop Fabricated Steel	Titan Fabricators	
Thermocouples/Thermowells	Alloy Engineering	
Thermocouples/Thermowells	ARI Industries	
Thermocouples/Thermowells	Claude S.Gordon	
Thermocouples/Thermowells	Emerson	
Thermocouples/Thermowells	Gulf Sensors	
Thermocouples/Thermowells	JMS Southeast	
Thermocouples/Thermowells	John H. Carter	
Thermocouples/Thermowells	Minco	
Thermocouples/Thermowells	Pinnacle Controls	
Thermocouples/Thermowells	PYCO	
Thermocouples/Thermowells	Thermo-Electric	
Thermocouples/Thermowells	Weksler	
Transformers, Main & Generator Step-Up (GSU)	ABB	No India Manufacturer
Transformers, Main & Generator Step-Up (GSU)	EFACEC	
Transformers, Main & Generator Step-Up (GSU)	Fortune	
Transformers, Main & Generator Step-Up (GSU)	GE	No Mexico Manufacturer
Transformers, Main & Generator Step-Up (GSU)	HICO	
Transformers, Main & Generator Step-Up (GSU)	Hitachi	
Transformers, Main & Generator Step-Up (GSU)	Hyundai	
Transformers, Main & Generator Step-Up (GSU)	Mitsubishi	
Transformers, Main & Generator Step-Up (GSU)	Siemens	No Mexico Manufacturer
Transformers, Main & Generator Step-Up (GSU)	SMIT	
Transformers, Main & Generator Step-Up (GSU)	TBEA	
Transformers, Unit Auxiliary	ABB	
Transformers, Unit Auxiliary	Fortune	

Equipment	Approved Supplier	Clarifications or Restrictions
Transformers, Unit Auxiliary	GE	No Mexico Manufacturer
Transformers, Unit Auxiliary	HICO	
Transformers, Unit Auxiliary	Hyundai	
Transformers, Unit Auxiliary	PTTI	
Transformers, Unit Auxiliary	Siemens	
Transformers, Unit Auxiliary	Waukesha	
Transmitters	Endress & Hauser	
Transmitters	Rosemount Analytical (Emerson)	
Transmitters	Schneider Electric (Foxboro)	
Transmitters	Yokogawa	
Traveling Screens	Atlas	
Traveling Screens	Eimco Water Technologies	
Traveling Screens	Screening Systems, international (SSI)	
Traveling Screens	Siemens Water Technologies	
UPS System & Batteries	Alcad	
UPS System & Batteries	Ametek Solidstate Controls/SCI	
UPS System & Batteries	Ash Battery	
UPS System & Batteries	Benning	
UPS System & Batteries	C & D Technologies	
UPS System & Batteries	Custom Power Chloride	
UPS System & Batteries	Cyberex (UPS & Chargers)	UPS & Chargers
UPS System & Batteries	Enersys	
UPS System & Batteries	Exide for Batteries	
UPS System & Batteries	Gutor/Schneider North America	
UPS System & Batteries	HDR (Inverters)	Inverters
UPS System & Batteries	HM Cragg	
UPS System & Batteries	Nolan Power Group	
UPS System & Batteries	Nolan Power Group	
UPS System & Batteries	Powerware (UPS & Chargers)	UPS & Chargers
UPS System & Batteries	Weiss Instruments GNB (battery)	Batteries
Valves, General Service Control	Celeros (Copes/Vulcan)	
Valves, General Service Control	Emerson (Fisher)	

Equipment	Approved Supplier	Clarifications or Restrictions
Valves, General Service Control	Flowserve	Flowserve is restricted from providing severe-duty control valves but may provide general-duty control valves.
Valves, General Service Control	IMI CCI	
Valves, General Service Control	KOSO	
Valves, Severe Service Ball	Bray	
Valves, Severe Service Ball	Cameron	
Valves, Severe Service Ball	Emerson (Fisher)	
Valves, Severe Service Ball	Mogas	
Valves, Severe Service Ball	ValvTechnologies	
Valves, Severe Service Control	Celeros (Copes/Vulcan)	
Valves, Severe Service Control	Emerson (Fisher)	
Valves, Severe Service Control	IMI CCI	
Valves, Severe Service Control	KOSO	
Water Treatment System	Aquatech International	
Water Treatment System	Evoqua	
Water Treatment System	Graver Technologies	
Water Treatment System	Graver Water Systems	
Water Treatment System	Progressive Water Treatment	
Water Treatment System	SAMCO	
Water Treatment System	Suez / GE Water & Process Technologies	
Water Treatment System	Suez / GE Water & Process Technologies	
Water Treatment System	US Water	
Water Treatment System	Veolia	

END OF ATTACHMENT A-16

BOT Scope Book
Attachment A-17
Combustion Turbine Generator (CTG) Technical Specification

Table of Contents

A-17.1 INFORMATION AND SCOPE OF WORK

A-17.1.1 General

A-17.1.1.1 The Seller shall provide CTG(s) complete with all required auxiliaries.

A-17.1.1.2 The combustion turbine-generator (CTG) design and construction shall be based on 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-17.1.1.3 The CTG equipment shall be designed for operation as specified in the Project Requirements.

A-17.1.1.4 Seller shall provide with PIDs showing terminal points. Based on this Terminal Point boundary, Seller to provide Equipment/Commodity listing of furnished materials.

A-17.1.1.5 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-17.1.2 CTG Scope of Work

A-17.1.2.1 Seller shall design, furnish, manufacture, shop test, and deliver to the Project site, the combustion turbine generator (CTG) package.

A-17.1.2.2 Equipment that requires additional bracing for shipment should have the temporary bracing clearly identified.

A-17.1.2.3 The Work shall include all necessary and/or usually supplied equipment and appurtenances for the safe, efficient, and convenient operation of the CTG within the scope of this specification whether or not such items are specifically referred to in this specification.

A-17.1.2.4 The 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-17.1.2.5 Seller's modularized enclosure shall be capable of future upgrades for future environmental compliance operations. Any additional systems required to support future environmental compliance are not included in current scope.

A-17.1.2.6 For the CTG, Seller shall provide auxiliaries and features including, but not limited to, the following:

A-17.1.2.6.1. Combustion Turbine Package complete with multi axial compressor, multistage turbine, thermal insulation, and Dry Low NO_x Combustors capable of burning natural gas. Synchronous Generator Package complete with all auxiliaries.

A-17.1.2.6.1. Generator static excitation system complete with all accessories, automatic voltage regulation system, and power system stabilizer.

A-17.1.2.6.2. Generator neutral grounding equipment.

A-17.1.2.6.3. Natural gas fuel and purge systems supplied by the Seller refer to Mechanical Design Criteria Attachment A-6. Provision for natural gas purge will be provided per Major Equipment supplier's standards.

A-17.1.2.6.4. Chromatograph with hydrocarbon dewpoint measurement capability.

A-17.1.2.6.5. Lubrication and generator seal oil systems.

A-17.1.2.6.6. Fire protection system (Detection and Suppression)

A-17.1.2.6.7. Inlet air system structural support system loads and loading criteria.

A-17.1.2.6.8. Inlet air filtration system

A-17.1.2.6.9. Inlet air evaporative cooler and auxiliaries

A-17.1.2.6.10. Inlet ductwork with silencer (as required to meet site noise requirements)

A-17.1.2.6.11. Inlet air bleed heat system, including interconnecting piping, valves, and supports (as required).

A-17.1.2.6.12. 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-17.1.2.6.13. Combustion turbine exhaust system with exhaust diffuser, thermal insulation, and exhaust manifold.

A-17.1.2.6.14. Exhaust system expansion joint connecting turbine exhaust diffuser to heat recovery steam generator inlet duct.

A-17.1.2.6.15. On-line and off-line water wash system

A-17.1.2.6.16. Instrument and control system, including automatic start-up/shutdown/emergency stop sequencing.

A-17.1.2.6.17. Performance monitoring system.

A-17.1.2.6.18. Equipment enclosures.

- CT Enclosure
- CT Aux Package
- CT Control Package
- Turning Device Package
- EXC & SFC Package

A-17.1.2.6.19. HVAC / H&V system for enclosures, as required.

A-17.1.2.6.20. Enclosures that are sized for personnel to be inside during regular maintenance will be equipment with interior and exterior lighting. Enclosures that require panel removal for access will be equipped with interior lighting. Lighting shall be of the LED type as defined in Attachment A-7.

A-17.1.2.6.21. Thermal and personnel protection insulation with lagging.

A-17.1.2.6.22. Shop applied priming and finish painting for external surfaces of all equipment and interior surfaces of enclosures.

A-17.1.2.6.23. 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-17.1.2.6.24. 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-17.1.2.6.25. PDC shall include space accommodations for two (2) wall mounted Security Panel/Box (one in each control package section, near end wall doors) 36"H x 30"W x 8"D and one (1) Floor Mounted LAN Cabinet (front/rear access) 24"W x 52"D x 84" H.

A-17.1.2.6.26. Batteries shall be located in battery rooms in the CTG Electrical package. Battery rooms shall contain eye wash and shower combination.

A-17.1.2.6.27. The CT control package shall be prewired to the extent possible. Wiring shall be provided to match wiring diagrams.

A-17.1.2.6.28. A complete and redundant generator protection system

A-17.1.2.6.29. AC/DC battery and charger system.

A-17.1.2.6.30. Electric motor driven turning gear and clutch.

A-17.1.2.6.31. CTG starting system.

A-17.1.2.6.32. Leveling blocks, soleplates, baseplates, thrust blocks, anchor bolts, jacking posts, fixators, embedded plates, anchor bolt and embedded plate erection templates and shims.

A-17.1.2.6.33. Lifting beams, lugs and other provisions for off-loading, erection, and maintenance.

A-17.1.2.6.34. Special tools required for installation, operation, and maintenance.

A-17.1.2.6.35. Spare parts and consumables as required for installation, commissioning and startup, and operation of the CTG through the Substantial Completion.

A-17.1.2.6.36. 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.

A-17.1.3 Services Scope of Work

A-17.1.3.1 Attend monthly design and scheduling meetings with Seller.

A-17.1.3.2 Training for five (5) days is included in the base scope for Buyer's operating and maintenance personnel.

A-17.1.3.3 Design drawings necessary to operate and troubleshoot the Seller-supplied equipment.

A-17.1.3.4 "As installed" drawings necessary to operate and troubleshoot the Seller-supplied equipment.

A-17.1.3.5 Service manuals for the Seller-supplied equipment

A-17.1.3.6 Transportation of the Seller-supplied equipment

A-17.1.3.7 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-17.1.3.8 Coordination with the Purchaser to provide compliance with Buyer-selected color scheme.

A-17.1.3.9 Provide Seller-recommended protective relay settings.

A-17.1.3.10 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-17.1.3.11 Seller shall provide training for 30 people.

A-17.1.4 Optional Scope of Work

A-17.1.4.1 Seller shall provide Optional pricing for each additional student beyond 30 for training.

A-17.1.4.2 Seller shall provide Optional pricing for One (1) 3-ton at the TOS of the structure and one (1) 1-ton capacity hoist near the top of the filter house and three (3) 10-ton capacity hoists below the top of steel for maintenance below.

A-17.1.5 General Operating Requirements

A-17.1.5.1 The CTG shall be designed for the operation described in the 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 Attachment A-4.

A-17.1.5.2 The CTG Unit shall have a design life of 30 years operation without distress due to cycling loads. Providing Buyer carries out maintenance according to supplier's manual and without abnormal operation.

A-17.1.5.3 The 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-17.1.5.4 The spatial average for near-field noise level shall not exceed 85 dBA outside of any enclosure or auxiliary equipment when measured 3 ft (1 m) in the horizontal plane and at an elevation of 5 ft (1.5 m) from grade. The generator noise level shall not exceed 85 dBA average when measured above the turbine generator deck.

A-17.1.6 Required Submittals

A-17.1.6.1 Requirements

A-17.1.6.1.1. Seller shall submit documents for review in accordance with the submittal requirements of Attachment A-4.

A-17.1.6.2 General

A-17.1.6.2.1. Complete list of drawings that will be submitted following contract award.

A-17.1.6.2.2. List and description of modularized skids.

A-17.1.6.2.3. List and description of piping and electrical termination points

A-17.1.6.2.4. Storage requirements

A-17.1.6.2.5. Cleaning requirements for all systems.

A-17.1.6.2.6. All equipment data sheets.

A-17.1.6.2.7. System operating procedures.

A-17.1.6.2.8. Expected life of all major components including major combustion components.

A-17.1.6.2.9. Identification of the location of service centers capable of turbine and/or generator maintenance and re-build.

A-17.1.6.2.10. 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 Attachment A-4.

A-17.1.6.2.11. 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-17.1.6.2.12. Design data sheets and drawings for natural gas equipment.

A-17.1.6.2.13. Detailed project schedule.

A-17.1.6.2.14. 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-17.1.6.2.15. A list of operating installations.

A-17.1.6.2.15.a. Seller shall provide a training program for Buyer's personnel to inspect, maintain, and operate the Equipment.

A-17.1.6.2.16. Complete Inspection and Testing Plan (ITP) shall be provided to include all hold points that are applicable to the equipment.

A-17.1.6.2.17. Certificates of Completion including checklists to confirm that the installation and commissioning is fully complete.

A-17.1.6.2.18. Inspection intervals for combustion and hot gas path components shall be provided.

A-17.1.6.3 Drawings

A-17.1.6.3.1. Drawings with principal dimensions of the equipment, including all auxiliaries furnished therewith.

A-17.1.6.3.2. Drawings that show equipment laydown area requirements with component weights and overall dimensions that will be required for erection, disassembly, and maintenance.

A-17.1.6.4 Procedures:

A-17.1.6.4.1. Seller's turbine lube oil flushing method, procedures, and recommendations.

A-17.1.6.4.2. Procedure for grouting of soleplates, sub-soleplates, etc.

A-17.1.6.4.3. Cleaning, checking, and testing procedures.

A-17.1.6.5 Equipment connection reactions.

A-17.1.6.5.1. All equipment connection reaction shall be supplied, including:

A-17.1.6.5.1.a. Allowable recommended reaction range on each turbine connection. Reactions should be stated as the resultant force and resultant moment for each connection.

A-17.1.6.5.1.b. Loading conditions on which the above reactions are based.

A-17.1.6.5.1.c. Total allowable moments on all casings and bearings from all reactions of the connections.

A-17.1.6.5.1.d. Free expansion direction data of all connections from cold to operating temperature position.

A-17.1.6.6 Performance Information

A-17.1.6.6.1. 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-17.1.6.6.2. 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 the Site Design Data Attachment A-4, including the project performance point. Performance to be provided with and without evaporative cooler in operation (as applicable for the ambient).

A-17.1.6.7 Performance Curves:

A-17.1.6.7.1. 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-17.1.6.7.1.a. Curves showing correction to heat rate vs. exhaust pressure in increments of 0.5 inches H_2O from zero to maximum CTG backpressure at specified loads.

A-17.1.6.7.1.a. Performance (power output, heat rate, fuel flow, water flow) with evaporative inlet cooling system in operation.

A-17.1.6.7.1.b. Curves showing performance degradation over time based on recommended maintenance practices.

A-17.1.6.8 CTG Emission information, including NOx, CO, UHC, VOC, PM, SOx, NO to NO2 ratio, Formaldehyde, and emission averaging basis. Information to be supplied in ppmvd and lb/hr.

A-17.1.6.9 Generator Curves shall be submitted:

A-17.1.6.9.1. Vee Curve - showing generator kVA output against field current through the entire power factor range (.85 leading to .95 lagging) at rated and reduced hydrogen pressures.

A-17.1.6.9.1.a. Capability Curve - showing reactive capability versus load for rated hydrogen pressure.

A-17.1.6.9.1.b. Decrement curves for three-phase, line-to-line, and line-to-line to ground, short circuits, including effect of voltage regulator.

A-17.1.6.9.1.c. Regulation curve with excitation and speed constant.

A-17.1.6.9.1.d. No load and full load saturation curves for the exciters.

A-17.1.6.9.1.e. Exciter load versus exciter voltage curves showing drooping characteristic.

A-17.1.6.9.1.f. 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-17.1.6.9.1.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-17.1.6.9.1.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-17.1.6.9.1.i. Table of generator constants.

A-17.1.6.10 Test Reports

A-17.1.6.10.1. Test Reports shall be provided, including:

A-17.1.6.10.1.a. The 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. The 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-17.1.6.10.1.b. Generator Factory Tests performed during the manufacture and assembly of the non- packaged power generators shall include all tests prescribed in ANSI C50.13 (2014), Table 8 for those generators "not completely assembled for test in the factory". Generator testing and quality control procedures shall be per Subcontractors standard and in compliance with C50.13. Copies of the applicable test reports for the following process testing shall be provided, for applicable tests a type test report will be submitted is 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.

Generator Assembly

1. Air gap Measurement*
2. Oil Flush*
3. Wiring Checks*
4. Hydrostatic Test of Coolers

* Generator Assembly tests are performed; however, no report is provided for these tests.

A-17.1.6.11 Instruction (Operation and Maintenance) Manuals

A-17.1.6.11.1. 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-17.1.6.11.2. Two (2) hard copies of each manual and CIP compliant electronic copy or other Buyer approved method copy shall be provided.

A-17.1.6.11.3. Instruction manuals shall include:

A-17.1.6.11.3.a. Equipment identification by equipment number, Station name, Unit number, and function name.

A-17.1.6.11.3.b. Final reduced drawings of general arrangements and cross Attachments, guaranteed performance data, design data, test results, and performance curves for all equipment.

A-17.1.6.11.3.c. Complete operation, troubleshooting and maintenance instructions.

A-17.1.6.11.3.d. Parts list 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-17.1.6.11.4. 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-17.1.6.11.5. 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-17.1.6.11.6. 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-17.2 GENERAL TECHNICAL REQUIREMENTS

A-17.2.1 General

A-17.2.1.1 The CTG shall conform to all federal, state, and local codes or regulations having jurisdiction at the Project site and references in the Project Requirements. It shall be Seller's responsibility to investigate such statutes and determine applicable provisions regarding the equipment they propose to furnish.

A-17.2.1.2 Electrical equipment shall be in accordance with the standards of 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-17.2.1.3 Foreign material sourcing shall include allowance for inspection of manufacturing process, sufficient notice, and mutual agreement with Buyer.

A-17.2.2 Cleanliness and Surface Preparation

A-17.2.2.1 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, the product shall be dry and clean inside and outside.

A-17.2.2.2 The Seller shall prepare, protect, prime, and paint the CTG to provide the required protection during shipment and installation of the equipment.

A-17.2.2.3 Structural steel and supports shall be hot dipped galvanized except for Electrical Packages that will be painted steel.

A-17.2.3 Painting Systems

A-17.2.3.1 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-17.2.3.2 Seller shall follow Attachment A-5 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-17.2.3.3 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-17.2.3.4 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-17.2.4 Spare Parts for Startup and Commissioning

A-17.2.4.1 The Seller shall provide spare parts required for startup purposes and for application of the Seller's operating and startup reliability guarantees.

A-17.2.4.2 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-17.2.4.3 Seller to provide standard provisions for startup and commissioning spares.

A-17.2.4.4 Shop inspection and testing shall be in accordance with the requirements identified in OEM'S Standard Integrated Test Plan (ITP) as approved by the Buyer, which meet the intent of the sub-articles below:

A-17.2.4.5 General:

A-17.2.4.5.1. The Seller or 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 will be mutually agreed to by the Seller and Buyer during project execution.

A-17.2.4.5.2. 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-17.2.4.5.3. Factory testing shall include low speed dynamic rotor balancing and high-speed dynamic rotor balancing. Overspeed trip test at 110% will be performed during commissioning.

A-17.2.4.5.4. All combustion turbine-generator 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-17.2.4.5.5. Buyer shall be given a minimum of two (2) weeks prior notice of the Seller’s intent to conduct any shop testing.

A-17.2.4.6 Combustion Turbine:

A-17.2.4.6.1. 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-17.2.4.6.2. 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 circuitry 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-17.2.4.7 Generator:

A-17.2.4.7.1. Standard IEEE/ANSI Tests (IEEE Std. C50.13 Section 9.1.3, Table 9) shall be made on the generator as a minimum requirement. No load test and sudden short-circuit tests at reduced voltage to determine reactance and time constants is excluded from this testing. Any excluded shops test may have a type test report submitted for customer reference.

A-17.2.4.7.2. The excitation system shall be tested in accordance with IEEE 421.1 and 421.2.

A-17.2.4.7.3. Destructive stator bar testing shall be performed for the generator in accordance with Manufacturer's standard procedures.

A-17.2.4.8 Control System:

A-17.2.4.8.1. All circuit boards, power supplies and 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-17.2.4.8.2. 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 input/output (I/O), redundant control processors, redundant power supplies, operator console(s), redundant communication highways, printer(s), and interfaces (foreign datalinks).

A-17.2.4.8.3. 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-17.2.4.8.4. 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-17.2.4.9 Electric Motor Testing

A-17.2.4.9.1. 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-17.2.4.9.2. Quality assurance requirements shall be in accordance with the requirements identified in OEM'S Standard Integrated Test Plan (ITP) as approved by the Buyer, which meet the intent of the sub-articles below:

A-17.2.4.9.3. To ensure the quality of materials, all materials used must be new and first run.

A-17.2.4.9.4. Quality assurance provisions shall meet the requirements as specified in the Project Requirements.

A-17.2.4.9.4.a. To ensure project quality, the following are mandatory witness points for which the Buyer must be notified (and can attend as desired).

A-17.2.4.9.4.b. Turbine and Compressor Rotor High Speed Balance (Bladed)

A-17.2.4.9.4.c. Generator Rotor Balance

A-17.2.4.9.4.d. Generator Stator and Field High Potential Test

A-17.2.4.9.4.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-17.2.4.9.5. Certificates of Completion

A-17.2.4.9.5.a. Certificates of Completion including checklists to confirm that the installation is fully complete shall be provided.

A-17.2.4.10 Fabrication Requirements

A-17.2.4.10.1. Welding shall be in accordance with the requirements identified in OEM'S Standard Integrated Test Plan (ITP) as approved by the Buyer, which meet the intent of the sub-articles below:

A-17.2.4.10.1.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-17.2.4.11 Nameplates and Numbering

A-17.2.4.11.1. 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-17.2.4.11.2. 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-17.2.4.11.3. The requirements shall apply to all of Seller's supplied equipment, included 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, all instrumentation connected to Facility DCS.

A-17.2.4.11.4. 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-17.2.4.12 Vibration

A-17.2.4.12.1. Critical speeds for all rotating components should be analyzed and removed from the 60 Hz. operating frequency

A-17.2.4.12.2. Design of the compressor and turbine Attachments shall avoid a vibrational response at any conditions within 10% of the operating speed.

A-17.2.4.13 Preparation for Shipment:

A-17.2.4.13.1. All equipment shall be adequately prepared for shipment, protection during transit and outdoor storage.

A-17.2.4.13.2. 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-17.2.4.13.3. 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-17.2.4.13.4. Before the equipment is shipped, the original shipping stops, bolts, ties, etc., shall be reinstalled in all devices and clearly identified.

A-17.2.4.13.1. 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-17.2.4.13.1. 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-17.2.4.13.2. 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-17.2.4.13.3. Motor rotors shall be locked to prevent movement during shipping. Oil lubricated motors shall be drained before shipping.

A-17.2.4.14 Services

A-17.2.4.14.1. 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-17.2.4.14.2. 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 combustion turbine-generator. The courses will include material on inspection, maintenance, troubleshooting, and operation of all equipment furnished with the specification.

A-17.2.4.14.1. Performance Testing Services:

A-17.2.4.14.2. Refer to Attachment A-3 for performance testing requirements.

A-17.3 GUARANTEES

Refer to Attachment A-3 for guarantees.

A-17.4 COMBUSTION TURBINE AND AUXILIARIES TECHNICAL REQUIRMENTS

A-17.4.1 General Design Criteria

A-17.4.1.1 The CTG shall be factory assembled to the greatest extent possible.

A-17.4.1.2 The 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 the CTG to mitigate these effects.

A-17.4.1.3 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-17.4.1.4 The CTG shall be provided with overspeed trip capability. Equipment design shall allow testing of overspeed protective devices without actually overspeeding the turbine.

A-17.4.1.5 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 if unacceptable windmilling is anticipated during shutdown.

A-17.4.1.6 All rotating equipment shall be capable of withstanding the normal fatiguing stresses from aerodynamically and mechanically induced excitation forces at all operating loads.

A-17.4.1.7 The 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-17.4.1.8 Seller shall provide hydraulic coupling bolts, with all necessary tools and a hydraulic pump, for the turbine-generator load coupling.

A-17.4.1.9 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-17.4.1.10 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-17.4.1.11 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-17.4.1.12 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-17.4.1.13 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-17.4.1.14 Couplings and guards shall be removable without removal of rotors of interconnected equipment and shall not prevent access to adjacent bearings and seals.

A-17.4.1.15 Sub-soleplates, if used, shall be factory drilled and tapped for leveling screws to level and support the equipment.

A-17.4.1.16 Press fit type fittings shall not be utilized in any system.

A-17.4.2 Combustion Turbine Design:

A-17.4.2.1 General:

A-17.4.2.1.1. 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-17.4.2.1.2. 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 his drawings all such movements at interfaces with Seller's supports.

A-17.4.2.1.3. 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-17.4.2.1.4. Casings shall be split horizontally for removal of internals.

A-17.4.2.1.5. Seller shall provide borescope inspection ports for internal inspections of critical components in the hot gas path of the turbine and compressor.

A-17.4.2.1.6. Turbine bearings shall be able to be examined and repaired without removing major components, i.e., inlet duct, and silencer.

A-17.4.2.2 Compressor and Turbine Blading:

A-17.4.2.2.1. 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-17.4.2.2.2. Rotating blades shall be individually removable for replacement. Vane segments shall also be removable.

A-17.4.2.2.3. Stationery and rotation blades shall be coated as necessary to minimize erosion and corrosion degradation.

A-17.4.2.3 Compressor Section:

A-17.4.2.3.1. 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-17.4.2.3.2. 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-17.4.2.3.3. Provisions shall be made for bleeding off air from the compressor when necessary to prevent compressor surge or stall. Bleed air shall be piped outside compressor enclosure through blow-off valves.

A-17.4.2.3.4. Seller to provide a permanently installed water wash system located at the compressor bellmouth.

A-17.4.2.3.5. Bell-mouth shall be coated with Contractor'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-17.4.2.4 Combustion Systems:

A-17.4.2.4.1. 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-17.4.2.4.2. Combustion system shall allow for continuous operation of the unit from base load condition to the Seller defined minimum stable operating load.

A-17.4.2.4.3. 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-17.4.2.4.4. 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 crossfire tubes.

A-17.4.2.4.5. As a part of Seller's standard design, the flame detection shall be performed by software monitoring of trend of blade path temperature in the CTG control system.

A-17.4.2.4.6. Multiple igniters shall be provided for starting the units and shall be removable after the unit is operating.

A-17.4.2.5 Turbine Section:

A-17.4.2.5.1. Turbine blading shall be designed to minimize loads due to tangential, axial, and torsional modes of vibration under all anticipated operating conditions.

A-17.4.2.5.2. 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 the Buyer for review.

A-17.4.3 Inlet Air System

A-17.4.3.1 General:

A-17.4.3.1.1. 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-17.4.3.1.2. Filter house to include a stair tower in lieu of platforms and ladders for normal maintenance and operations.

A-17.4.3.1.3. There shall be provisions for emergency egress from Inlet Filter House during maintenance in the event of a fire.

A-17.4.3.1.4. All ladders shall have anti-slip rungs. Rung covers, anti-slip tape and/or paints/coatings shall not be acceptable.

A-17.4.3.1.5. A complete high-pressure inlet bleed heat system with all associated piping shall be provided.

A-17.4.3.1.6. 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 stairway.

A-17.4.3.1.7. 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-17.4.3.1.8. 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-17.4.3.1.9. 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-17.4.3.1.10. Inlet silencing shall be provided as required to meet site noise requirements.

A-17.4.3.1.11. Inlet air system structural support steel shall be hot dipped galvanized in accordance with structural design criteria, Attachment A-5.

A-17.4.3.2 Filter System

A-17.4.3.2.1. The filter system shall include the following:

A-17.4.3.2.2. 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-17.4.3.2.3. 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 Attachment A-4. 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-17.4.3.2.4. 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 3mm (0.12 in), 30mm x 30 mm (1.25” x 1.25”) mesh center to center spacing.

A-17.4.3.2.5. 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-17.4.3.2.6. Stairways, ladders, and platforms shall follow the requirements contained in Attachment A-5.

A-17.4.3.2.7. Exterior LED lighting and convenience outlets upstream of final filtration stage.

A-17.4.3.2.8. Differential pressure transmitter with a built-in digital indicator for each stage of the inlet filter.

A-17.4.3.3 Filters:

A-17.4.3.3.1. 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-17.4.3.3.2. Evaporative Cooler

A-17.4.3.3.3. 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-17.4.3.3.4. Evaporative cooler modules shall be constructed of painted carbon steel except for the wetted surfaces, which require stainless steel to be used.

A-17.4.3.3.5. The evaporative cooler shall be sized for at least 85% design efficiency at the Summer Design conditions specified in the Construction Operating Requirements.

A-17.4.3.3.6. 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-17.4.3.3.7. 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-17.4.3.3.8. 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-17.4.3.3.9. The quality of supply water to the evaporative cooler shall be maintained in accordance with combustion turbine manufacturer requirements or industry standards.

A-17.4.3.4 Inlet Ductwork:

A-17.4.3.4.1. Ductwork downstream of the filter will be coated with 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-17.4.3.4.2. 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-17.4.3.4.3. Manway(s) 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-17.4.4 Exhaust System:

A-17.4.4.1 The combustion turbine package shall be furnished with a complete exhaust system including the exhaust diffuser plenum, supports and thermal insulation.

A-17.4.4.2 The exhaust plenum shall direct the exhaust gases into the HRSG.

A-17.4.4.3 The turbine exhaust system shall consist of an exhaust plenum 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 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-17.4.4.4 The exhaust plenum 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-17.4.4.5 The exhaust system shall be designed for the maximum expected temperature plus the 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-17.4.4.6 Hot end bearing tunnel temperature shall remain below 200°F when operating at base load with summer design conditions.

A-17.4.4.7 Mechanical design of the exhaust area should allow for a static pressure of at least 20 in. wc at maximum full load turbine exhaust temperature,

A-17.4.4.8 Exhaust system should include necessary instrument ports for use in testing and tuning of the CTG.

A-17.4.5 Fuel Gas System

A-17.4.5.1 The fuel gas system shall be designed to meet all requirements and recommendations based on codes and standards Attachment A-4.

A-17.4.5.2 The natural gas system shall be designed to operate on a range of natural gas compositions. Natural gas analysis is provided in the Site Design Data.

A-17.4.5.3 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-17.4.5.4 Seller shall provide a fuel gas performance heater. The fuel gas performance heater will use HRSG IP feedwater as the heating source. External marshalling cabinet shall be provided for the dew point heaters for ease of field wiring.

A-17.4.5.5 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-17.4.5.6 Seller shall provide two (2) gas calorie meters.

A-17.4.5.7 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 valve(s), interconnecting piping from gas module to combustion turbine base, ring manifold to burners, fuel gas condensate liquid drains tank and all required instrumentation.

A-17.4.5.8 Fuel gas isolation and automatic vent valve(s) shall be provided; however, the system is not required to meet NFPA 85 purge credit requirements.

A-17.4.5.9 Stop valves shall be provided on the natural gas piping at the combustion turbine base and on the off-base gas module 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-17.4.5.10 Two means for stopping fuel flow shall be provided at the off-base gas module. They shall respond to normal or emergency shutdown control signals. A fast-acting stop/shutoff valve shall be provided as one means.

A-17.4.5.11 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-17.4.5.12 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-17.4.5.13 All Seller supplied interconnecting fuel gas piping and valves, downstream of the last stage filter, shall be per Attachment A-6.

A-17.4.5.14 Fuel gas system shall be designed to allow for borescope inspection of fuel gas system based on Seller standard supply.

A-17.4.5.15 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-17.4.6 General Oil System Requirements

A-17.4.6.1 General:

A-17.4.6.1.1. The following requirements apply to the lubrication oil and generator seal oil systems.

A-17.4.6.2 Oil Piping:

A-17.4.6.2.1. Lube oil piping, valves, and fittings from the reservoir to the filters shall be, at 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-17.4.6.2.2. 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-17.4.6.2.3. 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-17.4.6.2.4. 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-17.4.6.2.5. Seller to supply all interconnecting piping.

A-17.4.6.3 Instrumentation:

A-17.4.6.3.1. Indicating pressure transmitters shall be provided on the main bearing lube oil supply header.

A-17.4.7 Lubrication Oil System

A-17.4.7.1 General:

A-17.4.7.1.1. 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-17.4.7.1.2. Lube oil accumulators shall be supplied and shall be designed and stamped to the requirements of ASME Boiler and Pressure Vessel Code Section VIII, Division I.

A-17.4.7.2 Oil Reservoir:

A-17.4.7.2.1. The oil reservoir 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-17.4.7.2.2. 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-17.4.7.2.2.a. Seller shall submit an inspection test plan that details specific lube oil tank and bearing pedestal/housing coating procedure and inspection.

A-17.4.7.2.2.b. Seller shall submit detailed documentation showing the results of the coating inspections and integrity tests that were performed during fabrication.

A-17.4.7.2.3. Seller shall provide differential pressure instrumentation across the lube oil filters.

A-17.4.7.2.4. Seller to supply lube oil system to include external purification equipment.

A-17.4.7.2.5. 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 reservoir 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-17.4.7.2.6. 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 will be automatically de-energized upon low oil level in the reservoir.

A-17.4.7.3 Lube Oil Pumps:

A-17.4.7.3.1. Two full-capacity AC motor driven pumps shall be supplied with one partial capacity emergency DC motor driven pump.

A-17.4.7.3.2. 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-17.4.7.3.3. Each pump shall have a suction strainer to protect the pump.

A-17.4.7.3.4. All control equipment necessary for operation of DC equipment on loss of Auxiliary AC power shall be provided.

A-17.4.7.4 Lube Oil Coolers

A-17.4.7.4.1. Seller shall provide two (2) 100 percent capacity water-cooled lube oil coolers with oil temperature regulators for Combined-Cycle applications.

A-17.4.7.4.2. The heat exchanger shall be plate and frame type.

A-17.4.7.4.3. Heat exchanger shall be accessible for cleaning without draining oil from the reservoir.

A-17.4.7.4.4. The heat exchanger shall gravity drain to the oil reservoir.

A-17.4.7.4.5. The lube oil system shall be capable of switching between oil coolers with unit on-line.

A-17.4.7.4.6. Coolers shall be provided with an inlet thermocouple at oil reservoir and thermocouples, pressure test connections, and vent and drain connections.

A-17.4.7.4.7. The 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-17.4.7.5 Lube Oil Filters:

A-17.4.7.5.1. Two (2) 100% capacity, Duplex type, multi-element bearing oil filters with continuous flow transfer valves shall be provided.

A-17.4.7.5.2. 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.

A-17.4.7.5.3. Replacement of oil filter cartridges shall not require draining of the oil reservoir.

A-17.4.7.6 Vapor Extractors:

A-17.4.7.6.1. 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.

A-17.4.7.6.2. Seller to supply piping isolation between the vapor extractors to allow maintenance during operation. Refer to mechanical design criteria, Attachment A-6 for equipment isolation requirements.

A-17.4.7.6.3. Coalescent type mist eliminators shall be provided. Electrostatic type mist eliminators are not acceptable.

A-17.4.8 Generator Seal Oil System

A-17.4.8.1 General

A-17.4.8.1.1. A complete generator seal oil system shall be provided for the purpose of lubricating seals and preventing hydrogen 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-17.4.8.1.2. Seller shall provide a complete seal oil system including pumps, filters, pressure regulation, piping, fill and vent valves, and instrumentation and controls.

A-17.4.8.1.3. Even in the case of shaft seal failure, any oil returned to the lubricating oil reservoir (if applicable) shall be free of hydrogen.

A-17.4.8.1.4. Seal oil pressure shall be controlled so that pressure is always greater than hydrogen pressure, even in upset conditions.

A-17.4.8.2 Seal Oil Pumps:

A-17.4.8.2.1. Two full-capacity AC motor driven pumps shall be supplied with one partial capacity emergency DC motor driven pump.

A-17.4.8.2.2. All control equipment necessary for operation of DC equipment on loss of Auxiliary AC power shall be provided.

A-17.4.8.3 Seal Oil Filter:

A-17.4.8.3.1. One (1) 100% seal oil filter shall be provided.

A-17.4.9 Cooling System

A-17.4.9.1 The Closed Cooling Water (CCW) will supply coolant to the lube oil coolers, atomizing air cooler (if applicable), generator hydrogen coolers, and any other water-cooled equipment provided by Seller.

A-17.4.9.2 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-17.4.9.3 Refer to the Mechanical Requirements and Design Criteria for CCW system design criteria.

A-17.4.10 Bearings

A-17.4.10.1 Seller's standard bearing design shall be used.

A-17.4.10.2 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-17.4.10.3 Tilt pad journal bearings temperature shall be measured using at least one dual element type-E thermocouple.

A-17.4.10.4 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-17.4.10.5 All journal shaft bearings shall be provided with vibration monitors. Active thrust bearing shall be monitored using a proximitor. 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-17.4.10.6 Lube oil reservoir vapor pressures shall be measured and indicated locally and on unit control system.

A-17.4.10.7 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-17.4.11 Water Wash System

A-17.4.11.1 One (1) water wash system shall be provided.

A-17.4.11.2 The CTG units shall be provided with an on-line and off-line compressor water washing system suitable for use with detergents.

A-17.4.11.3 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, water injection manifold piping and effluent drains on the combustion turbine. All interconnecting piping and accessories shall be provided by Seller.

A-17.4.11.4 The system design shall not allow water or detergents to enter the 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-17.4.11.5 Water/Detergent tank shall be stainless steel or HDPE. Piping, valves, etc., shall be stainless steel. All hardware shall be corrosion resistant.

A-17.4.11.6 The system shall be sized for one complete off-line wash and rinse cycle of one CTG.

A-17.4.11.7 Drains from the water wash system shall be routed to a separate storage tank for off-site disposal.

A-17.4.11.8 Compressor design shall be suitable for both online and offline washing, using detergents. The Seller shall provide a list of approved detergents.

A-17.4.12 Fire Protection and Detection System

A-17.4.12.1 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-17.4.12.2 CO2 fire protection system design requirements.

A-17.4.12.2.1. The fire protection system shall be a low-pressure CO2 system.

A-17.4.12.2.2. The system shall be designed in accordance with NFPA 12 and the CTG OEM requirements. In cases where requirements differ, the more stringent shall apply.

A-17.4.12.2.3. Fill and vapor return lines shall be stainless steel.

A-17.4.12.2.4. CO2 system tank shall be oriented to facilitate filling from the road.

A-17.4.12.2.5. CO2 system shall be sized for two (2) discharges into the largest hazard area.

A-17.4.12.2.6. Low pressure CO2 system will be designed to maintain the CO2 at a nominal pressure of 300 psi (2068 kPa) corresponding to a temperature of approximately 0F (-18C) 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-17.4.12.2.7. CO2 shall be refilled from a third party and needs not to be controlled at site.

A-17.4.12.2.8. The CO_2 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-17.4.12.2.9. The CO_2 system shall be skid mounted and complete.

A-17.4.12.2.10. The CO_2 system shall be FM approved and capable of providing protection for the entire enclosure.

A-17.4.12.2.11. CO2 system safety features shall include, at a minimum.

A-17.4.12.2.11.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-17.4.12.2.11.b. System lockout achieved through physical lockout valve closing.

A-17.4.12.2.11.c. Electric service disconnect switch interrupts releasing circuit allowing for testing without actuation of fire suppression system.

A-17.4.12.2.11.d. Odorizer (wintergreen) to indicate presence of discharging CO2 and any discharged CO2 lingering trapped in low spots.

A-17.4.12.2.11.e. System lockout indicators at each door.

A-17.4.12.3 Upon detection of a fire, compartment ventilation shall stop immediately.

A-17.4.12.4 A fire condition shall be detected by heat detectors.

A-17.4.12.5 The system shall include provisions for locating failed heat detectors. Each detector shall report to the local fire alarm control panel separately.

A-17.4.12.6 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-17.4.12.7 The zone of a detected fire should be clearly identified via annunciation to the local fire alarm control panel.

A-17.4.12.8 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-17.4.12.9 Handheld fire CO_2 extinguishers shall be provided for the control package.

A-17.4.12.10 Refer to the requirements of the Fire Protection Design Criteria in Attachment A-20 for additional fire protection and detection system requirements.

A-17.4.13 Starting System

A-17.4.13.1 One (1) LCI/static starter shall be provided.

A-17.4.13.2 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-17.4.13.3 The starting system shall be rated to supply 110% of the required starting and acceleration load during shutdown condition to self-sustaining speed.

A-17.4.13.4 If required for maintenance or cleaning, the start system shall be capable of running the CTG continuously at the unfired condition.

A-17.4.13.5 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-17.4.13.6 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-17.4.13.7 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-17.4.13.8 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-17.4.13.9 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-17.4.14 Turning Gear

A-17.4.14.1 A turning gear system complete with housing and safety guards shall be supplied for use during rotor cooldown.

A-17.4.14.2 Turning gear shall be capable of operation in case of AC power failure.

A-17.4.14.3 Turning gear shall maintain the rotor in a condition that allows for starting at any time after the shutdown period.

A-17.4.14.4 The turning gear device shall be suitable for indexing the rotor when performing borescope examinations and other maintenance/inspection activities.

A-17.4.14.5 Turning gear shall be provided with pneumatically operated turning equipment.

A-17.4.14.6 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-17.4.15 Enclosures

A-17.4.15.1 Enclosures shall be in accordance with the manufacturer's standard.

A-17.4.15.2 Equipment enclosures shall be provided as needed to meet environmental and noise requirements as specified in the Site Design Data. Enclosures shall be provided for the combustion turbine, generator, electrical equipment, and mechanical auxiliary equipment, as required.

A-17.4.15.3 Seller shall provide external and lighting for operation and maintenance. External lighting shall meet the requirements as specified in the Electrical Requirements and Design Criteria Attachment A-7. External lighting at door entrances shall be provided. All lighting shall be of the LED type.

A-17.4.15.4 Self-contained emergency backup lighting equipment provided in control and accessory areas in case of AC power outage.

A-17.4.16 Piping

A-17.4.16.1 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-17.4.16.2 All instrument air fittings, tubing, and piping shall be constructed of seamless stainless steel.

A-17.4.16.3 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-17.4.16.4 A preservative coating compatible with system oil shall be applied to all oil system piping to prevent corrosion and rusting of the piping.

A-17.4.16.5 For oil piping, at locations near bearing caps, oil piping shall be flanged to allow for field oil flushing.

A-17.4.16.6 Welded connections should be minimized to reduce field work.

A-17.4.16.7 All piping supports shall be hot dip galvanized.

A-17.4.17 HVAC

A-17.4.17.1 General:

A-17.4.17.1.1. Refer to Attachment A-4 for general HVAC design criteria and conditions.

A-17.4.17.2 Heaters:

A-17.4.17.2.1. 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-17.4.17.2.2. All heaters shall be thermostatically controlled.

A-17.4.17.3 Ventilation:

A-17.4.17.3.1. Seller shall provide redundant exhaust fans to create a negative pressure within the turbine compartment.

A-17.4.17.3.2. Ventilation design shall ensure that excessive temperatures are not reached in any of the supplied enclosures.

A-17.4.17.3.3. All ventilation shall exhaust outside of the CTG enclosure.

A-17.4.17.3.4. Ventilation for CT enclosure shall be equipped with fuel gas leak detection system.

A-17.4.17.4 Air Conditioning:

A-17.4.17.4.1. 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-17.4.18 Insulation and Lagging

A-17.4.18.1 General:

A-17.4.18.1.1. Insulation shall be used where required by OSHA for personnel safety. Personnel protection will 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-17.4.18.1.2. 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-17.5 GENERATOR AND APPURTENANCES TECHNICAL REQUIREMENTS

A-17.5.1 General

A-17.5.1.1 The generator and its appurtenances shall conform in all respect to the Institute of Electrical and Electronics Engineers Standard for Cylindrical Rotor Synchronous Generators (IEEE Std. C50.13) and for operation and maintenance of turbine generators (IEEE 67), with their latest revisions and additions, and to the following additional Specifications.

A-17.5.1.2 The generator shall be of the cylindrical rotor type, hydrogen cooled. The generator shall be designed to develop the capacities specified under the operating conditions described.

A-17.5.1.3 The generator shall be asbestos free.

A-17.5.1.4 The rotors shall be installed in the generator and shipped to site.

A-17.5.2 Generator Rating

A-17.5.2.1 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-17.5.2.2 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-17.5.2.3 Generator shall comply with NERC PRC-24-2

A-17.5.2.3.1. Generator shall be protected by a two-level V/Hz relaying scheme as indicated below:

A-17.5.2.3.2. Level 1 pick-up for alarm at 106% Volts/Hertz level instantaneously.

A-17.5.2.3.3. Level 2 to be set to a pickup for trip at 118% Volts/Hertz with a 2 second delay.

A-17.5.2.3.4. The V/Hz limiter in the AVR set at 105% Volts/Hertz level.

A-17.5.2.3.5. The protection in the AVR set to operate at 110% Volts/Hertz level.

A-17.5.2.4 The generator shall comply with all requirements in IEEE C50.13.

A-17.5.2.5 The generator shall have the following additional characteristics:

A-17.5.2.5.1. Cooling method shall be hydrogen cooled.

A-17.5.2.5.2. Rating by Seller

A-17.5.2.5.3. Power factor: 0.85 lagging, 0.95 leading

A-17.5.2.5.4. Voltage shall be Manufacturer's Standard

A-17.5.2.5.5. Number of phases: 3 (wye connected)

A-17.5.2.5.6. Frequency: 60 Hz

A-17.5.2.5.7. Speed: 3600 r/min

A-17.5.2.5.8. Short circuit ratio at rated H_2 pressure at maximum cooling water temperature: Not less than 0.50

A-17.5.2.5.9. The generator shall be capable of withstanding the effects negative phase-sequence current as specified in IEEE C50.13 without any resulting damage.

A-17.5.2.5.10. The generator shall be capable of withstanding the thermal effects of unbalanced faults at the generator terminals in accordance with IEEE C50.13 without any resulting damage.

A-17.5.2.5.11. 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 C50.13

A-17.5.2.5.12. The CTG shall withstand a 3-phase, phase-to- phase, phase-to-phase-to-ground, and phase-to-ground faults to the entire machine.

A-17.5.2.5.13. The generator shall also be capable of withstanding a 3-phase short circuit of 0.03 to 0.08 second duration.

A-17.5.2.5.14. BIL level shall be minimum 150 kV

A-17.5.2.5.15. The generator telephone influence factor shall be within the requirements of IEEE C50.13. The maximum value of balanced TIF shall not exceed 40. The residual TIF shall not exceed 30.

A-17.5.2.5.16. The Generator deviation factor for the open circuit terminal voltage wave of the generator shall not exceed 0.1.

A-17.5.2.5.17. Excitation system response ratio: 2.0 or greater

A-17.5.2.5.18. Nominal excitation voltage: Manufacturer's optimum

A-17.5.2.5.19. Stator winding connection: Copper

A-17.5.2.5.20. Stator winding connection: Star

A-17.5.2.5.21. Number of leads brought out:6

A-17.5.2.5.22. Field winding conductors: Copper

A-17.5.2.5.23. For hydrogen cooled generators, rated gas pressure:Manufacturer's standard

A-17.5.2.5.24. Hydrogen coolers, maximum inlet cooling water temperature Summer Design Conditions (See the Site Design Data)

A-17.5.2.5.25. The generator windings and end-turns shall be braced for peaking duty requiring frequent startups and shutdowns (See the Project Requirements for approximate number of startup and shutdown cycles per year).

A-17.5.2.5.26. 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-17.5.2.5.27. 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-17.5.2.5.28. 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-17.5.2.5.29. 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 C50.13.

A-17.5.2.5.30. Generator leads shall be brought out in 3-line side and 3 neutral side bushings.

A-17.5.2.5.31. Bushings shall be capable of being replaced without removing the generator rotor.

A-17.5.2.5.32. Generator lead box shall be modular to provide maximum shop assembly in consideration of transportation associated restrictions as applicable.

A-17.5.2.5.33. Generator control terminal boxes shall include maximum preassembly and prewiring in consideration of transportation associated restrictions as applicable.

A-17.5.3 Electrical Characteristics

A-17.5.3.1 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-17.5.3.2 The exciter shall have sufficient capacity to operate within its current rating with the generator operating at its maximum capability.

A-17.5.3.3 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-17.5.3.4 For hydrogen cooled cycles, the terminal bushing assembly shall be designed for operation without leakage under the specified maximum hydrogen pressure.

A-17.5.3.5 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-17.5.3.6 If brushless exciters are used, they shall be completely enclosed and air-cooled with ventilating systems as required.

A-17.5.3.7 Design of generator shall be such that stator and/or rotor may be removed and replaced with a minimum of difficulty.

A-17.5.3.8 Insulating materials used shall be of the best quality available and be properly applied to give a high factor of safety.

A-17.5.3.9 The insulation shall be Class F; however, the machine shall be designed for a Class B maximum temperature rise.

A-17.5.3.10 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-17.5.4 Stator

A-17.5.4.1 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-17.5.4.2 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-17.5.4.3 Phase and neutral terminals shall be marked consecutively in the order of their phase sequences.

A-17.5.4.4 Heaters shall be provided with the stator to avoid condensation moisture during stand-by periods.

A-17.5.4.5 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-17.5.4.6 Drains and liquid detectors and shall be provided at the low points.

A-17.5.4.7 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" NPT connection.

A-17.5.4.8 CO_2 shall be used as a purging medium. The CO_2 system shall provide for the H_2 evacuation and safe charging of the hydrogen from the generator.

A-17.5.4.9 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-17.5.4.10 H_2 and CO_2 storage shall be provided by Seller. Piping and connection between the storage and Seller's control stations shall be by Seller.

A-17.5.4.11 The control cabinet for Hydrogen shall be suitable for an outdoor environment with the applicable hazardous area classification.

A-17.5.4.12 Alarms shall have dry – C contacts to interface with the Facility DCS. The H_2 cabinet shall provide trouble indication.

A-17.5.5 Rotor

A-17.5.5.1 Castings shall not be used for any part of the rotor, unless approved by Buyer.

A-17.5.5.2 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-17.5.5.3 Generator rotor shall have two retaining rings, made of 18 Mn – 18 Cr forged material.

A-17.5.5.4 Collector rings shall be provided with an insulating barrier.

A-17.5.5.5 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-17.5.5.6 Brushes shall be mounted in such a way as to prevent uneven wear of the collector rings.

A-17.5.5.7 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.

A-17.5.5.7.1. One (1) – Generator flux probe

A-17.5.5.7.2. One (1) – Casing gland (gas-tight terminal connection))

A-17.5.5.7.3. One (1) – Signal wire (inside of generator only).

A-17.5.5.8 The field windings shall be designed for direct cooling by the cooling medium.

A-17.5.5.9 Rotor vibration shall meet the requirements of ISO 20816 Zone A/B.

A-17.5.5.10 Excitation System:

A-17.5.5.10.1. A static excitation system shall be supplied and shall include a line fed excitation transformer.

A-17.5.5.10.2. Excitation transformer shall be dry type, cast resin suitable for outdoor use.

A-17.5.5.10.3. Transformer shall be sized with sufficient capacity based on ceiling voltage at the rated generator conditions.

A-17.5.5.10.4. 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-17.5.5.10.5. Transformer BIL rating shall comply with the requirements of IEEE C57. Overload protection for the excitation transformer shall be provided.

A-17.5.5.10.6. The system shall be rated to provide generator voltage regulation from 95% to 105% of the rated voltage at any operating load.

A-17.5.5.10.7. An exciter field breaker or contactor shall be provided.

A-17.5.5.10.8. 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-17.5.5.10.9. If field flashing is used, a fused field flashing circuit shall be provided.

A-17.5.5.10.10. The generator field temperature shall be monitored and displayed.

A-17.5.5.11 Voltage Regulating Equipment:

A-17.5.5.11.1. 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-17.5.5.11.2. 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-17.5.5.11.3. 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-17.5.5.11.4. V/Hz pickup settings shall be as follows: shall allow continuous operation at 105%.

A-17.5.5.11.5. A means of local and remote voltage adjustment shall be provided.

A-17.5.5.11.6. Rotor temperature indicator as well as field current and field voltage transducers shall be provided.

A-17.5.5.12 Cooling System: The generator shall be totally enclosed hydrogen-cooled.

A-17.5.5.12.1. 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 Subcontractor’s standard, shall be conducted. A hydrogen flow meter with totalizing shall be provided.

A-17.5.5.13 Surge Arrestors and Potential Transformers shall be provided. Surge arrestors shall be station type and shall contain no PCBs by Seller.

A-17.5.5.13.1. 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-17.5.5.13.2. Two (2) sets of three (3) single phase potential transformers shall be provided with each set feeding primary and back up relaying per the CTG 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 PT's from the synchronizing circuits.

A-17.5.5.13.3. 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-17.5.5.14 Generator Neutral Grounding shall be provided.

A-17.5.5.14.1. 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's neutral current.

A-17.5.5.14.2. A high resistance grounding system (NGR) for the generator shall be provided. The grounding system shall be able to provide 100% generator ground fault protection.

A-17.5.5.15 Metering and Protection

A-17.5.5.15.1. 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-17.5.5.15.2. 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-17.5.5.15.3. 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-17.5.5.15.4. Generator Protective Relaying

A-17.5.5.15.4.a. Primary and backup relays shall be provided. Primary shall be SEL-300G and backup shall be Beckwith M-3425A. 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-17.5.5.15.4.b. Buyer shall be consulted to determine protection preferences (out of step, voltage-controlled overcurrent).

A-17.5.5.15.4.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-17.5.5.15.4.d. Generator frequency operation should have relaying protection that accommodates, as a minimum, under frequency and over frequency operation for the specified time frames as per NERC requirements.

A-17.5.5.15.5. Current transformers used for generator protection shall be relaying accuracy suitably sized for the burden.

A-17.5.5.15.6. 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-17.5.5.15.7. CT relaying accuracy shall be C400 and metering accuracy shall be 0.3B1.8.

A-17.5.5.15.8. All generator lockout relays shall be located in the GCRP, which will be located in the CT Control Package. As a minimum, one (1) 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-17.5.5.15.9. The turbine-generator shall have an appropriate synchro check relay and auto synchronizer to allow automatic synchronizing with the utility power grid.

A-17.5.6 Motor Control Center(s)

A-17.5.6.1 Attachment A-7 is not applicable to OEM-supplied CTG auxiliaries' motors; these motors will conform to OEM standard requirements. Motor Control Center(s) shall be per the CTG Subcontractor's One Line Diagrams. Minimum 10% of spare and 10% of space of MCC buckets shall be provided in each MCC.

A-17.5.6.2 Seller shall provide a complete low voltage power distribution system. Two AC 480-V MCC(s), each with NEMA 1 with Gasket design for the combustion turbine unit. These MCC's shall provide both power and control for the 480-V loads associated with the combustion turbine unit except for the loads larger than 250 HP, common loads (SFC etc.), and SFC and Excitation Pkg utility loads which will be fed from power distribution equipment for BOP equipment. All redundant loads will 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-17.5.6.3 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-17.5.6.4 MCC incoming cables shall be adequately sized, 600V having construction as specified in Attachment A-7.

A-17.5.6.5 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-17.5.7 Batteries

A-17.5.7.1 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-17.5.7.2 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-17.5.7.3 Location of the battery compartment shall allow direct access for service to all cells.

A-17.5.7.4 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-17.5.7.5 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-17.5.8 Grounding

A-17.5.8.1 Refer to the Electrical Requirements and Design Criteria for specific grounding requirements.

A-17.5.8.2 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-17.5.8.3 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-17.5.8.4 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-17.5.8.5 The cases of all instruments, relays, and switching devices shall be grounded.

A-17.5.9 Panels

A-17.5.9.1.1. Panels shall be assembled per CTG Subcontractor’s standard.

A-17.5.10 Terminal Blocks and Wiring

A-17.5.10.1 Terminal blocks and wiring shall be CTG Subcontractor's standard.

A-17.5.10.2 All terminal blocks and points be labeled as indicated on the electrical drawings.

A-17.5.11 Miscellaneous Requirements

A-17.5.11.1 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-17.5.11.2 All solenoid valves shall be suitable for continuous operation and shall have coils with Class "H" insulation. Solenoids shall have NEMA 4 enclosures.

A-17.5.11.3 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 boxes. NEMA 4 Boxes can be painted per OEM standard.

A-17.5.11.4 Power source conditioning is the responsibility of the Seller to protect against transient voltages.

A-17.5.11.5 Radio Frequency Interference:

A-17.5.11.5.1. The control system shall be designed to operate in a power plant environment and shall exhibit immunity to stray magnetic fields.

A-17.5.11.5.2. The control system shall be immune to radio frequency interference generated by radio transceivers.

A-17.5.11.5.3. 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-17.6 INSTRUMENTATION AND CONTROL

A-17.6.1 Control System-General

A-17.6.1.1 Seller shall furnish and install all instrumentation and control devices required for safe and efficient operation of the 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 Attachment A-8.

A-17.6.1.2 Seller shall provide the CTG with a complete and functional control system located adjacent to the 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 the CTG Unit Subcontractor's standard redundant network. A proven redundant, fiber optic datalink utilizing OPC over Ethernet shall connect the Facility DCS with the CTG control system network.

A-17.6.1.3 Seller's control system shall utilize distributed redundant microprocessor-based hardware.

A-17.6.1.4 The CTG control system will 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-17.6.1.5 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 the CTG - per unit. The Seller shall provide the system database files in Excel or Access format.

A-17.6.1.6 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-17.6.1.7 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. The Seller shall provide a USB drive or other Buyer approved method and two hard copies of the CTG control system configuration as-shipped drawings within one week of shipment of the system.

A-17.6.1.8 The 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, compressor air flow. The performance monitoring data shall be trended and archived within the CTG control system. Reports shall be supplied showing on-line performing information and past data.

A-17.6.1.9 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-17.6.1.10 The historical storage and retrieval system within the CTG 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-17.6.1.11 The CTG control system shall include a redundant OPC communication link to Facility DCS.

A-17.6.1.12 Emergency stop switches shall have a means to prevent accidental operation such as clear plastic / Lexan covers, or push button guards.

A-17.6.2 Control System - Functional Requirements

A-17.6.2.1 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. The 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-17.6.2.2 The CTG control system shall be designed for complete automatic startup, synchronizing, loading, protective shutdown, and manually initiated shutdown.

A-17.6.2.3 In the case of a sudden loss of load while the CTG is operating with maximum power output, the speed governing system will be capable of controlling the speed at a value that is less than the setting of the emergency over speed governor.

A-17.6.2.4 The 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-17.6.2.5 NFPA 85 HRSG purge and CT to HRSG interlock requirements must be satisfied by the CTG control system.

A-17.6.2.6 The load control subsystem shall include provisions for manipulating the CTG 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-17.6.2.7 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 the control system with on-line testing of EOST modules, such as overspeed protection, while the CTG is online.

A-17.6.2.8 All CTG control screens shall be replicated in the Facility DCS for the CTG. During the engineering stage, Seller shall provide graphics to be displayed in the DCS for Buyer's review.

A-17.6.2.9 Seller's equipment shall also include provisions for interfacing through hardwired facilitate controlling and redundant data highway for monitoring the 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-17.6.2.10 Seller's schedule shall include the duration required for engineering and testing the interface with DCS system.

A-17.6.3 Control System - Human-Machine Interface

A-17.6.3.1 Virtual HMI shall be applied to operator console, engineering workstation, historical storage and retrieval system, and OPC server.

A-17.6.3.2 Two (2) independent Host Server machines shall be provided in the control room. The 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-17.6.3.3 The remote operator console (Thin Client) for the 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-17.6.3.4 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 the CTG operation.

A-17.6.3.5 Seller shall furnish an engineering workstation (Thin Client) with 24-inch dual display monitor. The 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-17.6.3.6 An additional Thin Client with 24-inch display monitor shall be provided for historical and retrieval system and OPC server.

A-17.6.3.7 Software Assurance for Thin Client's licenses shall be a 2yr 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-17.6.3.8 Control System – I/O Partitioning and System Redundancy:

A-17.6.3.8.1. I/O shall be partitioned so that redundant field instruments/equipment shall be partitioned and assigned to different I/O cards.

A-17.6.3.8.2. 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-17.6.3.9 Data Communication Subsystem:

A-17.6.3.9.1. 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 the 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-17.6.3.9.2. Each functional processor and its backup shall be programmed to execute the assigned tasks with no communication overhead. Security of communication shall be assured 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-17.6.3.10 Control System - Programming/Configuring (Software)

A-17.6.3.10.1. 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-17.6.4 Vibration Monitoring System

A-17.6.4.1 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 will be allocated for Buyer to install Alta communication card.

A-17.6.4.2 Parameters Monitored:

A-17.6.4.2.1. 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 this Attachment.

A-17.6.4.2.2. The CTG Supervisory system values and alarms will communicate with the CTG control system via hardwired connections. Trips shall be hardwired between the CTG supervisory system and CTG 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-17.6.5 Performance Testing Instrumentation

A-17.6.5.1 Seller shall furnish all instruments and test ports required for performance testing of the CTG and the complete Facility.

A-17.6.6 Local Instrument Panels

A-17.6.6.1 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-17.6.6.2 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-17.6.6.3 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-17.6.6.4 Time Synchronization:

A-17.6.6.4.1. 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. The CTG internal system clock shall keep all CTG subsystems synchronized.

A-17.6.6.4.2. Seller shall provide an interface to a satellite clock for purposes of time synchronization of the CTG. The 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 the CTG control system.

A-17.6.6.4.3. Seller to supply linking generator relays to the time server.

A-17.6.6.5 NERC/CIPS compliance requirement and Cyber-Security.

A-17.6.6.5.1. The 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-17.6.6.5.2. 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-17.6.6.5.3. 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-17.6.7 Instrumentation - General

A-17.6.7.1 All instrumentation and control devices shall be suitable for the environment where they will be located.

A-17.6.7.2 Profibus and foundation fieldbus shall not be installed on instruments and valves.

A-17.6.7.3 Pressure indicators on pump headers shall be provided with snubbers and shall be glycerol filled.

A-17.6.7.4 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-17.6.7.5 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-17.6.7.6 Instrument tags shall be stainless steel and either screwed into instrument or attached to instrument by a stainless-steel wire.

A-17.6.7.7 All instrument tagging shall agree with the approved project tagging procedure and shall be read in English units.

A-17.6.7.8 Instrument tubing (304 stainless steel) shall not be welded and shall be ½ inch minimum in size. Generator may utilize smaller tubing per Major Equipment standard design.

A-17.6.7.9 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-17.6.7.10 Instruments located on the packaged equipment systems shall be furnished, mounted, and installed by Seller.

A-17.6.7.11 Pressure gauges shall be minimum 4 ½ inch local mounted, 3 ½ inch board mounted, and 1 ½ inch to 2 ½ inches mounted on air operated control valves.

A-17.6.7.12 Dual element temperature probes shall be furnished as a minimum.

A-17.6.7.13 All differential pressure instrumentation shall be supplied with five valve manifolds. Two valve manifolds shall be supplied for all pressure instruments.

END OF ATTACHMENT A-17

BOT Scope Book

Attachment A-18

Heat Recovery Steam Generator (HRSG) Technical Specification

Table of Contents

A-18.1 INFORMATION AND SCOPE OF WORK

A-18.1.1 General

A-18.1.1.1 The Facility will utilize a Heat Recovery Steam Generators (HRSG) to recover waste heat from the Combustion Turbine-Generator (CTG) to generate steam for use to produce electric power in the steam turbine. The Facility will be configured as with one (1) HRSG per CTG train and one (1) Steam Turbine Generator (STG). The HRSG equipment shall be designed for operation as shown in Project Requirements.

A-18.1.1.2 The Seller shall provide HRSG(s) 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. Base plates for columns shall be shop welded.

A-18.1.1.3 The HRSG design and construction shall be based on 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-18.1.1.4 The HRSG equipment shall be designed for operation as specified in the Project Requirements.

A-18.1.1.5 Seller shall provide with P&IDs showing terminal points. Based on this Terminal Point boundary, Seller needs to provide Equipment/Commodity listing of furnished materials.

A-18.1.1.6 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-18.1.1.7 Internal sections of the HRSG stack shall be primed and painted.

A-18.1.2 HRSG Scope of Work

A-18.1.2.1 The Seller shall design, furnish, manufacture, shop test, and deliver to the Project site) HRSG(s) as required.

A-18.1.2.2 All accessories and appurtenances as hereinafter specified including, but not limited, to the following:

A-18.1.2.2.1 Inlet gas transition duct from CTG exhaust to HRSG. All CTG exhaust plenum growth due to thermal expansion shall be accommodated.

A-18.1.2.2.2 HP superheater, evaporator, steam drum and economizer.

A-18.1.2.2.3 Reheat superheater.

A-18.1.2.2.4 IP superheater, evaporator, steam drum and economizer.

A-18.1.2.2.5 LP superheater, evaporator, steam drum and LP economizer.

A-18.1.2.2.6 Flow Accelerated Corrosion (FAC) analysis.

A-18.1.2.2.7 Extraction of water from the IP feedwater system (location to be optimized to achieve fuel gas temperatures required by the CTG) for the CTG fuel gas performance heater.

A-18.1.2.2.8 Confirmation of CTG outlet expansion joint details with the CTG exhaust interface.

A-18.1.2.2.9 Atmospheric blowdown tank with steam quenching capability (including instrumentation and control valves), vent stack and vent silencer.

A-18.1.2.2.10 Feedwater control valves

A-18.1.2.2.11 Exhaust stack (with silencer if required to meet noise guarantee) complete with emission monitoring ports and access platforms.

A-18.1.2.2.12 Stack damper with electric-motor drive.

A-18.1.2.2.13 Exhaust stack FAA lighting to meet the FAA regulations. All lighting shall be LED type.

A-18.1.2.2.14 Superheater and reheater interstage desuperheaters with associated spray control and stop valves to meet the requirement of ASME B31.1 and ASME B&PV.

A-18.1.2.2.15 Acoustic enclosures, barrier walls and silencers as required to meet the noise guarantee in the Site Requirements and Design Criteria.

A-18.1.2.2.16 Dual-function catalyst and SCR system designed for removal efficiency needed to achieve emission limits imposed by the air permit and performance guarantees.

A-18.1.2.2.17 Ammonia control, vaporization, dilution, and injection system.

A-18.1.2.2.18 CO/VOC oxidation catalyst spool piece (designated duct length of 20ft approximately) designed for future removal efficiency needed to achieve the Emission Requirements for 100% hydrogen firing.

A-18.1.2.2.19 Cranes and hoists as defined herein.

A-18.1.2.2.20 Test ports as defined herein.

A-18.1.2.2.21 Access doors as defined herein.

A-18.1.2.2.22 Gas tight casing, except for weep holes where required, with thermal insulation.

A-18.1.2.2.23 All ASME Section I piping and boundary valves for transition to ASME/ANSI B31.1 piping.

A-18.1.2.2.24 Instrument trim and trim piping.

A-18.1.2.2.25 Shop priming of all items suitable for all extremes of environment.

A-18.1.2.2.26 Hot dipped galvanized access walkways, platforms, handrail, and stairways for access to the HRSG and steam drums, stack outlet test ports and all valves in accordance with the Civil/ Structural, Architectural Requirements and Design Criteria.

A-18.1.2.2.27 Slide bearing assemblies for all non-anchor supports.

A-18.1.2.2.28 One set of all special tools.

A-18.1.2.2.29 Shop testing including functional testing of equipment specified.

A-18.1.2.2.30 Nitrogen connections on the water/steam side of the steam drums, and piping for long term layup of the equipment.

A-18.1.2.2.31 Steam and water sampling connections.

A-18.1.2.2.32 Chemical feed connections per manufacturer's standard.

A-18.1.2.3 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, AIG, and dual-function catalyst.

A-18.1.2.4 Seller shall provide documentation and data to Buyer, including but not limited to, the following:

A-18.1.2.4.1 QA/QC Program.

A-18.1.2.4.2 QA/QC maintenance procedures.

A-18.1.2.4.3 All drawings, including as-built drawings; these drawings shall include, in addition to the drawings listed in the Project Requirements, the following:

A-18.1.2.4.3.a Piping and Instrument Diagrams.

A-18.1.2.4.3.b Piping line and valve lists provided in Excel and PDF formats.

A-18.1.2.4.3.c System Descriptions.

A-18.1.2.4.3.d General arrangement drawings of plan, and two sides elevations of the HRSG and major equipment.

A-18.1.2.4.3.e Drawings of major components and subassemblies including but not limited to steam drum or steam separator. All Subcontractors drawings received by Seller including module dimensional drawings will be provided to Buyer.

A-18.1.2.4.3.f Welding procedures including construction code definition for field welding.

A-18.1.2.4.3.g Erection drawings and procedures.

A-18.1.2.4.3.h Certificates of Completion including checklists to confirm that the installation is fully complete.

A-18.1.2.4.3.i Commissioning procedures.

A-18.1.2.4.3.j Control systems description and logic diagrams associated with HRSG Systems.

A-18.1.2.4.3.k Instrument list and I/O list provided in Excel and PDF formats.

A-18.1.2.4.3.l Electrical control schematic and wiring diagrams for all major equipment.

A-18.1.2.4.3.m Insulation anchors, liners, and insulation details for the HRSG.

A-18.1.2.4.3.n Structural steel arrangement drawings.

A-18.1.2.4.3.o Ductwork arrangement including insulation and supports.

A-18.1.2.4.3.p Interface details between HRSG and CTG exhaust duct.

A-18.1.2.4.3.q Expansion joints.

A-18.1.2.4.3.r Piping arrangement drawings including overall dimensions, material specifications, wall thickness and spool piece information.

A-18.1.2.4.3.s Module arrangement drawings.

A-18.1.2.4.3.t Ladders, platforms, and access doors.

A-18.1.2.4.3.u Arrangement drawing for the SCR system section showing the catalyst module arrangement and structural support.

A-18.1.2.4.3.v Arrangement drawings with dimensions of the ammonia injection grid (AIG).

A-18.1.2.4.3.w Arrangement drawings of test port locations and dimensions.

A-18.1.2.4.3.x Arrangement drawings for the Supplemental Firing system and all associated subcomponents (as may be required by design).

A-18.1.2.4.3.y Safety Valve Drawings.

A-18.1.2.4.3.z Instrument installation details, instrumentation location drawings and instrument datasheets

A-18.1.2.4.3.aa Operation and maintenance manuals (draft and final).

A-18.1.2.4.3.bb Steam drum sizing basis including calculations, assumptions, capacity, and level setpoints.

A-18.1.2.4.3.cc Seller shall provide spare parts as follows:

- Installation, startup, and commissioning spares through the 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 ft length each). Buyer to indicate requested alloy (e.g., T11, T22 or T91) and geometry (e.g., diameter / wall thickness) prior to Seller purchase of HRSG tubing.

A-18.1.2.5 HRSG Performance Curves and Data

A-18.1.2.5.1 The following performance correction curves (or software program) shall be provided:

A-18.1.2.5.1.a High pressure steam outlet pressure and temperature correction curve.

A-18.1.2.5.1.b High pressure steam outlet flow correction curve.

A-18.1.2.5.1.c Hot reheat steam outlet pressure/temperature correction curve.

A-18.1.2.5.1.d Hot reheat steam outlet flow correction curve.

A-18.1.2.5.1.e Cold reheat steam inlet pressure and temperature correction curve.

A-18.1.2.5.1.f Cold reheat steam inlet flow correction curve.

A-18.1.2.5.1.g Intermediate pressure steam outlet pressure and temperature correction curve.

A-18.1.2.5.1.h Intermediate pressure steam outlet flow correction curve.

A-18.1.2.5.1.i Low pressure steam outlet pressure and temperature correction curve.

A-18.1.2.5.1.j Low pressure steam outlet flow correction curve.

A-18.1.2.5.1.k High pressure steam desuperheater flow correction curve (interstage and final/exit stage).

A-18.1.2.5.1.l Hot reheat steam desuperheater flow correction curve (interstage and final/exit stage).

A-18.1.2.5.2 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-18.1.2.5.3 Gas flow, temperature, and pressure data for the following sections over the specified ambient temperature and normal operating CTG load ranges:

A-18.1.2.5.3.a Inlet to the HRSG

A-18.1.2.5.3.b Inlet to the Oxidation Catalyst Spool

A-18.1.2.5.3.c Inlet to the Ammonia Injection Grid (AIG)

A-18.1.2.5.3.d Inlet to the Dual-Function Catalyst

A-18.1.2.5.3.e Inlet to the HP Section

A-18.1.2.5.3.f Outlet of the HP Section

A-18.1.2.5.3.g Inlet of the IP Section

A-18.1.2.5.3.h Outlet of the IP Section

A-18.1.2.5.3.i Inlet of the LP Section

A-18.1.2.5.3.j Outlet of the LP Section

A-18.1.2.5.3.k Inlet of the Economizer Sections

A-18.1.2.5.3.l Outlet of the HRSG

A-18.1.2.5.4 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-18.1.3 Emissions Performance Curves:

A-18.1.3.1 Stack emission values for the HRSG performance cases shall also be provided. The HRSG performance cases shall include the maximum and minimum ambient temperatures and selected intermediate ambient temperatures with the CTG at 100% load and at the minimum emissions compliance load (MECL). Curves as follow shall be submitted:

A-18.1.3.1.1 NO_X Reduction (%) vs. Temperature (°F).

A-18.1.3.1.2 NO_X Reduction (%) vs. Flue Gas Flow Rate (acfm or lb/hr).

A-18.1.3.1.3 CO Reduction (%) vs. Temperature (°F).

A-18.1.3.1.4 CO Reduction (%) vs. Flue Gas Flow Rate (acfm or lb/hr).

A-18.1.3.1.5 VOC Reduction (%) vs. Temperature (°F).

A-18.1.3.1.6 VOC Reduction (%) vs. Flue Gas Flow Rate (acfm or lb/hr).

A-18.1.3.1.7 Pressure drops 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-18.1.3.1.8 SO_2 to SO_3 oxidation with respect to temperature for the dual-function catalyst.

A-18.1.3.1.9 Formaldehyde Reduction (%) vs. Temperature (°F).

A-18.2 HRSG DESIGN CRITERIA AND OPERATING CONDITIONS

A-18.2.1 HRSG Minimum Design Requirements

Equipment Identification.................................. Heat Recovery Steam Generator
Number of HRSGs Required.. By Seller
Gas Flow.. ☒ Horizontal ☐ Vertical
Circulation Type.. ☒ Natural ☐ Forced
Pressure Levels.. 3
Configuration...Reheat
Operation Mode.................. ☐ Constant Pressure ☒ Sliding Pressure ☐ Hybrid
Stack Height (above grade) .... By Seller (ft)
Stack Damper with operator.. Yes
Stack Diameter (outer diameter)... By Seller (ft)
Duct Burners..By Seller

Combustion Turbine:

Manufacturer..By Seller
Model...By Seller

A-18.2.2 Other HRSG Requirements:

A-18.2.2.1 A Flow Accelerated Corrosion (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 industry guidelines for AVO (All Volatile-Oxygenated) treatment regime when performing the analysis.

A-18.2.2.2 The 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 between all loads from MECL to 100% load. HRSG stack emissions shall meet the Emissions Performance Guarantees as defined in the Project Requirements. The Seller shall be responsible for design and equipment supply for the catalyst spool piece, 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-18.2.2.2.1 The CO/VOC catalyst spool and SCR system shall be considered an integral part of the HRSG. Design, fabrication, inspection, and testing of this equipment shall be in accordance with the requirements of this specification.

A-18.2.2.3 A minimum of 25°F margin shall be provided between the design tube metal temperature and the highest predicted tube metal temperature.

A-18.2.2.4 During hot restarts of the STG, a bypass to ACC shall be supplied to provide system warm-up capabilities to meet the STG roll permissive.

A-18.2.2.5 Shop hydrostatic testing of all HRSG drums shall be included in Seller scope of work.

A-18.2.2.6 Any temporary shipping supports of the HRSG shall be optimized for quick and easy removal in the field (during erection).

A-18.3 GUARANTEES

A-18.3.1 Performance Guarantees:

A-18.3.2 Refer to Attachment A-3 for performance guarantees.

A-18.4 HRSG DESIGN REQUIREMENTS

A-18.4.1 General Design Requirements

A-18.4.1.1 The 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 the HRSG unit shall provide a minimum of two (2) printed copies and one (1) electronic copy of the proper Code certification that all Work performed by him or others responsible to him complies with all requirements of the Code, including design, construction, materials, and workmanship.

A-18.4.1.2 Electrical equipment shall be in accordance with the National Electrical Code (NFPA 70) as well as local and state ordinances.

A-18.4.1.3 HRSG shall be designed in accordance with NFPA 850 and NFPA 85.

A-18.4.1.4 The HRSG Unit shall have a design life of 30 years operation without distress due to cycling loads.

A-18.4.1.5 OSHA1910 Federal Standards, General Industry Safety Orders, codes, regulations and the Civil/ Structural, Architectural Requirements, Attachment A-5 and Design Criteria, Attachment A-4 shall apply for platforms, ladders, handrails, etc.

A-18.4.1.6 The 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-18.4.1.7 The HRSG outlet stack shall be designed in accordance with the Site Requirements and Design Criteria and ASME STS-1, Steel Stacks

A-18.4.1.8 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-18.4.1.9 The HRSG 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-18.4.1.10 Seller shall provide the material certification documentation for all materials used in pressure parts of the HRSG.

A-18.4.1.11 The HRSG 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-18.4.1.12 Lower tube headers in different services shall be physically separated; divider plates shall not be used in this application.

A-18.4.1.13 Requirements provided in Attachment A-6 Mechanical Requirements and Design Criteria for numbering and labeling shall apply to the Seller's supply of the heat recovery steam generator, electrical and control panels, electric motors, pumps, heat exchangers, instrumentation requiring interface connections with wiring by others, instrumentation wired directly into the Facility DCS, and valves. OEM IDs/tags must include unit and system designations.

A-18.4.2 Piping

A-18.4.2.1 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 Attachment A-6.

A-18.4.2.2 Aqueous ammonia piping shall be stainless steel.

A-18.4.2.3 Vaporized ammonia piping shall be stainless steel.

A-18.4.2.4 Equipment, piping, and instrumentation shall be provided with freeze protection (heat tracing and insulation), in compliance with the Mechanical Requirements and Design Criteria.

A-18.4.2.5 All components subject to freezing shall be freeze protected with electric heat tracing cable. Drum end enclosures shall be provided. 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-18.4.2.6 Identify piping, the 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 Sub-Contractor drawings and engineering lists), with adequate detail for procurement, construction and erection of heat tracing and insulation materials.

A-18.4.2.7 Positive material identification per ASME code requirements shall be maintained and submitted, as requested by Buyer, for all alloy piping. Seller shall keep the alloy pipe material identification and records for P91 field and shop welds on file for three years or submit it to Buyer. NDE requirement to provide testing points for hardness post heat treat in 4 quadrants with points specifically on base metal, heat affected zones, weld metal.

A-18.4.2.8 Access Facilities

A-18.4.2.8.1 The 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-18.4.2.8.2 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 24-inches between heat transfer sections.

A-18.4.2.8.3 Seller shall provide hinged or davit arm access and inspection doors for both sides of all parts of the HRSG and upstream and downstream of each heating transfer section, ductwork, flues, and other equipment. The minimum size of the doors shall be 18” wide by 24” 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 doors located more than 10 feet above grade and roof area doors.

A-18.4.2.8.4 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-18.4.2.8.5 Minimum clearance over walkways and platforms shall be 7'-6".

A-18.5 HRSG Operating Parameters

A-18.5.1 General Operating Parameters

A-18.5.1.1 The 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 the HRSG shall be compatible with the combustion turbines. The HRSG shall be designed for cycling operation and base load operation. The 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. The HRSGs shall be designed for the number of starts as defined in A-4. Refer to the Construction Requirements for additional details regarding operating parameter requirements.

A-18.5.2 Expansion Joints

A-18.5.2.1 Seller shall provide expansion joints as required for the design of the ductwork, HRSG, and stack.

A-18.5.2.2 Expansion joints shall be suitable for use at temperature 200°F above flue gas temperature.

A-18.5.2.3 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. The expansion joint between the CTG and HRSG inlet duct and the expansion joint between the HRSG exit and breech duct shall be a heavy duty, fabric type joint.

A-18.5.3 Ductwork

A-18.5.3.1 General Ductwork Design Requirements

A-18.5.3.1.1 Duct design shall be such that the velocity of gas or air will not be excessive. Abrupt turns shall be avoided, but where required to meet the HRSG and catalyst Subcontractor's requirements, distribution devices shall be provided. Internal design pressure of the ducts shall be 5" above intended design 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-18.5.3.1.2 The HRSG shall include the exhaust duct from the combustion turbine exhaust to the HRSG inlet (excluding expansion joint). The inlet transition ductwork shall not exceed a 51° 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-18.5.3.1.3 The stainless-steel covering system shall consist of suitable insulation for HRSG design and an interior floating liner system. 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-18.5.3.1.4 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-18.5.3.1.5 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 (6mm) 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-18.5.4 HRSG Outlet Stack

A-18.5.4.1 The exhaust stack shall be a self-supporting carbon steel stack, with emission testing ports, damper, platforms, caged ladder, personnel protection, access door, drain connections and a stack silencer (if required to meet noise requirement).

A-18.5.4.2 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 A 36 carbon steel with a corrosion allowance of 1/16 inch on the plate material incorporated in the stack design.

A-18.5.4.3 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-18.5.4.4 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-18.5.4.5 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-18.5.4.6 Stack shall include proper openings for sampling flue gas per the United States EPA specifications. A 5 ft 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-18.5.4.7 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-18.5.4.8 The HRSG stack shall be equipped with a stack beacon lighting system in accordance with FAA Advisory Circular 70/7460-1L "Obstruction Marking and Lighting". Lighting shall be LED type.

A-18.5.5 Stack Damper

A-18.5.5.1 HRSG design shall include an automatic, motorized, corrosion resistant stack damper to minimize draft cooling during shut down.

A-18.5.5.2 Each stack damper shall be a multi-blade louver type, actuated by a single AC motor-operator located external to the gas stream.

A-18.5.5.3 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-18.5.5.4 The damper linkage and one of the damper blades shall be configured to automatically open, should the combustion turbine-generator be started before the damper reaches the fully open position.

A-18.5.6 Casing, Insulation and Liner

A-18.5.6.1 HRSG inlet duct, boiler walls, shall be of a “cold frame” type of construction, with an exterior gas tight carbon steel casing, internal insulation, and a steel floating liner. The outlet duct shall be designed for external insulation and lagging.

A-18.5.6.2 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 assure runoff of rainwater. Stiffeners shall be designed in such a manner as not to impede rainwater runoff.

A-18.5.6.3 Exterior casing shall be welded steel plate to provide a gas tight 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-18.5.6.4 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 four (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 60.

A-18.5.6.5 Internal gas path liner shall be in accordance with the table below.

Max. Gas Temperature °F	**Material**
Below 750	Carbon Steel
750-1200	SA240 S40910
1200-1400	SA240 S30409

1401-1600	SA240 S30909

A-18.5.6.6 Transition ductwork internal gas path liner shall be a 12 gauge (3mm) minimum thickness for floor, sides, and roof. HRSG liner shall be 12-gauge (3mm) minimum thickness for floor panels and minimum of 16 gauge (1.5mm) 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 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-18.5.7 Tube Banks

A-18.5.7.1 All heat transfer sections shall be of modular design, supplied as C-Frames.

A-18.5.7.2 Each section shall be vertically oriented and capable of fully self-draining and venting.

A-18.5.7.3 Lower headers shall be furnished with 2-inch minimum drain pipe connections.

A-18.5.7.4 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-18.5.7.5 HRSG tubing heat exchange surface that is finned shall have fins no higher than ¾ inch and shall have a fin spacing no more than 8 fins per inch of tube length. The tube fin thickness shall be a minimum of 0.031 inch (0.8mm). Fins shall be attached to the tubes using a continuous high frequency electrical resistance welding technique.

A-18.5.7.6 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-18.5.7.7 Material/Welds

A-18.5.7.7.1 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-18.5.7.7.2 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-18.5.7.8 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 exhaust gas temperature to fall below acid dew point. The economizer temperature shall be controlled using an external heat exchanger arrangement instead of a recirculation pump system.

A-18.5.7.9 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-18.5.8 Evaporators

A-18.5.8.1 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-18.5.8.2 The LP Evaporator header shall be constructed of P11 alloy material.

A-18.5.9 Superheaters/Reheaters

A-18.5.9.1 Superheater/reheater design and location shall prevent wide fluctuations in steam temperature over the entire load range of the HRSG 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. The superheater and reheaters shall include the proper coil pressure drops and header sizing to ensure that the tube-to-tube steam flow mal-distribution shall not exceed 10%.

A-18.5.9.2 Superheater/reheater design shall be protected by a code overpressure device of not less than 115% of the calculated maximum required relieving flow.

A-18.5.9.3 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-18.5.9.4 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 and shall be butt-weld end located a minimum of 3 ft (1m) 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-18.5.9.5 A motor operated vent valve shall be provided to allow purging of the superheaters of gases and non-condensibles during startups. The vent line shall be connected to an exhaust silencer.

A-18.5.9.6 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 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-18.5.9.7 The 100% bypass system shall be primarily used for starting up and tripping the STG; 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-18.5.9.8 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-18.5.10 Desuperheaters

A-18.5.10.1 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-18.5.10.2 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-18.5.10.3 Seller shall provide complete design details for location of the final (exit) stage desuperheaters.

A-18.5.10.4 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-18.5.10.5 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-18.5.11 Economizers

A-18.5.11.1 All economizers shall be designed throughout the entire range of the combustion turbine and HRSG operating range.

A-18.5.11.2 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-18.5.11.3 Economizers that have the feedwater control valve located between the economizer exit and the steam drum inlet shall be provided with relief valve(s) per code.

A-18.5.11.4 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 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-18.5.11.5 LP economizers and/or condensate heaters prior to the stack shall be made of a carbon steel material or as required per this Attachment. 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 exhaust gas temperature to fall below acid dew point. The economizer temperature shall be controlled using an external heat exchanger arrangement instead of a recirculation pump system.

A-18.5.11.6 Steam Drums

A-18.5.11.6.1 Steam drums shall contain the following minimum connections (all redundant components, including instruments, shall have dedicated drum connection):

A-18.5.11.6.2 Feedwater Inlet/Outlet.

A-18.5.11.6.3 Downcomer Connections.

A-18.5.11.6.4 Riser Connections.

A-18.5.11.6.5 Steam Outlet.

A-18.5.11.6.6 Drum Vent.

A-18.5.11.6.7 Safety Valves.

A-18.5.11.6.8 Continuous Blowdown (HP and IP).

A-18.5.11.6.9 Intermittent blowdown

A-18.5.11.6.10 Chemical Feed Inlet, if manufacturer's standard

A-18.5.11.6.11 Nitrogen.

A-18.5.11.6.12 Pressure Gauge.

A-18.5.11.6.13 Pressure Transmitters (3 Sets/Drum).

A-18.5.11.6.14 Level Gauges (2 Sets/Drum).

A-18.5.11.6.15 Level Transmitters (3 Sets/Drum).

A-18.5.11.6.16 Feedwater pump connection for suction (LP Drum only).

A-18.5.11.6.17 Drums shall include a 1/16" corrosion allowance.

A-18.5.11.6.18 Drums shall include two elliptical manholes per steam drum (one on each end) shall be provided having a minimum size of 14" (356 mm) x 18" (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-18.5.11.6.19 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-18.5.11.6.20 All steam drum downcomers shall have vortex breakers.

A-18.5.12 Steam Drum Sizing

A-18.5.12.1 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-18.5.12.1.1 For 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-18.5.12.1.2 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-18.5.12.1.3 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-18.5.12.2 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-18.5.13 Boiler Drains

A-18.5.13.1 General Boiler Drain Requirements

A-18.5.13.1.1 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. Drain piping shall be routed to the east side of the HRSG. Piping shall not be discharged to grade. Boiler drains shall be given a service classification of "operational", "startup", or "maintenance".

A-18.5.13.1.2 Expansion bends or loops shall be provided where required for thermal expansion.

A-18.5.13.2 Operational Drains

A-18.5.13.2.1 Operational drains are defined as any drain that is required to be used during the startup, operation, shutdown, or hot restarts of the HRSG, 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-18.5.13.2.2 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 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-18.5.13.2.3 Seller shall provide the continuous blowdown line with a control valve such that the on-line water sampling system of the drum water may provide a control signal to the control valve adjusting the amount of continuous blowdown.

A-18.5.13.3 Maintenance Drains

A-18.5.13.3.1 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 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-18.5.13.4 Startup Drains (applies to warm or cold startup):

A-18.5.13.4.1 Seller shall provide startup drains with remote operated actuators and all Section I valves.

A-18.5.14 Boiler Trim Valves and Piping

A-18.5.14.1 Trim Valves

A-18.5.14.1.1 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-18.5.14.1.2 All manually, pneumatically, and motor operated valves required for complete operation of the HRSGs 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-18.5.14.1.3 All valves requiring operation during startup and shutdown of the HRSG 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-18.5.14.1.4 Piping root valves shall be provided for instrument connections. Double root valves are required on systems designed for 900 psig or greater.

A-18.5.14.1.5 Safety valves shall be provided for the HRSG to meet the requirements of ASME code. High Pressure 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-18.5.14.1.6 Material sourcing shall be provided per Attachment A-4.

A-18.5.15 Pipe and Fittings

A-18.5.15.1 Seller shall provide all "boiler proper" and "boiler external piping" within ASME Section I code boundaries.

A-18.5.16 Silencers

A-18.5.16.1 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 ft. above platforms or walkways (not including stack platforms).

A-18.5.17 Duct Burner

A-18.5.17.1 The duct burner system shall be of a low NOx design.

A-18.5.17.2 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-18.5.17.3 The burner system shall include burner elements, solid state igniters, flame scanners, duct burner frame, sensors, Fuel Skid, burner controls, Burner Management System, 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-18.5.17.4 Fuel combustion shall have no flame impingement on liners, tubes, supports, or baffles over the entire operating range.

A-18.5.18 Burner Management System

A-18.5.18.1 The Duct Burner System shall be provided with a Burner Management System (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-18.5.18.2 The fuel flow demand signal shall come from the Facility DCS.

A-18.5.18.3 Fuel gas for the duct burners shall be from a take-off on the Project fuel gas supply header.

A-18.5.18.4 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-18.5.18.5 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-18.5.18.6 Remote Start/Stop functions shall be available through the Facility DCS system.

A-18.6 SELECTIVE CATALYTIC REDUCTION (SCR) SYSTEM

A-18.6.1 SCR General

A-18.6.1.1 The HRSG shall be furnished with a complete selective catalytic reduction (SCR) system to control concentrations of NOX generated by the 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 the Seller.

A-18.6.1.2 The SCR system will utilize a dual-function catalyst to reduce NOx, CO, and VOCs in accordance with the Emissions Guarantees.

A-18.6.1.3 SCR and ammonia system shall be sized for the addition of 50% more catalyst volume in the future.

A-18.6.1.4 The design of the SCR system shall include consideration of sliding pressure operation of the HRSG, with optimization of the location of catalyst modules with respect to temperature and required performance.

A-18.6.1.5 Emission Performance Guarantees defined in the Guarantee Attachment shall be met concurrently for all combustion turbine exhaust conditions, all Project site ambient conditions while the combustion turbine 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 three (3) calendar years after initial operation or up to 24,000 actual hours of operation.

A-18.6.1.6 The 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-18.6.1.7 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-18.6.1.8 Dual-Function catalyst loading doors shall be included for easy replacement of the catalyst materials.

A-18.6.1.9 The SCR Subcontractor shall provide detailed operating and maintenance instruction for the equipment. This shall include:

A-18.6.1.9.1 Performance monitoring, to include differential pressure measurement across the catalyst.

A-18.6.1.9.2 Recommended system control schemes, both for the SCR itself and for auxiliary equipment items/skids.

A-18.6.1.9.3 Diagnostic and repair procedures

A-18.6.1.9.4 Performance correction curves

A-18.6.1.9.5 Provisions for controlling NO_X while maintaining or servicing SCR equipment to the extend practical.

A-18.6.1.9.6 Operating restrictions (temperatures, gas composition, etc.)

A-18.6.1.9.7 Dual- Function Catalyst design basis

A-18.6.1.9.8 Performance data – molar ammonia vs. NO_X, effect of ammonia injection on emissions (SO3, ammonium salts, etc.)

A-18.6.1.9.9 Preventive and scheduled maintenance requirements.

A-18.6.1.9.10 Recommended maintenance practices.

A-18.6.1.9.11 Recommended catalyst coupon testing plan

A-18.6.1.9.12 Recommended shutdown procedure and vaporized ammonia piping purge recommendations

A-18.6.1.9.13 Limitations of SCR performance with respect to NO/NO2 ratio

A-18.6.1.10 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-18.6.2 SCR Arrangement

A-18.6.2.1 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 casing and location of the AIG shall allow complete access to the catalyst front and rear face without removal of internal structures.

A-18.6.2.1.1 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.). The Seller shall provide all necessary stairs, platforms, and guardrails to allow access to the access doors.

A-18.6.2.2 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 otherwise.

A-18.6.2.3 The reactor system shall be designed and equipped for easy operation and maintenance. The catalyst must be easily accessible for visual inspection and cleaning.

A-18.6.2.4 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-18.6.2.5 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 are met. Flow correction devices throughout the HRSG shall be made of appropriate materials for the design life and conditions present throughout the HRSG.

A-18.6.3 Ammonia metering, vaporizing, and dilution:

A-18.6.3.1 Skid mounted ammonia dilution equipment shall be provided with the SCR system. Gas shall be introduced by a centrifugal blower and measured by an annubar type flow element.

A-18.6.3.2 The ammonia injection equipment shall include two 100 percent dilution gas or air fans, dilution air heaters, gaseous ammonia mass flow meter (with remote readout capabilities), flow control valve, instruments, and all other required accessories.

A-18.6.3.3 Diluted ammonia piping shall be provided as a single 100 percent train, unless otherwise required by Seller.

A-18.6.3.4 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-18.6.3.5 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 percent ammonia by volume for all load conditions and in no case shall contain greater than 7 percent ammonia by volume. The concentration shall be monitored, and the system shall be shut down if the ammonia concentration is greater than 12 percent.

A-18.6.4 Ammonia/Gas Mixing and Injection Grid

A-18.6.4.1 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 percent CT load.

A-18.6.4.2 Skid mounted dilution equipment shall be provided with each SCR system. Aqueous ammonia will be provided at the inlet to the 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 percent 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 percent system per HRSG. HRSG 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-18.6.4.3 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 Attachment) at full load.

A-18.6.4.4 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-18.6.4.5 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 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-18.6.5 SCR Reactor & Catalyst

A-18.6.5.1 The reactor shall be large enough to accommodate a catalyst with 50% larger volume than that required to meet the NOx limits outlined in the Performance Requirement Attachment.

A-18.6.5.2 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-18.6.5.3 The design velocity through the SCR reactor shall be limited to 20 fps based on maximum flow through the reactor.

A-18.6.5.4 The SCR reactor shall be equipped with dual-function catalyst, designed to reduce NOX, CO and VOC emissions and limit ammonia slip.

A-18.6.5.5 The catalyst shall be the regular packed parallel flow type and shall be designed to be within the overall HRSG exhaust gas pressure loss specified by the 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 catalyst's life.

A-18.6.5.6 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-18.6.5.7 Appropriate seals shall be provided with the catalyst to prevent any flue gas bypass through catalyst elements or around the catalyst modules.

A-18.6.5.8 In order to monitor catalyst life and performance, a minimum of 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-18.6.5.8.1 The catalytic element sampling coupons or elements shall be readily accessible without disturbing other equipment and by use of common tools. Identify the catalyst 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-18.6.5.8.2 At a minimum, 1 replacement coupon shall be provided by the Seller for each removable elements/cassettes.

A-18.6.5.9 Catalyst shall be shipped in weatherproof packaging of the catalyst modules.

A-18.6.5.10 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-18.6.5.11 Any Special tools or necessary equipment to transport the catalyst modules from the lifted location to the final reactor positions shall be included.

A-18.6.6 Control Requirements

A-18.6.6.1 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. The Seller shall provide an isolation and a manual bypass for the ammonia flow control valve.

A-18.6.6.2 All alarms will be transmitted to the Facility DCS for annunciation in the control room.

A-18.6.6.3 The process control system logic shall utilize a triple loop control scheme which uses exhaust gas flow, inlet NOX emission level, and stack outlet NOX emission level.

A-18.6.6.4 Seller shall supply calculations, equations, and curves for use in control of the SCR. Seller shall provide NOX analyzers and flow meters as needed for ammonia injection rate determination.

A-18.6.6.5 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 in order to assure reliability of the SCR system and associated equipment.

A-18.6.6.6 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-18.6.6.7 Appropriate signals from the control system shall also be transmitted to the Continuous Emissions Monitoring System (CEMS) for reporting to the federal and state regulatory agencies.

A-18.6.6.8 Ammonia Area Monitors

A-18.6.6.8.1 The 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 ±5 percent accuracy and ±2 percent repeatability of reading.

A-18.6.7 SCR Operating Requirements

A-18.6.7.1 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 due to limitations on rate of thermal change. The design shall include, but not be limited to, the following operating parameters:

A-18.6.7.1.1 Starting of flue gas source into a cold system.

A-18.6.7.1.2 Starting of flue gas source into a hot system.

A-18.6.8 SCR Materials

A-18.6.8.1 Copper or copper alloys shall not be used for any components in the SCR system.

A-18.6.8.2 The dual-function catalyst shall be the regular packed parallel flow type and shall be designed to be within the overall HRSG exhaust gas pressure loss specified by the 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 de-lamination 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-18.6.8.3 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-18.6.8.4 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. The catalyst casing shall include all required internal supports for catalyst loading, thermal stress, and earthquake loading.

A-18.6.8.5 The SCR shall be the same as the HRSG pressure part sections.

A-18.6.9 Performance guarantee requirements:

A-18.6.9.1 The following system performance parameters shall be guaranteed when firing natural gas:

A-18.6.9.1.1 Nitrogen oxide (NO_X) emissions.

A-18.6.9.1.2 Ammonia slip emissions.

A-18.6.9.1.3 Catalyst life.

A-18.6.9.1.4 Ammonia injection and consumption rate.

A-18.6.9.2 All guarantees are to 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-18.7 FLOW MODEL TEST

A-18.7.1 Objectives

A-18.7.1.1 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 swirl angles and gas path configuration or manufacturer's CFD model as the flow input.

A-18.7.1.2 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-18.7.1.3 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-18.7.1.4 Establish the locations for gas test ports for performance testing of the SCR system and future CO catalyst.

A-18.7.1.5 The Seller shall be responsible for determining all gas flow vaning, straightening, or distribution devices required by the HRSG and SCR systems and future CO catalyst. The required devices shall be based on the model tests described herein. These devices shall become an integral part of the HRSG design.

A-18.7.1.6 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-18.7.1.7 Seller shall perform any other tests or determinations not specifically listed herein which are normally performed or required for proper operation of the HRSG, SCR systems and future CO catalyst or to achieve the test flow model study objectives listed herein.

A-18.7.2 At a minimum, the following systems shall be included in the model:

A-18.7.2.1 CT outlet swirl angle

A-18.7.2.2 CO catalyst spool (with and without CO catalyst installed)

A-18.7.2.3 Ammonia injection

A-18.7.2.4 SCR reactor

A-18.7.2.5 Stack

A-18.7.2.6 Supplemental Firing as required by design.

A-18.7.3 The results of the flow model(s) shall prove that the following distribution requirements have been met, at a minimum:

A-18.7.3.1 The maximum deviation from the flow-weighted mean of the ammonia concentration downstream of the catalyst shall not vary more than +50 percent/-50 percent.

A-18.7.3.2 Under all operating conditions, variation in temperature across the duct cross-sectional area at the catalyst face inlet shall not vary by more than +/-20°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-18.7.3.3 NH_3 to NO_X ratio: The NH_3/NO_X ratio shall not exceed 5 percent in 90 percent of the cross-sectional area and 10 percent in the remaining 10 percent 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-18.7.3.4 Dual-function Catalyst Inlet Gas Velocity Distribution: The velocity of the flue gas in 90 percent of the cross-section of the HRSG upstream of the ammonia injection grid shall not vary more than +10 percent from the arithmetic mean value of the velocity at the test conditions. For the remaining 10 percent of the cross-section, the velocity of the flue gas shall not vary more than +25 percent 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-18.7.4 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-18.7.5 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-18.7.6 Seller shall provide a final report including the following items as a minimum:

A-18.7.6.1 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-18.7.6.2 Development of flow model inputs, physics parameters, boundary conditions, etc.

A-18.7.6.3 Effect of various arrangements of flow correction devices on gas distribution and pressure loss.

A-18.7.6.4 Recommendations on the location and configuration of the flow correction devices and ammonia injection grid.

A-18.7.6.5 Drawings with location of turning vanes, perforated plates, AIG, and sample port locations corresponding to each run reported.

A-18.7.6.6 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-18.8 HRSG INSTRUMENTATION

A-18.8.1 Seller shall provide instrumentation including, but not necessarily limited to, the following:

A-18.8.1.1 Electronic transmitters

A-18.8.1.2 Pressure switches

A-18.8.1.3 Differential pressure switches

A-18.8.1.4 Pressure gauges

A-18.8.1.5 Differential pressure gauges

A-18.8.1.6 Flow measuring orifices.

A-18.8.1.7 Flow measuring nozzles, venturies, and low loss tubes.

A-18.8.1.8 Thermocouples, RTDs, and thermowells. Thermowells shall be of the same materials as the component in which it is installed.

A-18.8.1.9 Temperature switches, if required

A-18.8.1.10 Temperature gauges

A-18.8.1.11 Liquid level transmitters

A-18.8.1.12 Liquid level switches

A-18.8.1.13 Level gauges

A-18.8.1.14 Control valves

A-18.8.1.15 Boroscope inspection ports on evaporator

A-18.8.2 General Instrumentation Requirements

A-18.8.2.1 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-18.8.2.2 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-18.8.2.3 Seller's instruments and device accuracy's, sensitivities, and error limits shall conform to the ASME PTC 19 requirements and/or the Technical Specification requirements, whichever are more stringent.

A-18.8.2.4 Process transmitters (pressure, temperature, level, differential pressure, flow, etc.) shall be supplied in lieu of switches. Seller to obtain Buyer 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-18.8.2.5 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-18.8.2.6 All attemperator valve stations shall include a manual shutoff valve, check valve, automatic block valve, flow element, control valve, and attemperator. The remote operated block valves are to be air operated ball valves (1 per HRSG, total of 2).

A-18.8.2.7 The attemperator spray water control valves and automatic block valves shall conform with the requirements of ASME/ANSI Standard TDP-1-2013.

A-18.8.3 Economizer Instrumentation

A-18.8.3.1 Seller shall provide one temperature element/thermowell and one test well at the inlet and exit of each economizer tube bank module.

A-18.8.3.2 Redundant measurements shall have separate tap points for each measurement.

A-18.8.3.3 Pressure indicators on pump headers shall be provided with snubbers and shall be glycerol filled.

A-18.8.3.4 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-18.8.3.5 All instrument tagging shall agree with the approved project tagging procedure and shall be read in English units.

A-18.8.3.6 Instrument located on the packaged equipment systems shall be furnished, mounted/installed by Seller.

A-18.8.3.7 Pressure gauges shall be 4 ½ inch minimum local mounted, 3 ½ inch board mounted, and 1 ½ inch to 2 ½ inch mounted on air operated dampers and control valves.

A-18.8.3.8 Instrument tags shall be stainless steel, either screwed into instrument or attached to instrument by stainless steel wire.

A-18.8.3.9 Instrument tubing shall not be welded and shall be ½ inch minimum size.

A-18.8.3.10 All instrumentation and control devices shall be suitable for the environment where they will be located.

A-18.8.3.11 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. The minimum bending radius for tubing sensing lines shall be three (3) times the tubing diameter.

A-18.8.3.12 Profibus and foundation fieldbus shall not be installed on instruments and valves.

A-18.8.3.13 Emergency stop switches shall have a means to prevent accidental operation, such as clear plastic/Lexan covers or push button guards.

A-18.8.4 Steam Drum Instrumentation

A-18.8.4.1 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 12 conductivituy 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-18.8.4.2 HP Drum level control shall be upstream of the Economizer.

A-18.8.4.3 One pressure gauge shall be independently connected to each steam drum.

A-18.8.4.4 Double root valves shall be provided for drum pressure and level transmitters.

A-18.8.4.5 Two (2) inner wall and two (2) mid-wall thermocouples on each drum shall be provided.

A-18.8.4.6 IP Drum level control shall be downstream of the Economizer and upstream of the IP Drum.

A-18.8.5 Superheater Instrumentation

A-18.8.5.1 At the inlet and exit of each superheater tube bank module a test well shall be provided for troubleshooting and testing. A test well is not required at the superheater inlet from the steam drum.

A-18.8.5.2 At each superheater outlet there shall be at least one (1) temperature element and thermowell.

A-18.8.5.3 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-18.8.6 Reheater Instrumentation

A-18.8.6.1 At the inlet and exit of each reheater tube bank module a test well shall be provided for troubleshooting and testing.

A-18.8.6.2 At each reheater outlet there shall be at least one (1) temperature element and a thermowell.

A-18.8.6.3 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 attemperation.

A-18.8.7 Gas Path Instrumentation

A-18.8.7.1 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-18.8.7.2 All transmitters shall be Rosemount model 3051 and provided with HART protocol. All thermocouples shall be furnished with thermowells and shall be type E except where gas temperature exceeds 1501ºF for which type K thermocouples shall be furnished.

A-18.8.7.3 Instruments requiring periodic maintenance shall be accessible from platforms. If any instrument is not accessible from platforms, a secondary platform shall be provided.

A-18.8.8 Motor and Miscellaneous Electrical Requirements

A-18.8.8.1 For Electrical requirements, refer to The Electrical Requirements and Design Criteria.

A-18.8.8.2 All electrical equipment and devices furnished for separate mounting shall be checked and tested in the factory before shipment.

A-18.8.8.3 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-18.8.8.4 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-18.8.8.5 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-18.8.8.6 All electrical enclosures shall comply with the following:

A-18.8.8.6.1 Enclosures shall be suitable for the environment and provide the degree of protection of the enclosed electrical equipment according to NEMA Standard 250.

A-18.8.8.6.2 NEMA Type 4X

A-18.8.8.6.3 Minimum box depth shall be 6 inches.

A-18.8.8.6.4 All external hardware shall be stainless steel.

A-18.8.8.6.5 Adjacent enclosures, cabinets, etc., shall be installed to maximize their accessibility and minimize walkway interference.

A-18.8.8.6.6 The door of the enclosure, when it is opened, shall not block access to adjacent enclosure(s).

A-18.8.8.6.7 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-18.8.8.6.8 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-18.8.8.6.9 Barriers shall be provided to separate different voltages.

A-18.8.8.6.10 Door gaskets shall be solid neoprene.

A-18.8.8.6.11 Terminal boxes and control enclosures shall be provided with 10-gauge aluminum backing plate on which to mount terminal blocks and devices.

A-18.8.8.6.12 Backing plates shall be bonded to the box.

A-18.8.8.6.13 Not more than two (2) conductors shall be terminated at any one termination point, minimum 20 percent spare terminals shall be provided.

A-18.8.8.6.14 A ¼ 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-18.8.8.6.15 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-18.8.8.6.16 All spare relay contacts shall be wired out to terminal blocks.

A-18.8.8.6.17 Pushbuttons and selector switches shall be heavy-duty, NEMA Type 4X

A-18.8.8.6.18 Seller shall furnish integral starters for all motor-operated valves (MOV), damper drives, and local starters for all other motors less than ½ hp. Starters or breakers will be provided by others for all motors ½ hp and above.

A-18.8.8.6.19 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-18.9 PLATFORMS AND STAIRS

A-18.9.1 As a minimum, a stairway shall be provided to the following platforms:

A-18.9.1.1 Main operating platform (360° at steam drum level).

A-18.9.1.2 Safety Valves, and drums

A-18.9.1.3 Stack sampling and monitoring ports (360°) via ladder access from the steam drum level platform.

A-18.9.1.4 All isolation and block valves on superheater outlets

A-18.9.1.5 All desuperheater valves

A-18.9.1.6 All drum valves and instrumentation (ladder access from the operating platform to items on top of the drums).

A-18.9.1.7 Stack damper platform.

A-18.9.1.8 A staircase shall be provided on one side of the 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 the HRSG as a secondary means of egress.

A-18.10 CRANES AND HOISTS

A-18.10.1 Seller shall provide a 1-ton capacity (minimum) stack-mounted jib crane with hoist for the HRSG.

A-18.10.2 All lifting devices and monorails shall be clearly stenciled with rated lifting capacity. All lifting devices shall be capable of reaching grade elevation.

A-18.11 CLEANING

A-18.11.1 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-18.11.2 Surfactant flush (cold water de-grease) or high pH boil-out (alkaline chemical clean) of the HRSG shall be performed during the commissioning phase of the project. Cleaning flanged connections shall be supplied for each pressure level of the HRSG.

A-18.12 TRAINING

A-18.12.1 Manufacturer shall assist Seller in the training of Buyer’s operating personnel.

A-18.12.2 On-site HRSG training modules shall start in the classroom and incorporate system walk-downs.

A-18.12.3 Course material shall include manufacturer’s recommended procedure for regular startups, operation, shutdown of the equipment including emergency conditions, and shall include maintenance training for all control systems.

A-18.12.4 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-18.12.5 Course material shall include a spare parts list and reordering information.

END OF ATTACHMENT A-18

BOT Scope Book

Attachment A-19
Steam Turbine Generator (STG) Technical Specification

Table of Contents

A-19.1 GENERAL REQUIREMENTS

A-19.1.1 STG General Requirements

A-19.1.1.1 The STG shall consist of one tandem-compound, condensing unit with reheat, and a three-phase, 3,600 rpm, 60 Hz synchronous generator with excitation system.

A-19.1.1.2 The STG shall exhaust sideward to an air-cooled condenser.

A-19.1.1.3 Seller shall provide interface list and DOR for approval by Buyer.

A-19.1.1.4 The STG unit will be located outdoors with an HP/IP enclosure and designed for the environmental design data provided in the Site Design Criteria, Attachment A-4,and shall operate in conjunction with CTG/HRSG train(s). The STG shall be sized based on the maximum output of the CTG/HRSG train(s).

A-19.1.1.5 The STG unit shall be designed to operate with steam supplied from a combined cycle HRSG and shall be subjected to the operating cycle, modes and operating conditions set forth in Attachment A-4, Project Requirements, and shall be designed for such conditions.

A-19.1.1.6 The STG shall be designed to allow continuous operation over the load range corresponding to the full emissions compliant, steady-state load range of the combustion turbines. The electrical output of the STG shall be controllable from CTG MECL through the STG Turbine Maximum Continuous Rating (TMCR) and suitable for continuous operation across the load range.

A-19.1.1.7 The normal operating mode of the turbine shall be sliding pressure operation; however, the STG shall be capable of operating in either fixed pressure or sliding pressure modes.

A-19.1.1.8 Reliability, availability, and maintainability are of the utmost importance in the design of the turbine generator. The unit shall be capable of a design life of 30 years of operation without distress. Providing Buyer carries out maintenance according to supplier’s manual and without abnormal operation.

A-19.1.1.9 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-19.1.1.10 All STG mechanical, structural, and electrical components and systems shall be designed in accordance with the site design data provided in Attachment A-4 Site Requirements and Design Criteria and codes and standards set forth in Attachment A-4 Project Requirements.

A-19.1.1.11 The STG 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 during bypass operation, provided by Seller.

A-19.1.1.12 The STG 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-19.1.1.13 The STG 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 unit trip speed for short durations while staying within vibration limits established by the manufacturer.

A-19.1.1.14 The STG 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 OEM.

A-19.1.1.15 Seller to provide the necessary equipment as required for automation of the turbine-generator unit. 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 and complete control functions interface via redundant data link to the Facility control system.

A-19.1.1.16 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-19.1.1.17 The STG 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 turbine control system shall be provided with on-line testing capability for EOST modules. The turbine control system shall also be provided with an actual overspeed test. This test, however, must be performed with the generator off-line.

A-19.2 SCOPE OF WORK

A-19.2.1 Provided by Seller

A-19.2.1.1 The Seller shall impose on each sub-Seller the applicable requirements of this specification and shall be directly responsible that the manufacturers and sub-contractors are aware of these requirements, and that items and services meet the specified requirements.

A-19.2.1.2 The following items are included in, but not limited to, the Seller's scope of supply:

A-19.2.1.2.1 Steam turbine

A-19.2.1.2.2 Generator

A-19.2.1.2.3 Manufacturer's standard enclosures:

A-19.2.1.2.3.a HIP Steam Turbine enclosure and enclosure between LP Steam Turbine and Generator

A-19.2.1.2.3.b Steam Turbine/Generator Excitation Equipment Enclosure

A-19.2.1.2.4 Excitation system, including:

A-19.2.1.2.4.a Voltage regulators

A-19.2.1.2.4.b Excitation Transformer, including HV and LV terminal enclosures and cable supports.

A-19.2.1.2.4.c Solid state electronics

A-19.2.1.2.4.d Current transformers

A-19.2.1.2.4.e Instrumentation

A-19.2.1.2.4.f Controls and protections

A-19.2.1.2.4.g Ground fault protection and detection

A-19.2.1.2.4.h Power system stabilizer

A-19.2.1.2.4.i Thyristor rectifier

A-19.2.1.2.4.j Field circuit breaker

A-19.2.1.2.4.k Weatherproof, conditioned enclosure for thyristor rectifier and field circuit breaker

A-19.2.1.2.5 Turbine and generator grounding system

A-19.2.1.2.6 Foundation soleplates, fixators with grout forms, and shims

A-19.2.1.2.7 Main steam stop and control valves including supports and steam blow kits where applicable.

A-19.2.1.2.8 Reheat steam stop and control valves, including supports and steam blow kits where applicable.

A-19.2.1.2.9 HP exhaust (cold reheat steam) air-assisted non-return valve.

A-19.2.1.2.10 LP steam stop and control valves, as applicable, including supports and steam blow kits where applicable.

A-19.2.1.2.11 Turbine control system, including control logic, turbine protection, data storage (common with CTG control system), human machine interface (HMI) (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-19.2.1.2.11.a Critical SOE signals mean status indication for Trip, Alarm, Event only so DCS timestamp matches TCS indication for tracking purposes.

A-19.2.1.2.12 Common operator workstations and engineering workstations shall be provided for CTG and STG (refer to CTG Spec, A-17). Two (2) operator workstations (Thin Clients) with dual 24” monitors shall be provided. The operator workstations will be located in the control room. One engineering workstation (Thin Client) with dual 24” monitors shall be provided which will also be located in the control room.

A-19.2.1.2.13 IP to LP steam crossover piping.

A-19.2.1.2.14 ASME PTC 46 will be primarily applied; ASME PTC 6.2 steam turbine performance test connections to be provided.

A-19.2.1.2.15 Exhaust casing relief diaphragms

A-19.2.1.2.16 Bolted turbine and generator shaft couplings

A-19.2.1.2.17 Turning gear (including jacking oil pump system if required)

A-19.2.1.2.18 Lube oil system, including main pumps, emergency pump, oil conditioning skid, valves, filters, exhausters, strainers, heat exchangers, reservoir, instrumentation, and controls.

A-19.2.1.2.19 Generator seal oil system, including main pumps, emergency pump, valves, filters, traps, instrumentation, and controls.

A-19.2.1.2.20 Electro-hydraulic control (EHC) system, including but not limited to, pumps, filters, valves, accumulators, coolers, vessels, enclosure, piping, and supports.

A-19.2.1.2.21 Gland seal steam system, including valves, traps, exhausters, heat exchangers, instrumentation, and controls.

A-19.2.1.2.22 LP steam turbine exhaust hood spray system, including valves, internal piping, instrumentation, and controls. Hood spray valves to be installed in STG piping.

A-19.2.1.2.23 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).

A-19.2.1.2.24 Generator hydrogen dryer shall be included.

A-19.2.1.2.25 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-19.2.1.2.26 The Seller shall provide piping, hangers, and supports for all piping that connects manufacturer-provided equipment and systems, including lube oil, seal oil, electro-hydraulic control, generator cooling, hydrogen/CO2 gas, and gland steam.

A-19.2.1.2.27 Rigging devices

A-19.2.1.2.28 Specialty tools

A-19.2.1.2.29 Spare parts for startup and commissioning

A-19.2.1.2.30 Separate spare part list for long term operation and maintenance

A-19.2.1.2.31 Valve Calibration will be performed using logic monitoring function of the Operator Station. Simulated valve position command can be inputted in the function directly.

A-19.2.1.2.32 Automated steam turbine startup mode selection software in the turbine control system.

A-19.2.1.2.33 Steam turbine and generator supervisory instrumentation system (TSI), including system and vibration monitoring.

A-19.2.1.2.34 Steam turbine auxiliary instrumentation wired to manufacturer's terminal enclosure and/or control panel.

A-19.2.1.2.35 Generator control panel, including multi-transducers and synchronizing relays.

A-19.2.1.2.36 Voltage transformer (VT) / surge arrestor (SA) enclosure

A-19.2.1.2.37 Generator terminals, including neutral shorting bar.

A-19.2.1.2.38 Generator terminal enclosure

A-19.2.1.2.39 Neutral grounding resistor

A-19.2.1.2.40 Generator protection relay panel

A-19.2.1.2.41 DC motor starters for emergency seal oil pump motor and emergency lube oil pump motor

A-19.2.1.2.42 Acoustic/weather enclosures shall include interior lighting and ventilation in accordance with the requirement in Attachment A-4. All lighting shall be LED type.

A-19.2.1.2.43 On-site storage for 6 months per manufacturer's standard recommendations.

A-19.2.1.2.44 On-site steam turbine operations and maintenance training, including OEM's standard STG general training and advanced controls maintenance training, consisting of five (5) man-days for each course section.

A-19.2.1.2.45 Warranty

A-19.2.1.2.46 All interconnecting piping and tubing, including hangers/supports, between the STG and auxiliary support skids and other equipment/components.

A-19.2.1.2.47 Hydrogen and CO2 bulk gas storage system and piping external to manufacturer's terminal points. Piping that connects between manufacturer-provided equipment may be provided by the manufacturer as determined by the Seller.

A-19.2.1.2.48 100% Steam turbine steam bypass system

A-19.2.1.2.49 Exhaust connection expansion joints

A-19.2.1.2.50 Condensate piping to the exhaust hood spray system and steam seal attemperating system

A-19.2.1.2.51 Safety relief valves located in the main and reheat steam lines.

A-19.2.1.2.52 Drain piping.

A-19.2.1.2.53 Vacuum breaker valves and piping

A-19.2.1.2.54 Steam Turbine Control system has an inlet steam pressure control function utilizing sliding pressure control mode.

A-19.2.1.2.55 Auxiliary steam supply to the steam seal regulator

A-19.2.1.2.56 Water supply and return piping for all coolers.

A-19.2.1.2.57 Lube oil

A-19.2.1.2.58 Exhaust piping from vapor extractor

A-19.2.1.2.59 Redundant power supply to the Turbine Control system

A-19.2.1.2.60 EHC system cooling water piping

A-19.2.1.2.61 Hydrogen system cooling water piping

A-19.2.1.2.62 Hydrogen and CO2 supply piping and vent piping

A-19.2.1.2.63 Auxiliary electric power for the turbine control system

A-19.2.1.2.64 Steam Turbine Bypass System

A-19.2.1.2.65 Control room alarms integrated in the Facility DCS

A-19.2.1.2.66 Mounting and wiring of any loose instruments

A-19.2.1.2.67 Connection from generator neutral to manufacturer-supplied neutral grounding equipment

A-19.2.1.2.68 Static excitation system interconnecting wiring and installation.

A-19.2.1.2.69 Wiring and mounting of static excitation system remote indicators and control switches

A-19.2.1.2.70 Auxiliary power supplied to equipment, including 120V UPS system auxiliary power and 125 VDC auxiliary power.

A-19.2.1.2.71 Grounding

A-19.2.1.2.72 Motor control equipment for manufacturer-provided pumps, excluding DC starters.

A-19.2.1.2.73 480V Motor control center motor starters

A-19.3 SUBMITTALS

A-19.3.1 General Requirements

A-19.3.1.1 Submit documents for review in accordance with the submittal requirements of Attachment A-4 Document Submittal Requirements.

A-19.3.1.2 Submittals shall include the following:

A-19.3.2 General:

A-19.3.2.1 An experience list of operating installations with equipment of similar service and steam conditions

A-19.3.3 STG maintenance schedule

A-19.3.3.1 List of operational enhancement options and descriptions

A-19.3.4 Drawings:

A-19.3.4.1 Drawings showing equipment lay-down area requirement with component weights and overall dimensions which will be required for erection, disassembly, and maintenance of the turbine-generator.

A-19.3.4.2 Drawings showing details of the turbine control system and other controls furnished.

A-19.3.4.3 P&IDs

A-19.3.5 Procedures:

A-19.3.5.1 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-19.3.5.2 Formulas for determination of operating hours for use in determining inspection/

A-19.3.5.3 overhaul intervals, with descriptions of inspections and minor/major overhauls, including scope and duration for each.

A-19.3.5.4 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-19.3.5.5 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-19.3.5.6 Curves showing maximum allowable steam turbine exhaust pressure with alarm and trip limits over the full range of exhaust flows.

A-19.3.5.7 Description of STG minimum continuous operating load, including criteria for determining minimum load, and maximum load ramp rate from minimum load.

A-19.3.5.8 The Seller shall provide a detailed description of the construction, reliability, moisture erosion resistance, and experience for the last two LP stage blades.

A-19.3.5.9 The Seller shall provide a statement describing the minimum expected STG blade life and the criteria required to achieve the desired blade life.

A-19.3.5.10 The Seller shall provide a detailed description of the method of rolling the turbine with bypass in operation.

A-19.3.5.11 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-19.3.5.12 Complete description of hydrogen equipment, including sealing glands, coolers, pumps, dryers, purifiers, filling and purging equipment, instruments, and control devices.

A-19.3.5.13 Complete description of voltage regulating equipment.

A-19.3.5.14 Manufacturer's turbine oil flushing method, procedures, and recommendations.

A-19.3.5.15 Main stop and control valve closure times

A-19.3.5.16 The Seller shall provide a single, comprehensive document identifying minimum preventative maintenance requirements for components in the manufacturer's scope of supply, including buy-out items.

A-19.3.6 Advisory Services

A-19.3.7 Steam Turbine Thermal Kit:

A-19.3.7.1 Steam turbine heat balance diagrams

A-19.3.7.2 Turbine exhaust loss curve

A-19.3.7.3 Steam turbine degradation curves

A-19.3.7.4 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-19.3.7.5 Curves showing corrections to load for variations in HP turbine flow capacity for all guarantee heat balance cases.

A-19.3.7.6 Curves showing corrections to load for variations in reheat system pressure drop for all guarantee heat balance cases.

A-19.3.7.7 Curves showing corrections to load for variations in reheat steam flow for all guarantee heat balance cases.

A-19.3.7.8 Curves showing corrections to load for variations in LP admission steam flow for all guarantee heat balance cases.

A-19.3.7.9 Curves showing corrections to load for variations in steam turbine exhaust pressure for all guarantee heat balance cases.

A-19.3.7.10 Curves showing the turbine-generator mechanical and electrical losses over a range of power factors.

A-19.3.7.11 Curves showing corrections to load for variations in generator hydrogen pressure.

A-19.3.7.12 Steam and water quality requirements per the STG manufacturer

A-19.3.8 Generator Curves

A-19.3.8.1 Vee Curve – showing generator kVA output against field current through the entire power factor range (0.85 lagging to 0.95 leading) at rated and reduced hydrogen pressures.

A-19.3.8.2 Capability Curve - showing reactive capability versus load for rated hydrogen pressure.

A-19.3.8.3 Decrement curves for three-phase, line-to-line, and line-to-line to ground, short circuits, including effect of voltage regulator.

A-19.3.8.4 Regulation curve with excitation and speed constant.

A-19.3.8.5 No load and full load saturation curves for the exciters.

A-19.3.8.6 Exciter load versus exciter voltage curves showing drooping characteristic.

A-19.3.8.7 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-19.3.8.8 Block diagram, gains, and time constants of the power system stabilizer, voltage regulator and exciter based on the standard models in IEEE 421.5.

A-19.3.8.9 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-19.3.8.10 Table of generator constants actual tolerance of the synchronous, transient, sub-transient, negative sequence and zero sequence reactance of the generator as constructed will be within ±15% of the designated values.

A-19.3.8.11 Generator Vee-curves shall all be plotted at the nameplate voltage and frequency from zero to the nameplate kVA rating. The generator reactive output in kVA versus capability in kW curves shall show the maximum lagging and leading reactive kilovolt-ampere output available at the kilowatt loads with constant rated voltage and frequency, from 0 to a kilowatt value corresponding to rated kilovolt-amperes at 1.0 pf, without exceeding the specified temperatures on stator or rotor. It shall be assumed that voltage is maintained constant by the system to which the generator is connected.

A-19.3.9 Test Reports:

A-19.3.9.1 Reports of all tests performed on steam turbine and generator equipment.

A-19.3.10 Motor Nameplate Data:

A-19.3.10.1 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-19.3.11 Instruction Books:

A-19.3.11.1 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 Attachments. 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-19.3.11.2 Instruction books shall include:

A-19.3.11.2.1 Equipment identification by equipment numbers, station name, unit number and function name.

A-19.3.11.2.2 Final reduced drawings of general arrangements and cross sections, warranted performance data, design data, test results, and performance curves for all equipment.

A-19.3.11.2.3 Complete operation, troubleshooting and maintenance instructions.

A-19.3.11.2.4 Part lists shall be complete in every respect. Parts shall be identified by the original manufacturer's complete part number as well as by the Seller's identification number.

A-19.3.11.2.5 Lubricants list

A-19.3.11.2.6 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-19.3.11.2.7 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-19.3.12 Material Specifications:

A-19.3.12.1 Seller shall provide material specifications (material information on chemical composition and mechanical properties) for the following main components:

A-19.3.12.1.1 Rotors

A-19.3.12.1.2 Inner and outer casings, exhaust hood

A-19.3.12.1.3 Rotating and stationary blades

A-19.3.12.1.4 Main valve casings (Main Steam, Hot Reheat, LP Admission)

A-19.3.12.2 Spare Parts:

A-19.3.12.2.1 List of recommended operational spare parts for equipment, which shall include prices quoted by the manufacturer.

A-19.3.13 Coatings:

A-19.3.13.1.1 All manufacturer-supplied coatings shall be in accordance with the requirements set forth in Attachment A-5. 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-19.3.14 Instrument Numbers and Data Sheets:

A-19.3.14.1.1 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-19.3.14.1.2 The data furnished by Seller will 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-19.3.14.1.3 Instrument numbers shall be assigned per Attachment A-13. Seller shall use the assigned number on all tags and in all references to the instrument on drawings, correspondence, manuals, reports, etc.

A-19.3.14.1.4 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-19.3.15 Quality Assurance Program:

A-19.3.15.1 Manufacturer's quality assurance program documentation in accordance with Attachment A-4.

A-19.3.15.2 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-19.3.16 Certificates of Completion

A-19.3.16.1 Certificates of Completion including checklists to confirm that the installation and commissioning is fully complete.

A-19.4 MECHANICAL REQUIREMENTS

A-19.4.1 Turbine General

A-19.4.1.1 STG and auxiliary equipment noise levels shall meet the requirements specified in the Attachment A-4.

A-19.4.1.2 The STG 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-19.4.1.3 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-19.4.1.4 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. The compatibility of materials with cooling medium is the responsibility of the Seller.

A-19.4.1.5 The STG shall be fitted throughout with renewable wearing parts.

A-19.4.2 Normal and Off Frequency Operation

A-19.4.2.1 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-19.4.2.2 During system disturbances and abnormal conditions, the steam turbine-generator 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 63Hz).

A-19.4.2.3 STG shall be designed for normal frequency of 58.8 to 61.2Hz for continuous operation.

A-19.4.2.4 STG shall be designed such that it complies with PRC-024 and does not impinge on the frequency no trip zone.

A-19.4.2.5 A STG worst-case, over-speed analysis shall be performed by the manufacturer. The manufacturer shall identify the basis for failure criteria.

A-19.4.2.6 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-19.4.2.7 Borescope inspection ports for off-line inspection shall be provided for the last stages of each HP, IP, and LP turbine section (manholes will be used for LP).

A-19.4.2.8 The Seller shall provide turbine atmospheric relief diaphragms and emergency relief trip function required to protect the complete unit from over pressure operation.

A-19.4.3 Stop Valves, Intercept Valves, and Control Valves

A-19.4.3.1 Valve design shall provide the capability of on-line partial stroke testing. The Seller shall identify the maximum load at which this testing may be performed.

A-19.4.4 Turbine Steam Piping

A-19.4.4.1 The Seller shall provide three (3) HP inlet and three (3) reheat inlet steam pressure tap for load reference purposes.

A-19.4.4.2 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-19.4.4.3 The Seller shall provide all pipe and fittings, including all required valves and accessories for the following systems:

A-19.4.4.3.1 Piping between inlet stop valves and HP turbine casing.

A-19.4.4.3.2 Piping between reheat stop valves and IP turbine casing.

A-19.4.4.3.3 Crossover piping between IP outlet and LP inlet turbine casings.

A-19.4.4.3.4 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-19.4.5 Rotor

A-19.4.5.1 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-19.4.5.2 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-19.4.5.3 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.

A-19.4.5.4 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 up to 115% in a dynamic spin pit with full vacuum. The rotor shall be tested at critical speed, running speed and 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-19.4.5.5 A rotor 15% overspeed test shall be performed while fully bladed.

A-19.4.5.6 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-19.4.5.7 The natural frequencies of the rotor system with blading shall be out of the range of 120Hz ± 3Hz.

A-19.4.5.8 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-19.4.5.9 The critical speeds of the rotating element of the assembled turbine generator 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 STG 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-19.4.5.10 The influence of the foundation on all critical speeds shall be taken into account by the manufacturer.

A-19.4.5.11 Damage due to circulating electrical currents in the turbine generator rotor shaft and bearings shall be prevented.

A-19.4.6 Blading

A-19.4.6.1 All rotating blading shall use a well proven design and shall be made from bar block or forged material. The last stages of low-pressure blades shall be designed for protection against erosion by wet steam.

A-19.4.6.2 Steam turbine last stage blades shall be steel material. Titanium last stage blades are not acceptable.

A-19.4.6.3 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-19.4.6.4 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-19.4.6.5 The STG blade life shall be equal to the design life of the Facility.

A-19.4.7 Bearings

A-19.4.7.1 All bearings shall be readily accessible and capable of removal and replacement without removing the rotors or turbine casings.

A-19.4.7.2 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-19.4.7.3 Journal bearing shall be horizontally split, capable of vertical and lateral adjustment without removal of the rotors.

A-19.4.7.4 Thrust bearings shall be tilting-pad type.

A-19.4.7.5 All bearings shall be machined to accept vibration probes. Field machining will not be permitted for installation.

A-19.4.7.6 Bearing housings shall be designed for water-resistance, dust-resistance, and oil-leakage resistance.

A-19.4.8 Exhaust Hood Sprays

A-19.4.8.1 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-19.4.8.2 The exhaust hood spray system will be fed from a single source of condensate provided by the Seller.

A-19.4.9 Exhaust Outlet

A-19.4.9.1 The LP exhaust outlet of the STG shall be arranged for welding/bolting to the air-cooled condenser steam inlet duct.

A-19.4.10 Lube Oil System

A-19.4.10.1 A complete lubrication system including storage, main oil pumps, emergency DC pump, 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 steam turbine-generator unit shall be furnished.

A-19.4.10.2 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-19.4.10.3 The lubricating system main reservoir, pumps, heaters, coolers, and filters shall be packaged on a skid-mounted unit.

A-19.4.10.4 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-19.4.10.5 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-19.4.10.6 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-19.4.11 Oil Reservoir:

A-19.4.11.1 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 unit on loss of AC power.

A-19.4.11.2 The oil reservoir shall be sized to hold full flow-back of all oil on shutdown.

A-19.4.11.3 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 unit's control system.

A-19.4.11.4 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-19.4.11.5 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-19.4.11.6 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-19.4.12 Oil Piping:

A-19.4.12.1 Lube oil piping, which interconnects manufacturer-supplied equipment and/or skids shall be supplied by the manufacturer as determined by the Seller.

A-19.4.12.2 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-19.4.12.3 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-19.4.12.4 Hydraulic oil piping, tubing, valves, and fittings shall be ASTM A312 Type 304 stainless steel.

A-19.4.12.5 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-19.4.12.6 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-19.4.12.7 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-19.4.12.8 Compression type couplings shall not be used.

A-19.4.13 Oil Pumps:

A-19.4.13.1 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 unit, shall be furnished.

A-19.4.13.2 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-19.4.13.3 Each lube oil pump shall have a suction strainer to protect the pump. Seal oil pump protection shall be via a screen at the seal oil vacuum tank.

A-19.4.13.4 All control equipment necessary for operation of DC equipment including the DC starter on loss of auxiliary AC power shall be provided.

A-19.4.13.5 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-19.4.14 Lube Oil Coolers:

A-19.4.14.1 Two (2) 100% water-cooled lube oil coolers shall be provided. Cooling water shall be supplied by the cooling water system.

A-19.4.14.2 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 ft^2-F-hr/Btu fouling factor.

A-19.4.14.3 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-19.4.14.4 The lube oil system shall be capable of switching between oil coolers with unit on-line. Each lube oil cooler shall be removable for maintenance with the unit in operation. Coolers shall be arranged such that any fluid leaks shall not cause equipment damage or fires.

A-19.4.15 Lube Oil Filters:

A-19.4.15.1 A duplex, multi-element filter with a continuous flow transfer valve shall be provided. The two (2) 100% nominal, at least ten-micron filters with a manually controlled continuous flow transfer valve shall be furnished to filter contaminants out of the lubricating oil.

A-19.4.15.2 Connections shall be provided for an auxiliary lube oil conditioner.

A-19.4.16 Vapor Extractors:

A-19.4.16.1 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-19.4.16.2 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-19.4.17 Instrumentation:

A-19.4.17.1 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-19.4.17.2 Bearing header and vapor extraction vacuum pressures shall be measured and indicated locally and on the unit control system.

A-19.4.17.3 Sight glasses shall be included to allow confirmation of lube oil flow from each bearing.

A-19.4.18 Generator Seal Oil System

A-19.4.18.1 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 detraining 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-19.4.18.2 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 emergency pump 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 unit.

A-19.4.18.3 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 CO_2 at the inlet of the gas valve station, and air purge.

A-19.4.18.4 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-19.4.18.5 The seal oil equipment shall be skid mounted and shall include an enclosure designed for the environmental conditions provided in the Site Design Criteria, Attachment A-4.

A-19.4.18.6 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-19.4.19 Generator Hydrogen Gas System

A-19.4.19.1 The Seller shall supply a complete hydrogen gas system including valves and gauges.

A-19.4.19.2 The generator hydrogen gas system design shall ensure the safe charging and evacuation of hydrogen from the generator. CO_2 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-19.4.19.3 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-19.4.19.4 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-19.4.19.5 Buyer to provide all gases prior to substantial completion.

A-19.4.20 Electro-Hydraulic Control (EHC) System

A-19.4.20.1 Hydraulic fluid system shall be furnished as follows:

A-19.4.20.1.1 The turbine EHC fluid system shall use a fire resistant, ASTM fluid.

A-19.4.20.1.2 A stainless steel EHC reservoir shall be provided which shall have access doors, float type indicating oil gauge and level transmitter for the high- and low-level alarm. A level transmitter High- and low-level alarm shall be monitored with the transmitter signal in the turbine control system.

A-19.4.20.1.3 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-19.4.20.1.4 The EHC system shall be served by two (2) 100% AC motor-driven, positive displacement pumps with suction strainers.

A-19.4.20.1.5 The EHC skid shall include one (1) hydraulic fluid cooler with stainless steel tubes.

A-19.4.20.1.6 EHC system shall include two (2) full-size inline filters. The inline filter shall be metallic. Filter shall have differential pressure instrumentation.

A-19.4.20.1.7 Type 304 stainless steel, welded piping from reservoir to and from turbine and to hydraulic actuators shall be provided.

A-19.4.20.1.8 Dual Chromel constantan (Type E) thermocouple (one (1) dual-element thermocouple (remote indication at HMI) on EHC reservoir for fluid temperature.

A-19.4.20.1.9 Triple redundant indicating pressure transmitters for indication and protective interlocks of hydraulic pressure.

A-19.4.20.1.10 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-19.4.20.1.11 The EHC reservoir shall include oil heating function.

A-19.4.20.1.12 Seller shall provide a bypass provision for field flushing of hydraulic lines.

A-19.4.21 Gland Steam Sealing System

A-19.4.21.1 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-19.4.21.2 The gland steam sealing system shall be automatic and shall comply with ASME standard TDP-1. Gland steam for start-up is to be drawn from the turbine bypass steam system.

A-19.4.21.3 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-19.4.21.4 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-19.4.21.5 The automatic gland steam system shall be comprised of:

A-19.4.21.6 Steam seal glands in accordance with manufacturer's standard design.

A-19.4.21.7 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-19.4.21.8 Automatically operated shutoff and bypass valves.

A-19.4.21.9 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-19.4.21.10 All instrumentation sensors, switches, and other devices for connection to the Facility DCS system.

A-19.4.21.11 Gland steam unloading valve shall be furnished by Seller.

A-19.4.21.12 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-19.4.21.13 Expansion joints provided in steam seal piping shall be of stainless-steel metal bellows type.

A-19.4.22 Steam Turbine Bypass System

A-19.4.22.1 The 100% steam turbine bypass system, supplied by the Seller, shall be designed to provide the ability of operating the steam generators 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 air-cooled condenser via the HRH bypass valve station. LP steam will bypass the steam turbine and be routed to the air-cooled condenser via the LP bypass valve station. The bypass system will be designed to operate at 100% of TMCR load. Upon steam turbine trip, either or both in the HRSG or inlet cooling at the CTG will also be tripped, reducing steam flows to the air-cooled condenser during bypass operation.

A-19.4.23 Turning Gear

A-19.4.23.1 The Seller shall provide a turning gear which shall be of the automatic engagement type and shall be capable of starting the STG 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-19.4.23.2 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 shall also be possible.

A-19.4.23.3 Normal control of the turning gear shall be from the turbine control system with supervisory control from the Facility DCS operator console in the main control room. A lever for local engaging of the turning gear shall be provided.

A-19.4.23.4 Turning gear shall be furnished complete with AC electric motor drive, and auxiliary switches to indicate in and out positions of gear mechanisms.

A-19.4.23.5 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-19.4.23.6 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-19.4.23.7 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-19.4.23.8 Turning gear shall automatically engage at zero shaft speed if proper oil pressure is established.

A-19.4.23.9 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-19.4.23.10 Turning gear system shall include a handle for manual turning of the turbine by the operator.

A-19.4.24 Steam Strainers

A-19.4.24.1 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-19.4.25 Turbine Drains

A-19.4.25.1 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-19.4.25.2 Manufacturers 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-19.4.25.3 Enclosure for HP/IP turbine and Enclosure between LP turbine and Generator

A-19.4.25.4 The enclosure shall include the Contactor's recommended access clearance for maintenance and inspection around the full perimeter.

A-19.4.25.5 The enclosure's walls and roof shall be painted metal siding, and acoustically lined as necessary to achieve noise limits per Attachment A-4. The coating system and siding color shall be in accordance with Attachment A-5.

A-19.4.25.6 The enclosure roof sections shall be self-supporting and removable to allow for maintenance activities.

A-19.4.25.7 Structural steel members shall be hot-dipped galvanized.

A-19.4.25.8 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-19.4.25.9 A gutter system, including downspouts, along the full length of both sides of the enclosure shall be provided.

A-19.4.25.9.1 Flashing and/or gaskets, as applicable, for penetrations, wall corners, roof sections and wall sections shall be provided.

A-19.4.25.10 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-19.4.25.11 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-19.4.25.12 The manufacturer shall pre-fabricate the enclosure to the maximum extent feasible in order to minimize site labor requirements.

A-19.4.26 Insulation and Lagging

A-19.4.26.1 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-19.4.26.2 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-19.4.26.3 All materials shall be free of asbestos and free of man-made vitreous fiber. Seller shall identify and provide basis for any applications where this requirement cannot be satisfied.

A-19.4.26.4 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-19.4.26.5 Acoustical insulation shall be utilized where thermal insulation is not sufficient to meet the sound level requirements set forth in Attachment A-4.

A-19.4.26.6 The manufacturer's insulation design shall minimize the differential temperature gradients between the upper and lower casings to allow for rapid re-start.

A-19.4.26.7 Removable skirt lagging for the generator shall be provided as necessary for acoustical treatment.

A-19.4.26.8 Insulation studs, holding clips, or similar fixation devices shall be provided for attachment of insulation wire to hold insulation securely in place.

A-19.4.27 Guards

A-19.4.27.1 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-19.4.28 Steam Valves

A-19.4.28.1 Stop valves shall have backseat capability.

A-19.4.28.2 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-19.4.29 Hazardous Materials

A-19.4.29.1 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-19.4.30 Specifically Prohibited Materials

A-19.4.30.1 The following materials are prohibited for the project:

A-19.4.30.1.1 Asbestos, including gaskets, packing, and other materials.

A-19.4.30.1.2 Man Made Vitreous Fibers (MMVF) (Fiber reinforced plastic (FRP) and epoxy impregnated glass roving used for generator electrical insulation is acceptable).

A-19.4.30.1.3 Mercury

A-19.4.30.1.4 Lead-Based Paint

A-19.4.30.1.5 PCBs

A-19.4.30.1.6 Lead products (other than bearing babbitt) – Seller to justify any uses.

A-19.4.30.1.7 Ceramic fibers

A-19.4.31 Welding

A-19.4.31.1 Fabrication or repair welding of unit 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-19.4.31.2 Fabrication or repair welding of the Steam turbine-generator 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-19.4.31.3 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-19.4.31.4 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-19.4.31.5 The governing welding code for any equipment attached to primary equipment shall be dictated by the code associated with the primary equipment.

A-19.4.32 Preparation for Shipment

A-19.4.32.1 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 the manufacturer's standard requirements and coating system.

A-19.4.32.2 Coating systems shall be suitable for the environment in which the units 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-19.4.32.3 All external machined surfaces shall be coated with cup grease or a grease-based preservative.

A-19.4.32.4 Piping supports shall be either galvanized or shop-painted.

A-19.4.32.5 Finish color requirements shall be per Attachment A-5 Civil/Structural/Architecture Requirements and Design Criteria.

A-19.4.32.6 Oil from oil lubricated motors shall be drained from bearings prior to shipment and rotors shall be blocked to prevent movement during shipment.

A-19.4.32.7 All openings shall be immediately closed after cleaning.

A-19.4.32.8 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-19.4.32.9 Openings prepared for field welding shall be closed using pressed metallic caps and sealed using waterproof tape.

A-19.4.33 Special Tools

A-19.4.33.1 Any special tools required for the proper maintenance of the turbines shall be provided by the Seller.

A-19.4.34 Nameplates and Numbering

A-19.4.34.1 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-19.4.34.2 Requirements provided in Attachment A.13for 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-19.4.34.3 All equipment and instrumentation not included in the above list shall have the manufacturer's standard identification nameplate and number.

A-19.4.34.4 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-19.4.34.5 Seller shall refer to Buyer's standard unit numbering of 1C.

A-19.4.35 Advisory Services

A-19.4.35.1 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.

A-19.4.35.2 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-19.4.36 Spare Parts

A-19.4.36.1 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-19.4.36.1.1 Spare part name, description, and part or catalog number

A-19.4.36.1.2 Recommended quantity for two years of service

A-19.4.36.1.3 Expected shelf life.

A-19.4.36.1.4 Pricing valid for 24 months from time of last delivery of major spare parts by manufacturer, plus delivery price to the job site

A-19.4.36.1.5 Manufacturing lead time

A-19.4.37 Shop Inspection and Testing

A-19.4.37.1 Shop inspection and testing shall be in accordance with the requirements identified in OEM's Standard Integrated Test Plan as approved by Buyer, which meet the intent of the sub-articles below:

A-19.4.37.2 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-19.4.37.3 The Seller shall assure, through testing, that the equipment provided is in accordance with equipment specifications and will perform as specified.

A-19.4.37.4 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-19.4.37.5 STG unit individual Attachments shall be factory assembled to establish proper fit, alignment, critical clearances, weld connections, mating surfaces, and dimensional accuracy.

A-19.4.37.6 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-19.4.37.7 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-19.4.37.8 The manufacturer's factory testing of components shall include, but not be limited to, the following:

A-19.4.37.8.1 Rotors dynamic balancing

A-19.4.37.8.2 Turbine rotor test at 115% of rated speed under full vacuum

A-19.4.37.8.3 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-19.4.37.8.4 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-19.4.37.8.4.a Software verification of graphic displays and functionality, simulations of startups, shutdowns, STG subsystems, alarms, and trips at manufacturer's facility

A-19.4.37.8.4.b 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-19.4.37.8.4.c Test of the graphics and alarms for the STG 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 check out during the Facility DCS FAT.

A-19.4.38 Hydrostatic Testing

A-19.4.38.1 The main steam and reheat piping will be hydrostatically tested at a pressure of 1.5 times the system design pressure per ASME B31.1. It is intended that the turbine main steam stop valves and the reheat stop/intercept valves (with hydrostatic test devices installed) will be used to isolate the pipe at the turbine end during hydrostatic testing and, therefore, shall be mechanically suitable to accommodate the hydrostatic test pressure. Hydrostatic test water temperature and valve body temperature will be near to ambient during the test.

A-19.4.39 Generator Testing

A-19.4.39.1 Generator Factory Tests performed during the manufacture and assembly of the non-packaged power generators shall include all tests prescribed in ANSI C50.13 (2014), Table 10 for those generators "not completely assembled for test in the factory". Generator testing and quality control procedures shall be per Subcontractors standard and in compliance with C50.13. Copies of the applicable test reports for the following process testing shall be provided, for applicable tests a type test report will be submitted is lieu of a factory performed test report:

A-19.4.39.1.1 Resistance of Stator and rotor windings

A-19.4.39.1.2 Dielectric test of stator and rotor windings

A-19.4.39.1.3 Phase Sequence

A-19.4.39.1.4 Overspeed to 120% of rated speed

A-19.4.39.1.5 Insulation resistance of stator and rotor windings

A-19.4.39.1.6 Measurement of bearing insulation resistance

A-19.4.39.1.7 Rotor winding shorted turn test at rated speed

A-19.4.39.1.8 Generator Assembly (* Generator Assembly tests are performed; however, no report is provided for these tests.)

A-19.4.39.1.8.a Air gap Measurement*

A-19.4.39.1.8.b Oil Flush*

A-19.4.39.1.8.c Wiring Checks*

A-19.4.39.1.8.d Hydrostatic Test of Cooler

A-19.5 INSTRUMENTATION AND CONTROLS

A-19.5.1 The turbine control system (TCS) and the turbine supervisory instrumentation (TSI) shall be included for proper operation and protection of the steam turbine generator.

A-19.5.2 Turbine Control System Functional Requirements

A-19.5.2.1 The turbine-generator control system (TCS) shall be a redundant microprocessor-based control complete with the operator human machine interfaces (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-19.5.3 The TCS shall have the following functions, as a minimum:

A-19.5.3.1 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 of manual operation of the turbine startup. The unit shall be capable of automatic unloading from 100% to 20% load.

A-19.5.3.2 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-19.5.3.3 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 will 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-19.5.3.4 The TCS shall be capable of shutting down the turbine generator and its auxiliaries in a safe and controlled manner from any load.

A-19.5.3.5 The TCS shall have the capability of automatically controlling the turbine speed to prevent the unit from reaching overspeed tripping point in the event of an instantaneous change in load from full load to no load.

A-19.5.3.6 Electronic overspeed protection system shall be provided. Speed sensors and electronics shall be triple redundant.

A-19.5.3.7 Valve positioning units (including valve position feedback) for:

A-19.5.3.7.1 Main stop valves, including stop valve lift limit.

A-19.5.3.7.2 Control valves with protection against excessive rate of initial pressure decay.

A-19.5.3.7.3 Intercept and induction valves.

A-19.5.3.8 Testing circuits for turbine steam valves capable of fully stroking the control valve from the control room with the unit 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-19.5.3.9 Emergency trip devices, including:

A-19.5.3.9.1 Overspeed trip with provisions for testing online.

A-19.5.3.9.2 Vacuum trip, with provisions for remote reset.

A-19.5.3.10 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:

A-19.5.3.11 Values of all relevant process variables

A-19.5.3.12 Status of all relevant equipment

A-19.5.3.13 Abnormal conditions

A-19.5.3.14 Present step (e.g., soaking at 2000 rpm)

A-19.5.3.15 Next step (e.g., synchronization)

A-19.5.3.16 Operator instructions (e.g., increase speed); an on-line instruction manual is not required.

A-19.5.3.17 VAR and voltage regulator control

A-19.5.3.18 The TCS shall take into account the turbine bypass system.

A-19.5.3.19 The TCS shall communicate with the Facility DCS with a redundant fiber optic datalink, using OPC over ethernet.

A-19.5.3.20 Provision for hardwired trips of the steam turbine, one trip hardwired for an operator initial pushbutton and indication in the main control room and one hardwired contact indicating that no turbine is operating.

A-19.5.3.21 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-19.5.3.22 An engineering console (Thin Client, common with CTG) with 24" dual monitors shall be provided with networked printer (common with CTG) to assist and support the engineering/programming functions of the TCS.

A-19.5.3.23 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-19.5.3.24 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-19.5.3.25 The TCS cabinet(s) shall be freestanding enclosures that shall be located in a building in the turbine area.

A-19.5.3.26 A STG control cabinet shall be provided and utilized to interface with all control system I/O points with field wiring.

A-19.5.3.27 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-19.5.3.28 The turbine control system shall provide data to perform full performance monitoring of the turbine. The turbine control system shall provide vibration monitoring, generator capability, rotor stress monitoring, temperature/pressure ramps, and trending of both current and historical data.

A-19.5.3.29 All STG turbine control system screens shall be replicated in the Facility DCS.

A-19.5.3.30 Emergency stop switches shall have a means to prevent accidental operation, such as clear plastic/lexan covers or push button guards.

A-19.5.4 Turbine Supervisory Instrumentation

A-19.5.4.1 A complete turbine supervisory instrumentation (TSI) system, including locally mounted supervisory instruments, shall be provided as required for the safe startup, operation, and shutdown of the turbine generator.

A-19.5.4.2 The TSI shall include, but not be limited to, the following features:

A-19.5.4.2.1 Three (3) non-contact proximity probes installed near the thrust collar to measure thrust position.

A-19.5.4.2.2 TSI sensors will be provided in the following configuration:

A-19.5.4.2.2.a HP differential expansion: Single or dual non-contact probe

A-19.5.4.2.2.b LP differential expansion: Single or dual non-contact probes

A-19.5.4.2.2.c Keyphaser: Single non-contact probe

A-19.5.4.2.2.d Zero speed sensor (for turning gear operation): Single noncontact probe

A-19.5.4.2.2.e Eccentricity: Single non-contact probe

A-19.5.4.2.2.f Bearing shaft vibration: Two (2) probes per bearing at x-y position

A-19.5.4.2.3 Thrust bearing monitors

A-19.5.4.2.4 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-19.5.4.2.5 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-19.5.4.2.6 Temperature measurements of turbine metal, STG bearings, and generator stator.

A-19.5.4.2.6.a One (1) dual element thermocouple per bearing for measurement of bearing metal temperature.

A-19.5.4.2.6.b Twelve (12) single element RTD's for the measurement of temperature between coils in slot.

A-19.5.4.2.7 Temperature measurement (RTD's) of generator hot gas and cold gas, inlet and outlet, and AC exciter air cooler.

A-19.5.4.3 The STG supervisory system shall be a stand-alone system as manufactured by Bently Nevada 3500. The system shall provide alarm and trip contact output signals connected to the TCS via hardwired connections.

A-19.5.5 Instruments

A-19.5.5.1 All instrumentation used for turbine protection shall be triple-redundant using 2 out of 3 logic except for shaft vibration sensors.

A-19.5.5.2 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-19.5.5.3 Redundant pressure switches shall be provided for the emergency oil pump.

A-19.5.5.4 Pressure indicators on pump headers shall be provided with snubbers and shall be glycerol filled.

A-19.5.5.5 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-19.5.5.6 Instrument tags shall be stainless steel, either screwed into instrument or attached to instrument by stainless steel wire.

A-19.5.5.7 Instrument tubing (304 stainless steel) shall not be welded and shall be ½ inch minimum size. Generator may utilize smaller tubing per Major Equipment standard design.

A-19.5.5.8 All instrumentation and control devices shall be suitable for the environment where they will be located.

A-19.5.5.9 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-19.5.5.10 Profibus and foundation fieldbus shall not be installed on instruments and valves.

A-19.5.5.11 Instruments located on the packaged equipment systems shall be furnished, mounted, and installed by Seller.

A-19.5.5.12 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-19.5.6 Instrument Data

A-19.5.6.1 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-19.5.6.2 An "Instrument List" with descriptive information for all instruments shall be provided.

A-19.5.6.3 Instrument data sheets in ISA format shall be provided for all instruments furnished for the STG.

A-19.6 GENERATOR AND APPURTENANCES

A-19.6.1 General

A-19.6.1.1 The generator and its appurtenances shall conform in all respects to the American National Standards Institute Standards for synchronous machine (ANSI C50.10) and to ANSI Standard for cylindrical rotor synchronous generators (ANSI C50.13-2014), with their latest revisions and additions, and to the following additional specifications.

A-19.6.1.2 The generator shall be of the cylindrical rotor type, hydrogen cooled. The generator shall be designed to develop the capacities specified under the operating conditions described. Cooling water design conditions are given in Attachment A-6.

A-19.6.1.3 Generator shall be asbestos free.

A-19.6.1.4 Rotor shall be installed in the generator and shipped to site.

A-19.6.2 Generator Rating

A-19.6.2.1 The generator shall comply with all requirements of IEEE C50.13

A-19.6.2.2 The generator to operate continuously at TMCR, during normal operating conditions and remain in operation during system disturbance. Following shall be the minimum requirements for operation modes and withstanding capability of the generator:

A-19.6.2.2.1 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-19.6.2.2.2 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-19.6.2.2.3 STG shall be designed such that it complies with PRC-024 and does not impinge on the frequency no trip zone.

A-19.6.2.3 Generator shall be protected by a two-level V/Hz relaying scheme as indicated below:

A-19.6.2.3.1 Level 1 pick up for alarm at 106% Volts/Hertz level instantaneously.

A-19.6.2.3.2 Level 2 to be set to a pickup for trip at 118% Volts/Hertz with 2 seconds delay.

A-19.6.2.3.3 The V/Hz limiter in the AVR set at 105% Volts/Hertz level.

A-19.6.2.4 Generator overcurrent shall be in accordance with IEEE C50.13

A-19.6.2.5 The generator shall remain in synchronism if the system frequency momentarily rises to 62.4 Hz or falls to 57.6 Hz.

A-19.6.2.6 The generator shall withstand a continuous negative sequence unbalanced current.

A-19.6.2.7 The generator shall be required to withstand without tripping, the unbalance loading during clearance by the backup protection of a close-up phase-to-phase fault on the grid.

A-19.6.2.8 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 as provided in the heat balance diagram of the driving turbine without exceeding the guaranteed temperature rise. The generator nor its excitation system nor its accessories shall limit Facility output. The generator shall have the following additional characteristics:

A-19.6.2.8.1	Cooling method	Hydrogen Cooled
A-19.6.2.8.2	Rating	by Seller
A-19.6.2.8.3	Power factor	0.85 lagging to 0.95 leading
A-19.6.2.8.4	Voltage	Manufacturer's Standard
A-19.6.2.8.5	Number of phases	3 phase Y connected.
A-19.6.2.8.6	Frequency	60 Hz
A-19.6.2.8.7	Speed	3600 r/min
A-19.6.2.8.8	Short circuit ratio at rated H2 pressure at maximum cooling water temperature and 5% over voltage	Not less than 0.50
A-19.6.2.8.9	Negative sequence capability (I2) 2T	Per ANSI C50.13-2014
A-19.6.2.8.10	3-phase short circuit capability	Not less than 10 seconds
A-19.6.2.8.11	Unbalance fault withstand	Per IEEE C50.13
A-19.6.2.8.12	Minimum BIL	150 KV
A-19.6.2.8.13	Excitation system response ratio	2.0 or greater
A-19.6.2.8.14	Nominal excitation voltage	Manufacturer's optimum
A-19.6.2.8.15	Stator winding connection	Star
A-19.6.2.8.16	Number of leads brought out	6
A-19.6.2.8.17	Field winding conductors	Copper

A-19.6.2.8.18	For hydrogen cooled generators, rated gas pressure	Manufacturer's standard
A-19.6.2.8.19	Stator winding insulation	Class F with Class B rise

A-19.6.2.9 The generator windings and end-turns shall be braced for peaking duty requiring frequent startups and shutdowns (see the Project Requirements, Attachment A-4 for approximate number of startup and shutdown cycles per year).

A-19.6.2.10 The steam turbine-generator will operate 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-19.6.2.11 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-19.6.2.12 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. Generator shall have a balanced Telephone Influence Factor (T.I.F.) of not more than 40, and residual T.I.F. of not more than 30. The EMC limits of IEC 60034-1 Annex B shall not be exceeded.

A-19.6.2.13 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". Buyer does not want to invoke PRC-024-2, Section B Paragraph R3.

A-19.6.2.14 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-19.6.2.15 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-19.6.2.16 The exciter shall have sufficient capacity to operate within its current rating with the generator operating at its maximum capability.

A-19.6.2.17 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-19.6.2.18 For hydrogen cooled cycles, the generator stator housing shall have a minimum number of gas tight joints to minimize the leakage of hydrogen and shall be designed strong enough to contain within the frame and housing the destructive effect of an internal explosion of the gas contents.

A-19.6.2.19 For hydrogen cooled cycles, the terminal bushing assembly shall be designed for operation without leakage under the specified maximum hydrogen pressure.

A-19.6.2.20 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-19.6.2.21 If brushless exciters are used, they shall be completely enclosed and air-cooled with ventilating systems as required.

A-19.6.3 Stator

A-19.6.3.1 All stator parts, whether gas-cooled or air-cooled, shall be tested to ensure unrestricted passage of the coolant.

A-19.6.3.2 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-19.6.3.3 Phase and neutral terminals shall be marked consecutively in the order of their phase sequences.

A-19.6.3.4 Heaters shall be provided with the stator to avoid condensation moisture during stand-by periods.

A-19.6.3.5 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-19.6.3.6 Stator mounting and core construction shall be designed to reduce the effects of vibration.

A-19.6.3.7 Stator core shall be made of high permeability low loss silicon punching. Stator core and iron heating shall be minimized.

A-19.6.3.8 The stator core and windings shall be spring mounted in such a manner that double frequency magnetic vibrations will be held to a minimum (not to exceed 4 mils).

A-19.6.3.9 The stator enclosure shall be equipped with at least four openings with removable covers permitting visual inspection of the interior.

A-19.6.3.10 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-19.6.3.11 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-19.6.3.12 Manufacturer shall incorporate into the design suitable features to prevent the generation of copper particles in the generator.

A-19.6.3.13 Liquid detectors and drains shall be provided at the low point(s) in accordance with the manufacturer's standard design.

A-19.6.3.14 A 1-inch NPT connection shall be provided in the stator cold gas discharge for Seller's temperature detecting device.

A-19.6.3.15 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-19.6.3.16 The hydrogen control cubicle shall 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 suitable for the appropriate hazardous area classification.

A-19.6.3.17 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-19.6.4 Rotor

A-19.6.4.1 The generator rotor shall be capable of withstanding without mechanical damage, an overspeed of 20% for two minutes, in accordance with IEEE C50.13.

A-19.6.4.2 Field winding shall be hard drawn silver bearing copper and not subject to permanent distortion during operation.

A-19.6.4.3 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-19.6.4.4 The field winding insulation shall be provided with liberal creepage distance. The completed winding shall be fully baked and seasoned before balancing.

A-19.6.4.5 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. Shaft grounding copper braid assembly shall be furnished.

A-19.6.4.6 Generator rotor shall have two retaining rings, made of 18 Mn – 18 Cr forged material.

A-19.6.4.7 Collector rings shall be provided with an insulating barrier.

A-19.6.4.8 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-19.6.4.9 Brushes shall be mounted in such a way as to prevent uneven wear of the collector rings.

A-19.6.4.10 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-19.6.4.11 The field windings shall be designed for direct cooling by the cooling medium.

A-19.6.4.12 Design shall allow for high voltage bushing replacement without removing the generator rotor.

A-19.6.4.13 Generator bearings shall be oil pressure lubricated from the turbine oil system.

A-19.6.4.14 At least one generator bearing shall be insulated.

A-19.6.4.15 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-19.6.5 Excitation System

A-19.6.5.1 General

A-19.6.5.1.1 A static excitation system shall be supplied and shall include a line fed excitation transformer.

A-19.6.5.1.2 Excitation transformer shall be dry type, cast resin suitable for outdoor use.

A-19.6.5.1.3 Transformer shall be sized with sufficient capacity based on ceiling voltage at the rated generator conditions.

A-19.6.5.1.4 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-19.6.5.1.5 Transformer BIL rating shall comply with the requirements of IEEE C57. Overload protection for the excitation transformer shall be provided.

A-19.6.5.1.6 The system shall be rated to provide generator voltage regulation from 95% to 105% of the rated voltage at any operating load.

A-19.6.5.1.7 An exciter field breaker or contactor shall be provided.

A-19.6.5.1.8 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-19.6.5.1.9 A fused field flashing circuit shall be provided. Field flashing power shall be from the Facility DC system.

A-19.6.5.1.10 High and low voltage limiter in accordance with NERC requirements shall be furnished.

A-19.6.5.1.11 The generator field temperature shall be monitored and displayed.

A-19.6.5.1.12 Rated thyristor and excitation transformer secondary voltage shall be greater than or equal to 108% of the rated generator field voltage.

A-19.6.5.1.13 Rated thyristor and excitation transformer secondary current shall be greater than or equal to 106% of the rated generator field current.

A-19.6.5.1.14 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-19.6.5.1.15 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-19.6.5.1.16 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-19.6.5.1.17 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-19.6.5.1.18 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-19.6.5.1.19 The excitation system shall be controlled from the operator's station along with manufacturer supplied industrial PC location to be determined by Seller.

A-19.6.5.1.20 The rectifiers in the power conversion units will 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-19.6.5.1.21 Thyristor rectifier is capable of operating at rated excitation current with one rectifier element out of service.

A-19.6.5.1.22 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-19.6.5.1.23 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-19.6.5.1.24 Thyristor rectifier cubicle enclosure shall be rated IP41 or NEMA 3R in accordance with manufacturer's standard.

A-19.6.5.1.25 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-19.6.5.1.26 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-19.6.6 Automatic Voltage Regulator

A-19.6.6.1 General

A-19.6.6.1.1 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-19.6.6.1.2 The Automatic Voltage Regulator (AVR) shall be redundant with bumpless fast transfer capability.

A-19.6.6.1.3 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-19.6.6.1.4 The voltage regulating system shall, under steady-state operation, furnish control power to the thyristors from the control power sources listed within this Attachment.

A-19.6.6.1.5 The voltage regulator shall automatically gate the controlled rectifiers.

A-19.6.6.1.6 Maintain the average three-phase generator voltage within ±0.5%, without hunting, when operating under steady load conditions for any load within the operating range of the generator.

A-19.6.6.1.7 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-19.6.6.1.8 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-19.6.6.1.9 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-19.6.6.1.10 Provide an adjustable online 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-19.6.6.1.11 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-19.6.6.1.12 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-19.6.6.1.13 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-19.6.6.1.14 Selectable terminal voltage, reactive power, and power factor control modes shall be available as part of the AVR.

A-19.6.6.1.15 PT loss protection shall initiate an automatic transfer to backup AVR.

A-19.6.6.1.16 The voltage regulator auto and manual control shall be microprocessor based, fully digital.

A-19.6.6.1.17 Analog components in the voltage regulator are not acceptable. This regulator shall include the required power devices.

A-19.6.6.1.18 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-19.6.6.1.19 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-19.6.6.1.20 Design shall include a Power System Stabilizer.

A-19.6.6.1.21 Enclosures shall be rated for the conditions required by manufacturer-supplied excitation system enclosure design.

A-19.6.6.1.22 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-19.6.6.1.23 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-19.6.6.1.24 All information within the excitation system shall be made available to the Facility DCS via the communication link.

A-19.6.6.1.25 All alarms and diagnostic messages from the exciter shall be presented to the operator in clear, easily understandable text messages.

A-19.6.6.1.26 The ability to modify and maintain excitation control parameters shall be done via the manufacturer supplied interface.

A-19.6.7 Surge and Potential Transformers Cabinet

A-19.6.7.1 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-19.6.7.2 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-19.6.7.3 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-19.6.7.4 Generator Neutral Grounding shall be provided.

A-19.6.7.5 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-19.6.7.6 A high resistance grounding system (NGR) for the generator shall be provided. The grounding system shall be designed provide 100% generator ground fault protection.

A-19.6.8 Facility DCS Information Display and Relaying

A-19.6.8.1 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-19.6.8.2 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-19.6.8.3 At a minimum, transducers shall be provided for the following parameters to be displayed in the Facility DCS:

A-19.6.8.3.1 Generator Frequency

A-19.6.8.3.2 Generator Voltage, phase-to-phase (3 phases with a voltmeter switch)

A-19.6.8.3.3 Generator Current (3 phases with an ammeter switch)

A-19.6.8.3.4 Generator Field Voltage

A-19.6.8.3.5 Generator Field Current

A-19.6.8.3.6 Generator Gross Watts

A-19.6.8.3.7 Generator Gross VARS

A-19.6.8.3.8 Generator Gross Watt-hours (with a pulse output suitable for tele-metering)

A-19.6.8.3.9 Power Factor (showing both leading and lagging) transducer minimum accuracy of 3.0%.

A-19.6.8.4 The following metered data shall be available via the Seller’s interface for remote operation:

A-19.6.8.4.1 Voltage

A-19.6.8.4.2 Current

A-19.6.8.4.3 Kilowatts (generator terminals)

A-19.6.8.4.4 Kilovars

A-19.6.8.4.5 Generator gross watt-hours

A-19.6.9 Generator Protective Relaying

A-19.6.9.1 Primary and backup relays shall be provided. Primary shall be SEL-300G and backup shall be Beckwith M-3425. 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-19.6.9.2 Buyer shall be consulted to determine protection preferences (out of step, voltage controlled overcurrent).

A-19.6.9.3 The following generator protective relays and protection schemes shall be provided:

A-19.6.9.3.1 Phase fault protection, generator differential

A-19.6.9.3.2 Impedance back up 21P.

A-19.6.9.3.3 Ground fault protection during normal operation and for ground faults close to the neutral

A-19.6.9.3.4 Short reach loss of field with time delay and long reach loss of field

A-19.6.9.3.5 Pole slipping protection.

A-19.6.9.3.6 Reverse power

A-19.6.9.3.7 Generator No-Load over excitation (for off-line protection)

A-19.6.9.3.8 Negative sequence

A-19.6.9.3.9 Dual volts per Hertz with stepped activation

A-19.6.9.3.10 Voltage balance

A-19.6.9.3.11 Generator motoring protection

A-19.6.9.3.12 Automatic synchronizing

A-19.6.9.3.13 Exciter and generator field ground fault protection

A-19.6.9.3.14 Over excitation protection

A-19.6.9.3.15 Transfer trip from switchyard or substation

A-19.6.9.3.16 Stator over temperature protection

A-19.6.9.3.17 Inadvertent energization

A-19.6.9.3.18 Under / over frequency

A-19.6.9.3.19 Under / over voltage

A-19.6.9.3.20 Generator breaker failure protection

A-19.6.9.3.21 Lockout relay for generator breaker trip

A-19.6.9.3.22 Generator frequency operation should have relaying protection that accommodates, as a minimum, under frequency and over frequency operation for the specified time frames as per NERC requirements.

A-19.6.9.4 The generator stator temperature relay shall be used for alarm only.

A-19.6.9.5 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 14NO and 14NC contacts. Relays shall be located on the generator control cabinet and equipped with test switches.

A-19.6.9.6 The turbine generator shall have an appropriate synchro check relay and auto synchronizer to allow synchronizing with the grid.

A-19.6.9.7 Current transformers used for generator protection shall be relaying accuracy suitably sized for the burden.

A-19.6.9.8 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-19.6.9.9 CT relaying accuracy shall be C400 and metering accuracy shall be 0.3B1.8

A-19.6.10 Motors

A-19.6.10.1 For specific motor requirements, see Attachment A-7.

A-19.6.11 Grounding

A-19.6.11.1 For grounding requirements, see Attachment A-7.

A-19.6.12 Panels

A-19.6.12.1 For panel requirements, see Attachment A-7.

A-19.6.13 Terminal Blocks and Wiring

A-19.6.13.1 For panel requirements, see Attachment A-7.

A-19.6.14 Miscellaneous Requirements

A-19.6.14.1 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-19.6.14.2 All solenoid valves shall be suitable for continuous operation and shall have coils with Class “H” insulation. Solenoids shall have NEMA 4 enclosures.

A-19.6.14.3 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 boxes. NEMA 4 Boxes can be painted per OEM standard.

A-19.6.14.4 Power source conditioning is the responsibility of the Seller to protect against transient voltages.

A-19.6.14.5 All manufacturer supplied equipment and control systems shall be shop wired and tested to the fullest extent possible prior to shipment.

A-19.6.14.6 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-19.6.14.7 All Seller supplied wiring shall be clearly identified on manufacturer's drawings using dashed lines or notes.

A-19.6.14.8 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-19.6.14.9 If AC power is unavailable or the AC motor driven pumps fail, the emergency DC motor driven pump shall start automatically. 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.

A-19.6.14.10 DC Motor Starter for the EOP will be mounted in Seller's electrical room.

A-19.6.14.11 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 turbine control system to test the auto-start provisions of each pump.

END OF ATTACHMENT A-19

BOT Scope Book
Attachment A-20
Fire Protection Requirements and Design Criteria

Table of Contents

A-20.1 INFORMATION AND SCOPE OF WORK

A-20.1.1 General

A-20.1.1.1. The intent of this specification Attachment is to describe the minimum equipment and systems requirements to be provided by the Seller for the fire protection system.

A-20.2 FIRE PROTECTION AND DETECTION

A-20.2.1 Regulations and Codes:

A-20.2.1.1. Design of the fire protection and alarm system and the associated Equipment shall be in accordance with the latest 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 prior to being issued for construction. Applicable NFPA codes, Standards, and Recommended Practices shall include, but are not limited to the following:

A-20.2.1.1.a. NFPA 10, Standard for Portable Fire Extinguishers

A-20.2.1.1.b. NFPA 11, Standard for Low-, Medium-, and High-Expansion Foam

A-20.2.1.1.c. NFPA 12, Standard on Carbon Dioxide Extinguishing Systems

A-20.2.1.1.d. NFPA 12A, Standard on Halon 1301 Fire Extinguishing Systems

A-20.2.1.1.e. NFPA 13, Standard for the Installation of Sprinkler Systems

A-20.2.1.1.f. NFPA 14, Standard for the Installation of Standpipe and Hose Systems

A-20.2.1.1.g. NFPA 15, Standard for Water Spray Fixed Systems for Fire Protection

A-20.2.1.1.h. NFPA 16, Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems

A-20.2.1.1.i. NFPA 17, Standard for Dry Chemical Extinguishing Systems

A-20.2.1.1.j. NFPA 17A, Standard for Wet Chemical Extinguishing Systems

A-20.2.1.1.k. NFPA 20, Standard for the Installation of Stationary Pumps for Fire Protection

A-20.2.1.1.l. NFPA 22, Standard for Water Tanks for Private Fire Protection

A-20.2.1.1.m. NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances

A-20.2.1.1.n. NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems

A-20.2.1.1.o. NFPA 30, Flammable and Combustible Liquids Code

A-20.2.1.1.p. NFPA 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines

A-20.2.1.1.q. NFPA 54/ANSI Z223.1, National Fuel Gas Code

A-20.2.1.1.r. NFPA 55, Compressed Gases and Cryogenic Fluids Code

A-20.2.1.1.s. NFPA 56, Standard for Fire and Explosion Prevention During Cleaning and Purging of Flammable Gas Piping Systems

A-20.2.1.1.t. NFPA 58, Liquefied Petroleum Gas Code

A-20.2.1.1.u. NFPA 70®, National Electrical Code®

A-20.2.1.1.v. NFPA 72®, National Fire Alarm and Signaling Code

A-20.2.1.1.w. NFPA 75, Standard for the Protection of Information Technology Equipment

A-20.2.1.1.x. NFPA 76, Standard for the Fire Protection of Telecommunications Facilities

A-20.2.1.1.y. NFPA 80, Standard for Fire Doors and Other Opening Protectives

A-20.2.1.1.z. NFPA 80A, Recommended Practice for Protection of Buildings from Exterior Fire Exposures

A-20.2.1.1.aa. NFPA 85, Boiler and Combustion Systems Hazards Code

A-20.2.1.1.bb. NFPA 101®, Life Safety Code®

A-20.2.1.1.cc. NFPA 214, Standard on Water-Cooling Towers

A-20.2.1.1.dd. NFPA 241, Standard for Safeguarding Construction, Alteration, and Demolition Operations

A-20.2.1.1.ee. NFPA 750, Standard on Water Mist Fire Protection Systems

A-20.2.1.1.ff. NFPA 780, Standard for the Installation of Lightning Protection Systems

A-20.2.1.1.gg. NFPA 850, Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations

A-20.2.1.1.hh. NFPA 2001, Standard on Clean Agent Fire Extinguishing Systems

A-20.2.1.1.ii. NFPA 2010, Standard for Fixed Aerosol Fire Extinguishing Systems

A-20.2.1.2. 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-20.2.1.3. 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-20.2.1.4. All fire protection design drawings and calculations shall be signed and sealed by a Registered Professional Engineer in the State in which the project is constructed. 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-20.2.1.5. 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-20.2.1.6. 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-20.2.1.7. 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-20.2.1.8. 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-20.2.1.9. 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-20.2.1.10. 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-20.2.2 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:

Area	Equipment	Accessories	Sprinkler System & Other Design Details
Administration / Control Building			Automatic wet pipe, sprinkler system throughout (areas without electrical or computer equipment), automatic clean agent gas containing no PFAS chemicals". (For areas with computer or electrical equipment) For excluded areas, Triple redundant dry pipe system may be considered as an alternative. Automatic smoke detection; portable fire extinguishers throughout
Warehouse			Automatic wet pipe sprinkler system
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			Automatic smoke detection; portable fire extinguishers
Power Distribution Center 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
Transformers (Oil-Filled)	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

Area	Equipment	Accessories	Sprinkler System & Other Design Details
Standby Diesel Generator			Minimum separation of 50 ft. from other structures or fire-rated barrier 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-17. Combustible gas detectors for turbine compartments for DCS monitoring Provided by CTG OEM
Combustion turbine and generator electrical / control package			Portable fire extinguishers Automatic Smoke detectors Provided by CTG OEM
Motor driven pumps			If more than 100 gallons of oil: Automatic, wet or dry pipe or single interlock pre-action
Yard hydrants	Dry barrel type with two 2½” outlets and 4½” Fire Department pumper outlet; NST National		Located throughout entire station and placed at 300 foot spacing and no closer than 40 feet from the Building/

Area	Equipment	Accessories	Sprinkler System & Other Design Details
	Standard Fire Hose Thread connections		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, Private Fire Service Mains
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-20.2.3 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-20.2.3.1. In general areas, including small oil hazards, ABC Fire Extinguishers including stored pressure dry chemical shall be utilized.

A-20.2.3.2. 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-20.2.3.2.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-20.2.3.3. Computer or controls-type electrical equipment areas shall feature Clean Agent Fire Extinguishers, Halotron, mist water or other agents that do not leave residue. Fire extinguishers containing dry chemicals shall not be used. Automatic clean agent gas containing shall contain no "PFAS chemicals".

A-20.2.3.4. Other electrical equipment areas shall feature CO_2 or other clean agent fire extinguishers. Fire extinguishers containing dry chemicals shall not be used. Clean agent shall contain no "PFAS chemicals".

A-20.2.3.5. 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-20.2.4 Piping up to the various water control valves shall be continuously charged with high-pressure water.

A-20.2.5 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 a 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-20.2.6 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-20.2.7 Spatial separation and/or fire barrier criteria for transformers and other equipment complying with NFPA 850 is preferred. Where separation is not practical Seller shall provide an automatic deluge fire suppression system.

A-20.2.8 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-20.2.9 Bulk hydrogen supplies for Hydrogen Cooled Generators shall be equipped with excess flow prevention/alarm devices to protect against undetected hydrogen leaks.

A-20.2.10 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-20.2.10.1. Maintain a minimum 10 ft. horizontal physical separation throughout the cable run.

A-20.2.10.2. Place DC Driven Pump cabling in separate dedicated conduits.

A-20.2.11 Pressurized Lube Oil for turbines and generators (bearings or seal oil) shall be per attachments A-17 and/or A-19.

A-20.2.12 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-20.2.13 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-20.2.14 Project Site Fire Main:

A-20.2.14.1. The Facility areas shall be provided with a buried fire main appropriately sized, which shall be complete in all respects.

A-20.2.14.2. All piping valves, hydrants and associated equipment needed to provide a ring main system, which shall include sufficient Attachment isolating valves for maintenance purposes, shall be supplied. The buried piping and fittings shall be HDPE material and ductile iron to AWWA unless otherwise approved. Above ground piping and fittings shall, unless otherwise approved, be ASTM A120 carbon steel. 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-20.2.14.3. 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-20.2.14.4. 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-20.2.15 Fire Pump House:

A-20.2.15.1. 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-20.2.15.2. 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 fire pumps), and complete with UL listed automatic controllers.

A-20.2.15.3. The Fire Pump House shall be equipped with heating and ventilation as required to maintain the temperature at a minimum of 70°F and a maximum of 120°F, unless specified otherwise by the pump/controller OEM.

A-20.2.15.4. 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-20.2.15.5. The motor-driven and diesel engine-driven fire pumps shall be separated by a 2-hour (min.) fire rated wall.

A-20.2.15.6. 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-20.2.15.7. 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-20.2.15.8. 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-20.2.15.9. System design shall account for the following fire hose demand, which is in addition to the automatic suppression system demand:

A-20.2.15.9.a. 500 gpm for all lube oil and liquid fuel hazards (if any), regardless of quantity

A-20.2.15.9.b. 250 gpm for all outdoor transformers containing less than 1,000 gallons of mineral oil.

A-20.2.15.9.c. 500 gpm for all outdoor transformers containing more than 1,000 gallons of mineral oil.

A-20.2.15.10. 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-20.2.15.11. 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-20.2.15.12. The Diesel Engine air intake/filter shall be protected from direct water impingement from the building sprinklers.

A-20.2.15.13. 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-20.2.15.14. 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-20.2.15.15. 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-20.2.15.16. 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-20.2.15.17. 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-20.2.16 Painting / Coating of Fire Hose Cabinets, Extinguishers and Hose Outlet Areas:

A-20.2.16.1. 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-20.2.16.2. 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-20.2.16.3. 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-20.2.16.4. Fire hose cabinets in architecturally finished areas shall not be coated.

A-20.2.17 General Electrical Requirements:

A-20.2.17.1. 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-20.2.17.2. All large stationing 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-20.2.18 Fire Detection and Alarm Systems:

A-20.2.18.1. All equipment and material shall be UL listed and/or FM Approved.

A-20.2.18.2. 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-20.2.18.3. An electronic historian shall be included with the Main Fire Alarm Control Panel, capable of retrieving record of alarms.

A-20.2.18.4. The following alarm facilities, including initiating devices shall be provided:

A-20.2.18.4.a. Graphic display panel on the system control panel in the control room, showing status of all fire system/devices and equipment.

A-20.2.18.4.b. Local remote audible and visual indications of the operation of any suppression system.

A-20.2.18.5. 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-20.2.18.6. Each initiating device shall be individually addressable.

A-20.2.18.7. 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-20.2.18.8. 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 attachments 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-20.2.18.9. 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-20.2.18.10. 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-20.2.18.11. 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-20.2.18.12. Communication / network wiring shall be Class A, while individual initiating, notifying, and releasing circuits may be Class B.

A-20.3 FIRE PROTECTION MASTER PLAN AND DESIGN BASIS DOCUMENTS

A-20.3.1 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-20.3.2 The Seller shall comply with design requirements of the Seller Specification and the Fire Protection Master Plan and Design Basis Document. In a case of conflict between the two, the more stringent of the two documents shall apply in all cases.

A-20.3.3 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-20.3.4 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-20.3.5 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-20.3.6 Documents shall consist of, as a minimum, the following:

A-20.3.6.1. Building and Fire Codes and Life Safety Compliance Review Report

A-20.3.6.1.a. The report shall identify and address for each building, pre-engineered and/or prefabricated building, equipment enclosure and/or structure the applicable federal, state, and local building and fire codes, standards, recommendations, and amendments.

A-20.3.6.2. Fire Risk Evaluation Report

A-20.3.6.2.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-20.3.6.3. Fire Protection Design Basis Document

A-20.3.6.3.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 through Substantial Completion.

A-20.3.6.4. Hazardous Area Classification Evaluation Drawings

A-20.3.6.4.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-20.3.6.5. Fire Hydrant Location Drawings

A-20.3.6.5.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-20.3.6.6. Portable Fire Extinguisher Location Drawings

A-20.3.6.6.a. Drawings shall indicate the location and type of portable fire extinguishers.

A-20.3.6.7. Fire Protection System Construction Execution Plan

A-20.3.6.7.a. Execution plan shall be developed to outline the implementation strategy from engineering and design, through construction. This shall identify any/all Sellers 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 ATTACHMENT A-20

BOT Scope Book
Attachment A-21
Generator Step-Up Transformer (GSU) Technical Specification

Table of Contents

A-21.1 EXTENT

A-21.1.1 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-21.1.2 The transformers shall be three-phase, 2-winding, 60 Hz, outdoor, step-up, oil-immersed type, cooling class ONAN/ONAF/ONAF. 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-21.1.3 The average winding temperature rise above ambient temperature shall not exceed 65ºC 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-21.1.4 The maximum (hottest spot) winding temperature rise above ambient temperature shall not exceed 70 ºC 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 ºC 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-21.1.5 Seller shall ensure compatibility with isolated phase bus duct connections based on supplier drawings. Seller shall confirm 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-21.1.6 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-21.1.7 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-21.1.8 There will be a circuit breaker between the GSU transformers and their respective generator.

A-21.1.9 The Seller shall provide the magnetization or core saturation characteristic of the transformers. This magnetizing characteristic shall be suitable for the simulation studies using the transient's programs. The characteristic shall be a Voltage (p.u.) vs. Current (p.u.) or flux (weber) vs. Current (Amps).

A-21.1.10 Geomagnetically Induced Current (GIC) Capability:

A-21.1.10.1 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-21.1.11 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-21.1.12 The transformer manufacturer shall place confined space "Warning Signs" in conspicuous locations on the transformer tanks and covers.

A-21.1.13 The transformer will be used for starting the plant auxiliaries by backfeeding from the high-voltage system through the transformer while the generator breaker is open. The Seller shall state, in their proposal, any limitations or special considerations for utilizing the transformer in this manner including the procedure/limitations for energizing the transformer from the high voltage system in order to avoid overstressing the transformer and/or avoid the transformer trip due to a transient high current inrush.

A-21.1.14 Design Review Meeting:

A-21.1.14.1 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 Sellers 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-21.2 TECHNICAL DATA

A-21.2.1 Values shall be the output of Seller's calculation. The values shown on the Conceptual Single Line Diagram are for bid purposes only.

A-21.2.2 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. Table A-21-1 shall be completed by Seller for each GSU associated with each generator. Seller to determine BIL levels with Buyer approval for HV equipment.

Table A-21-1 GSU 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)	TO BE PROVIDED BY SELLER)	
b	Nominal System Voltage (line-to-line).....(kV)	By Seller	By Seller
c	Rated winding voltage (line-to-neutral)....(kV)	By Seller	By Seller
d	Transformer connections (wye or delta) ...(kV)	wye	delta
e	Impedance (ONAN)	Provided by Seller	
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	N/A
h	Basic lightning impulse insulation level (BIL)... (kV)	By Seller	By Seller
i	Neutral low frequency insulation level(kV)	By Seller	N/A

A-21.2.3 The Generator Step-Up Transformers (GSUT) shall have the following ratings:

A-21.2.3.1 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-21.2.3.2 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-21.2.3.3 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-21.3 REFERENCE DOCUMENTS

A-21.3.1 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 Attachment A-4, 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 Attachment A-4.

A-21.3.1.1 ANSI C2 – The National Electrical Safety Code.

A-21.3.1.2 ASME Y14.100 – Engineering Drawing Practices.

A-21.3.1.3 ASTM D1275 – Standard Test Method for Corrosive Sulfur in Electrical Insulating Oils.

A-21.3.1.4 ASTM D2300 – Standard Test Method for Gassing of Electrical Insulating Liquids Under Electrical Stress and Ionization.

A-21.3.1.5 ASTM D3612 – Standard Test Method for Analysis of Gases Dissolved in Electrical Insulating Oil by Gas Chromatography.

A-21.3.1.6 ASTM D3487 – Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus.

A-21.3.1.7 Doble TOPS – Doble Transformer Oil Purchase Specification.

A-21.3.1.8 IEEE C37.04 – Rating Structure for AC High Voltage Circuit Breakers.

A-21.3.1.9 IEEE C57.12.00 – IEEE Standard General Requirements for Liquid-Immersed Distribution, Power and Regulating Transformers.

A-21.3.1.10 IEEE C57.12.10 – 230 kV and Below, 833/958 through 8333/10417 kVA Single-Phase and 750/862 through 60000/80000/100000 kVA Three-Phase without Load Tap Changing; and 3750/4687 through 60000/80000/100000 kVA with Load Tap Changing - Safety Requirements.

A-21.3.1.11 IEEE C57.12.70 – Standard Terminal Markings and Connections for Distribution and Power Transformers.

A-21.3.1.12 IEEE C57.12.80 – Standard Terminology for Power and Distribution Transformers.

A-21.3.1.13 IEEE C57.12.90 – IEEE Standard Test Code for Liquid-Immersed Distribution, Power and Regulating Transformers.

A-21.3.1.14 IEEE C57.13 – IEEE Standard Requirements for Instrument Transformer.

A-21.3.1.15 IEEE C57.19.00 – IEEE Standard General Requirements and Test Procedures for Outdoor Apparatus Bushings.

A-21.3.1.16 IEEE C57.19.01 – IEEE Standard Performance Characteristics and Dimensions for Outdoor Apparatus Bushings.

A-21.3.1.17 IEEE C57.91 – Guide for Loading Mineral Oil-Immersed Transformers.

A-21.3.1.18 IEEE C57.98 – Guide for Transformer Impulse Tests.

A-21.3.1.19 IEEE C57.109 – IEEE Guide for Liquid-Immersed Transformer Through-Fault Current Duration.

A-21.3.1.20 IEEE C57.113 – IEEE Guide for Partial Discharge Measurement in Liquid-Filled Power Transformers and Shunt Reactors.

A-21.3.1.21 IEEE C57.116 – IEEE Guide for Transformers Directly Connected to Generators.

A-21.3.1.22 IEEE C62.11 – IEEE Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits.

A-21.3.1.23 IEEE C62.22 – Guide for the Application of Metal-Oxide Surge Arresters for Alternating-Current Systems.

A-21.3.1.24 IEEE C63.2 – Electromagnetic Noise and Field Strength Instrumentation.

A-21.3.1.25 IEEE 32 – Neutral Grounding Devices.

A-21.3.1.26 NEMA LA1 – Surge Arresters.

A-21.3.1.27 NEMA 107 – Methods of Measurement of Radio Influence Voltage (RIV) of High Voltage Apparatus.

A-21.3.1.28 NEMA C84.1 – Electrical Power Systems and Equipment – Voltage Ratings (60 Hertz).

A-21.3.1.29 NEMA TR1 – Transformer Regulators and Reactors.

A-21.3.1.30 NFPA 70 – National Electrical Code

A-21.4 SUBMITTALS

A-21.4.1 Submit the following documents for review in accordance with the submittal requirements of Attachment A-4 Document Submittal Requirements:

A-21.4.1.1 General:

A-21.4.1.1.1 General specifications covering the type and design of all principal components of the equipment.

A-21.4.1.1.2 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-21.4.1.1.3 Equipment cross-attachment drawing including identification of parts, termination points and interfaces.

A-21.4.1.1.4 Drawings showing the electrical, instrumentation and controls interface points for Buyer's connections.

A-21.4.1.1.5 Inspection and testing procedures shall be submitted for review.

A-21.4.1.1.6 Performance Curves:

A-21.4.1.1.6.a 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-21.4.1.1.6.b Transformer capability vs. ambient temperature.

A-21.4.1.1.6.c Transformer overload capability vs. time.

A-21.4.1.1.6.d Transformer volts/hertz vs. time curve.

A-21.4.1.1.6.e Transformer magnetization or core saturation characteristic suitable for simulation studies with a transient program. These characteristics shall be Voltage (piu.) vs. Current (p.u.) or Flux (weber) vs. Current (amperes).

A-21.4.1.1.6.f Current transformer excitation curves.

A-21.4.1.1.6.g Current transformers ratio correction curves.

A-21.4.1.1.7 Equipment lay-down and pull space area requirements with component weights and overall dimensions that will be required.

A-21.4.1.1.8 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-21.4.2 Structural:

A-21.4.2.1 Structural loading drawings indicating the vertical and lateral loads transmitted to the foundation.

A-21.4.3 Electrical:

A-21.4.3.1 Physical Drawings:

A-21.4.3.1.1 Outline dimension drawings and elevations of the transformer. Drawings shall show locations of cable entrances. Nameplate information for all devices shall also be shown.

A-21.4.3.1.2 Internal control panel component arrangement drawings including terminal block size, location, spacing and types.

A-21.4.3.1.3 Physical location drawings showing the location of all equipment supplied by Seller which requires an interconnecting cable or wire connection.

A-21.4.3.1.4 Detailed information concerning the plug connector cables.

A-21.4.3.1.5 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-21.4.3.2 Schematic Diagrams:

A-21.4.3.2.1 Electrical schematic (elementary) drawings, showing all individual components and interlocks and functionally in agreement with the Buyer's logic diagrams 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-21.4.3.3 Wiring Diagrams:

A-21.4.3.3.1 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-21.4.3.3.2 Cross references shall be provided between wiring diagrams and corresponding schematic diagrams.

A-21.4.3.4 Electrical Bill of Material:

A-21.4.3.4.1 Bill of material for all electrical equipment and components showing manufacturer, catalog numbers, ratings, quantities, equipment reference, etc.

A-21.4.4 Erection:

A-21.4.4.1 Seller shall provide information package to be included in the equipment erection bid packages, including the following:

A-21.4.4.1.1 A detailed scope of work involved in the complete erection of this equipment, including all accessories.

A-21.4.4.1.2 Drawings, Procedures and Data:

A-21.4.4.1.2.a 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, inspection, insulation and lagging, painting, testing, etc., required to be done by the erection Sellers.

A-21.4.4.1.2.b Erection sequence schedule.

A-21.4.4.1.2.c Electrical outline and wiring diagrams required for erection.

A-21.4.4.1.2.d Weights of the equipment and all components.

A-21.4.4.1.2.e 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-21.4.4.1.2.f Shipping drawings showing degree of assembly and center of gravity of the equipment.

A-21.4.4.1.2.g All other pertinent data or information required by the Engineer to prepare the erection specifications.

A-21.4.4.2 Seller's erection information shall be formatted and coordinated so the erection Sellers can identify and cross-reference shipping piece numbers with the erection drawing numbers, bills of material listings and the instructions.

A-21.5 GENERAL QUALITY CONTROL AND QUALITY ASSURANCE PROVISIONS

A-21.5.1 Refer to Attachment A-10 for Quality Assurance and Quality Control (QA/QC).

A-21.6 DELIVERY, HANDLING AND STORAGE

A-21.6.1 The transformer shall be shipped less oil.

A-21.6.2 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-21.6.2.1 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-21.6.2.2 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-21.6.2.3 The dry air shall have a dew point of minus 60°F or lower.

A-21.6.3 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.

A-21.6.4 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-21.6.5 Insulating oil shall be shipped in truck tankers or rail car tanker(s).

A-21.6.6 High Voltage (HV) bushings and surge arresters shall be shipped loose for field assembly.

A-21.6.7 Seller shall list all items that are shipped loose for field erection or assembly.

A-21.6.8 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-21.7 PROJECT / SITE CONDITIONS

A-21.7.1 Refer to Attachment A-4 – Site Requirements and Design Criteria.

A-21.7.1.1 Each transformer shall be suitable for an outdoor location.

A-21.8 ACCEPTABLE MANUFACTURERS AND PRODUCTS

A-21.8.1 Refer to Attachment A-16, Approved Vendor List.

A-21.9 TRANSFORMER TANK AND BASE

A-21.9.1 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-21.9.2 The tank shall be designed to withstand vacuum filling at full vacuum in the field.

A-21.9.3 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 Engineer'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-21.9.4 The external paint system(s) shall meet or exceed the coating system performance requirements of IEEE C57.12.29.

A-21.9.5 The interior finish of the main tank shall be bright white without affecting the insulation system of the windings, including the insulating oil.

A-21.9.6 The tops of the main and the tap changer tanks shall have a non-skid coating for safety.

A-21.9.7 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-21.9.8 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-21.9.9 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-21.9.10 Lifting, moving, and jacking facilities shall be in accordance with IEEE Standard C57.12.10.

A-21.9.11 The transformer base shall be designed to permit rolling and skidding in the directions of the center lines of the segments. The bank base and the underside of the tank shall be coated with asphalt mastic or a coal tar epoxy-polyamide paint system.

A-21.9.12 All metallic parts, exclusive of those energized, shall be bonded.

A-21.9.13 Provision for a fall protection system shall be provided.

A-21.9.14 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 Buyer 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-21.9.15 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-21.10 TERMINAL CONNECTIONS AND BUSHINGS

A-21.10.1 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 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-21.10.2 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-21.10.3 The bushing color shall be ANSI 70 Gray.

A-21.10.4 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-21.10.5 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-21.10.6 The neutral bushings shall be cover-mounted.

A-21.10.7 Oil-filled bushings shall be tested for power factor at the factory, and test values shall be included in test reports to the Buyer and the Buyers' Engineer. 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-21.10.8 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-21.10.9 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-21.10.10 Corona rings on top of the bushings and corona shields on the bottom of the bushings shall be required for the high side 230 kV and higher voltages.

A-21.10.11 All current carrying parts of power transformer bushings shall be copper or copper alloy material and surfaces shall be plated to inhibit deterioration.

A-21.10.12 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-21.10.13 The core ground shall be brought out of the tank through a 2.5kV class 45kV BIL porcelain or Polycast (or Buyer-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-21.10.13.1.1 Copper bar connections shall be provided to ground the lightning arresters via insulated post type insulators.

A-21.11 BUSHING CURRENT TRANSFORMERS

A-21.11.1 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-21.11.2 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-21.11.3 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 though eyelets welded to the tank cover. Spacing between the eyelets shall not exceed 24 inches.

A-21.11.4 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-21.11.5 Provision shall be made to remove and replace the current transformers without removing the tank cover.

A-21.11.6 Buyer's Engineer may require both HV and LV current transformers to provide transformer differential protection.

A-21.11.7 Neutral bushing H0 shall have two (2) current transformers with C800 accuracy class minimum.

A-21.12 SURGE ARRESTERS

A-21.12.1 The following surge arresters shall be furnished mounted on and grounded to the transformer tank.

A-21.12.2 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-21.12.3 One (1) station-type surge arrester for each high side bushing terminal.

A-21.12.4 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.

A-21.12.5 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-21.12.6 All ferrous parts exposed to the weather and subject to corrosion shall be zinc coated by the hot-dipped galvanized process.

A-21.12.7 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-21.12.8 The color of the arresters shall be ANSI 70 Gray.

A-21.12.9 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-21.12.10 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-21.12.11 Surge arresters shall be porcelain or silicone polymer, as manufactured by ABB, Cooper, Siemens or Toshiba-Mitsubishi, or Buyer’s approved equivalent.

A-21.12.12 Connections between transformer bushings and lightning arresters shall be sized to carry full rating of transformer continuously.

A-21.13 ACCESSORIES AND FITTINGS

A-21.13.1 The transformers shall be equipped with a complete set of manufacturer's standard accessories and fittings which shall include:

A-21.13.1.1 Oil level gauge, magnetic type, Qualitrol or Buyer 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-21.13.1.2 Oil drain and filter valve (2 inch minimum).

A-21.13.1.3 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-21.13.1.4 One inch or larger valve for oil purifier with top connection.

A-21.13.1.5 Vacuum pump connection

A-21.13.1.6 Oil filling connection with oil deflectors inside the tank

A-21.13.1.7 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-21.13.1.8 Dial-type winding hot spot indicator with four (4) N.O. adjustable contacts for control of cooling equipment and alarms.

A-21.13.1.9 Low gas pressure alarm, if applicable.

A-21.13.1.10 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-21.13.1.11 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-21.13.1.12 All equipment requiring frequent inspection shall be installed in easily accessible locations.

A-21.13.1.13 All indicating thermometers, oil level gauges, etc., shall be located so they can be easily read from ground level.

A-21.13.1.14 Gas sampling valve, when specified or required by ANSI Standards, shall be located opposite the nitrogen gas tank inlet.

A-21.13.1.15 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-21.14 TRANSFORMER OIL PRESERVATION SYSTEM AND ACCESSORIES

A-21.14.1 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-21.14.2 Inert Gas Equipment: If required, equipment shall have the necessary accessories including separate high-pressure nitrogen tank, automatic pressure regulating valve, 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-21.14.3 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-21.14.4 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-21.14.5 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-21.14.6 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-21.14.6.1 Top of the breathers shall be within approximately five feet of the transformer base.

A-21.15 TRANSFORMER OIL

A-21.15.1 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-21.15.1.1 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-21.15.1.2 The insulating oil shall be inhibited, The Type II, 0.3 percent DBPC, or DBP and 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-21.15.1.3 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-21.15.2 Determination of Quantities:

A-21.15.2.1 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-21.15.2.2 The apparent quantity of oil shall be corrected to a 60°F basis in accordance with ASTM Standard D1250, "Petroleum Measurement Tables."

A-21.16 NAMEPLATES

A-21.16.1 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-21.16.1.1 Zero sequence impedances.

A-21.16.1.2 Equipment Tag Number.

A-21.16.1.3 Number of core grounds.

A-21.16.1.4 Load tap changer model number and type (if applicable)

A-21.16.1.5 Full load capability of the transformer with the loss of one radiator.

A-21.16.1.6 Maximum transformer sound level at each transformer rating.

A-21.16.1.7 The purpose of all CTs, winding temperature CT, as well as all CT ratios and taps on all CTs.

A-21.16.1.8 The vacuum ratings for the main tank, radiators and No-Load Tap Changer (NLTC).

A-21.16.2 The transformer bushings shall be provided with nameplates in accordance with IEEE C57.19.00.

A-21.16.3 The surge arresters shall be provided with nameplates in accordance with IEEE C62.11.

A-21.16.4 Nameplates shall be fastened to the equipment with stainless steel screws.

A-21.16.5 PCB free statement shall be included in nameplate or a decal shall be affixed to the transformer tank and all oil-filled accessories.

A-21.16.6 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 Vendor.

A-21.16.7 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-21.16.8 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-21.16.9 Four center of gravity nameplates shall be permanently attached to the tank:

A-21.16.9.1 Two identical nameplates indicating CG for equipment fully assembled, with radiators attached and oil filled shall be installed on two adjacent walls.

A-21.16.9.2 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-21.16.10 All nameplates shall be legible from ground level.

A-21.17 TAP CHANGER

A-21.17.1 A manually-operated No-Load Tap Changer (NLTC), per IEEE Standard C57.12.10, shall be provided for operation from the outside of the tank when the transformer is not excited.

A-21.17.2 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-21.17.3 The NLTC internal mechanism shall be readily accessible for inspection and repair without untanking from the top of the transformer.

A-21.17.4 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-21.18 COOLING SYSTEM

A-21.18.1 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-21.18.2 All cooling equipment shall include supports, mountings, automatic control equipment, conduits, and wiring.

A-21.18.3 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-21.18.4 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-21.18.5 A spare installed radiator shall be provided for each transformer in case of loss of another radiator.

A-21.18.6 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-21.18.7 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-21.18.8 Automatic control of double-stage cooling equipment for forced-cooled transformers shall be in accordance with and shall include:

A-21.18.8.1 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-21.18.8.2 A winding temperature device with electrically independent contacts to control the single- or double-stage cooling and initiate remote alarms.

A-21.18.8.3 An Auto-Off-Manual switch for automatic and manual control.

A-21.18.8.4 A switch for duty cycle selection for transformers with double-stage cooling.

A-21.18.8.5 An alarm relay for each stage for cooling failure.

A-21.18.8.6 Means to turn off the cooling system with a remote contact.

A-21.18.8.7 Weatherproof cabinet enclosing switching equipment.

A-21.18.9 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-21.18.10 Control circuits shall be designed for operation on 120 Vac, 60 Hz and alarm circuits for 125 Vdc.

A-21.18.11 Cooling controls shall be designed so that in case of failure of the initial source, the fans for both cooler groups will be started.

A-21.18.12 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-21.18.13 The Seller shall provide an ASCO automatic transfer switch for each transformer as follows:

A-21.18.13.1 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-21.18.13.2 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-21.18.13.3 The transfer switch shall not use current limiting fuses to limit the momentary current that it will be exposed to under fault conditions.

A-21.18.13.4 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-21.18.13.5 The transfer switch shall be furnished with a normally closed auxiliary alarm contact and a 1-second time delay before transfer.

A-21.18.14 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-21.19 CONTROL DEVICES AND SMALL WIRING

A-21.19.1 Control relays, breakers, contactors, etc., shall be furnished in a weatherproof cabinet. Refer to Attachment A-07 Electrical Design Criteria for additional requirements.

A-21.19.2 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-21.19.3 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-21.19.4 480V wiring shall be physically separated from 120V wiring with Plexiglas.

A-21.19.5 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-21.19.6 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-21.19.7 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-21.19.8 Double lugging (two wires in one connector) and the use of shims to allow use of larger connectors are prohibited.

A-21.19.9 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-21.20 CONTROL CABINET

A-21.20.1 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-21.20.1.1 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.

A-21.20.1.2 The top of the cabinet shall be sloped to prevent water accumulation. A drip shield shall be provided above the cabinet door.

A-21.20.1.3 The control cabinet shall be insulated from transformer vibration and heat.

A-21.20.1.4 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-21.20.1.5 The design of the cabinet shall be such as to inhibit the formation of condensation.

A-21.20.1.6 The cabinet shall be equipped with an exterior hinged and padlockable door complete with heavy duty, handle-type three-point latch and shall be capable of being latched open or closed.

A-21.20.1.7 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-21.20.2 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-21.20.3 The control cabinet interior shall be painted white. The cabinet exterior paint color shall be manufacturer’s standard.

A-21.21 TEMPERATURE MONITORING SYSTEM

A-21.21.1 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-21.21.2 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-21.21.3 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-21.21.4 The ETM shall have the digital displays for the following:

A-21.21.4.1 HV Winding Hottest Spot Temperature, each phase.

A-21.21.4.2 LV Winding Hottest Spot Temperature, each phase.

A-21.21.4.3 Transformer Tank Top Oil Temperature.

A-21.21.4.4 Transformer Tank Bottom Oil Temperature.

A-21.21.4.5 Ambient Temperature.

A-21.21.4.6 Control Cabinet Interior Temperature.

A-21.21.4.7 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-21.21.4.8 Indicating the maximum temperature(s) reached.

A-21.21.4.9 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-21.21.4.9.1 Contact 1 – to initiate first cooling stage.

A-21.21.4.9.2 Contact 2 – to initiate second cooling stage.

A-21.21.4.9.3 Contact 3 – set at 115°C for Alarm 1.

A-21.21.4.9.4 Contact 4 – set at 120°C for Alarm 2.

A-21.21.4.10 Two (2) sets of contacts for Top Oil alarm set at 105°C and 110°C.

A-21.21.4.11 DNP 3.0 (latest level) communications.

A-21.21.4.12 Remote SCADA 4-20 mA output.

A-21.22 TRANSFORMER ONLINE AND GAS MONITORING SYSTEMS

A-21.22.1 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-21.22.2 The online monitoring system shall be capable of controlling the coolers operation in parallel with the conventional cooler controls. Buyer currently uses Dynamic Ratings Monitoring Control System (DRMCC) online monitoring with bushing monitoring system. A latest DRMCC monitoring system or better as approved by Buyer shall be provided with the transformer.

A-21.22.3 The online monitoring system shall have communications protocols built in to monitor all parameters in the DCS.

A-21.22.4 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-21.22.4.1 Detect, analyze, and correlate quantity of all dissolved fault gasses including hydrogen (H_2), oxygen (O_2), carbon monoxide (CO), carbon dioxide (CO_2), methane (CH_4), ethylene (C_2H_4), ethane (C_2H_6), acetylene (C_2H_2), nitrogen (N_2), moisture-in-oil and oil temperature.

A-21.23 ANNUNCIATOR / DATA LOGGER AND ALARMS

A-21.23.1 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-21.23.2 Annunciators shall be mounted on hinged weather tight panels, for easy access to rear wring, 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-21.23.3 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-21.23.3.1 Loss of primary AC Control Power.

A-21.23.3.2 Loss of backup AC Control Power

A-21.23.3.3 High Winding Temperature (Hot Spot).

A-21.23.3.4 High Oil Temperature (Top Oil).

A-21.23.3.5 Low Oil Level.

A-21.23.3.6 Loss of DC Supply.

A-21.23.3.7 Oil Level Trip: Transformer Tank.

A-21.23.3.8 Gas detector Relay.

A-21.23.3.9 Low Nitrogen Cylinder Pressure.

A-21.23.3.10 Transformer Tank Pressure High.

A-21.23.3.11 Transformer Tank Pressure Low.

A-21.23.3.12 Conservator Tank Vacuum.

A-21.23.3.13 Pressure Relief Device Actuated.

A-21.23.3.14 Sudden Pressure Relay Operation.

A-21.23.3.15 Fan motor current excessive.

A-21.23.3.16 Fan Fail.

A-21.23.3.17 Cooling Contactor Fail.

A-21.23.3.18 Cooling System Breaker Fail.

A-21.23.3.19 Fan Run Time.

A-21.23.3.20 Control Cabinet Temperature High.

A-21.24 INSPECTION AND TESTS

A-21.24.1 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-21.24.2 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-21.24.3 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-21.24.4 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-21.24.5 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-21.25 ROUTINE AND OTHER TESTS

A-21.25.1 The tests listed in IEEE Standard C57.12.00 and as specified below shall be performed per IEEE Standard C57.12.90.

A-21.25.1.1 Resistance measurements.

A-21.25.1.2 Ratio.

A-21.25.1.3 Polarity and phase relation.

A-21.25.1.4 No-load loss and excitation current at 90%, 100%, 105%, 110% and 115% rated volts for a 24 hour duration

A-21.25.1.5 Impedance voltage and load loss.

A-21.25.1.6 Zero-phase sequence impedance test, providing the follow values:

A-21.25.1.6.1 Zero-phase sequence impedance voltage

A-21.25.1.6.2 Zero-phase sequence short circuit impedance

A-21.25.1.6.3 Zero-phase sequence excitation current and excitation losses

A-21.25.1.6.4 Temperature rise (required for the first unit of an order unless test data from a previous transformer of identical design is available).

A-21.25.1.7 Dielectric tests required:

A-21.25.1.7.1 Low-frequency applied voltage.

A-21.25.1.7.2 Low-frequency induced voltage.

A-21.25.1.7.3 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-21.25.1.7.4 Switching impulse tests (on 230 kV and above winding terminals only).

A-21.25.1.7.5 Internal partial discharge measurement.

A-21.25.1.7.6 Two methods shall be employed:

A-21.25.1.7.7 RIV (microvolt) method per IEEE Standard C57.12.90.

A-21.25.1.7.8 Apparent charge (picocoulomb) method per IEEE Standard C57.113.

A-21.25.1.7.9 Insulation power factor.

A-21.25.1.8 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-21.25.1.8.1 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-21.25.1.8.2 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-21.25.1.8.3 Measurement shall be made at all terminals that have a condenser-type bushing.

A-21.25.1.8.4 The apparent charge and RIV measurements shall be read simultaneously during the one-hour induced test at intervals outlined in IEEE C57.113.

A-21.25.1.8.5 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-21.25.1.8.6 No guaranteed limits for apparent charge (picocoulomb) will be set at this time.

A-21.25.1.9 Audible sound level.

A-21.25.2 In addition to the Routine Tests noted above, other tests as listed below shall be made on the transformer:

A-21.25.2.1 Bottom Oil Temperature.

A-21.25.2.2 Insulation power factor between any winding and ground and between the two windings. Test value shall not exceed 0.5% at 20°C.

A-21.25.2.3 Bushing power factor test in accordance with ANSI/IEEE C57.19.01. The partial discharge shall not exceed 10 pC or 10 μV.

A-21.25.2.4 Pressure test on the tank and cooling system employing hot oil at 50°C and 5 psig pressure maintained for 24 hours.

A-21.25.2.5 Vacuum test on the transformer tank and cooling system designed for vacuum filling.

A-21.25.2.6 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-21.25.2.7 Current transformer Tests as required by IEEE C57.13 including the following:

A-21.25.2.7.1 Applied Potential Test.

A-21.25.2.7.2 Induced Potential Test.

A-21.25.2.7.3 Polarity Test (to be repeated at their control cabinet terminals after installation in the transformer).

A-21.25.2.7.4 Saturation Curve.

A-21.25.2.7.5 DC Resistance (to be repeated at their control cabinet terminals after installation in the transformer).

A-21.25.2.7.6 Megger.

A-21.25.2.8 Winding Temperature

A-21.25.2.9 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 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-21.25.2.9.1 Core to Frame.

A-21.25.2.9.2 Core to Core-Frame insulation of all series transformers.

A-21.25.2.10 Control Wiring Insulation Test

A-21.25.2.10.1 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-21.25.2.11 Sweep Frequency Response Analysis (SFRA) Test

A-21.25.2.11.1 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-21.25.2.12 Single-phase exciting current test at 10 kV as outlined in Doble Test TECM-576, or approved equal.

A-21.25.2.13 Dissolved Gas-In-Oil Analysis Tests – A minimum of three (3) tests as follows:

A-21.25.2.13.1 First – Before Any Tests.

A-21.25.2.13.2 Second – After Insulation Tests.

A-21.25.2.13.3 Third – After Heat Run Test.

A-21.25.3 Test results and oscillograms for all of the tests specified shall be recorded in the Test Report.

A-21.25.4 Test data for all testing shall be included in the Certified Test Report.

A-21.25.5 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-21.25.6 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-21.25.7 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-21.26 TRANSFORMER LOSSES AND AUXILIARY POWER REQUIREMENTS

A-21.26.1 The load losses, efficiency and regulation shall be corrected to a reference temperature according to IEEE Standard C57.12.00.

A-21.26.2 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-21.27 INSTALLATION

A-21.27.1 Seller shall perform all required installation and related activities as defined in this Specification. For component locations and installation requirements, see Attachment A-7 Electrical Requirements and Design Criteria.

END OF ATTACHMENT A-21