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PASADENA WATER & POWER

Glenarm Repowering Project (GT-5 Combined Cycle Installation)

BOP ENGINEERING, PROCUREMENT, AND CONSTRUCTION SCOPE OF WORK

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123374

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BOP ENGINEERING, PROCUREMENT, AND CONSTRUCTION SCOPE OF WORK

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BOP ENGINEER, PROCUREMENT, AND CONSTRUCTION SCOPE OF WORK

GLENARM REPOWERING PROJECT, GT-5 COMBINED CYCLE INSTALLATION

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BOP ENGINEER, PROCUREMENT, AND CONSTRUCTION SCOPE OF WORK

GLENARM REPOWERING PROJECT, GT-5 COMBINED CYCLE INSTALLATION

A. INTRODUCTION

The City of Pasadena Water & Power is repowering the existing 71 MW B-3 steam plant with the new GT5 71 MW 1x1 combined cycle power plant. The project site is located at the existing Glenarm site bounded by South Fair Oaks Ave and East Glenarm Street on the south side of downtown Pasadena. Major project elements include:

1. Management
2. Engineering
3. Procurement of BOP Contractor provided equipment and bulk materials
4. Demolition and preparation of the project site
5. Mothballing the Glenarm Building
6. Rehabilitation of the Maintenance Building
7. Modifying the access to the State Street cul-de-sac
8. Construction of the new control room/admin facility
9. Construction of the new water lab
10. Construction of the natural gas line from the SoCalGas meter station to GT5
11. Construction of 17 kV and 34.5 kV underground conduit and vaults
12. Construction of the GT5 plant
13. Operating Procedures
14. Training
15. Commissioning
16. Performance Testing
17. Project closeout

All of the project scope must be bid for the bidder's proposal to be deemed responsive. Item 6 is optional scope for the project and, the City at its discretion, may not be included in the final project scope. However failure to provide pricing for this option will result in the entire proposal being deemed non-responsive and not being considered further.

A.1 Project Team

The project team will consist of the following:

1. Pasadena Water & Power, the owner and operator
2. Processes Unlimited, the Project/Construction Management Team
3. POWER Engineers, the Owner's Engineer
4. General Electric, the Power Island Equipment supplier
5. BOP Contractor, the Balance of Plant engineering, procurement, and construction contractor

A.2 BOP Contractor Selection Process

The following process will be used to select the BOP Contractor:

1. Qualification Interviews - Week of December 2, 2013
2. Notify bidders of RFQ results - by December 13, 2013
3. Issue BOP Contractor RFP - December 16, 2013
4. Bidders respond with number of attendees coming to pre-bid - January 2, 2014
5. Mandatory pre-bid meeting - January 8, 2014 at 8:00 AM

a. Site tour
b. Hydrologue will be present during the site tour and can discuss the site conditions
c. GE presentation on the LM6000 PG and differences relative to the LM6000 PC
d. IST presentation on the Once Through Steam Generator
e. Walk through the project conceptual design
f. Q&A

6. Final date to submit questions - February 28, 2014
7. Bid opening - March 18, 2014
8. Expected Award Date - Prior to June 13, 2014

The following criteria will be used to select the BOP Contractor:

1. Responsive to BOP Contract Specification requirements; exceptions or clarifications will be deemed non-responsive
2. Lowest cost responsive bidder

A.3 Project Completion Date

Commercial Operation Date - Prior to May 15, 2016

A.4 General Electric Power Island Equipment Scope of Supply

General Electric will be providing the Power Island Equipment (PIE) under contract to PWP. The equipment within their scope includes the following:

1. One General Electric 56 MW LM6000 PG SPRINT gas turbine and auxiliaries. The Turbine Control Panel will ship loose for the BOP Contractor to install in the PDC. The LM6000 PG differs from the LM6000 PC in two respects:

    i. The PG has a gearbox between the 3900 rpm turbine and the 3600 rpm generator
    ii. Common utility skid with NOx water pumps with an enclosure for noise attenuation. The normal aux skid was combined with the NOx injection pumps.
    iii. Mineral oil skid for the generator and gear box
    iv. Lube oil cooler for the generator/gear box oil is separate.

2. Gas turbine inlet air conditioning package composed of:

    i. A conventional chiller to cool inlet air to achieve maximum gas turbine output and plant output and efficiency
    ii. A heater skid using main steam to heat the chiller fluid to in turn heat the inlet air to maximize plant efficiency at part load conditions
    iii. A heat exchanger to quickly cool the chiller fluid when transitioning from part-load to full load operation

3. One Innovative Steam Technologies single pressure un-fired once through steam generator (OTSG) with stack, stack damper, platforms, SCR equipment, and tempering air fans

    i. Orbital welding of the OTSG tubes to the headers using IST's proprietary process is not within General Electric's scope of supply.

ii. The BOP Contractor will contract separately with IST to perform the welding.
iii. IST's price to perform this work is ~$80,000.

4. One CEMS with three probes, one unheated probe in the stack and one heated probe in the stack with a common umbilical cord, and one unheated probe in the duct with its own umbilical
5. One Shin Nippon 15 MW steam turbine with a Hyundai generator and auxiliaries, including an EHC/Control Panel for the BOP Contractor to install in the PDC. The steam turbine generator will be shipped in four skid mounted assemblies:

    i. Steam turbine with gearbox
    ii. Generator
    iii. Lube oil skid
    iv. Gland steam condenser

6. One two-pass water cooled condenser without a split waterbox
7. 2x100% liquid ring vacuum pumps
8. 2x100% Condensate Pumps
9. One steam turbine enclosure that encloses the following equipment:

    i. Steam turbine generator (see item 5)
    ii. Lube oil skid and conditioner (see item 5)
    iii. Gland steam condenser (see item 5)
    iv. Water cooled condenser (see item 6)
    v. Vacuum pumps (see item 7)
    vi. Condensate pumps (see item 8)
    vii. Electric auxiliary boiler (see item 19)
    viii. Condenser sealing steam superheater (see item 20)
    ix. Flash tank (provided by the BOP Contractor)
    x. Pipe rack and platforms (by BOP Contractor)

10. One two-cell fiberglass framed counterflow Cooling Tower (erection by BOP Contractor)
11. 2x100% Vertical Circulating Water Pumps
12. 3x50% Vertical Auxiliary Cooling Pumps
13. 2x100% Condensate Polisher
14. 2x100% Feedwater Pumps
15. Steam Turbine Bypass Valve
16. One Three Winding 13.8-34.5kV GSU Transformer
17. 2x100% rotary screw Gas Compressors
18. 2x100% Air Compressor/drier/receiver skid
19. One electric auxiliary boiler with condensate feed pump
20. One electric sealing steam superheater
21. Initial spare parts

Equipment deliveries will start at the beginning of 2015. In addition to the foregoing equipment, General Electric will also be supplying:

1. Engineering data
2. Control narratives
3. Training for the General Electric scope of supply
4. O&M Manuals for the General Electric scope of supply

5. TAs to support the BOP Contractor during installation (1,134 m/d)
6. TAs to support the BOP Contractor during commissioning and performance testing (454 m/d)

General Electric is responsible for the following guarantees:

1. Plant output @ 25%, 50%, 75%, and 100% power
2. Plant heat rate @ 25%, 50%, 75%, and 100% power
3. Emissions @ 25%, 50%, 75%, and 100% power
4. 10 minute gas turbine startup
5. 120 minute plant startup
6. 60 minute plant shutdown
7. Demineralized water consumption
8. Ammonia consumption
9. Reliability
10. Capability
11. Near field noise
12. Far field noise

A.5 Balance of Plant Contractor Scope of Supply

The BOP Contractor will be supplying the following equipment:

1. The Plant Control System (PCS)

    i. Provides control, monitoring, and full integration of the GT5 unit
    ii. Design, procurement, and installation is by the BOP Contractor
    iii. General Electric will provide control narratives for their scope of supply

2. One Power Distribution Center enclosing:

    i. 13.8 kV Generator Breakers
    ii. 13.8 kV, 4160 V, and 480 V Switchgear
    iii. 480 V Motor Control Centers for all equipment, including the GTG and STG
    iv. Batteries (gel-type) for plant load as well as the GTG and STG
    v. Gas turbine and steam turbine Turbine Control Panels (supplied by General Electric)
    vi. Engineer's Work Station for the Plant Control System.

3. Two 4160V-480V auxiliary transformers
4. One 13.8kV-4160V auxiliary transformer
5. One 17.2kV-4160V auxiliary transformer
6. Lighting panels and transformers as needed for building and plant loads
7. Inlet air filter house coil condensate sump and pumps
8. One gas turbine wash water tank
9. One condensate storage tank
10. 2 x 100% Condensate Makeup pumps
11. 1 x 100% Auxiliary Cooling Water/Component Cooling Water shell and tube heat exchanger
12. 2x100% Bearing (Component) Cooling Water pumps
13. One Bearing (Component) Cooling expansion tank
14. One Atmospheric Flash Tank with vent silencer and forwarding pumps
15. Condensate Transfer pumps

16. A new ammonia forwarding pump skid to be located by the existing B-3 tank
17. The steam water analyzer / sample panel
18. Cycle chemical feed system
19. Cooling tower chemical feed system
20. 2x100% Demin water pumps
21. 2x100% Demin water forwarding pumps
22. One Demin water storage tank
23. One Fuel gas drains tank for gas compressors
24. One Fuel gas drains tank for final/last chance filter at gas turbine
25. 2x100% Process drains forwarding pumps
26. Equipment drain sump and pumps
27. One Potable water recirculation skid for eyewash stations
28. Two Air receiver tanks to be installed at GT 3 & 4
29. 2 x 100% Waste water transfer pumps
30. One Wastewater storage tank
31. One Sanitary sewer lift station
32. Weather station

In addition to the foregoing equipment, the BOP Contractor will also be supplying:

1. Management
2. All engineering and studies to design the plant and integrate the PIE equipment
3. Procurement of BOP Contractor provided equipment and bulk materials
4. Demolition and preparation of the project site (see Project Items of Note below)
5. Modifying the access to the State Street cul-de-sac and addition of gates
6. New 10’-0” high concrete wall and solid metal gates on the west side along South Fair Oaks Ave
7. Construction of the new control room/admin facility
8. Construction of the new water lab
9. Construction of the natural gas line from the SoCalGas meter station to GT5
10. Construction of 17 kV and 34.5 kV underground conduit and vaults
11. Construction of the GT5 plant
12. Installation of conduit for use by PWP in installing the IT, telecom, and security infrastructure
13. Reroute of the underground 4’x6’ storm drain and any necessary bypasses or laterals
14. Operating Procedures for GT5
15. Training for the BOP Contractor supplied equipment
16. Commissioning
17. Project closeout

In addition there is one scope of work that will be bid as an option. Pricing must be supplied for the bidder’s proposal to be deemed responsive.

1. Rehabilitation of the Maintenance Building

The BOP Contractor is expected to subcontract for the following services:

1. A paleontologist and archaeologist for pre-excavation kickoff and site monitoring on an as needed basis
2. Hydrologue, a local Pasadena geotechnical firm, must be used for all geotechnical related 3rd party inspections including compaction, soil testing, etc.
3. Other 3rd party inspection/testing services, e.g. concrete testing, high strength bolting, etc.

4. Innovative Steam Technologies to perform the OTSG orbital welding
5. Cooling tower supplier for erection of the General Electric supplied cooling tower
6. All other subcontractors necessary for the BOP Contractor to perform its scope of work subject to the 50% self-performance requirement.

The BOP Contractor must be signatory to the Project Labor Agreement (PLA). The PLA does include a requirement that 25% of the certified payroll be local hires (from within the zip codes that are a part of the City of Pasadena).

The entity that designs the Plant Control System, either the BOP Contractor, its engineer, or a subcontractor, shall have the following experience:

1. Combined cycle experience
2. Experience with the GE Mark VIE control system
3. Experience with Once Through Steam Generators

GE Integration would be an acceptable provider.

The BOP Contractor is responsible for the following guarantees:

1. Auxiliary Power
2. Schedule
3. Complying with allowable piping losses as defined by General Electric
4. Near field noise of the equipment and piping supplied by BOP
5. Far field noise of the equipment and piping supplied by BOP

A.6 Pasadena Water & Power Scope of Work

Pasadena Water & Power will be performing the following scopes of work in support of the project:

1. Relocation of the fire hydrant and water service and backflow preventer on the west side of the project site next to South Fair Oaks Ave
2. Relocation of the backflow preventer at the south side of the project site next to the State Street project entrance
3. Purchasing, pulling, testing and terminating the 34.5 kV and 17 kV cables (assume aluminum for conduit sizing).
4. Relocate overhead 4160 V distribution line and install a 480V service for the use of the BOP Contractor
5. IT, telecom, and security installation utilizing conduit installed by the BOP Contractor

A.7 Project Items of Note

Notable features of the project include:

1. There is a demolition phase of the project that includes:

    i. Removal of abandoned underground infrastructure, largely under the steam turbine, including removal and proper disposal of transite pipe, asbestos insulated fuel oil piping with residual fuel oil, electrical switchgear and transformers (believed to be PCB free), and circulating water piping.

ii. Removal of lead contaminated soil
iii. Removal of and replacement of existing soil with engineered fill
iv. Removal of the Glenarm Building stack and foundation
v. Removal of an old house concrete foundation, bricks and asphalt in the proposed tank area
vi. Removal of Glenarm Building exterior ductwork
vii. Removal of the compressor building and restroom on the exterior of the Glenarm Building, including removal of lead paint on the interior and exterior
viii. Closure of the below grade vault/circulating water tunnel openings

2. While the majority of this work can be performed from outside of the Glenarm Building, particularly once the top of the vaults/circulating water tunnels are opened up, some access from inside of the building will be required to seal the below grade openings in the Glenarm Building.
3. Mothballing of the Glenarm Building including sealing of roof and wall penetrations and stabilizing doors and windows.
4. The project site itself is ~2 acres. Additional space available for use includes:

    i. There are ~1.5 acres of construction parking nearby across the Metrorail light rail tracks. Construction workers will proceed from the parking lot using the East Glenarm Street sidewalk, crossing the Metrorail line using the public crossing, and then proceed south using the South Fair Oaks Ave sidewalk to reach the plant.
    ii. There is ~1.5 acres available for laydown
    iii. The existing Maintenance Building, the one to be rehabilitated, will be available for some office space and ship loose parts storage

5. There is a 90 calendar day window between GT5 First Fire and when B-3 must be shut down per the air permit
6. Due to the use of an OTSG, the condensate and feedwater piping from the condenser to the OTSG will be all stainless steel, and a high degree of cleanliness must be maintained in the condensate, feedwater, and main steam piping (P22) and equipment so that water chemistry requirements to admit water to the OTSG can be easily achieved.
7. The heaviest expected single lift is 301,000 pounds for the OTSG economizer/evaporator module
8. Steam and Air Blows shall be silenced (no gas blows permitted). BOP to coordinate notifying the public before steam blows (visual concern).

B. GENERAL

The City of Pasadena proposes to install a new 71MW (gross) aeroderivative based 1 x 1 combined cycle power plant to be called "Glenarm Repowering Project, GT-5 Combined Cycle Installation" at their Glenarm site utilizing two primary contracts. The first is the *Combined Cycle Power Island Equipment (PIE)* Contract which includes the supply and delivery of the major plant equipment. The second contract will be a separate *Balance of Plant (BOP)* contract for engineering, procurement of remaining equipment, construction, start-up, testing and turnover of the new facility. The purpose of this document is to define the work scope requirements for the BOP Contractor.

This is scope of work defines the minimum requirements for the project:

- High level of reliability through component redundancy, quality construction implementation, quality equipment selection, and plant maintainability.
- Maximum operational flexibility
- Optimize initial capital costs to achieve the lowest overall life cycle costs
- Efficient operation and maintenance through equipment arrangement, convenient access and convenient laydown areas.
- Enhanced plant performance by optimum system and equipment design.
- Utilize safe, competitive and environmentally sound practices.

Meet the site construction, air permit and operational noise requirements. The primary focus on the project up to this point has been the permitting aspects and procurement of the major plant equipment. The Scope of Work document includes a collection of materials generated during this period, and collected from the plant archives for existing structures and utilities. In most cases, information provided in these specifications that is archival or historical in nature is provided in order to facilitate the bidding process and should be considered as reference only. The successful Contractor shall be fully responsible for verifying existing site and process conditions at their own expense, prior to completing design and commencing construction of a given system.

- Attachment A.1to the Specifications will consist mostly of this scope of work and narrative package.
- Attachment A.2 contains specifications for the balance of plant equipment to be purchased and installed by the BOP Contractor, Construction and Equipment Specifications, the Design Criteria document, Preliminary Design Drawings (Architectural, Civil, Electrical, I&C and Mechanical), an Equipment List, a Piping Service Index and other reference documents.
- Attachment A.3 contains:

    - General Manager-supplied equipment contract documents. There are preliminary arrangement drawings (which will be updated via addenda as received from the PIE Contractor), a preliminary electrical one-line for the GTG, Flow Diagrams and F&IDs, the PIE Contract conformed equipment specifications (Attachment 24 to the GE Contract) GE specifications, performance data, high level scope of supply documents, a narrative on PIE supplied Technical Advisors, Testing documents and the Training scope of supply for the PIE vendor. The City purchased a limited amount of Technical Advisor time for all equipment supplied under the PIE Contract (1113 mandays total, 659 mandays for construction and 454 mandays for commissioning) to support the BOP Contractor with installation , commissioning and testing of the PIE Equipment. Use of Technical Advisor time shall be coordinated with the General Manager. Exceeding these budgeted hours due to

BOP Contractor inefficiency will require the BOP Contractor to provide for additional mandays as part of its scope.

- General Manager obtained permit documents such as, the SCAQMD PTC (air permit), CEQA/EIR documents, a Mitigation Summary, the existing SUSMP and SWPPP documents for reference and the Waste Water permit application.
- Existing Pasadena Water and Power Documents. Due to the history associated with the Glenarm site, there is an assortment of drawings with some dating as far back as the 1920's up to the more recent GT 3 & 4 installation in 2004.

    - There will be an as-built of the water main backflow preventer relocation coming off of the State Street Cul-de-sac after it is completed. This is being performed to increase the turning radius for trucks coming off of State Street into the project site (this is now shown on the C1-3 drawing).
    - There are structural drawings for the existing Pump Building (which will become the Maintenance Shop)
    - An existing GT3 & 4 GSU foundation drawing has been included strictly for reference on construction methodology, grating, elevation, etc. Similar construction will be used for the GT-5 GSU and auxiliary transformers.
    - The Demolition Scope supporting documents are included in this section (narrative below under Civil)
    - Drawings for the existing underground Electrical infrastructure that will be used to convey 34.5kV and 17.2kV cables from the site to the Receiving and Distribution yards located to the north of Glenarm Street. Also included are existing underground electrical duct banks for reference in routing new utilities in the plant.
    - The existing underground Mechanical piping systems in the GT 3 & 4 site are also included for reference in routing new utilities in the plant.
    - There are some existing survey drawings included for reference; however the BOP Contractor will be required to perform their own pre-installation surveying and conduct surveying as a course of installing the Work. *Please note during the early phases of the project it was discovered that there were some minor discrepancies between the survey and some of the as-built drawings provided to PWP for the GT 3 &4 project.* The plant has been laid out using the current survey information.
    - There is an assortment of other existing underground drawings that the BOP Contractor will need to study to familiarize himself with prior to beginning the Work. Included in this section are unmarked versions of the existing circulating water tunnels (these were modified to illustrate the scope of demolition work in the demolition section. The originals are provided for clarity). Also included are details illustrating the Broadway-Glenarm tunnel, which currently serves to provide an avenue between the two sites beneath the Metro railroad tracks. A new ammonia line and some interconnecting conduits will need to be run between the two sites in this tunnel. No new borings beneath the tracks will be permitted.

        - The Geotechnical Reports are also included in this section. There was more than one report performed for this project and all are relevant to the Work. The BOP Contractor is expected to review the information provided. After the soil remediation work is complete, additional resistivity testing shall be performed by the BOP Contractor using Hydrologue.

- One is the Limited Phase II Environmental Investigation describing the soil conditions on and under the site. This section discusses removal of a small quantity of lead contaminated soil.
- One is the Geophysical Investigation Report that describes findings from electromagnetic and ground penetrating radar testing. This report includes some color illustrations of existing subterranean features, many of which are coincident with the provided drawings.
- The Geotechnical Investigation contains details associated with the over-excavation and recompaction of in situ soils, removal of organic materials and recommendations for foundations and roadways. This section also discusses the soil corrosivity for design information. For purposes of this project, it is assumed the equipment will bear on mat foundations placed over properly over-excavated and recompacted in situ materials. Some structural fill will likely need to be imported to account for losses in the demolished areas.

Soil Thermal Resistivity was also performed on site with a report provided. The Equipment List included in A.2 and Division of Responsibility further defines the scope split between the PIE Contractor, the BOP Contractor, the Engineer and the General Manager.

The City has completed its EIR/CEQA process and has received the air permit from South Coast Air Quality Management District. The Mitigation Measures listed in Section A.3 will need to be adhered to by the BOP Contractor as further defined in this scope document. Provisions identified in this document affecting design and construction of the facility will also need to be incorporated. Waste water discharge permits are being authorized through the Los Angeles County Sanitation District. Other permitting authorities PWP is coordinating with are the California Department of Toxic Substances Control, the California Air Resources Board, the Regional Water Quality Control Board, and the US Environmental Protection Agency.

C. PROJECT DESCRIPTION

The Glenarm Repowering Project, GT-5 Combined Cycle Installation will consist of one (1) GE LM6000 PG SPRINT aeroderivative gas turbine generator with a pulse type inlet air filter and all associated auxiliary equipment ("GTG Unit") exhausting through a Once Through Steam Generator ("OTSG") for steam generation and NOx, CO and VOC emissions reduction monitored by a continuous emissions monitoring system ("CEMS") coupled with one (1) steam turbine generator. The steam turbine will be supplied with a sound attenuation enclosure/building that will also cover the lube oil system, vacuum pumps, condenser and condensate pumps. Additionally, the Power Island Contractor shall supply the steam turbine condenser, cooling tower, circulating water pumps, aux cooling pumps, boiler feedwater pumps, condensate pumps, condensate polisher, gas turbine inlet conditioning skids (a combination of chiller and heater skids), gas compressors, air compressors, turbine bypass valves, the aux boiler and superheater for warm standby operation and the three winding generator step-up transformer. This equipment will be supplied by the Power Island Contractor (PIE) and integrated into the complete combined cycle project by the BOP Contractor. *The BOP Contractor will be responsible for the complete controls integration of the PIE control panels and balance of plant equipment.*

The PIE equipment will be supplied with turbine control panels and equipment-mounted PLC's as further defined in the control system specifications. This will all need to be fully integrated with the BOP supplied equipment, control valves, instruments, etc. The work covered by these specifications will include the engineering, development of detailed design documents, procurement and/or manufacturing of all balance of plant equipment and materials, constructing, startup and commissioning, site-specific custom Operation and Maintenance manuals, site-specific training manuals, and performance testing.

Operation and Maintenance manuals include operating procedures for the BOP installed/modified systems and maintenance manuals for the BOP Contractor furnished equipment. Except as otherwise specified herein, the BOP Contractor shall provide all facilities and services as required for a complete and operating facility

The Glenarm Site is a parcel of land located south of East Glenarm Street and east of South Fair Oaks Avenue. Across the MTA Commuter Rail and west of Arroyo Parkway lies the Broadway Site. The commuter line separates the Glenarm and Broadway sites. The Broadway site hosts the retired B-1 and B-2 boiler and steam turbine units as well as the currently operating B-3 unit, which GT-5 will ultimately replace. There will be some interfaces between the Broadway site and the Glenarm Site, but they shall be limited. Also, there are strict scheduling requirements referenced in the permitting documents tied to the operation of B-3 and the first fire of GT-5 for commissioning. This will be discussed further during the Commissioning section of this scope of work, but due to its significance we have highlighted it here.

The project will serve to repower PWP's existing 71MW (gross) B-3 Boiler and Steam Turbine Generator, constructed in 1962. The B-3 plant will continue to operate until the GT-5 project is ready to be commercially operational. There is a 90 day window from the time the GT-5 gas turbine is first fired until the B-3 boiler must be decommissioned. The BOP Contractor shall schedule and execute the first fire and commissioning activities of the GT-5 gas turbine, for which the BOP Contractor is responsible, in such a way as to ensure that GT-5 will be satisfactorily tested and commercially operable no later than the last day B-3 is permitted to operate. PWP has the following operational requirements pertaining to both GT-5 and B-3:

- B-3 must be shutdown 90 days after first fire of GT-5. This is a requirement of the air permit.
- Both GT-5 and B-3 may operate concurrently during this 90 day period
- GT-5 must be commercially operable prior to the end of the 90 day period.

The existing 34.5kV electrical interconnect for B-3 will also serve as the final interconnect for GT-5, however a temporary arrangement is being made to accommodate B-3's operation and revenues for as long as possible. The BOP contractor shall coordinate with the General Manager for making the transition as efficient as possible to limit generation outages. The complete scope of the 34.5kV interconnect and this transition is described later in this document.

The BOP Contract scope includes the detailed engineering scope of work for the project, procurement of equipment not supplied under the PIE Contract, demolition and/or relocation of some existing infrastructure, site preparation, soils remediation, construction, installation of equipment, commissioning, testing and turnover of the new plant. The BOP Contractor will be responsible for obtaining the necessary construction permits from the City Planning and Fire Departments. The BOP Contractor will be responsible for overall site safety as well as all QA/QC on the project. Complete turnover packages for all systems and training on the balance of plant equipment shall be included in this scope. The BOP Contractor will need to coordinate with the City of Pasadena's General Manager for all scope issues and day to day activities. Pasadena Water and Power will stay involved as necessary to support the project and will attend regular meetings. Final turn-over and acceptance and will be the responsibility of the BOP Contractor. The BOP Contractor shall be responsible for obtaining the necessary construction permits from the City Planning and Fire Departments as well as any Certificates of Occupancy for the buildings included in this scope. The project will not be recognized for commercial operation without the Certificates of Occupancy from the City.

The plant will be constructed on a site with actively running power plant equipment. On the Broadway site, east of the train tracks, B-3 and its supporting auxiliaries are still in operation. The GT 3 & 4 gas

compressors are operational; as are the ammonia storage tanks, the demin water treatment equipment, compressed air systems as well as the daily operation and maintenance of the facility (the plant control room is adjacent to B-3). On the Glenarm site, GT 1, 3 & 4 are operational. Any work performed within the GT-5 site area will be under the control of the BOP Contractor. Outside of the GT-5 site area will require hot work permits from PWP Operations. BOP Contractor shall not enter these operating areas without a work permit and need to be aware of the energized systems on the site. The BOP Contractor shall coordinate with the General Manager staff for work permits and properly train their personnel whenever the work requires access into operating areas. Appropriate lock out tag out measures will be implemented if tying into existing systems. Project safety requirements will be discussed in more detail further in this document.

As defined by the EIR, a Mitigation, Monitoring and Reporting Program will be in effect, with the General Manager as the lead. The BOP contractor shall contribute documentation to support this reporting, and follow all imposed requirements and restrictions governed by the Program. Construction, Building and Excavation permits will need to be obtained from the Building Department and Fire Department. Construction, staging, and traffic management plan, oversized loads, etc., will need to be provided per the CEQA mitigations. Storm water SWPPP and SUSMP permits will need to be obtained by the BOP contractor.

The plant shall be capable of being operated from the BOP Contractor supplied Power Distribution Center (PDC), as well as the new Control Building Control Room. The GTG and STG turbine control panel equipment, supplied by the PIE Contractor, shall be located in the PDC along with the BOP Contractor supplied Plant Control System (PCS). The PIE Contractor will ship the GTG and STG control panels to the BOP's PDC vendor. BOP Contractor to coordinate.

The PDC will also need to be supplied by the BOP Contractor with MCC's and batteries normally supplied by the GTG vendor as PWP desires to maintain all major electrical loads in one central location. The BOP Contractor shall coordinate with the PIE Contractor so that the entire scope of equipment provided under this Section may be operated from the PCS in either location. As part of this scope of work, the BOP contractor shall also make provisions for the other four existing gas turbines, GT 1, 2, 3 & 4, to be operable from the new control room. Essentially, the new control room operations console shall be large enough for the future transfer of control from the B-3 control room to the new control room in the Control Building. The BOP contractor shall run adequate conduits from GT 1, 2, 3 & 4 as shown on the Tie Point drawing M1-1-6 to the PDC and the new Control Building and make provisions in the E-Stop console on the control building operations consol for new E-Stop buttons on the existing turbines, as well as master fuel trip buttons for all units (each capable of being independently tripped by the units' individual E-Stop Buttons).

. Additional detail is provided further in this scope of work.

The plant needs to have the capability to operate in islanding mode for an indefinite period of time. The proposed equipment described within this RFP needs to be equipped to operate in this condition. Islanding mode is defined as a condition where the City of Pasadena's 34.5kV system is disconnected from Southern California Edison, and the Pasadena Water and Power generators continue to operate, responding as necessary, to changes in load. Depending on current operating scenarios, this may mean some of the plant's generators will need to start and come up to load or if already in operation, continue to operate as necessary, responding to changes in load, frequency and voltage. The Power Island Equipment is being provided capable of operating in islanding mode. The BOP contractor shall develop the control system to interface with the PIE equipment, the switchyard, etc., to be able to operate in islanding mode.

A black start generator is not a requirement of this RFP, but the Power Island Equipment will be provided configured to operate in Black Start mode if modified in the future.

The PIE Equipment shall be provided with an electric auxiliary boiler and superheater to maintain temperature of (and vacuum on) the STG and associated piping systems in warm stand-by mode. The general arrangement drawings indicate the approximate location of this equipment. Auxiliary transformers will need to be sized for the auxiliary boiler and superheater load. The provided overall one-line, PDC floorplan and associated specifications included with this package further illustrate the electrical equipment requirements. The BOP Contractor will need to provide the detail design for equipment operation while the plant is on warm stand-by mode.

Site plans have been provided for the contractor to be aware of the limited project area available. The site is constrained by the historic Glenarm Building to the north, the existing GT 3 & 4 gas turbines to the south and existing GT1 & 2 gas turbines to the east, Fair Oaks Blvd to the west and the historic Pacific Electric (PE) Building to the south. PIE equipment sizes shown are based on the best information available at the time of this RFP package being released and will be updated via addenda as more becomes available. The equipment supplied by the BOP Contractor shall not significantly deviate from the provided general arrangement and site plans. **Please note that the OTSG stack coordinates and the cooling tower stack coordinates provided on C1-3 were used for purposed of air modeling and these positions are fixed**. The remaining are equipment is shown in their preferred locations, however there is some room to adjust the position of this equipment as the detail design progresses, equipment information becomes available, underground features affect their position, access can be improved, etc. The BOP contractor shall not adjust the position of any plant equipment shown without prior approval by General Manager/Project Manager.

The Project shall be designed for a 30-year life based on performance of normal maintenance repair and parts replacement.

C.1 Qualifications

Design shall be accomplished under the direction of a qualified architect and/or professional engineer that is licensed to practice in the State of California. All construction documents shall be stamped and sealed by registered design professionals licensed to practice in the State of California.

C.2 Quality Assurance and Quality Control

The BOP Contractor shall develop, maintain, and submit for review the following manuals or plans describing its quality assurance program: (a) a controlled copy of Contractor's quality assurance or quality system manual, (b) a controlled copy of Contractor's quality control procedures applicable to the Work, (c) an integrated project specific construction plan that identifies the process control plans that Contractor and its Subcontractors will apply to their activities at the Facility Site, and (d) a site-specific quality control plan that will describe in detail all quality verification activities Contractor intends to perform.

The BOP Contractor shall furnish a site specific Quality Control / Quality Assurance manual for General Manager review within one month of contract award. A hold point inspection matrix shall be included with the plan. The plan shall demonstrate how the Contractor will monitor and record all aspects of quality on the project from site work through turnover and acceptance of the project.

The plan should be broken down by discipline and illustrate the types of control that will be implemented, tracking and recording of employee qualifications (such as welding certifications), maintaining documentation for code compliance, completion of vendor supplied erection/installation, commissioning manuals, system turnover and close-out.

When the General Manager approves these submittals, the General Manager will notify the BOP Contractor that the same shall constitute, in the aggregate, the "Approved Quality Assurance Program." The BOP Contractor will provide the General Manager with one (1) copy of the Approved Quality Assurance Program. The BOP Contractor will follow the Approved Quality Assurance Program throughout its performance of the Work; provided, that the provisions of this Agreement shall always control over the provisions of the Approved Quality Assurance Program. The BOP Contractor shall meet with the PWP Construction Manager on a weekly basis to review quality documentation.

A system of sign-off sheets shall be employed by the contractor, to be authorized or reviewed by the General Manager. Below are some examples of the types of documentation that the BOP Contractor shall implement and maintain:

- Soils Compaction and Asphalt density tests
- Concrete placement release cards
- Compression tests (grout, concrete and asphalt)
- Holiday "Jeep" Tests and Mil Thickness tests
- Backfill cards (creates a hold point before covering any subsurface work)
- Bolt tensioning / structural steel inspection
- Hydrostatic testing
- Tank vacuum box tests
- Pneumatic test reports
- Vessel closure forms
- Welding program (Qualifications, procedures, certifications, rod storage, inspections, x-ray, etc.)
- Welders Qualification Log
- Welder Control and NDE Summary by Welder
- Welder Control and NDE Summary by Line or Drawing
- Weld Information Matrix
- Weld maps
- Weld Summary Report
- Materials certifications
- ASME documentation (P3's, etc, for ASME Section 1, for boiler certifications)
- Field Weld and NDE Matrix by Line Class
- In-Process Welding Examination Report
- Welding Procedure Verification Report
- Welder Job Qualification Test
- Field Preheat and PWHT Reports
- Pipe Cleaning Record
- Pipe flushing reports
- Steam and gas blow reports – must meet criteria of steam turbine manufacturer. Calls out the number of targets required. Gas line blow will be an air blow. No gas blows permitted on site.
- "U" sheets for underground fire piping
- "A" sheets for aboveground fire piping
- Spring Support Installation Log

- Insulation release form (assures hydro is complete, hangers are installed, etc.)
- Paint release (assures hydro is complete on non-insulated piping)
- Painting monitoring, thickness verification, manufacturer's recommendation compliance.
- Electrical testing – megger, hi-pot, continuity, etc.
- Functional Loop Checks
- Mouse and mandrelling conduits. All new and existing conduits will be assured to be free of debris by blowing or pulling a rope with a mandrel and conduit brush (mouse) through each conduit.
- Cadwelding
- Grounding testing
- Radiographic inspection (X-Rays). All Fuel Gas and high energy piping will be 100% radiographed.
- Instrument calibration forms
- Preliminary Alignment and Soft Foot Check for Rotating Equipment
- Final Alignment for Rotating Equipment
- Grout release (assures alignments are bought off, grounding attached, etc., before grouting equipment)
- Motor bump checks / rotation confirmation (uncoupled run-in as well)
- OS&D's (Over/Short/Damage on shipping receiving)
- Materials receiving and storing reports
- Material inventory control and release procedures
- Heat-Exchangers Bolt Torquing Summary Report
- Lubrication information (fills, flushes, etc)
- Preservation records, removal of desiccants, etc.
- Electrical mechanical connection bolt tensioning

Equipment supplied by both the Power Island Equipment Contractor and the Balance of Plant Contractor shall be stored in accordance with the vendor's recommended storage practices. All piping connections shall remain covered and sealed until mated to the piping systems they are being installed in. Motor heaters shall be energized while in storage or while installed, waiting to be commissioned. Where heaters are not available, desiccants shall be installed and monitored, or stored as approved by the PWP Construction Manager. Specific attention shall be made for the following:

- Appropriate equipment, materials and methods for the installation shall be used. This includes equipment and materials suitable for the service/system rating they are in.
- Good craftsmanship will be used for every installation with the appropriate tool for the job.
- Ensure proper maintenance and operating access clearances are met. This means conduit, piping, tubing, etc., are routed in areas that will not restrict access or create "head bangers". This also applies to concrete design. If multiple pads are required in a small area, one pad shall be placed with smaller housekeeping pads used for equipment support.
- Ensure all valves, etc., requiring daily/routine operation are accessible or a platform is provided.
- The greatest effort shall be made to ensure rust will not occur. This includes conduit / piping threads, steel piping, anchor bolts, equipment, etc.
- Ensure underground piping flanges extend above final grade at least 6" with expansion material placed around piping penetrating paving.
- All grounding will be cast in PVC sleeves embedded in concrete. In no case shall grounding run over the over top of concrete as an afterthought. The grounding locations shall be dimensioned on engineering drawings.

- Carbon steel wire wheels shall not be used on stainless steel welds. Any pipe weld made and cleaned up with a carbon steel wheel shall be replaced.
- Properly install and pre-spring pipe supports
- Ensure low points (storm inlets) and high points (vaults, etc.) on finish paving are correct and not severe slopes. GT 3 & 4 is an example of how NOT to do finish paving.
- Ensure all galvanized steel is shop fabricated to the maximum extent possible to limit cold galvanizing touch up in the field.
- All platforms, stairs, ladders, etc. shall be designed by an engineer, shop fabricated from structural steel, hot dipped galvanized and installed with concrete housekeeping pad landings.
- All equipment drains will have commercially manufactured drain hub connections
- Dissimilar metals on piping shall not be used without an isolation means. Carbon steel flanges shall not be used on stainless steel piping systems. Flange studs shall not be dissimilar metals.
- Install isolation flanges between below and above ground piping and install dielectric unions between piping material changes.
- Unistrut shall not be used for pipe supports without prior approval from the General Manger.
- Conduit risers shall come up as close as practical to motors and other electrical users. Flex conduit shall not be used to make up for conduit risers in the wrong location.

C.3 Shop Inspections

The General Manager anticipates participating in factory inspections of the BOP Contractor furnished PDC, auxiliary transformers and BOP control system as a minimum.

General Manager's inspectors must have free access to all facilities used in the manufacturing and design of the equipment. Suitable office facilities are required during their inspection visits, if requested. Inspection visits shall be coordinated through the BOP Contractor's Project Manager.

The inspectors shall have access to all quality control and other records that document the design, testing, and integration of the system. Photographs shall be permitted during system assembly to record progress of manufacture.

The BOP Contractor shall submit a schedule showing dates and locations where all major pieces of equipment will be fabricated one hundred and twenty (120) days after the Effective Date of the Contract. The schedule will show dates for all major fabrication tests and shipments. Thereafter, if changes to the schedule are made, the General Manager must be notified in writing at least two weeks prior to the date of the re-scheduled event to allow the General Manager's inspectors' time to arrange inspection visits as required.

C.4 Included Work

The General Manager's Engineer along with the General Manager will review the BOP Contractor's design documents for compliance with these specifications and suitability for the overall operation and maintenance of the facility. The General Manager will also review the listing of proposed equipment suppliers and vendors and subcontractors. This review does not relieve the BOP Contractor of responsibilities under this Contract.

The BOP Contractor shall develop comprehensive and complete procedures for system flushing, hydro, passivation, checkout, startup, turn-over and performance testing. These procedures shall be submitted in accordance with the requirements specified in the Commercial section of the Contract. Please note that

all "clean" systems that will use demineralized water during operation, such as condensate, boiler feedwater, the demin water tanks and systems, the OTSG, etc., shall ONLY be hydrostatically tested using demin water. PWP will supply the demin water for hydro. Disposal of the hydrostatic test water shall not be to grade. It will either be trucked from site, sent to the process drains with LA County Authority approval, or placed in an operating cooling tower, coordinating with PWP Operations.

The BOP Contractor shall assemble Project specific custom Project Procedures Manual, Operation and Maintenance (O&M) and training manuals, including standard operating procedures (SOP) for systems and equipment, for the equipment supplied under the BOP scope of work. The Power Island Equipment O&M manuals shall not be merged with the balance of plant (BOP) equipment in the custom facility O&M manuals.

The BOP Contractor shall utilize their own craft personnel during the check out, startup and testing of the facility equipment and systems. The BOP Contractor shall provide specialized commissioning personnel including commissioning manager, mechanical, electrical and controls commissioning leads and dedicated field technicians for tasks such as equipment checks, loop checks, instrument calibration, relay setting and control logic checks. The BOP Contractor shall perform the overall facility performance tests in accordance with the requirements specified in Section A.2

C.4.1 Major components of the work under these specifications for engineering, procurement, and facility construction are as follows:

C.4.1.1 Management services including, but not limited to the following:

- Commercial Management
- Technical Management
- Construction Supervision
- Administration Services
- Coordination with Interfacing Utilities
- Scheduling Services
- Health and Safety Program
- Cost Control Services
- Document Control Services
- Quality Assurance Program
- Quality Control Inspections
- Environmental Compliance
- Pre-commissioning, Commissioning, Start-up and Turnover

C.4.1.2 Engineering services including, but not limited to the following:

- Onsite Resident Engineer (RE) to act as interface with the local Building Officials and their plan check engineers.
- Onsite Resident Engineer (RE) shall develop documents and manage submittals for the Pasadena Fire Department for regulatory compliance.
- Complete Procurement and Construction Design Documentation - Drawings, Specifications, Calculations, Lists and Schedules - (stamped by California PE in responsible charge as required by California codes and regulations) including, but not limited to, the following disciplines:

- Geotechnical (if additional is required)
- Surveying
- Civil
- Structural
- Architectural
- Plumbing
- HVAC
- Process and Performance
- Mechanical
- Electrical
- Instrumentation & Control
- Fire detection and protection

- Studies including, but not limited to, Grounding resistance testing (post soils remediation), Electrical Protection and Coordination, including Ground Fault, Electrical Grounding per IEEE 80, Power System Stabilizer Settings Electrical Protective Relaying Settings shall be provided in Protection Study report.

C.4.1.3 Procurement services including, but not limited to the following:

- Procurement of Equipment, Materials and Services to complete the BOP scope of work
- The Request for Proposals (RFP) Packages for all Procurements
- Vendor Negotiation, Purchase Order Development and Expediting Services
- Vendor Submittal Management, Document Distribution and Review Comment Coordination
- Quality Inspections and Factory Test Participation
- Procured Equipment and Material Receiving, Handling and Storage (including General Manager supplied Equipment)
- Startup Spare Parts for equipment supplied by the BOP Contractor)

C.4.1.4 Technical writing and manual assembly services including, but not limited to the following:

- Managing Equipment O&M Manuals
- Developing Turnover Packages and Commissioning Procedures
- Developing Performance Testing Procedures
- Assembling Recommended Spare Parts List
- Developing Custom O&M Manuals, with operating procedures suitable for training purposes
- Lubrication and Preventive Maintenance Schedules

C.4.1.5 Testing services including, but not limited to the following:

- Preoperational Checks including Instrument Calibration, Loop Checks, Electrical Equipment Testing, Relay Setting, Motor Control Checks, Motor Tests, Coating Tests, Pipe Support Adjustments Control Logic Checks and System Walk-Downs
- System Functional Testing
- Performance Testing
- Emissions Source Testing (CEMS Certification by PIE Contractor)
- Reliability Testing

C.4.1.6 Project close-out services including, but not limited to the following:

- Punch List Management and Actions
- Record Update to As-Built Procurement and As-Built Construction Documents
- Final Touchup Painting
- Final Site Cleanup

Training services for the General Manager's personnel as described in Section Q.

C.5 Submittal of Engineering Data

It is expected that the successful BOP Contractor design the project utilizing a 3D modeling system that will be viewable/useable by the BOP Contractor's site personnel during construction. The model shall be provided in a native editable format at the completion of the project, prior to final acceptance. Complete, detailed and accurate design development and construction documents furnished under this Contract are essential to the successful completion of this Project. Section M describes the minimum set of documents to be submitted by the BOP Contractor for review by the General Manager.

The BOP Contractor shall submit a Design Documents Deliverable List within eight (8) weeks of the Effective Date of the Agreement. Drawings that are expected to be provided for this project are:

- Discipline Cover Sheets with Drawing Lists for Each Set
- One Line Diagrams
- Three Line and Phasing Diagrams
- Control and Protection Functional One-Lines and Three Lines
- Site Plan
- Grading Plan and Details
- Paving Plan
- Fencing Plans and Details
- Wall Plans and Details, with Solid Metal Gate Details
- Excavation and Demolition Plans
- Glenarm Basement Closure Details
- Equipment General Arrangements
- Equipment Location Plans
- Process and Instrumentation Diagrams
- Piping Plans, Sections and Details
- Piping Isometrics
- Piping Hanger Details
- Underground Piping Plans
- Composite Underground Plans
- Electrical Equipment Plan
- Duct Bank Drawings and Details
- Electrical Elevations and Sections
- Electrical Power and Control Plans
- Power Distribution Plan
- Control Building Layout, Elevations and Details
- Control Building Auxiliaries (lighting, HVAC, plumbing, etc)
- Control Console Arrangement
- Water Lab Building Layout, Elevations and Details

- Water Lab Building Auxiliaries (lighting, HVAC, plumbing, etc.)
- Maintenance Building Layout, Elevations and Details
- Maintenance Building Auxiliaries (lighting, HVAC, plumbing, etc.)
- Welding Shop Layout, Elevations and Details
- Welding Shop Auxiliaries (lighting, HVAC, plumbing, etc.)
- Cable Trench Plans and Details
- Cable Tray Plans
- Cable and Raceway Schedule
- Grounding Plan and Details
- AC Three Line Schematic Diagrams
- DC Control and Protection Schematic Diagrams
- SCADA RTU and DFR Schematic Diagrams
- Control System Architecture Diagrams
- Annunciator Schematic Diagrams
- Control and Relay Panel Elevations
- Equipment Connection Diagrams
- Control and Relay Panel Connection Diagrams
- Metering Connection Diagrams
- AC and DC Station Service System Schematic and Details
- AC Distribution Panel Schematic
- DC Distribution Panel Schematic
- Fiber Cable Termination Cabinet Connection Diagrams
- Automation and Integration Architecture Diagrams
- Communications Architecture Diagrams
- SCADA, SAS and DAHS and DFR points listings
- Structural Steel Location Plan
- Structural Steel Details
- Steel Platform Plans
- Steel Platform Details
- Foundation Plans and Details
- Overall Foundation Location Plan
- Erosion Control Plan and Barrier Details
- Fire Protection Plans
- Fire Detection and Annunciation Plans
- Additionally the 3D model will be a deliverable

The BOP Contractor shall develop and submit documents in accordance with the schedule (see Appendix B-2 Schedule) and requirements specified herein to assure compliance with the overall Project construction and operating schedule. The General Manager will be given fifteen (15) working days for review of all identified document submittals, including referenced deliverables list.

C.6 Coordination Meetings

Approximately) two (2) weeks after the Effective Date of the Agreement, the BOP Contractor shall conduct a project kick-off to include basis of design, constructability, commissioning, testing and turnover with the General Manager. This meeting shall be held at the Contractor's facilities.

Representatives of the BOP Contractor shall attend coordination meetings at times and places prescribed by the General Manager, including formal monthly coordination meetings, to discuss matters relative to the execution of the Contract.

During construction the BOP Contractor shall conduct weekly project review meetings to review the current status of the Project. The General Manager may teleconference into or send a representative to these review meetings.

During the testing phase of the Project, the BOP Contractor shall hold daily coordination meetings as discussed further in the Appendix on Facility Testing Requirements.

C.7 MARCO Criteria

C.7.1 MARCO is an acronym representing the following concepts which shall be incorporated into the design of the facility equipment and systems to the extent practicable:

C.7.1.1 Maintainability - The primary maintainability objective shall be to minimize the complexity and time required for maintenance. The following general criteria shall be followed to achieve this objective:

- Equipment and systems shall be of a low maintenance design and shall be easily maintainable.

- Equipment shall be designed to be maintained in place, if practical, with minimum disassembly of surrounding equipment and minimum usage of temporary scaffolding and handling equipment. Permanent maintenance platforms shall be provided where required to assure safety and efficiency. In addition, platforms should be provided where period operator rounds, equipment checks or lubrication are required.

- Buildings, structures, equipment arrangements, pipe routings, and cable tray locations shall be designed for maximum equipment accessibility and to allow for the following types of access:

    - Space shall be provided to allow facility personnel access to all equipment which may require maintenance.
    - Space shall be provided to allow unobstructed access for maintenance tools and equipment required for maintenance on permanently installed equipment.
    - Space shall be provided to motor-operated equipment areas for work carts.
    - Space shall be provided to allow removal and laydown of any equipment that cannot be maintained in place or may require replacement.
    - Monorails with manual trolleys shall be provided beneath the piperack for maintenance of the boiler feed pumps and other equipment as necessary.
    - Lifting eyes shall be provided on equipment to facilitate installation and removal for maintenance. Assemble the entire fixture and drive the trolley outside of the package (simulating engine removal) to make sure everything lined up and worked.

- Techniques for minimizing corrosion of structures and equipment exposed to chemically or environmentally corrosive atmospheres shall be incorporated into the facility design. Removable panels with lifting eyes on enclosures shall be provided where required.

- Attention shall be given to providing appropriate enclosures, curbs, drip guards, and collection systems to control and contain contact water, hose spray water, chemicals, and oils.

- Where feasible, similar equipment shall be provided by the same manufacturer to minimize spare parts inventories and also to minimize the number of different manufacturers' equipment that facility personnel must be familiar with maintaining.

- Transmitters and local instruments shall be located and oriented to allow access and maintenance by maintenance personnel without the need for portable ladders or reaching devices.

- Structures and internal building spaces shall be designed to minimize house-cleaning requirements by avoiding dead pockets, difficult to reach horizontal surfaces, and exposed small equipment that otherwise could be compartmentalized.

- Floor and equipment drains shall be installed within buildings and structures and at material handling areas so that hose sprays can be used for wash down.

- Vertical and horizontal access shall be provided for transportation to a lay-down area in the near vicinity where further dismantling can be performed or to a location outside the building/structure where remote maintenance or shipment can be made.

C.7.1.2 Availability/Reliability - The design of the facility systems and selection of facility components shall be based on the potential effect on equipment reliability and generation capability. Systems which can cause a unit outage if one of the system components fails shall be designed for high reliability and ease of maintainability. The design of new facility equipment and systems shall be based on achieving an overall annual facility operating availability of 95 percent, defined as the percent of time that the unit is capable of operation at full load.

- Equipment redundancy shall be as indicated in the system descriptions and P&IDs. In general, systems containing equipment whose loss would cause a unit outage shall be designed with redundant equipment and with provisions to safely maintain the equipment during system operation.

- Reliability criteria which shall be applied to the design of the facility including buildings, structures, equipment arrangements, pipe routings, systems, and components are as follows:

- The design of each system shall be based on proven design concepts which have been applied successfully in the power generation industry.

- Purchased equipment shall be of a proven design. The equipment shall be of a design that has been in successful, reliable, continuous operation in the United States power generation industry for a minimum of 30 years, unless otherwise approved by the General Manager.

C.7.1.3 Constructability - The primary constructability objective is to minimize the complexity of construction to realize maximum schedule and cost benefits.

C.7.1.4 Operability - The primary operability objective is to design facility systems that are easy to operate and that require minimum operator surveillance. The facility controls design shall integrate PIE systems necessary for combined cycle operation into one control system that shall allow routine facility operations by no more than two operators per shift. The following general criteria shall be followed to achieve these objectives:

- Equipment system design selections shall be based on minimizing the amount of operator attention.

- Automatic operation of systems and processes from the main control room shall be provided. Systems that operate on independent programmable logic controllers shall provide supervisory process information exchange with the main control room in order to provide surveillance capabilities.

- Operator control interfaces shall incorporate human engineering factors, including visual observation. Operator control interfaces for multiple systems shall be coordinated to prevent operator confusion, e.g. color schemes, symbols, keyboard functions, etc.

- Process systems and equipment operation shall be adequately monitored to provide control room operators with all information required for efficient, safe, and easy operation of the facility, as well as facility upset conditions.

- Systems and equipment shall be located for easy operational access and logical operational sequences.

- Special attention shall be given to adequate lighting, ventilation, and acoustic dampening of all operational spaces.

- Equipment and system components which may be operated locally shall be arranged with personnel access. Equipment, valves, dampers, instrument, and control devices shall be located to include, but not be limited to, the following considerations:

- Valves - Valve and damper operators shall be located and oriented for manual operation within the normal reach of operating personnel without the need for portable ladders or reaching devices. Permanent extension operators of a conventional design may be used.

- Local Instrumentation - All local instrumentation indicating pressures, temperatures, levels, flows, etc., or indicating the position or status of equipment shall be readily visible to operating personnel from the ground, walkways, or aisles without the use of temporary ladders or platforms.

- Testing Devices - Testing devices shall be located in a position accessible to the operating or testing personnel and oriented where the equipment and instrumentation critical to its testing can be observed.

- Visible Inspection and Tending - Portions of equipment requiring visual inspection, lubrication, and tending activities shall be safely accessible and adequately lighted to assure proper operation and servicing.

- Safety - In addition to OSHA and other related safety requirements, equipment arrangement and access will minimize personnel exposure to physical harm during the operation, testing, or maintenance of the equipment. Consideration will be given to avoiding low clearance passageways and tripping obstacles.

C.8 Facility Operating Requirements

Facility Operating Modes - The Facility shall be designed to operate under several different modes of operation as defined in the Design Criteria in Section A.2

C.9 Health and Safety

The BOP Contractor shall furnish a site specific Health and Safety plan for PWP Construction Manager review within one month of contract award. The plan shall demonstrate how the Contractor shall hire, orient each staff and craft member, ensure minimum OSHA, CalOSHA, and site specific training on the project is performed. PWP will provide site specific training materials addressing the safety aspects and hazards of working around an operating power facility.

Some of the hazards the BOP staff and craft will be need to be aware of while working on the Glenarm/Broadway site are:

- Electrical generating and transmission equipment
- High, medium and low voltage switchgear
- High energy piping systems
- Fuel gas compression, metering and delivery systems
- Aqueous ammonia unloading, storage, transfer and injection systems
- Demin water production systems
- Cooling tower and cycle chemical feed systems
- Active commuter railways through the Broadway/Glenarm property. The pathway for craft personnel between the existing Jacobs parking lot and the Glenarm site will require crossing this rail system (two tracks).
- Existing conditions (there are areas where lead and asbestos may be encountered)
- Possible contaminated soils (see geotech and phase II reports)
- Confined spaces and below grade hazards

In addition to any known hazards, the PWP plan shall include discussions regarding the Glenarm Building Historical significance, as well as the PE Building.

The plan should also identify those items deemed as sensitive by the EIR (see mitigation measures) and other permitting authorities.

- The BOP Contractor plan shall describe the site specific safety orientation, identify incident reporting measures, log certifications of issued safety equipment, perform Job Task Analyses, daily toolbox safety meetings, weekly, monthly meetings. Emergency actions and muster points should be discussed with plant personnel.

The BOP Contractor shall employ one full time safety manager at a minimum. More safety officials will be required as the staff/craft count grows. The safety manager shall have authority to stop any unsafe actions observed while on site.

The plan shall describe all day to day work hazards as well as:

- Confined spaces. This site will involve work in several existing confined spaces such as the underground circulating water tunnels, the underground electrical equipment vaults, and the vaults on either end of the Broadway – Glenarm tunnel. The Broadway to Glenarm tunnel currently allows passage of ammonia piping and electrical systems beneath the Metro railway. This tunnel will be the corridor for any conduits that will need to pass between sites for power and signals with the new ammonia skid and new tank instrumentation installed on the B-3 ammonia tank. The BOP Contractor will need to coordinate with PWP Operations for access in this tunnel, which is approximately 200'-0" from vault to vault, and is approximately 42" in diameter.
- Employee reporting avenues and resolution of hazard concerns.
- Personal protective equipment required for the activities that might be encountered.
- Safe rigging practices. All lifts over 50,000 pounds or 80% of lift chart will require a lift plan.
- Trench demolition
- Shoring of existing structures for excavation

Hydrostatic testing, backfeed, air blows for fuel gas piping, flushing, energizing equipment, etc. The plan shall describe personal protective equipment required for the activities that might be encountered. BOP contractor shall take appropriate steps to clean all piping systems to support the project schedule.

Personnel access shall be restricted to the Glenarm site unless necessary to perform work. Contractor shall restrict its employees, subcontractors and vendors from entering the operating areas of GT 1, 2, 3 & 4. Access to the Broadway side of the plant will also be limited to an as-needed basis.

Contractor needs to be aware of the frequent passage of the commuter train on the rails separating the Glenarm and Broadway properties and shall restrict vehicular and foot traffic in this area.

- Existing hazards of gas, ammonia, turbines, etc.
- Critical Lift Pre-Lift Meeting Checklist
- Crane Lift Planning Sheet – All lifts greater than 50,000 pounds will have a lift plan.

D. PROJECT INTERFACES

This section describes the requirements for the BOP Contractor to locate and make connections with various existing site utilities. The BOP Contractor shall work with PWP operations for proper lockout/tag out and flushing/ventilating of the existing systems. Drawing M1-1-6 illustrates the approximate location for each interface point with a description of each listed in the legend. This drawing is intended to be used in conjunction with the Tie Point Index, M9-10 sheets 1 and 2 and the P&IDs. Connection types shown on the Index are intended to show the desired connection type the BOP contractor shall make at each location (it does not mean this is the existing connection). The connection type listed on the Index can be altered with approval of the General Manager. At any time the pipeline connection is made above grade and then transitions below grade, the contractor shall provide an isolation kit and provide cathodic protection for any new lines run. The below numbered list narrating the interconnection corresponds to the items listed on drawing M1-1-6:

1. Fuel Gas Supply – The fuel gas source for this project will be from a new meter installed by Sempra at the existing gas connection. It is intended that this gas line will make an above ground connection, route below grade heading west and turn north under the access road north of State Street, west of GT 3 & 4.
2. City Water Connection for Potable and Service Water - A new connection shall be made underground and run to the site for purposes of supplying potable water for the eyewash stations, restrooms, sinks, cooling tower make-up, demin trailer connection, etc. PWP will relocate the existing water line visible on the SW side of the Glenarm Building to the west side of the project, inside the properly line by Fair Oaks. New backflow preventers will also be installed by PWP..
3. City Water Connection for Fire Water – This connection will be made underground to service the new fire water loop and above ground users described in the fire protection specifications and the P&IDs.
4. City Water Connection for Maintenance Building – A new connection shall be made underground for supplying new fire protection water for the offices, maintenance and welding shop areas as well as the maintenance building basement.
5. Demineralized Water – The intent is to have a connection made at the existing GT 3 & 4 demin water tank for new forwarding pumps supplying water to the GT 5 project. This tank receives water from the existing demin system on the Broadway site. New forwarding pumps at this location will supply water via a new underground pipeline to the new GT-5 demin tank.
6. Demineralized Water – this tie point is for a recirculation line above ground from the new forwarding pumps located at the existing GT 3&4 demin tank to discharge back to the tank
7. Demineralized Water – this tie point will require cutting into the existing GT 3 & 4 fill line to provide a bypass around the existing GT 3 & 4 tank to fill the new GT 5 demin tank should the GT 3 & 4 demin tank be out of service. This connection will be run above ground as close to the existing tank as possible without restricting access to new or existing equipment.
8. Equipment Drains Sump to Existing OWS – this connection will be made from the new equipment drains sump provided by the BOP Contractor, which is intended to receive new potentially oily drains gravity flowing underground to the sump. This discharge of this sump will be routed underground to interface with the GT 3 & 4 OWS influent. A new check valve will be installed on the existing GT 3 & 4 OWS influent line. Refer to the existing drawings for reference on the OWS piping arrangement.
9. OWS Effluent to Waste Water Storage Tank – The Glenarm weir, which accepts all non-sanitary waste streams from the Glenarm property, is limited in the amount of flow it can discharge on a per minute basis. This new connection is intended to cut into the discharge line from the existing GT 3 & 4 OWS and route a new pipeline underground to the new waste water holding tank south of the new demin storage tank.

10. GT-5 Wastewater to Existing Discharge Pipe – This new tie point is intended to receive waste streams directly from the plant and bypass the waste water storage tank.
11. CT-3 Cooling Tower – this connection provides a connection from the GT 3 cooling tower to the new waste water storage tank. This line will be run underground.
12. CT-4 Cooling Tower – this connection provides a connection from the GT 4 cooling tower to the new waste water storage tank. This line will be run underground.
13. Wastewater Storage Tank Discharge Pipe – this connection provides for a new connection from the new waste water storage tank to the existing waste water line going to the Glenarm weir.
14. Fountain Drain – a permanent connection needs to be installed for a sump pump to drain the fountain. This line will interconnect with the cooling tower (see P&ID M3-13-1)
15. GTG Water Wash Drains Pump Out – this is a new connection for the plant coming off of the new water wash drains tank.
16. Aqueous Ammonia Supply – Refer to mechanical sketches SKM1-7, 8 and 9 for additional details on the ammonia supply configuration. A new pumping skid will be located in a secondary containment next to the existing B-3 ammonia storage tank. First it will be arranged to take suction (and be recirculated as necessary) from the GT 3 & 4 19% aqueous ammonia storage tank, then it will take suction from the B-3 29% aqueous ammonia tank after B-3 is shut down. The tank will then use 19% solution for GT-5. To prevent the need to run a new double wall stainless steel pipe system through the existing 42" Broadway-Glenarm pipe culvert/tunnel, the B-3 ammonia tank fill line will be repurposed as the supply line to GT-5. The discharge from the new GT-5 pumping skid will be routed to the existing B-3 tank fill line. In order to accommodate this, the B-3 line will be cut close to the tank storage area and the existing GT 3 & 4 fill line will be cross connected downstream with the B-3 fill point. The new GT-5 discharge will enter the line after this cross tie where it was cut. The existing B-3 fill line currently resides in the existing grating covered trench, which runs north-south on the Broadway site, and will intersect with a vault at the east end of the existing Glenarm-Broadway tunnel, which runs east to west under the Metro Rail train tracks. Where the existing B-3 fill line comes up in the Glenarm tunnel pit and then runs to the truck filling station underground, this line will be cut and capped to the fill station (existing U/G line to be abandoned in place) and a new double wall stainless steel piping system will then be run to the ammonia vaporization skid / flow control unit south of the new GT-5 OTSG. The new power supply and controls required for the GT-5 pump skid, as well as the new instruments to be installed on the B-3 tank shall be run in conduits following the ammonia line through the trench and tunnel. No new boring will be permitted under the tracks and no utilities may be routed over the tracks.
17. Aqueous Ammonia Minimum Flow – This will be local to the existing B-3 tank for new forwarding pump protection, and temporarily run to the GT-3 & 4 tank when operating in the interim mode between GT-5 start-up and B-3 shutdown.
18. Aqueous Ammonia Pump Skid Recirculation – This will be local to the existing B-3 tank for new forwarding pump protection and temporarily run to the GT-3 & 4 tank when operating in the interim mode between GT-5 start-up and B-3 shutdown.
19. 34.5kV Interconnect – this terminal point is intended to show where a new BOP Contractor installed duct bank will interface with the existing underground electrical vault. The final terminal point for these cables will be in the Distribution Center as described in the electrical sections.
20. 17kV Interconnect – this terminal point is intended to show where a new BOP Contractor installed duct bank will interface with the existing trench system to head north to the Dispatch Building basement as described in the electrical sections.
21. GT-1 Control System – this tie point is intended to show where new underground conduits shall be run from the PDC to the existing GT-1 control building. The location of the riser for these conduits shall be coordinated with the General Manager. These conduits will be installed with

pull strings for installation of controls interface cables to be installed by others at a later date. New conduits shall then be installed from the PDC to the Control Building. Pull strings shall be installed for cable installation by others at a later date.

22. GT-2 Control System – this tie point is intended to show where new underground conduits shall be run from the PDC to the existing GT-2 control building. The location of the riser for these conduits shall be coordinated with the General Manager. These conduits will be installed with pull strings for installation of controls interface cables to be installed by others at a later date. New conduits shall then be installed from the PDC to the Control Building. Pull strings shall be installed for cable installation by others at a later date.
23. GT-3 Control System – this tie point is intended to show where new underground conduits shall be run from the PDC to the existing GT-3 and 4 control building. The location of the riser for these conduits shall be coordinated with the General Manager. These conduits will be installed with pull strings for installation of controls interface cables to be installed by others at a later date. New conduits shall then be installed from the PDC to the Control Building. Pull strings shall be installed for cable installation by others at a later date.
24. GT-4 Control System – this tie point is intended to show where new underground conduits shall be run from the PDC to the existing GT-3 & 4 control building. The location of the riser for these conduits shall be coordinated with the General Manager. These conduits will be installed with pull strings for installation of controls interface cables to be installed by others at a later date. New conduits shall then be installed from the PDC to the Control Building. Pull strings shall be installed for cable installation by others at a later date.
25. 34.5kV Relay Panel – this is shown as an approximate location of where the BOP Contractor supplied relay panel shall be installed in the PDC to interface with the 34.5kV Distribution Center. Pull strings shall be installed for cable installation by others at a later date.
26. Phone – this is shown to indicate where the nearest known phone connection can be made for the new plant. New conduits shall be run underground from the GT-3 & 4 control building, along with the conduits described in tie points 23 and 24 to the PDC. New conduits shall then be installed from the PDC to the Control Building. Pull strings shall be installed for cable installation by others at a later date.
27. Internet – this will be a new underground conduit following the phone line above. Pull strings shall be installed for cable installation by others at a later date.
28. Sanitary Sewer – this tie point is shown as an approximate underground location of the existing sanitary sewer connection. If required due to depth, a new lift station shall be provided by the BOP Contractor to allow the sanitary line from the Control Building to enter the existing line.
29. Instrument Air – a cross tie shall be made underground between the GT 3 & 4 system to the new GT-5 system as shown on the P&IDs. This line shall run along with the waste water lines and interface the new air line system where practical and in accordance with the P&IDs.
30. OWS Level Instrument – a new level alarm shall be supplied on the existing OWS in GT 3 & 4 to satisfy the Fire Marshal.
31. Existing B-3 Control Room – this is provided to show where the existing fire alarm control panel and the new fire alarm system shall interface. New conduits will need to be run through the Glenarm-Broadway tunnel along with the ammonia supply line as described in item 16.
32. Aqueous Ammonia Fill Connection – this locates the approximate area where the BOP Contractor shall cut the B-3 fill line and cap it, then run a new line over to the new GT-5 ammonia vaporization skid.

E. SITE DESIGN CONDITIONS

Refer to the 480020 Site Conditions Document

E.1 Noise

Due to the location of the project site, the BOP Contractor and the PIE Contractor will be held to very strict noise limitations for the project. Refer to Section 480033 Combined Cycle Balance of Plant Noise Control Performance

E.2 Utilities

E.2.1 Fuel Gas

The project shall be designed to operate on pipe line quality natural gas only. The fuel source is supplied by Sempra. The constituents are provided in the Site Conditions document

E.2.2 Raw Water

The constituents are provided in the Site Conditions document

E.2.3 Demin Water

The constituents are provided in the Site Conditions document

E.3 Codes and Standards Summary

The project shall be designed and constructed in accordance with the latest revision of all Federal, State and Local laws, ordinances, regulations and standards (LORS), including all addenda, in effect at the time of Contract signing.

The project design shall comply with the California Code of Regulations Title 24 Building Codes.

The following list of LORS applicable to the project design and construction methods is not meant to be all encompassing or relieve the contracted entity in any way of the responsibility to research and comply with all applicable codes and standards.

E.3.1 General

Jurisdiction	LORS
Federal	Federal Code of Regulations (CFR) - 40 CFR 60/75
State	California Code of Regulations (CCR) Title 24 (Building Codes)
State	California Code of Regulations (CCR) Title 8 (Cal OSHA)
State	California Accidental Release Program (Cal ARP)
State	Business and Professions Code
State	Health and Safety Code (H&SC)
State	California Environmental Quality Act (CEQA)
State	State Water Resources Control Board (SWRCB)
State	California Integrated Waste management Act (CIWMA)
State	California State Fire Marshalls (CSFM) - Listing and Labeling

Jurisdiction	LORS
Local	City Building Department
Local	City Planning Department
Local	City Public Works Department
Local	Local Fire Department Approvals and Standards
Standard	National Fire Prevention Association (NFPA)
Standard	Underwriters Laboratories (UL) - Listing and Labeling
Standard	Factory Mutual (FM) - Listing and labeling

E.3.2 Civil, Architectural and Structural Engineering

Jurisdiction	LORS
Federal	Americans with Disabilities Act (ADA)
State	California Building Code Part 2 (Building Code)
State	Alquist Priolo Earthquake Fault Zoning Act
Standard	The Green Book - Standard Plans for Public Works Construction
Standard	The Green Book - Standard Specifications for Public Works Construction
Standard	American Association of State Highway and Transportation Officials (AASHTO)
Standard	American Society of Civil Engineers (ASCE)
Standard	American Concrete Institute (ACI)
Standard	American Institute of Steel Construction (AISC)
Standard	American Reinforcing Steel Institute (ARSI)
Standard	American Iron and Steel Institute (AISI)
Standard	Aluminum Manufacturer's Association (AMA)
Standard	Builders Hardware Manufacturer's Association (BHMA)
Standard	Metal Building manufacturer's Association (MBMA)
Standard	Steel Door Institute (SDI)
Standard	Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
Standard	Society of Steel Protective Coatings (SSPC)
Standard	The Masonry Society (TMS)
Standard	Research Council on Structural Connections (RCSC)
Standard	International Code Council (ICC)
Standard	AISC Manual of Steel Construction – Allowable Stress Design 9th Edition
Standard	ACI 318-05 Building Code Requirements for Structural Concrete
Standard	ACI 530/ASCE 5/TMS 402 Building Code Requirements for Masonry Structures
Standard	ASCE 7-05 Minimum Design Loads for Building and Other Structures
Standard	AISC ASD/LRFD 13th Edition Steel Construction Manual
Standard	RCSC Specification for Structural Joints Using ASTM A325 or A490 Bolts
Standard	AISC Specification of Structural Steel Buildings - Allowable Stress

Jurisdiction	LORS
	Design and Plastic Design
Standard	IEEE 693 Recommended Practice for Seismic Design of Substations

E.3.3 Mechanical Engineering

Jurisdiction	LORS
State	California Building Code Part 4 (Mechanical Code)
State	California Building Code Part 5 (Plumbing Code)
State	California Building Code Part 6 (Energy Conservation)
State	California Building Code Part 9 (Fire Code)
Standard	American National Standards Institute (ANSI)
Standard	American Society of Mechanical Engineers (ASME)
Standard	ASME Power Test Codes (PTC)
Standard	American Society for Testing and Materials (ASTM)
Standard	American Petroleum Institute (API)
Standard	American Water Works Association (AWWA)
Standard	American Welding Society (AWS)
Standard	American Standard of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
Standard	Thermal Insulation manufacturers Association (TIMA)
Standard	Tubular Exchanger Manufacturers Association (TEMA)
Standard	Heat Exchanger Institute (HEI)
Standard	Pipe Fabrication Institute (PFI)
Standard	Hydraulic Institute (HI)
Standard	Cooling Tower Institute (CTI)
Standard	Compressed Air and Gas Institute (CAGI)
Standard	Expansion Joint Manufacturing Association (EJMA)
Standard	Manufacturers Standardization Society (MSS)
Standard	American Refrigeration Institute (ARI)
Standard	American Gear manufacturers Association (AGMA)
Standard	NFPA - 10, 13, 14, 15, 20, 22, 30, 37, 54. 70, 72, 72E, 80, 85B, 90B, 101, and 850
Standard	ANSI - B15.1, B16.36, B16.5, B31.1, B31.3, K61.1, and K93.2
Standard	ASME - Boiler and Pressure Vessel Code, PTC 22, and PTC 46
Standard	ASTM - Material Specifications (as applicable), Sampling and Testing Standards (as applicable), and Nondestructive Examination Procedures and Criteria.

E.3.4 Electrical and Controls Engineering

Jurisdiction	LORS
Federal	ANSI/NFPA 70 - National Electrical Code (NEC)
Federal	ANSI C2 - National Electrical Safety Code (NESC)
State	California Building Code Part 3 (Electrical Code)
State	General Order 95 (GO-95)
State	California Independent System Operator (CAISO)

Jurisdiction	LORS
Standard	Instrumentation, Systems and Automation (ISA)
Standard	Association of Edison Illuminating Companies (AEIC)
Standard	Anti-Friction Bearing manufacturers Association (SFBMA)
Standard	Institute of Electrical and Electronic Engineers (IEEE)
Standard	Illuminating Engineering Society (IES)
Standard	National Electrical Manufacturers Association (NEMA)
Standard	ANSI C29.2 & C29.9 - National Insulator Standards
Standard	ANSI C50.10 – Rotating Electrical Machinery – Synchronous Machines
Standard	ANSI C50.14 – Requirements for Combustion Gas Turbine Driven Cylindrical Rotor Synchronous Generators
Standard	IEEE Standard 80 Guide for Safety in AC Substation Grounding
Standard	ANSI/IEEE 81 – IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of Ground System
Standard	ANSI/IEEE 979 – IEEE Guide for Substation Fire Protection
Standard	ANSI/IEEE 980 – IEEE Guide for Containment and Control of Oil Spills in Substations
Standard	ANSI/IEEE C37 – Guides and Standards for Circuit Breakers, Switchgear, Substations and Fuses
Standard	ICEA P-46-425 – Power Cable Ampacities
Standard	ICEA P-54-440 – Ampacities in Open top Cable Tray
Standard	IEEE 112 – IEEE Standard Test Procedure for Polyphase Induction Motors and Generators
Standard	IEEE 141 – Recommended Practice for Electric Power Distribution for Industrial Plants
Standard	IEEE 142 – Recommended Practice for Grounding of Industrial and Commercial Power Systems
Standard	IEEE 422 – Guide for the Design and Installation of Cable Systems in Power Generating Stations
Standard	IEEE 450 – IEEE Recommended Practice for Maintenance, Testing and Replacement of Vented Lead-Acid Batteries for Stationary Application
Standard	IEEE 484 – IEEE Recommended Practice for Installation Design and Installation of Vented Lead-Acid Batteries for Stationary Applications
Standard	IEEE 493 – Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems
Standard	IEEE 665 - Guide for Generating Station Grounding
Standard	IEEE 693 – Recommended Practice for Seismic Design of Substations
Standard	IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems
Standard	IEEE C37.2 – Standard Electric Power System Device Function Numbers and Contact Designations
Standard	IEEE C57.105 – IEEE Guide for Application of Transformer Connections in Three Phase Distribution Systems
Standard	IEEE C57.12.00 - Guide for Liquid-Immersed Distribution, Power and Regulating Transformers
Standard	IEEE C57.91 – IEEE Guide for Loading Mineral-Oil-Immersed Transformers
Standard	IEEE C57.93 – IEEE Guide for Installation of Liquid-Immersed Power

Jurisdiction	LORS
	Transformers
Standard	IEEE C62.23 – IEEE Application Guide for Surge Protection of Electric Generating Plants
Standard	IEEE C62.41 – IEEE Recommendation Practice on Surge Voltages in Low-Voltage AC Power Circuits
Standard	NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum)
Standard	NEMA AB-1 – Molded Case Circuit Breakers
Standard	NEMA ICS2 – Industrial Control and System Controllers, Contactors and Overload Relays rated 600 Volts
Standard	NEMA MG1 – Motors and Generators
Standard	NEMA MG2 – Safety Standard for Construction and Guides Selection, Installation and use of Electric Motors and Generators
Standard	NEMA PB-1 – Panel Boards
Standard	NEMA TR-1 – Transformers, Regulators, and Reactors
Standard	NEMA VE 1 Cable Tray Systems
Standard	NEMA WC5 – Thermoplastic – Insulated Wire and Cables
Standard	NFPA 780 – Lightning Protection Code
Standard	UL 50– Enclosures For Electrical Equipment
Standard	UL 514B – Standard for Fittings for Conduit and Outlet Boxes
Standard	ANSI ICS6 - Enclosures for Industrial Control Systems
Standard	SP51 Instrumentation Symbols and Identifications

F. ARCHITECTURAL REQUIREMENTS

Refer to the Architectural Scope in Section A.2

The intent is for the BOP Contractor to take the document 037-5056 Architectural Scope of Work included in A.2 along with the Site Conditions document, the Architectural drawings and specifications, to facilitate building pricing and erection. With respect to the new Control Building, Water Lab and the Maintenance Shop tenant improvement, the BOP is responsible for complying with the current and applicable sections of the California Green Building Code, Title 24, Part 11 (CAL Green), in addition to City of Pasadena Building Codes which amend and in some cases supersede the CAL Green standards.

G. CIVIL AND DEMOLITION REQUIREMENTS

G.1 General Requirements

This section identifies the scope of work to properly design the facilities and to perform the civil construction work for the City of Pasadena GT-5 Glenarm Repowering Project.

Civil engineering work shall be performed under the direction of engineers licensed in the State of California with experience in the requirements for this highly seismic area. The civil engineering work shall further comply with the technical requirements, as identified herein. Copies of calculations and drawings shall be submitted to local building inspectors as required as part of the process for obtaining any required building permits, as well as to the General Manager and Engineer.

The civil work includes the underground demolition activities, over-excavation and recompaction of the substrate per the Geotech report, rough grading and compaction, drainage, roads, parking, fences and construction sedimentation control activities to be done throughout the project site, before the majority of the other work commences. It is intended that this rough earthwork be done to provide a suitable work area to allow the installation of the plant facilities. Quantities of soil to be excavated and recompacted, organic materials and lead contaminated soils to be removed from site and concrete volumes to be demolished have been provided as an allowance below. Contractor shall provide unit rates to account for additional material to be handled / removed, or to provide credit for materials not handled or removed. Please note that the soil volume listed as “Organics removed from site” will most likely be reduced. This soil, if cleared of organic material, can be used for fill on site per the Geotech report. It is a requirement of this scope of work that the author of the geotechnical report, Hydrologue, be on site for a pre-excavation meeting, and on site to witness the earthwork activities. Hydrologue shall be retained by the BOP Contractor and their costs be incorporated into the proposal pricing. The BOP Contractor will work the General Manager to assure accurate accounting of the materials.

- Concrete demo for tunnels, stack foundation, train tracks, gantry crane: **700 cy**
- Concrete demo from old house foundations near new tanks **50cy**
- Remove brick and asphalt buried near old house foundation **50cy**
- Import Fill to fill the tunnel voids **2500 cy**
- Organics removed from site **1300 cy**
- Over-excavate and re-compact soils, but not removed from site **13,000 cy**
- Lead contaminated soil, removed from site **25 cy**

An overall site plan, C1-3, has been included in this scope of work to illustrate the location of the new plant in relation to its surroundings, as well as indicate some improvements associated with the plant. The plant will be located south of the historically significant Glenarm Building formerly used by the City for power generation and north of the historically significant Pacific Electric Building, formerly used for maintenance of the street trolleys in Pasadena. These buildings will need to be protected from damage as a course of installing the new plant.

G.2 Site Development and Demolition of Existing Site Infrastructure

The Project site has been used for power generation for over 100 years and is clearly a "brownfield" site. The site is essentially flat with some existing features visible from grade. Before work can begin, the existing fencing between the GT-5 site and GT's 1, 2, 3 & 4 shall be carefully removed and retained. A temporary fence will be installed near GT 1, 2, 3 and 4 to keep craft personnel out of operating areas and provide site security as illustrated on C3-4. Location of the temporary fence shall be coordinated with the General Manager to not hamper day to day access for operations. The existing fencing that is removed will be reused at South State Street.

There are security cameras mounted along the existing fence described above. The BOP Contractor shall coordinate relocating these cameras with the General Manager prior to removing the fence.

The existing site shall have rubbish and debris removed, especially around the Pacific Electric Building. Coordinate with PWP for debris that should be removed.

There are several existing underground structures, mechanical piping, fire lines, electrical conduit, storm drains, and train rails, etc., that will need to either be demolished or relocated as part of the GT-5 project. Please refer to the demolition scope drawings for details. These drawings can be found in A.3, Reference and Preliminary Design Scoping, Existing PWP Drawings, Demolition Scope. The General Manager has performed ground penetrating radar of the site and a report is included in this scope of work identifying many of the existing underground utilities and structures. The Contractor shall clear the existing surfacing, taking care to retain or replace the existing storm water erosion mitigation measures.

Please note that prior to excavation on site, the CEQA permit documents require that both an archeologist and a paleontologist be present on site for a pre-excavation meeting, and that they be contacted in the event an artifact is encountered (this can be one person if they qualified to observe in both capacities). Additionally, part of this scope is to have the soil tested for dioxins while excavation is being performed. The Geotech, Hydrologue, will need to be available for testing during excavation. The duct work that runs down the south face of the Glenarm Building will need to be removed down to grade. All supports attached to the building will need to be removed. Areas where concrete or other substrate is exposed as a course of doing this work will be repaired and painted to match the existing surface. The open ends of the duct work on the roof will need to be permanently sealed to keep out the elements and wildlife from entering through the openings. Any areas where the duct removal will leave a void in the handrail shall be replaced in kind to make the roof safe for PWP personnel.

The exhaust stack will need to be removed. The handrail where walkway from the stack to the roof meets shall be replaced in kind to make the roof safe for PWP personnel.

The foundation that the stack currently is supported from extends below grade approximately 17'-0" Since this stack foundation will be beneath the north roadway for the new plant, it only needs to be removed far enough down (approximately six feet) to prevent a hard spot in the road. Actual depth of removal shall be determined by detail design and any utilities that may pass through this area. Other foundations that exist to support equipment previously installed between the duct work and the stack shall also be removed in a similar fashion.

The air compressor room on the south side of the building is not part of the original Glenarm Building, so it has been deemed to not be of historical significance and can be removed, along with the equipment and foundation. Beneath this room is an electrical switchgear room that still has the gear and some transformers installed. They shall also be removed and disposed of. Demolition of this room is further defined below under tunnel demolition. For purposes of this bid, assume the transformers are PCB contaminated and **will** need to be disposed of as hazardous materials. PWP will sign manifests for

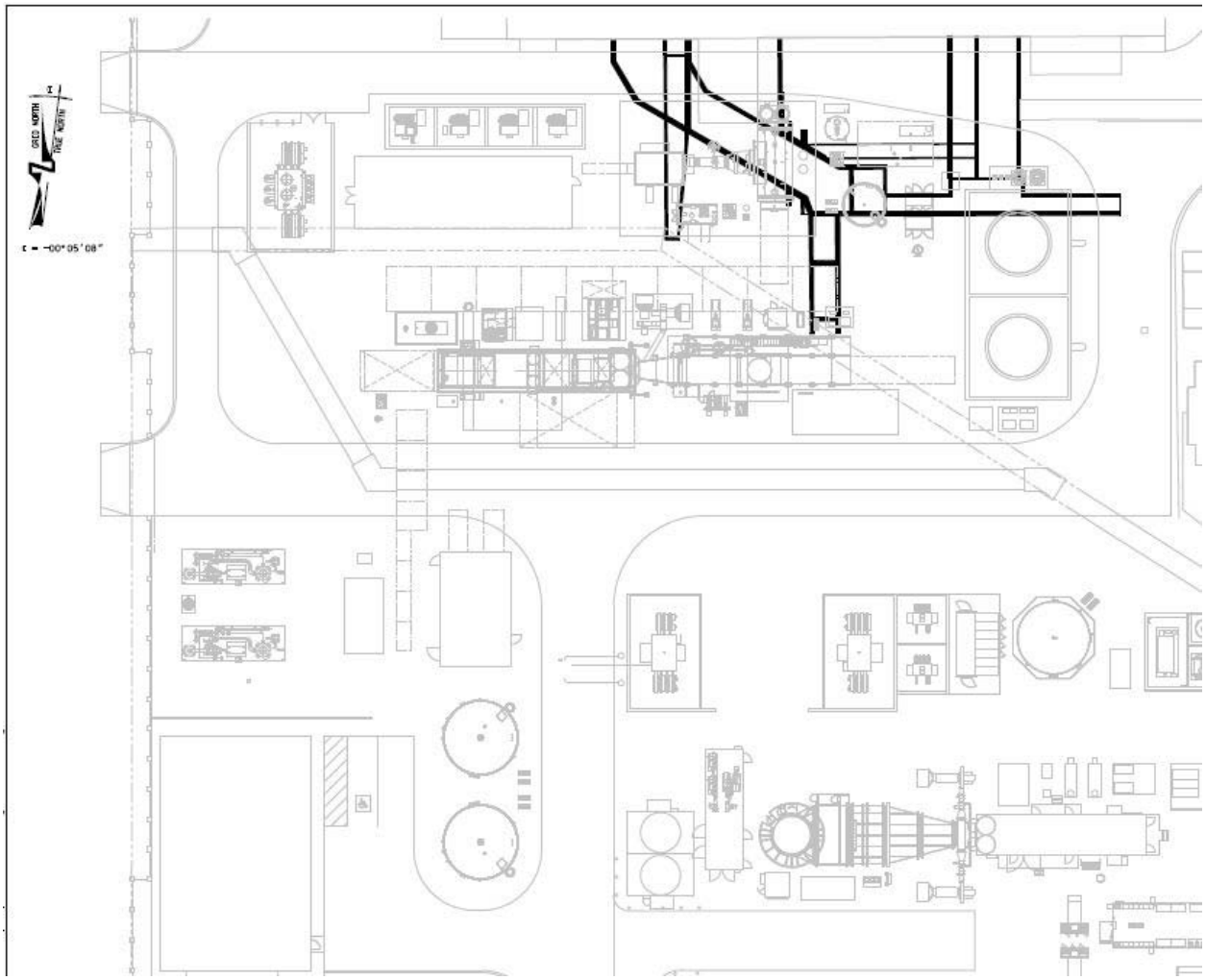
removal of hazardous materials from site. See photo below of existing transformers.

The restroom on the southeast corner of the Glenarm Building is also not considered to be a feature of historical significance. It shall be removed as part of this work scope to make room for the access road and all materials disposed of in a similar fashion. Lead based paint was used on the structure walls. Contractor is responsible for proper remediation, demo and disposal. Debris from this room shall be hauled off and disposed of properly. There are several features visible from the surface of the property that belies existing substructures, utilities and foundations. Refer to the information provided in the demolition section of A.3 for underground features, as well as civil drawing C3-1, which shows some of the existing underground features. The BOP Contractor shall coordinate with the General Manger to determine which features can be demolished, relocated or abandoned in place. All steel ductwork, the steel stack, the building, and equipment from the rooms and the electrical gear removed as part of this scope shall become the property of the BOP Contractor. The scrap salvage value should be realized by the BOP Contractor in the proposal offering.

The photo below was included as an overview to show where some of the existing features are that will need to be removed as part of this scope of work. It is obviously not intended to be all inclusive, but to assist with putting a relationship between the drawings and the real world for bidding purposes. The south wall of the Glenarm Building is column line "K" and shows up on several of the existing drawings included in this package for reference.

The existing Glenarm Building contains decommissioned boilers, steam turbines and condensers formerly used for power production. Part of this equipment's supporting infrastructure still exists and needs to be addressed before the GT-5 Project can be constructed. The STG condensers received their cooling water from cooling towers located to the south of the Glenarm Building. Most of the cooling tower structures have been previously removed, but there are still underground concrete tunnels which contain the circulating water piping that supplied water between the condensers and cooling towers. There are two sets of tunnels as there were four operating steam turbines in that building. Crossing both sets of tunnels, in the east-west direction, is existing electrical infrastructure and fuel oil transfer piping. Contractor shall

assume fuel oil piping still contains fuel oil and shall be fully responsible for required remediation measures, demolition and disposal. In addition to and including the circulating water piping, electrical infrastructure and fuel oil piping, there are several process pipes that are insulated with asbestos containing materials (ACM), some of which are failing and/or in poor condition. During the course of the tunnel exposure/sealing and infrastructure demolition, the Contractor shall be fully responsible for; the removal and disposal of ACM in the tunnel segments to be demolished; the encapsulation (or removal and disposal of areas that have failed beyond the limits of encapsulation) of ACM in the adjacent tunnel segments which are not designated for demolition, which may become disturbed or dislodged as part of the nearby activities. PWP will sign the manifests for hazardous materials removed from site. Drawing SKM-1 (snapshot included below) shows an overlay of the existing tunnels compared to where the new GT-5 equipment will be placed.



Additionally, the area beneath the existing air compressor building on the south side of the Glenarm building houses an existing electrical switchgear room. The gear and the transformers located within shall be removed and the room floor, ceiling and walls demolished up to the southern limits of the Glenarm basement wall. The doorway entering this electrical room shall also be removed, sealed with concrete and made water tight.

As part of the project demolition and improvements, the below grade tunnels need to be exposed, the piping removed, concrete structure demolished and all penetrations through the south wall need to be closed off with structural concrete in the same thickness as the existing subgrade wall. Adequate shoring shall be designed, installed and maintained to limit the extent the Glenarm Building basement wall is unsupported, to limit the extent of excavation and to protect employees working in the trench. The openings and pipe penetrations in the wall shall be cleaned of all structurally unsound material utilizing a combination of bush hammering, pressure washing, blasting, etc., reinforcing steel shall be installed by drilling and epoxy grouting into the perimeter of each opening, reinforcing steel installed across the opening, bentonite type waterstop (or other approved material) securely installed, bonding agent applied, the openings formed and concrete placed to produce a water tight and structurally sound bearing surface. Note, the most effective and cost effective way to seal the east tunnels may be to place a new wall on the south side of the Glenarm Basement. Water currently enters into the basement of the Glenarm building through these tunnels, so it is imperative the openings be repaired with structure and water tightness in mind. For UG concrete that is needed for water proofing/sealing of below grade wall openings, Xypex shall be added to the concrete as an admixture. This product crystallizes the using the free water to seal micro cracks and waterproof the surfaces. Any other penetrations discovered upon exposing the basement wall shall also be sealed in a like manner.

Once the concrete has sufficiently cured, the forms shall be stripped, the bond between new and old concrete, as well as any defects in the face of the new concrete, shall be "rubbed out" to blend the seam as best practical inside and out.

The extent of the tunnel demolition shall be such that no part of an existing tunnel shall be left in place beneath the vertical projection of any a foundation, nor within the zone of influence of any equipment foundations. Please note that on overlays of the general arrangement on the existing subgrade features, it will indicate new permanent improvements will reside over the existing tunnels. The tunnels in the area beneath the north road, south of the Glenarm Building may be demolished in their entirety or only to a depth of eight feet, with the exposed tunnel cavity backfilled with engineered fill to finished grade in accordance with the requirements of the Geotechnical Report. Should the Contractor choose to not remove the tunnels in their entirety beneath the north road, the Contractor shall test the condition of the soil beneath the tunnels in accordance with the requirements below. Final determination shall be made by the engineer responsible for sealing the drawings in cooperation with the on-site Geotech.

The soil beneath the tunnel areas shall be evaluated by the geotechnical engineer to determine if they can be backfilled as is, or if they need to be scarified and recompacted. Backfill material shall then be placed in controlled lifts with compaction tests taken regularly as recommended by the Geotech report, or flowable fill used to assure sound bearing. If the base of a tunnel is left intact, it should be penetrated in several areas to allow water to pass through.

The BOP Contractor shall take into consideration the surcharge that construction equipment, permanent equipment foundations and heavy truck loads when performing the backfill adjacent to the Glenarm Building basement wall.

As part of the GT-5 project, some of the existing site surface paving will need to be removed to accommodate the subsurface construction work, and new surfacing will later be installed. Areas removed or inadvertently damaged by the contractor shall be replaced as part of this scope. Also note that there will be several areas where existing paving will need to be removed and replaced, such as for running the gas line from the meter station area, conduits to pick up the GT 1, 2, 3 and 4 control interfaces, the waste water lines to and from the OWS, the new demin water line from the GT 3 & 4 tank, the ammonia line from the Broadway side, etc. The replacement of these removed paving areas is included in this scope of work.

G.3 Storm Drain Relocation

Existing below grade utilities include a 6 ft by 4 ft (8 ft by 6 ft out to out) reinforced concrete box culvert for drainage which passes through the site draining from west to east as shown on the drawings. Details and sections of the box are shown on RBC sections 2001 C003-05, and photos from the relocation performed to accommodate the installation of the GT 3 & 4 project are included below. This reinforced concrete box culvert storm drain line crosses the project from west to east and shall be rerouted as shown on the civil drawing C3-1. Please note that this route provided is approximate, but should be a similar routing finalized as part of detail design. It will need to be installed in support of the BOP Contractor's design and in order to avoid existing underground utilities. The new box culvert shall match the 6 ft x 4 ft inner diameter of the existing box culvert and shall have a constant slope between connection points. The new box culvert shall be designed to withstand H-20 Highway loading for the worst case depth of cover under the proposed access roads. In crane access areas, the box culvert will need to have additional protection. Note that civil drawing C3-3 indicates a thickened slab area west of the GTG and south of the GSU transformer. This is intended to provide protection of the 34.5kV duct bank shown on E6-10 and the storm culvert for crane access. This shaded area is intended to show the area that will be left open for crane service to the power block. . A similar thickened area shall be included in the road south of the new cooling tower, though not shown on the civil drawings as of initial BOP Scope publishing.

It is anticipated that the existing box culvert material will not be useable. When the culvert was relocated for the GT 3 & 4 project, the contractor backfilled it with either flowable fill or lean concrete, plus the storm system cannot be out of service except for the final tie, therefore the contractor shall provide new concrete culvert material to be installed and make the interconnect as quickly as possible. Given the unpredictable nature of storm drain flows, Contractor shall assume that bypass piping and/or pumping will be required by the City of Pasadena Public Works Department during the tie-in. Note in the photo below, the contractor utilized asphalt to temporarily divert the storm water during the transition period. The new storm drain shall be installed before removing the active storm drain. Existing laterals accepting the current surface runoff will need to be reattached to the rerouted storm drain; however the catch basins may be relocated to accommodate the BOP Contractor's final general arrangement. The existing concrete culvert shall then be disposed of offsite by the contractor. All demolished materials shall be removed from site.

The southern limit of where the storm drain culvert may rerouted is dictated by the existing 34.5kV duct bank leaving GT-3 & 4's generator step up transformers (see drawing 2-2-1562 and drawing 20001-E-004-13) and the existing storm drains installed for GT3 & 4 (shown on drawing 20001-C-002-01 and 03). The duct bank runs north, then west, and then turn south into an existing underground vault numbered 4275 or UGPB-05 depending on the drawing referenced. This vault will also be where the underground 34.5kV duct bank for GT-5 will enter to connect the new GSU transformer with the 34.5kV switchyard. Care must be taken not to damage the duct bank while installing the new storm drain culverts. Also note that there is a fire protection line running east to west in this area servicing a hydrant by GT 3&4's oil water separator. Existing, drains and utilities shall be exposed and identified. Abandoned utilities may be removed. Utilities still in use must be rerouted with appropriate size and material and connected at each end of the project. Verify with the General Manager if a line is abandoned before attempting to remove or relocate it.

Existing industrial drains and other abandoned process piping coming from the Glenarm Steam Plant building at the north end of the project will generally be located capped using high strength grout at the exposed end(s) and abandoned in place. In areas where the drains underlie proposed foundations, the drains will be removed or rerouted. The location of the existing drains and process piping shall be

verified so that it will not adversely affect the bearing for the foundations. The photos below show the storm drain getting ready for backfill, looking northwest.

The photo below shows the same run backfilled with flowable fill or slurry material.

G.4 Soil Conditions

The existing soils on the site consist of 5 ft -10 ft of fill that is unsuitable for support of structures, concrete and heavy vehicular traffic in its current condition. The contractor will be required to remove and stockpile the fill to a depth that can be proof rolled and approved by PWP's geotechnical engineer. The fill is expected to be suitable for replacement and re-compaction under the supervision of a geotechnical engineer. Soils under the proposed areas to be paved may be removed to a minimum depth of 2 feet below finished grade and re-compacted to sub base elevation.

Contractor shall review the Draft Soils Engineering Investigation (August1, 2011) to determine the site compaction and grading requirements. If necessary, the BOP Contractor shall obtain additional geotechnical data at Contractor's expense. Contractor shall be responsible for improving the pre-existing soil conditions of the Site, to the extent presented in the Allowances.

The subsurface exploration was performed to evaluate the soil and groundwater conditions at the proposed site and to determine the type and depth of foundation systems suitable for the proposed power plant and auxiliary systems. The information obtained and analyses of conditions are the basis of the foundation design. However, if considered necessary, the Contractor shall conduct additional exploration at Contractor's sole expense for the purposes of their final design and construction. The soils are described as moderately corrosive and cathodic protection will need to be provided accordingly. Soil resistivity testing shall be performed after over excavation and recompaction.

Should structural backfill materials need to be imported; a source must be identified and supplied by the Contractor. Prior to use, the BOP Contractor shall submit a complete analysis of any needed material to the General Manager, prior to using the proposed material. This is for review purpose only. All materials shall be the sole responsibility of the Contractor. All materials imported or placed shall be identifiable by place of origin and the soils analysis described above. For this purpose, Contractor shall maintain a log with trucking tickets or bills of lading which indicate where the soil was imported from, the approximate areas placed and the quantities placed. Imported soil shall be subject to random inspection and Contractor shall comply with PWP personnel in its performance of these inspections. If hazardous, deleterious, unsuitable material, or material for which the Contractor has no records of origin and analysis, has been placed, it shall be removed and replaced with materials for which origin and analysis has been provided, at the Contractor’s expense. Flowable Fill may be used for backfill areas as accepted by the General Manager. Contractor shall document areas, type and approximate quantities where flowable fill has been used on the as-built drawings.

G.5 Topographic and Site Survey

A preliminary topographic and site survey was performed and was utilized for preliminary design work as well as air permit modeling. The existing topo is shown on C3-1 as well as proposed finish grade. A final site survey shall be completed by the BOP Contractor for final design to accurately represent the existing surface conditions and to layout proposed buildings and equipment. Final top of concrete shall be per the Design Criteria document. All exposed concrete areas, including equipment foundations, shall be designed to drain and not puddle.

The BOP contractor shall establish at least three permanent concrete and brass hub survey monuments on site for use in control of the project construction. These monuments will need to be protected to prevent their disturbance by vehicular and construction equipment traffic. These monuments will be left in place after the contractor has demobilized for future site control use and turned over as part of the as-built drawing information. The existing survey was performed off of control points indicated on C1-3.

The BOP Contractor will be responsible for all surveying to locate existing features, for interconnect points, to assist with plant layout and for control during construction and equipment assembly.

G.6 Site Preparation

Graded areas shall be smooth, compacted, free from irregular surface changes, and sloped to drain. Slopes for embankments will be no steeper than 3:1 (horizontal: vertical) unless otherwise determined by the geotech. Areas to be backfilled will be prepared by removing unsuitable materials and rocks. The bottom of an excavation will be examined for loose or soft areas. Such areas will be fully backfilled with compacted fill.

In General, Backfilling shall be performed in accordance with the Geotechnical Soils Investigation Report, in Section A.3.C of these Specifications. Backfilling shall be done in layers of uniform, specified

thickness. Soil in each layer will be properly moistened to facilitate compaction to achieve the specified density. To verify compaction, representative for tests field density and moisture content shall be performed during compaction. All testing will be in accordance with ASTM standards.

G.7 Roads and Paving

Roadways on-site will be designed for "heavy truck drive" as outlined in section 9.0 Paving of the Soils Investigation Report (the geotech report) in Section A.3.C of the Specifications and paved during final grading operations. The Contractor shall maintain all site access roads during construction including dust suppression.

Roads shall be provided by Contractor for access to the site for personnel, delivery of goods and equipment and fire fighting vehicles. The general site earthwork portion of the civil section is responsible for proof rolling and compacting the sub base and placing the base course as recommended in section 9.0, "Paving" of the Geotechnical Soils Investigation Report, in Section A.3.C of the Specifications. Areas to be paved are shown on the construction parking, lay down, staging and access plan.

Culverts and ditches should be used to divert water around and under the roads during 15 minute duration, 100 year storm event. Per the Site Conditions

The Contractor shall determine grades required, including ditches or other diversion methods to channel runoff. The drainage system shall be designed for a 100 year, 15 minute storm having an intensity per the site conditions (100 year storm event). The elevation of the existing site must be taken into consideration to provide for a logical seamless transition. In no case, shall the paving be placed as was done around units GT 3 & 4 with respect to finished concrete elevations relative to electrical pull boxes. These areas and around the GTG's have drastic changes in elevations.

Drawing C3-1 has been provided to show the anticipated final grading, contingent upon final equipment layout. It shows where existing catch basins are to be retained, removed, or added for basis of bid. Additional catch basins may be required per the BOP Contractor's final design. Please note there are some existing features that will need to be adjusted to account for final grade, such as the electrical box on the east side of the cooling tower. Some existing equipment trenches will need to be preserved for use on this project.

Note there will be a cooling tower screen wash down area sump provided as part of the civil scope. The intent is to have the BOP Contractor furnish a monorail and electric hoist at the cooling tower to lift the screens and move them west of the pump pit for wash down and return the screens for re-installation. This sump will need to be slightly higher than the surrounding grade so that rain will not run to and collect in it, but it will need to be flush with the final paving with an H-20 rated grate. This sump will have a weir installed in it to retain any solids washed into it, but allow water to run into the new equipment drains sump south of the cooling tower, which will ultimately go to the existing GT 3 & 4 OWS.

The final site surfacing shall be done as described on C3-1 and C3-3. As a general rule, PWP prefers the site roadways to be constructed of road base covered by the Geotech recommended thickness of asphalt paving. The operating areas are generally covered by reinforced concrete paving suitable for H-20 loading. Expansion joint material shall be installed between all concrete foundations and concrete paving with this joint sealed with self-leveling expansion joint sealants. Control joints shall be installed per recommended practices and at all corners/interfaces with new foundations.

Some areas will receive gravel surfacing. This surfacing will need to be similar to road base material or as approved by the General Manager. Note, any area where asphalt paving comes in contact with the gravel

areas, a flush concrete curb extending 18" below grade shall be installed to prevent the edges of the asphalt from breaking off. Where asphalt abuts concrete paving or foundations, this is not required.

G.8 Fences and Gates

The plant site shall be enclosed on the west side by a ten foot high concrete wall with solid metal gates (assume 10 gauge plate, reinforced at locking areas, with tubular framing support structure for bidding purposes. Gates shall be a rolling design that can be opened by one operator. Paint to match the concrete color.) as shown on drawing C1-3 and C3-1. The walls are intended to be cast in place concrete columns with precast panels installed similar to a highway sound wall. Drilled piers may be required to adequately support the fence and span the root balls of the existing trees. See tree protection information below. . An east-west free standing 10'-0" high reinforced concrete fire/blast separation wall located to the north of the north wall of the Control Building shall be designed and installed to protect the occupants in the case of fire/explosion in the gas compressor area as part of the BOP scope of work. Both the perimeter wall on Fair Oaks and this separation wall shall be designed and installed by the BOP Contractor.

The existing oleander bushes shall be removed to permit installation of the fence. No existing trees on the fence line may be removed. A single tree by the PE building shall be removed as indicated on the drawings. **Contractor shall coordinate with the City prior to removing any foliage.** New concrete drives/curb cuts shall be installed to align with these gates, as shown on C1-3 and C3-1

The northern entry gate shall be made A 20 foot solid sliding type and the southern access gate on Fair Oaks Blvd shall be a 24 ft. solid sliding gate. Personnel access gates shall be provided as required, but shall be limited in number for security purposes.

As part of the CEQA / EIR process, Pasadena Water and Power obtained permission to reclaim the State Street cul-de-sac south of the PE Building and GT-4, and limit it from public access. It will essentially become part of the power plant property. As part of the attachments to this scope of work, there are conditions provided to the City for modifications and improvements at this location. The entrance to State Street will be modified by extending the sidewalks as shown on C1-3 and per the details provided from the City, S-414 sheets 1 through 3, included on C3-5. A new motorized sliding gate will be provided, 24'-0" wide with remote operation controllable from the new control building control room as well as with card readers for employee access. A keypad with speakers shall be provided outside of the gate to alert the operators of visiting vehicles and security cameras shall be provided to attend the gate, as well as the cul-de-sac areas. These should be furnished and installed by the BOP Contractor and either meet or exceed the existing Broadway and Glenarm equipment. The existing State Street fencing will be retained as is.

New lighting at the entrance shall be provided for operators to see visitors / passengers after dark.

The new fencing across State Street shall utilize the salvaged wire mesh taken down from the between the new site and the existing facilities. New poles and framework shall be installed to replicate the fence that was removed between the new site and existing facilities. The new gate shall also be constructed of the salvaged mesh material (or replaced if damaged by the contractor).

The lay down/staging areas and the site craft parking and office trailer areas shall be fenced and each provided with one 30 ft double swing equipment access gate and one personnel access gate. Refer to C3-4 for additional information regarding staging and laydown. The southeast corner of the Glenarm

Building may be used for dry storage with after discussion with the General Manager. Temporary fencing shall be used to limit craft access into other parts of the building.

G.9 Conditions of Approval of State Street Closure are inserted below for compliance by the BOP Contractor:

Metropolitan Transportation Authority (MTA)

1. The proposed security gate installed by the BOP Contractor shall be continuously monitored by PWP staff 24 hours a day and seven days a week. MTA staff with proper agency identification shall be able to access the MTA right-of-way without delay, by ringing the entry key pad at the security gate. In addition, Pasadena Fire Department shall be allowed emergency access to the MTA right-of-way without delay at all times.

2. MTA may install a pedestrian gate near the existing drive approach at the east end of current State Street cul-de-sac for emergency access purpose. The area fronting the vicinity of the pedestrian gate shall be kept clear for access at all times, by means of proper signage.

3. PWP shall remove all existing vines on the fence and other vegetation near its ground to ensure clear access to the pedestrian gate. The area shall be maintained free of said overgrowth by PWP on a regular and continuous basis.

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1. The proposed security gate shall have a minimum of 20 feet wide opening.

2. All private improvements in State Street, including the proposed security gate, shall be constructed with a minimum of 40 feet setback, measuring from the back of the existing sidewalk on Fair Oaks Avenue.

3. In order to comply with the Americans with Disabilities Act (ADA) standards, the BOP Contractor shall reconstruct the intersection of State Street and Fair Oaks Avenue in one of the following ways:

a) Remove the existing curb returns at the northeast and the southeast corners, and reconstruct the intersection as a private drive approach in accordance with Standard Plan S-414 and to the satisfaction of the City Engineer. The improvements shall consist of the construction of concrete curb, gutter, sidewalk, standard drive approach, and other necessary work. Improvements shall also include the relocation and upgrading of affected street lights, signals and various utilities.

b) Extend the existing curbs by 5 or 6 feet on both sides of State Street to construct two new curb bulbouts or chokers. Construct new curb ramps at the northeast and the southeast corners in accordance with Standard Plan S-414. Install proper traffic signage per requirements of Department of Transportation.

The BOP Contractor is responsible for the design, preparation of plans and specifications, and construction of all the above required public improvements. The plans shall be prepared by a registered civil engineer and submitted to the Department of Public Works for review and approval. The BOP Contractor is responsible for the construction of the approved plans.

4. PWP shall be responsible for the maintenance of all improvements within the proposed closure area in State Street. Said improvements include pavement, sidewalk, trees, and all street light facilities. The street light facilities may either be removed and salvaged to the Department of Public Works or they may remain in place. If they remain, the street lights will be removed from the department inventory so that Public Works is not responsible for their energy consumption and PWP shall be responsible for all associated maintenance costs.

G.10 Grading and Drainage

The site drainage system will provide storm water conveyance to convey rainfall in the entire disturbed are of the site. Pipes will connect into the 6' x 4' box culvert running through the site and will be sized to accommodate flow from a 100 yr, 15 minute duration rainfall period (100-year storm event) and shall comply with Applicable Laws; including local and state codes and standards. Buildings and equipment shall be constructed in a manner that provides protection from such a 100-year storm. Design rainfall shall be 5 inches in 1 hour.

The design of the drainage system shall comply with all Applicable Laws, including federal, state and local regulations. Within the actual project site, buildings and equipment are constructed on foundations with the overall site grading scheme designed to route surface water around and away from all equipment and buildings. Storm water will be directed to catch basin and pipes as shown on the preliminary grading and drainage plan.
Spill containment areas shall be provided for equipment containing oil or chemicals. The containments shall be provided with sumps to pump out rain water or contaminated water. Plant drains will be routed to the existing GT3&4 oil/water separator be collected in a waste oil tank for transport to offsite recycling. Clean water from the oil/water separator shall be discharged into the Glenarm weir. All spill containment areas shall be set to gravity drain to grade with a lockable secondary valve similar to what exists at GT 3 & 4 GSU containments. Spill containment basin floor elevation and containment drains shall be sloped and designed and constructed in such a way as to permit complete drainage from the containment area, i.e. the invert of the drain pipe shall be at the same elevation or below the lowest elevation of the containment basin floor. The bottom elevation of these containment areas will need to be elevated for this purpose. All equipment containing oils or chemicals will need to have secondary containment unless noted otherwise.

G.11 Erosion and Sedimentation Control

Potential impacts to water resources during construction of the Glenarm Repowering Project include sediment-laden storm water runoff and potential contamination of surface waters by accidental spills of hazardous materials. Potentially minor releases during construction of the Project shall be avoided by the implementation of Best Management Practices (BMPs). Construction and operational activities will be performed in accordance with the California National Pollution Discharge Elimination System (NPDES) general permit for the discharge of storm water associated with construction activity, and the California NPDES general permit for the discharge of storm water associated with industrial activity and all Applicable Laws. The NPDES general Permit for the discharge of storm water associated with construction activity shall include development of a Storm Water Pollution Prevention Plan (SWPPP) meeting all state and EPA regulations and supporting PWP in updating their SUSMP permit. The SWPPP will implement measures to control erosion, sedimentation, release of contaminated runoff and will include drainage inspection reports and developing plans to show chemical areas, equipment storage areas, construction restrooms, and other items not directly related to drainage. The NPDES general permit for the discharge of storm water associated with industrial activity shall address potential storm water runoff of water quality constituents specifically related to the industrial activity, and specifies BMPs to control pollutant runoff.

An erosion control plan will be used at the site during the construction phase to control sediment-laden runoff and ensure the integrity of the storm water collection system during construction. The plan will use control measures, as necessary, such as sedimentation ponds and ditches, stabilized construction entrances, gravel-covered construction lay down area, silt fencing, and seeding of the disturbed area. Specifically, runoff from all affected areas will be diverted to the erosion control measures before discharging off site.

Upon completion of the project, areas disturbed by construction will be stabilized. After sediment removal and stabilization of the site, all construction sediment control measures will be removed.

G.12 Sanitary Sewer

One new sanitary sewer connections are available for BOP Contractor to make connections with the new Control Building and Water Lab Building. This is located approximately on the Tie Point drawing, M1-1-6

G.13 Facility Interfaces

Due to the brownfield nature of this site, there will be several interconnections that will need to be made. These are indicated on the Tie Point drawing, M1-1-6 and the P&IDs. Existing drawings for both underground and above ground have been provided for use in routing new piping and duct banks. Since there is no “one call” service available on the power plant site, the BOP Contractor will need to utilize these drawings and coordinate with the General Manager and PWP plant personnel to locate underground services. However, for work done under these specifications outside or adjacent to the property, the Contractor shall contact Southern California Dig Alert for mark-out before any excavation is performed. New underground plans shall include all underground facilities and shall clearly indicate interface, routing and terminal points needed for construction of the systems. Underground plans shall include, but are not limited to fuel gas, sanitary sewer, fire water, potable water, demineralized water, waste water, aqueous ammonia, storm drains, 34.5kV, 17.2kV, control systems interfaces, fire protection interfaces, intercom, fiber optics, potable water, equipment drains, grounding and electrical power.

H. STRUCTURAL REQUIREMENTS

H.1 General Requirements

This section describes the structural design basis for the facility's buildings, structures, foundations and general structural work. Importance factors and structural design criteria shall be confirmed with the General Manager before commencement of calculations.

H.2 Facility Loads

H.2.1 Design Loads

Design loads for all buildings, enclosures, modules, structures, equipment, equipment supports, structural elements and components, and connections shall be determined according to the criteria specified in this subsection unless the applicable building code requires more severe design conditions. Detail design loads shall be as listed in the 480020 Site Conditions document

H.3 Foundations

H.3.1 Foundations General

The equipment and building foundations shall be designed in accordance with the CBC 2013, equipment manufacturers' or building manufacturer's loadings and the Project Site soil conditions. In general, foundations shall project a minimum of 6 inches above finish grade, but shall not be a tripping hazard or access problem.

a. Both static and dynamic loading criteria as set forth by the manufacturer shall be considered in the gas turbine and generator (GTG) foundation design.

- Take into account the dynamic sub grade modulus of the soil to insure non-resonance.

- Spill containment shall be provided for GSU transformers, auxiliary transformers, and any other equipment containing 55 gallons or more of a combustible or hazardous liquid. Containment shall be designed to contain 110% of tank volume plus 25 year/24 hour storm rainfall criteria. Containment of the STG lube oil skid shall account for the volume of potential fire water spray inside the STG enclosure. A curbed area shall encircle the transformers or equipment with a low point sump supporting spill pump out for off-site disposal.
- Transformer firewalls shall be provided between oil-filled transformers and adjacent structures and equipment as required for separation. The walls shall be constructed from reinforced concrete. At a minimum, it is expected that there will be fire walls between each of the auxiliary transformers and the south edge of the transformer foundations to provide separation from the PDC.

H.3.2 Shallow Foundations

Shallow foundations may be used for lightly loaded structures such as pipe supports and minor equipment.

H.4 Concrete

H.4.1 Scope

This Section specifies cast-in place concrete, including reinforcement, concrete materials, admixtures, mix design, placement procedures, finishes and curing.

H.4.2 Steel Reinforcement

a. Reinforcing Bars: ASTM A 615, Grade 60, deformed. ASTM A 706 shall be used for any bars to be welded or per seismic requirements. Cooling tower steel shall be epoxy coated.
b. Plain-Steel Wire: ASTM A 82, as drawn.
c. Deformed-Steel Wire: ASTM A 496.
d. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.
e. Deformed-Steel Welded Wire Fabric: ASTM A 497, flat sheet.

H.4.3 Concrete Materials

a. Portland Cement: ASTM C 150, Type II, modified for alkali soil if required per Project Site soil conditions.
b. Water: Potable and complying with ASTM C 94.

H.4.4 Admixtures

General: Admixtures shall be certified by manufacturer to contain no water-soluble chloride ions by mass of cementitious material and to be compatible with other admixtures and cementitious materials. Admixtures containing calcium chloride shall not be used. Admixtures added to the concrete shall be in accordance with the manufacturer's recommendations and shall conform to the following:

a. Water-Reducing Admixture: ASTM C 494, Type A.
b. Air-Entraining Admixture: ASTM C 260.
c. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
d. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E.
e. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.

H.4.5 Concrete Mixes

Prepare a design mix for mass concrete and a design mix for the remainder of the site concrete with the strength of concrete determined by either laboratory trial mix or field test data bases.

a. Mix designs offered shall have a recent successful history of strength performance parameters as evidenced by documented use on other local projects as well as specific laboratory batch test reports for the mix proposed.

b. GTG and OTSG Foundation:

- Mass concrete mix shall minimize the weight of cement used in an effort to control the heat of hydration, while maintaining the required design strength.
- Proportion normal-weight concrete mix.
- Minimum Compressive Strength (28 Days): 4000 psi.

c. Footings and Foundation Walls:

- Proportion normal-weight concrete mix.
- Minimum Compressive Strength (28 Days): 3000 psi

d. Slab-on-Grade:

- Proportion normal-weight concrete mix.
- Minimum Compressive Strength (28 Days): 3000 psi

e. Electrical duct concrete encasement:

- The primary electrical duct banks shall be encased in red-dyed concrete for identification as a warning to any one digging into high voltage cable run.
- Proportion normal-weight concrete mix. Aggregate size shall be considered to ensure even distribution around conduits.
- Minimum Compressive Strength (28 Days): 3000 psi
- Burial warning tape shall be placed one foot above all duct banks.

f. Air Content:

- Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content of 3 percent within a tolerance of plus 1 or minus 1.5 percent, unless otherwise indicated.

g. Slump tests and 7-day and 28-day concrete strength tests shall be performed and logged. At a minimum, one set of cylinders shall be taken for every 100 yards of concrete placed per every day concrete is placed. Store cylinders on site in secured BOP Contractor-furnished concrete curing boxes.

H.4.6 Embedded Items

a. Anchor bolts:

- Anchor bolts shall conform to the requirements of ASTM F 1554, Grade 36 or A 307.
- Nuts shall be ASTM A 563, Grade A, heavy hex.
- Washers shall conform to ASTM F 436.
- Plate washers shall be ASTM A 572, Grade 50 material.
- All equipment anchor bolts shall be provided by the BOP Contactor.
- If the Contractor elects to use anchor bolt sleeves to permit minor adjustments after casting the anchor in concrete, the engineer of record shall provide embedment calculations which prescribe the depth of the anchor sleeve and shall demonstrate adequate strength inclusive of the use of the sleeve. Prior to grouting, water and debris shall be removed to ensure adequate grout flow around the sleeve (note – only steel sleeves will be permitted – no Wilson plastic anchor bolts sleeves will be allowed).

b. Structural steel embeds:

- Structural steel embedded plates, bars and shapes shall be fabricated from ASTM A 572, Grade 50 or ASTM A 36 shall conform to the requirements of the American Institute of Steel Construction (AISC).
- Embedments shall be blast cleaned in accordance with SSPC 6 "Commercial Blast Cleaning."
- Surfaces of embedments that will not be in contact with the concrete, except surfaces that will receive welding, shall be galvanized. Surfaces that will come in contact with the concrete and surfaces that will receive welding shall be protected with a solvent removable rustproof coating.
- Steel embeds shall be provided by the BOP Contactor.

c. Embedded trench and curb angles shall be provided complete with floor plate or grating. Embedded ledger angles for trenches shall be “W” style, i.e. shall be made of two angle shapes welded toe-to-toe rather than single angle. Embedded angles shall be hot-dipped galvanized.

d. Miscellaneous embedded items which are manufacturer's standard items shall be as shown on the approved design drawings, or a General Manager approved equal.

- Standard items shall have a zinc coating conforming to ASTM A 123, A 153 or A 525.

H.4.7 Finishing Floors and Slabs

General: Comply with recommendations in ACI 302.1R for screeding, re-straightening, and finishing operations for concrete surfaces.

a. Float Finish: Apply a uniform, level granular texture float finish to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.
b. Trowel Finish: Apply a smooth uniform trowel finish to floor and slab surfaces exposed to view or as required for surface finishes.
c. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps and exterior equipment maintenance slabs.

H.4.8 Grout

a. Grout: Grout shall be non-shrink, non-corrosive, non-staining grout.
b. The cementitious cured grout shall be natural aggregate (nonmetallic) grout:

- Grout shall be a premixed packaged type grout.
- Grout shall be installed in strict accordance with the manufacturer's directions. Restrained grout cubes shall be taken for every batch of grout made, or as agreed to with the (General Manager)
- Grout shall develop a minimum compressive strength of 5000 psi at 7 days, and 7000 psi at 28.

c. The epoxy grout:

- Epoxy grout shall be a premixed packaged type grout.
- Epoxy grout shall be installed in strict accordance with the manufacturer's directions. Restrained grout cubes shall be taken for every batch of grout made, or as agreed to with the Construction Manager (General Manager)
- Epoxy grout shall develop a minimum compressive strength of 8,000 psi at 24 hr. and 12,000 psi at 28 days.

d. Epoxy Adhesives:

- Epoxy adhesives shall be a two component, 100 percent solids, 100 percent reactive, moisture insensitive epoxy resin system.
- Adhesive shall conform to ASTM C 881 standard for Type IV epoxy resin adhesives.

e. Grout Uses:

- Unless modified by equipment manufacturer's recommendations, grouting for sole plates, jacking plates and other similar devices for equipment shall be accomplished using non-shrink grout.
- Grouting of machinery, pumps, compressors and other equipment having dynamic operating forces shall be in strict compliance with the equipment manufacturer's recommendations. If the equipment manufacturer's recommendations are not available, such machinery and equipment shall be grouted with non-shrink grout.
- Epoxy grout shall be used for high temperature, high load or dynamically loaded areas where cementitious grout is unsuitable.

- Grouting for tanks and vessels may be flowable non-shrink or dry pack grout.
- Column base plates having shear lugs, and column base plates to which access is limited, shall be grouted with non-shrink grout. Where accessible and without shear lugs, column base plates may be grouted with dry pack grout.
- Epoxy adhesives shall be used for anchoring reinforcing bars, dowels and anchor bolts into existing concrete.

H.5 Structural Steel

Comply with applicable provisions of the following specifications and documents:

a. Welding Standards: Comply with applicable provisions of AWS D1.1 "Structural Welding Code--Steel."
b. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

H.5.1 Materials

a. W-shapes: ASTM A 992.
b. Channels, Angles, S shapes: ASTM A 36.
c. Plates and Bars: ASTM A 36.
d. Cold-Formed Structural Steel Tubing: ASTM A 500, Grade B.
e. Steel Pipe: ASTM A 53, Type E or S, Grade B

   - Weight Class: As noted on drawings.
   - Finish: Black, except where indicated to be galvanized.

f. High-Strength Bolts, Nuts, and Washers:

   - ASTM A 325, Type 1, heavy hex steel structural bolts
   - ASTM A 563 Grade DH heavy hex carbon-steel nuts
   - ASTM F 436 hardened steel washers.
   - Finish: Mechanically deposited zinc coating, ASTM B 695, Class 50.
   - Direct-Tension Indicators: ASTM F 959, Type 325

g. Adhesive and expansion anchors: All post-installed anchors shall be covered by a valid ICBO Evaluation report. Adhesive anchors and expansion anchors to be used for exterior exposure shall be stainless steel.
h. Non-High Strength Bolts, Nuts, and Washers: ASTM A 307, Grade A; carbon-steel, hex-head bolts; carbon-steel nuts; and flat, unhardened steel washers.

   - Finish: Mechanically deposited zinc coating, ASTM B 695, Class 50.
   - ASTM A 307 bolts shall not be used unless noted on design drawings.

i. Shear Connectors: ASTM A 108, Grade 1015 through 1020, headed-stud type, cold-finished carbon steel, AWS D1.1, Type B.

   - Finish: Mechanically deposited zinc coating, ASTM B 695, Class 50.

j. Welding Electrodes: Comply with AWS requirements. Weld filler material shall be capable of producing welds with a minimum Charpy V-notch toughness of 20 ft-lbs at –20 0F.
k. Stainless steel bars and shapes: ASTM A 276, Type 304 or 304L as specified on the design drawings.
l. Rolled Stainless Steel Floor Plate: ASTM A 793, Type 304.
m. Grating: ASTM A 569, 3/16"x 1-1/4" bearing bars on 1-3/16" centers and cross bars spaced at 4" on center, serrated for outdoor use.
n. Metal Deck: ASTM A 653, Grade A, with a minimum coating class of G90 as defined in ASTM A 653.

H.5.2 Coatings

a. All outdoor structural steel shall be hot-dip galvanized.

b. All Stairs, ladders, safety cages and grating shall be hot-dip galvanized.

- Ladder rungs shall be of a non-slip design.
- Stair treads shall have a non-slip nosing.

c. Galvanizing shall be in accordance with the requirements of ASTM A 123, ASTM A 153, and/or ASTM A 653. Galvanized nuts and bolts shall conform to ASTM B 695.

- All surfaces shall be prepared in accordance with SSPC-SP8 "Pickling" or SSPC-10 "Near-White Metal Blast Cleaning" immediately prior to galvanizing.
- Galvanizing Repair Paint: High zinc dust content paint; Galvanox or approved equal.

d. Interior structural steel shall be shop primer painted. Exposed interior structural steel shall also be field finish coat painted.

- Steel surfaces to be painted shall be cleaned in accordance with SSPC SP-6 "Commercial Blast Cleaning".
- Primer paint: inorganic zinc oxide primer.
- Finish coat: epoxy polyamide paint.
- Structural steel exposed to chemical spills and vapors: chemical resistant epoxy paint.

H.5.3 Miscellaneous Metal Fabrications

Platforms, stairs, access ways, catwalks, stiles, and ladders shall be furnished and installed on BOP Contractor supplied equipment, vessels, tanks, etc. for access to gauges, valves, motors, switches, instruments, equipment, etc that require periodic inspection, access, etc. Platforms, stairs, and ladders shall also be furnished and installed on GTG Unit, vessels, tanks, etc. for access to gauges, valves, equipment, access ways, etc. to areas that require periodic inspection, access, etc and that are not already provided for by the General Manager's equipment vendors.

BOP Contractor shall be responsible to provide any additional platforms, etc. necessary to meet the maintainability of the equipment and local codes and standards, which were not provided by the equipment vendors.

H.6 Masonry

H.6.1 Performance Requirements

a. Concrete Unit Masonry: Net area compressive strength f'm = 1500 psi at 28 days.
b. Determine compressive strength of masonry by testing masonry prisms according to ASTM C 1314.
c. Comply with requirements of the International Building Code.

H.6.2 Concrete Masonry Units

a. Concrete Masonry Units: ASTM C 90 and as follows:

- Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi and as required to obtain specified masonry compressive strength.
- Masonry units shall include a water repellent additive in the block mix.
- Weight Classification: Normal weight.
- Provide Type I, moisture-controlled units.
- Size (Width): Manufactured to the following dimensions:
    - 8 inches nominal; 7-5/8 inches actual.
- Exposed Faces: Manufacturer's standard color and texture, unless otherwise indicated.

b. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification.

- Extended-Life Mortar for Unit Masonry: Mortar complying with ASTM C 1142 may be used instead of mortar specified above, at BOP Contractor's option.
- Limit cementitious materials in mortar for exterior and reinforced masonry to Portland cement, mortar cement, and lime.
- For reinforced masonry and where indicated, use Type S.

c. Grout for Unit Masonry: Comply with ASTM C 476.

- Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that shall comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
- Provide grout with sufficient slump for the specified construction application, measured according to ASTM C 143.

H.6.3 Reinforcing Steel

a. Uncoated Steel Reinforcing Bars: ASTM A 615; ASTM A 616, including Supplement 1; or ASTM A 617, Grade 60.
b. Masonry Joint Reinforcement: ASTM A 951
c. Ties and Anchors: Hot-Dip Galvanized Carbon-Steel Wire: ASTM A 82; with ASTM A 153, Class B-2 coating.
d. Steel Sheet, Galvanized after Fabrication: ASTM A 366 cold-rolled, carbon-steel sheet hot-dip galvanized after fabrication to comply with ASTM A 153.
e. Steel Plates, Shapes, and Bars: ASTM A 36.

H.7 Workmanship

H.7.1 General

All workmanship shall be in accordance with federal, state and local codes, regulations, laws and acceptable practices to ensure the work is fit for purpose and shall be serviceable for the design life of the facility.

The BOP Contractor shall submit to General Manager the drawings, specifications and calculations associated with the structural work.

Testing and Quality Assurance:

- Testing and quality assurance of structural construction work shall be comprehensive and in accordance with federal, state and local codes, regulations, laws and acceptable practices.
- Comprehensive testing, observation and inspection reports shall be submitted to General Manager on a regular basis as required.
- Structural tests, observations, inspections and special inspections shall be performed in accordance with the requirements of Chapter 17 of the IBC.

Non-compliant materials and workmanship shall be rejected and replaced at the expense and full liability of the BOP Contractor.

I. MECHANICAL REQUIREMENTS

I.1 General

This section describes the mechanical equipment and systems, their functions, and the criteria upon which their design shall be based.

The Power Island Equipment (PIE) Contract has been executed with General Electric Packaged Power, Inc. This contract is for the design, fabrication/manufacture and delivery for most of the major pieces of plant equipment. The pertinent sections of the GE contract have been included in section A.3.A for the BOP Contractor's information and use. The conformed specifications are also included in A.3.A to define the equipment being supplied as part of the PIE Contract. The Division of Responsibility in Section A.3.D and the Equipment List in Section A.2.E further differentiate between materials and equipment supplied by the PIE Contractor and the BOP Contractor. A high level summary of equipment supplied by the PIE Contractor is as listed below:

1. One LM6000 PG SPRINT Gas Turbine and auxiliaries
2. One OTSG Boiler with stack, damper, platforms, SCR equipment and tempering air fans
3. One Steam Turbine Generator, auxiliaries and enclosure.
4. One water cooled condenser
5. 2x100% Liquid ring vacuum pumps
6. 2x100% Vertical Circulating Water Pumps
7. One two-cell fiberglass framed counterflow Cooling Tower (erection by BOP Contractor)
8. 3x50% Vertical Auxiliary Cooling Pumps
9. 2x100% Condensate Pumps
10. 2x100% Condensate Polisher
11. 2x100% Boiler Feedwater Pumps
12. Steam Turbine Bypass Valve
13. 1 Three Winding 13.8-34.5kV GSU Transformer (dress out by BOP Contractor)
14. 2x100% rotary screw Gas Compressors
15. 2x100% Air Compressor/drier/receiver skids
16. Inlet Air Chiller and Performance Heater Skids and separate plate and frame heat exchanger.
17. One CEMS with stack / duct probes and umbilical cords
18. One each Auxiliary Boiler and Superheater

This list is not intended to be comprehensive; Contractor is responsible for fully identifying the scope of supply under the PIE contract by reviewing these specifications and attachments.

The remaining mechanical equipment will be furnished and installed by the BOP Contractor.

An Equipment List, M9-1, has been provided to clarify the equipment to be supplied by the BOP Contractor under this scope of work. Unless the supplier is listed as "Existing" or "By PIE Contractor" the equipment shall be designed and furnished by the BOP Contractor. Included with this scope of work package are specifications indicating the minimum standards for each piece of equipment to be supplied by the BOP Contractor, with data sheets on the anticipated process capacities. The equipment will still need to be detail designed by the BOP Contractor. The specifications for the specific equipment, coupled

with the site conditions document, the noise specification, the electrical-mechanical equipment, low voltage motor specifications and system P&ID, can be sent to equipment suppliers to obtain pricing.

A high level summary of equipment to be supplied by the BOP Contractor (the electrical equipment is listed in the electrical section, and the PCS is defined in detail in the controls section):

1. 1 x 100% Shell and Tube Aux Cooling / Bearing Cooling heat exchanger
2. A new ammonia forwarding pump skid to be located by the existing B-3 tank
3. The steam water analyzer / sample panel
4. 2x100% Bearing Cooling water pumps
5. 1 Bearing Cooling system expansion tank
6. 2 x 100% Condensate make-up pumps
7. 1 Condensate storage tank
8. Cycle chemical feed system
9. Cooling tower chemical feed system
10. Inlet filter house coil condensate sump and pumps
11. Weather station
12. 2x100% Demin water pumps
13. 2x100% Demin water forwarding pumps
14. 1 Demin water storage tank
15. 1 Fuel gas drains tank for gas compressors
16. 1 Fuel gas drains tank for final/last chance filter at gas turbine
17. 1 Turbine wash water tank
18. 2x100% Process drains forwarding pumps
19. Equipment drain sump and pumps
20. 1 Potable water recirculation skid for eyewash stations
21. 2 Air receiver tanks to be installed at GT 3 & 4
22. 1 Atmospheric flash tank with vent silencer
23. 2 x 100% Waste water transfer pumps
24. 1 Wastewater storage tank
25. 1 Sanitary sewer lift station
26. The Plant Control System (PCS)

This list is not intended to be comprehensive; Contractor is responsible for furnishing all equipment and apparatus, and associated process design necessary to provide a fully functioning plant in accordance with requirements of these specifications.

I.1.1 Gas Turbine

The prime mover for the Glenarm GT-5 project will be a General Electric LM6000PG aeroderivative gas turbine generator (GTG). This gas turbine is packaged differently than a classic PC SPRINT or NxGen. The PG comes equipped with an auxiliary module containing turbine lube oil, coolers, hydraulic start and water wash systems. Two NOx water injection pumps are located inside this module. This module, which normally is supplied without an enclosure, will be enclosed to limit noise migration from the starting motor and will require the design, furnishing and installation of fire protection by the BOP Contractor. . One unique aspect of the LM6000 PG is that is utilizes a planetary load gear since it was originally designed as a 50 hertz machine. This load gear and the GTG generator lube oil supplies are fed

from a separate mineral oil skid and reservoir, not in the generator skid frame as is common on a PC SPRINT unit. Since the GTG is water cooled, the primary auxiliary skid contains water to oil shell and tube heat exchangers for cooling the turbine oil. The generator and load gear skid is cooled by separate oil to water shell and tube exchangers. The GTG system also includes a CO2 turbine enclosure fire protection system, inlet air filtration system, inlet air chiller, inlet air heater, totally enclosed water to air cooled (TEWAC) generator, fuel gas system, and spray water inter-cooling (SPRINT) skid. A turbine control panel will be provided by the GTG vendor for incorporation into the Power Distribution Center and new control room, both of which will be provided by the BOP Contractor. The chiller and heater skids are mounted remotely from the GTG package as shown on M1-1 and further defined below.

The GTG Turbine Control Panel will be supplied with a means for the PIE Contractor to remotely monitor the LM6000 package. The BOP Contractor shall provide the means for this communication to take place, coordinating with the General Manager and the PIE Project Manager.

The filter house will be a pulse type and is mounted on free-standing columns. GE advises all pulse style filters require these supports and are not supported from the skid frame. GE does not permit the addition of loads to the filter house support structure; BOP Contractor will need to design, furnish and install piping and conduit supports which are structurally independent of the filter house structure. The filter house will be equipped with platforms and a ladder. These columns will need to be coordinated with the piperack location and arrangement. Other platforms for the GTG will be supplied by the BOP Contractor as defined in the Design Criteria.

The GTG will be supplied with a monorail assembly to allow the engine to be pulled to the south. The BOP Contractor shall install foundations for the monorail frame and a concrete pad for turbine removal. Anchor bolting for the installation shall be designed to allow repeated installation and removal and may comprise drop-in anchors for this purpose. The Anchoring system shall not present a tripping hazard when the frame is not installed; the pad and frame support foundations shall be flush with the adjacent grade. **BOP Contractor shall install the GTG engine utilizing the aforementioned monorail crane system, in conjunction with the crane furnished in the turbine package, in order to demonstrate its functionality.**

I.1.2 Once Through Steam Generator

The gas turbine connects with ductwork that conveys exhaust to the Once Through Steam Generator (OTSG) for combined-cycle operation. The OTSG is a single pressure non-duct fired unit supplied by IST. The ductwork system is designed to minimize pressure drop and distribute the exhaust gas to the OTSG inlet uniformly. 2x100% tempering air fans are supplied to maintain catalyst temperature in periods where feedwater is not admitted to make steam. The primary means of purging the OTSG will be by periodically rolling the gas turbine on the hydraulic starting motor.

The OTSG is a drum-free boiler with feedwater entering through IST supplied control valves at the top of the OTSG and exits as steam at the lower superheater section of the unit. The OTSG will be shipped as ductwork, stack sections, boiler modules and platforms. The boiler tubes, which are Inconell, will need to be welded together via orbital welding by the BOP Contractor utilizing IST for their proprietary methodology. This scope was excluded by the PIE Contractor, so the BOP Contractor will need to coordinate with IST for these services. Section 1 piping and valves on the feedwater and steam headers will be shipped as part of the PIE scope.

Selective Catalytic Reduction (SCR) units in the OTSG reduce concentrations of carbon monoxide (CO) and nitrogen oxides (NOx) in the exhaust gas. In the NOx SCR unit, the NOx are reduced to nitrogen and water. 2x100% blowers on the ammonia vaporization skid deliver vaporized aqueous ammonia to the NOx SCR for the reduction reaction. Heat for ammonia vaporization is via an electric heater on start-up and once up to temperature, a side stream of the turbine exhaust gas is ducted to the ammonia vaporization skid. In the CO catalyst, carbon monoxide is converted to carbon dioxide and water. The CO catalyst does not require any additional feed.

The SCR catalyst is loaded through an opening on the side opposite the GTG. A platform is provided at this location for receiving the catalyst modules and is installed by placing the catalyst on an IST supplied cart and rolling it down tracks mounted internally to the OTSG. The CO catalyst is installed by hand.

The OTSG exhaust system also includes a Continuous Emissions Monitoring System (CEMS) to monitor the exhaust gas before and after the SCR units to control and establish emissions compliance. The CEMS equipment follows a full extractive monitoring technique where sample gas is drawn directly from the stack, analyzed and represented as an electrical signal which is recorded and then digitally transmitted from the local equipment enclosure to a Data Acquisition/Reporting System. A hardwire communication channel(s) is also provided between the CEMS and the Plant Control System (PCS) and/or the Gas Turbine Control System for plant and gas turbine control and indication signals. The in situ monitors measure the gas characteristics on the stack and relay electrical signals proportional to the measurements to the CEMS shelter where they are handled in the same manner as the signals from the analyzers. GE will provide flow from the on-board fuel gas meter via modbus to the CEMS for gas measurement. BOP contractor will have to provide and install the cable.

The CEMS building will be located north of the OTSG, near the stack. The sample tubing supplied with the CEMS will need to be properly supported to the CEMS port stack platform as well as to the upstream connection near the GTG. The drains coming off of this building's HVAC system and other HVAC systems will need to be piped to an equipment drain so there is no puddling of water. To facilitate calibration gas change out, a concrete ramp will be supplied so that a hand truck can roll bottles in and out.

The CEMS includes a sample handling system, analyzers, calibration gases, controller units, ink jet printer, a Data Acquisition and Handling System (DAHS), and SCAQMD System RTU/Chart Recorders in a climate controlled equipment enclosure (CEMS shelter) as its principal components.

The OTSG receives feedwater from the boiler feedwater pumps. The high pressure steam generated in the OTSG is supplied to the steam turbine, the inlet air heater, gland steam system and the steam and water sampling panel.

As shown on the General Arrangement, a tube pull space is shown in accordance with the IST drawings. This pull space is elevated, but the area needs to be kept clear for maintenance access into the area south of the condensate polisher and west of the cooling tower.

The exhaust stack is equipped with a motor operated damper to "bottle up" the OTSG's residual heat upon shutdown and to protect the SCR and CO catalyst from rain damage when not in operation. This stack shall be remotely operable by a BOP Contractor-supplied hand-off-auto switch station located at grade. Consequently, stack damper being open shall be a permissive to begin gas turbine start-up.

I.1.3 Boiler Feedwater System

The Boiler Feedwater (BFW) system includes 2x100% boiler feedwater pumps. The boiler feedwater pumps receive condensate from the condensate polisher and deliver feedwater to the OTSG. Feedwater is also used for de-superheating/quenching the steam on the turbine bypass to the condenser as well as the attemperator on the outlet of the OTSG. The BFW pump minimum recirculation line is routed to the condensate storage tank.

I.1.4 High Pressure Steam

The HP Steam system extends from the OTSG Section 1 outlet connection to the steam turbine stop/control valve. HP steam can be bypassed to the water cooled condenser during startup or during a steam turbine trip. HP steam also supplies steam to the Gland Steam System and the inlet air heating skid. Any condensate formed in the HP steam piping is directed through drip legs to the atmospheric flash tank.

HP steam may also be vented through an IST supplied start-up vent valve. This valve will be located in BOP piping of the HP steam system and will piped back to the relief valve silencer mounted on the OTSG. The piping and supports between the start-up valve and the silencer will be supplied by the BOP Contractor. IST has advised the structural steel on the OTSG may be used to support this line.

A steam turbine bypass system shall be provided by the PIE Contractor to facilitate startup of OTSG. The system will have the capacity to bypass 100% of the total OTSG steam flow. The attemperation water for the steam bypass valve shall be drawn from the hotwell feed pump discharge header.

Drip pots shall be provided to remove the condensate from the system. Steam piping drains that originate closer to the OTSG shall be routed to the OTSG blowdown tank. Steam piping drains that originate closer to the STG shall be routed to the condenser or a drains tank.

The piping shall be routed to provide the shortest length consistent with a stress analysis designed to limit forces and moments on the OTSG and turbine-generator connections.

The BOP Contractor shall perform the pipe stress analysis of the entire steam piping, as well as any other high-energy piping subject to the analysis requirements of ASME code, and ensure that the forces and moments don't exceed the turbine nozzle loading conditions at the steam turbine or the OTSG. . BOP Contractor shall furnish these analyses upon request from the PIE Contractor and/or the General Manager.

Prior to putting the steam piping system into operation, the newly installed steam piping shall be steam blown. The steam blow will be a silent quenched blow. Targets shall be provided for the General Manager, the STG vendor and the BOP Contractor's records. All constant support and spring hangers shall be corrected to cold load, adjust all solid hangers to correct position, and remove all temporary hangers used in erection and testing. Due to the unique nature of the OTSG, the steam blow shall be done in a manner as to not allow the OTSG to free blow. Some form of a controlled pressure steam blow needs to be employed to prevent damage to the OTSG tubes. IST, the manufacturer of the OTSG, has advised that pressurizing the boiler and allowing it to free blow, as is commonly done with air blows will likely damage the OTSG tube assemblies. For this reason, the steam blow procedure shall be approved by IST and the General Manager prior to execution. Submit the steam blow procedure no less than 30 days prior to steam blow.

The BOP Contractor shall coordinate with the General Manager to notify the local community of the steam blow. Even though the blow shall be a silenced quenched blow, the presence of the steam cloud emitting from the site could be cause for alarm to the neighbors.

Auxiliary Steam

The Auxiliary Steam System provides low pressure steam to the gland steam system and the condenser hotwell during periods when the plant will be down to maintain vacuum and temperature for rapid start-up. When the plant is down the condensate pumps distribute condensate from the condensate storage tank to the auxiliary boiler feed pump and then the auxiliary steam skid where the steam is generated in the electric boiler and superheated in the electric superheater. The auxiliary steam is used in the gland steam system to maintain seals in the steam turbine when HP steam is not available and in the condensate hotwell to assist in condensate de-aeration when the OTSG is offline. The condensate system and the auxiliary cooling water system will need to operate at this time. Note that normally the gland steam condenser is cooled with condensate from the hotwell. For this project, due to the aux boiler addition, the gland steam condenser will be cooled by auxiliary cooling water.

I.1.5 Steam Turbine Interconnections

The Steam Turbine Generator (STG) system comes equipped with a gland steam system, totally enclosed water to air cooled (TEWAC) generator, lube oil system, lube oil purifier, hydraulic oil system, and condensate drains. The STG system receives high pressure steam from the OTSG. After expansion in the turbine, the steam is discharged axially to the condenser. Pressure and temperature of the gland steam from the HP steam header is regulated before it is supplied to the turbine seals then discharged to the gland steam condenser. Condensate is supplied from a branch off the main condensate header to the exhaust hood spray at the discharge of the steam turbine to regulate STG exhaust temperature.

I.1.6 Steam Drains System

The Steam Drains System collects drip leg drains, vents, and steam trap drains external to the steam turbine (ahead of the main steam stop valve) and drip leg drains from the gland seal system. The drip legs are equipped with redundant level switches on each leg. The drain valves are opened when the detected liquid level in each drip leg reaches a predetermined set point. Collected liquid drains by gravity to the atmospheric flash tank where pressure is released to atmosphere. On steam turbine start up, the flash tank will likely see a steady flow of steam and condensate above the normal operation for steam line warm-up so a silencer on the flash tank vent will be required to comply with the site noise requirements, Section 480033 Combined Cycle Balance of Plant Noise Control Performance. Service water is sprayed into the atmospheric flash tank to condense flash steam. Condensate is transferred from the atmospheric flash tank to the cooling tower basin by the process drain forwarding pumps. The specifications for this BOP Contractor supplied equipment are included in A.2.

Condensate from steam drains off the steam turbine casing and after the main steam stop valve are collected and gravity fed to the condenser and returned to the steam cycle.

I.1.7 Steam and Water Sampling

The Steam and Water Sampling System provides a means to monitor the effectiveness of plant steam cycle and associated water chemistry control measures. Controlled water chemistry is critical to the

operation and material protection of the Once Through Steam Generator (OTSG), the Steam Turbine Generator (STG), and all associated support components. Sampling connections are provided to monitor the quality of the steam, boiler feedwater, condensate (pre- and post-polish), circulating water, and demineralized water. Sample analysis provides data to detect any deviations from control limits so that appropriate corrective actions can be taken.

Cooling water to the steam and water sample coolers is provided by the Bearing Cooling Water System.

The steam water analyzer and cooling skid will be mounted within the new lab building located to the south of the OTSG. As discussed in the Architectural section, the analyzer skid will need to have access to the back side for maintenance. The specifications for this BOP Contractor supplied equipment are included in A.2

I.1.8 Cycle Chemical Feed System

The Cycle Chemical Feed System treats the condensate and boiler feedwater to minimize corrosion and scale formation inside the associated heat transfer surfaces, pumps, valves, and piping. The Cycle Chemical Feed System consists of two subsystems, which operate independently of each other: oxygen scavenger feed and pH control feed. The system will consist of metering pumps taking suction from exchangeable totes/containers and injecting into the system as indicated on the P&IDs.

Although makeup water for the steam cycle is demineralized and the condensate water continuously has its non-condensable gasses removed via the condenser vacuum pumps, small amounts of oxygen and chemical contaminants may still remain. Under high temperature conditions, even minimal impurities can cause internal metal corrosion and the formation of chemical scales or "fouling" on heat transfer surfaces. Oxygen scavenger and pH control solutions are injected into the main condensate header downstream of the condensate polisher. Stainless steel piping will be used for condensate service between the condensate hotwell and the OTSG to reduce the potential for corrosive attack and minimize oxygen scavenger consumption rates.

The cycle chemical feed system skids will be located north of the OTSG on the east end of the pipe bridge to facilitate tote exchange. The pump skids and totes shall be located in a secondary containment. The specifications for this BOP Contractor supplied equipment is included in A.2

I.1.9 Gland Steam System

A shaft sealing system is required to keep high pressure steam inside the turbine from leaking into the turbine enclosure, as well as to keep air from leaking into the vacuum and sub-atmospheric areas inside the turbine and condenser. The system operates automatically at all turbine loads, back pressures, and all contract-specified steam supply pressures. Manual control can also be exercised when needed to override the automatic control. The Gland Steam System (GSS) comprises packings, all the necessary regulators, valves, valve operators, controllers, instruments and protective devices to allow fully automatic operation of the system.

At certain locations in the steam turbine, it is necessary to prevent excessive leakage of steam along the rotor surface. In addition, steam leaking to atmosphere must be prevented at the ends of the rotor. Segmented, spring-backed, metallic labyrinth packing is normally used for this service. This form of packing locates a series of sharp edged rings or “teeth” in close proximity to the rotor surface. At the rotor

ends, a series of such packing rings are situated, with individual chambers provided between each adjoining pair of rings.

Each chamber has a leak-off line to convey steam (or steam and air) either to or from this zone. The leak-off line at the outboard end of packing is connected to a gland exhauster system, which holds the operating pressure slightly below atmospheric pressure. The gland exhauster line carries a mixture of air and steam fluids. The next inner leak-off line is termed the steam seal line, and operates at a pressure slightly above atmospheric. The pressure in this steam seal line is regulated by the steam seal valves to maintain the appropriate operating pressure. The packing cells at the high pressure end of the turbine may be connected by "re-entry lines" to appropriate points in the turbine steam path, or to appropriate extractions.

The gland exhaust system is provided to prevent the steam-air mixture from venting outside the gland packings. The leak-off lines are piped to the shell side of the gland steam condenser heat exchanger where the steam is condensed from the mixture and the condensed water is returned to the main unit condensate system. The heat exchanger is cooled by auxiliary cooling water which returns the heat to the cooling tower. A motor driven gland exhaust blower is mounted on the outlet of the gland condenser. The blower provides a negative pressure to the gland exhaust system and pushes the residual saturated air to an outdoor vent.

During normal operating conditions, steam for the gland steam system is generated in the OTSGOTSG. The auxiliary boiler provides steam to the gland steam system during plant downtime and into plant startup until the OTSGOTSG can provide steam with adequate temperature and pressure.

I.1.10 Condensate System

The water-cooled condenser receives steam from the steam turbine exhaust and makeup water from the Demineralized Water System. The condensate pumps deliver condensate from the condenser hotwell via 2x100% vertical can condensate pumps to the condensate polisher and ultimately to the boiler feedwater system, the condensate storage tank, the Gland Steam System, the steam turbine exhaust hood cooling sprays, and the steam turbine bypass attemperator. The condenser and condensate pumps are sized for 100% STG bypass operation including attemperation spray for the turbine bypass valves.

The condensate is treated with pH Control and Oxygen Scavenger chemicals by the chemical feed system injection quills. These chemicals are added to the condensate polisher effluent, before the boiler feedwater pump. The Condensate system is sampled at three locations: the influent to the CDS polisher, the CDS polisher effluent and at the BFW pump discharge downstream of the chemical feed injection point. The condensate hotwell pumps are vented back to the condenser to prevent air binding. Minimum recirculation for the CDS hotwell pumps is routed to the condenser.

The condensate storage tank is of sufficient size to hold the volume supplied in the condenser hotwell as well as a full drain of the OTSG for dry run operation and includes estimated 50% margin. The condensate pumps deliver condensate to the condenser hotwell for initial fill and as required for steam cycle makeup. The specifications for the BOP supplied condensate forwarding pumps and condensate tank are in section A.2.

I.1.11 Condenser Air Extraction

The Condenser Air Extraction equipment is designed to continuously remove air and associated water vapor from the condenser. During startup, two liquid ring vacuum pumps are used to evacuate the steam side of the main condenser to allow the turbine to be brought online. During normal operation, only one vacuum pump is required to maintain vacuum.

Two vacuum pump coolers are also included and use auxiliary cooling water for cooling.

I.1.12 Circulating Water System

The Circulating Water system rejects heat from the water-cooled condenser through the cooling tower. Water is pumped by 2x100% vertical circulating water pumps through the water-cooled condenser and returned to the two cell cooling tower and then back to the basin. Two intake screens per circulating water pump shall be provided to remove debris from the water stream to prevent plugging of the water-cooled condenser tubes. A monorail with an electric hoist shall be supplied to pull the trash screens and wash them down to the wash down sump shown on the civil drawings. The cooling tower basin also receives flow from the steam drains, condensate from the chiller coils, service water, and auxiliary cooling water. The Auxiliary Cooling Water return is through the Circulating Water system return header to the cooling tower.

To prevent water hammer in the circulating water system, the circulating water pumps will need to be started against a closed valve and then gradually opened. Motor operated butterfly valves are to be provided for this purpose. Additionally, tilted-disc check valves with integral damping systems shall be provided to prevent water hammer upon shutdown of one or both pumps. Valmatic tilting disc check valves with oil dashpots shall be provided as found here: http://www.valmatic.com/tilteddisccheck.html. When one pump is running, the other pump's discharge valve will be closed. The pumps are also provided with anti-reversing motor ratchets to prevent the pumps from rotating backwards when switching pumps.

The routing for the circulating water piping will be to leave the circulating water pipes, enter the ground to a common header, head west underground to the condenser under the north road where it will come up under the condenser water box inside the STG enclosure, then the return line will also go underground, turn east under the north road and return to the cooling tower on the east side of the tower. The design intent with the aforementioned routing is to place the circulating water piping underneath the asphalt-paved areas in order to facilitate any future replacement or maintenance of the circulating water piping. The circulating water piping risers need to be adequately designed to be free standing without additional structural supports. Risers shall be protected from vehicle damage by a minimum of three removable bollards each. Riser isolation valves shall be located such that the manual valve operators are accessible from grade or a BOP Contractor furnished platform; a remote mounted hand-off-auto switch station alone will not be acceptable. The BOP Contractor will need to coordinate where the auxiliary cooling water return line intersects with the circulating water return line.

The pull space shown on the south side of the condenser needs to be considered for piping runs and equipment that will be located under the piperack north of the OTSG.

I.1.13 Auxiliary Cooling Water System

The purpose of the Auxiliary Cooling Water (ACW) system is to transfer heat from the chiller package, the vacuum pump coolers, the gland steam condenser and the closed loop of the Bearing Cooling Water

system to the cooling towers and dissipate that heat to atmosphere. 3x50% vertical pumps draw water from the cooling tower basin for the ACW system and control valves balance the flow between the chiller package, the vacuum pump coolers, and the Bearing Cooling Water system. The purpose for three 50% pumps is that the chiller load is approximately half of the load of the entire aux cooling system. Should the chiller need to be out of service, there needs to be a way to stop the flow to the chiller without putting double the flow through the shell and tube heat exchanger. In periods when the chiller is not operating, only one pump will need to run. The third pump is an installed spare, but will need to be operated in rotation to equalized usage.

I.1.14 Bearing Cooling Water System

The Bearing Cooling Water (BCW) System circulates water in a closed loop around the combined cycle plant collecting heat loads from major plant equipment. This is being supplied to maintain water chemistry and cleanliness to the equipment coolers. Major plant equipment includes GTG coolers (Turbine Lube Oil, TEWAC Generator and Lube Oil), STG coolers (Turbine Lube Oil, TEWAC Generator and Lube Oil), Fuel Gas Compressors (compressed gas and lubricating oil), and Sample Panel coolers. The system transfers this heat to the auxiliary cooling water system (and to the cooling tower) via the auxiliary cooling water shell and tube heat exchanger. The specifications for this BOP Contractor supplied equipment are included in A.2.

When BCW system blow down is necessary, water is discharged to the cooling tower basin. The BCW system is connected to the Demineralized Water system for clean make-up water.

I.1.15 Cooling Tower Chemical Feed System

The Cooling Tower Chemical Feed System provides protection of the main Circulating Water System and the Auxiliary Cooling Water System against scaling and corrosion. In addition, the Cooling Tower Chemical Feed System provides control of bacterial slime and algae that could affect heat transfer, impair flow distribution, and cause deterioration of materials.

The Cooling Tower Chemical Feed System consists of five chemical subsystems which operate independently of each other: bromine biocide feed, corrosion/scale inhibitor feed, sulfuric acid feed, Biocide A feed, and Biocide B feed. Sulfuric acid reduces alkalinity in order to minimize the scaling tendency of the circulating water. Corrosion/Scale Inhibitor reduces corrosion of materials and scale deposition. Three biocides control the growth of microorganisms and algae.

The Cooling Tower Chemical Feed System will be located to the south of the cooling tower. The pump skids and totes shall be located in a secondary containment. The specifications for this BOP Contractor supplied equipment are included in A.2.

I.1.16 Aqueous Ammonia System

The aqueous ammonia system supplies 19% aqueous ammonia to the Ammonia Vaporization skid at the OTSG at the desired pressure and flow. The aqueous ammonia is used in the SCR as a reducing agent. The SCR catalyst in the presence of a reducing agent will decompose nitrogen oxides (NOx) contained in the flue gas into nitrogen (N2) and water vapor (H2O).

The existing 29% solution aqueous ammonia storage tank will be re-purposed for use on the GT-5 Repowering Project, once B-3 has been shut down. A new pump skid will replace the existing pump skid at this tank. There will be a maximum 90 day interim period where B-3 is permitted to and must remain on line while commissioning GT-5. During this time, GT-5 will use a temporary connection to the GT-3 & GT-4 19% aqueous ammonia tank and the pumping skid will be set in a temporary (or permanent – coordinate with the General Manager) location. The B-3 tank fill line will be modified to become the GT-5 supply line to prevent the need to run a new double wall stainless steel piping system through the 42" Glenarm-Broadway culvert/tunnel. The B-3 tank will be filled by cross tying the GT 3 & 4 ammonia tank fill line at a location in close proximity to both the B-3 and GT 3 & 4 tanks. A new three-way valve will be supplied to prevent filling both tanks at the same time. Additionally, the existing isolation valves will be used to control flow to the tanks. A new control valve shall be installed at the B-3 tank as well. The existing tank vapor recovery/vent lines will still be utilized when tank filling. The current B-3 fill line will need to be cut at the Glenarm tunnel vault, the line to the filling station capped, and a new line run to the GT-5 vaporization skid. Drawings SKM1-7, 8 and 9 were developed to illustrate the Existing, Interim and Final piping and ammonia skid configurations. The existing pipe fill and vent evacuation systems with air operated diaphragm pumps will remain in place to clear the lines when not in use. The specifications for this BOP Contractor supplied equipment is included in A.2.

I.1.17 Fuel Gas System

The Fuel Gas System will utilize a branch from the existing main fuel gas supply line to Units GT-1 and GT-2 on East Glenarm Street. Fuel gas will be metered, filtered for solid and liquid particulates, and compressed to meet turbine fuel gas pressure requirements. The BOP Contractor shall run the new gas pipelines underground to the suction of the new gas compressors skids. The existing concrete paving will need to be neatly saw cut and replaced in kind. The gas line shall be buried to at least three feet of cover and a pipeline warning tape shall be installed one foot above the pipe. Provide cathodic protection as required. The BOP Contractor shall coordinate to receive a pulse from the SEMPRA supplied meter back to the Plant Control System. New conduit will need to be routed with the gas line for this purpose. Additionally, the BOP Contractor shall run a power supply in underground conduit to supply the SEMPRA meter with whatever power requirements the meter has. Underground drawings have been provided to assist with the routing.

2x100% rotary screw compressors with suction scrubbers, discharge filter/separators, and oil separator will deliver high pressure fuel gas meeting the supply requirements of the gas turbine manufacturer. Bearing Cooling Water will be supplied for the fuel gas discharge heat exchangers and the on skid equipment coolers.

The Fuel Gas System includes a final fuel filter to capture remaining solid and liquid particles to ensure fuel gas quality entering the turbine accessory module and subsequently the turbine combustion chamber is compliant with the turbine manufacturer's fuel gas specification.

Two drains tanks will be furnished by the BOP Contractor, the gas compressor drains tank and the final fuel filter drains tanks. The specifications for these tanks are included in section A.2.

I.1.18 Service Air System

The service air system will provide filtered, oil-free, dried air to Unit GT-5 to support miscellaneous air tool operation. BOP Contractor shall install up to twelve (12) air tool stations throughout the plant as

determined by the General Manager. The service air and instrument air systems share equipment and are located on the same skid. The service air system includes flow limiting valves at each air tool station to ensure that flow to the instrument air system is prioritized. A single connection between the GT-5 air system and the GT 3 & 4 air system will be made before the instrument and service air headers split on GT 3 & 4. Two new 100 gallon air receiver tanks will be supplied and installed by the BOP Contractor at the GT 3 &4 site, located as directed by PWP. These tanks will be lined to prevent condensate corrosion.

I.1.19 Instrument Air System

The instrument air system will provide filtered, oil-free, dried air to Unit GT-5 to operate instrumentation, pneumatic-operated valves and equipment. The service air and instrument air systems share equipment and are located on the same skid. Flow to the instrument air system is prioritized by flow limiting valves in the service air system.

I.1.20 Firewater System

The existing Firewater System will be expanded to provide fire protection for Unit GT-5 and associated equipment. The expanded system will include an additional firewater underground header loop, additional hydrants, and a new fire department connection to ensure fire fighting water is immediately available in the event of an emergency at Unit GT-5. Firewater supply risers will be brought into the STG enclosure to address the STG enclosure pre-action sprinkler, the STG lube oil deluge system and the STG bearings pre-action system. Another connection to the firewater supply loop will be made available for the Control Building fire protection system. A new fire water supply will need to be made for the Maintenance Building and its basement area. The Water Lab Building, the cooling tower, the GTG auxiliary skids and the cable tray area below the Power Distribution Center will all be fed from the new fire water loop on the Glenarm property.

The fire protection systems have been defined by separate specifications located in Section A.2. Specs for fire protection, prevention and alarms have been included. These specifications, coupled with the P&IDs and the physical building and site drawings can be used to obtain pricing for this scope from a fire protection subcontractor.

The fire protection systems shall be designed in accordance with NFPA 850, plus all applicable local, county, state, and federal codes and regulations. The EPC Contractor shall secure all permits and approvals for the fire protection systems as required by local, state, and federal regulations.

Cable trays shall not be routed through high risk or high temperature areas. When unavoidable, provide sprinkler coverage. Proper segregation is required between fire system cables and all other plant cables.

Fire separation walls shall be provided between transformers and other transformers or structures located within minimum NFPA spacing requirements, based upon transformer insulating oil capacity.

Portable fire extinguishers rated for Class A, B, and C fires shall be located throughout plant areas requiring manual suppression capability in accordance with local building codes and NFPA10 requirements. Portable CO2 extinguishers shall be located in areas containing sensitive electrical equipment, such as the control room and the electrical rooms.

I.1.21 Service Water System

The Service Water system delivers water from the City of Pasadena water supply connection to service water stations strategically placed around the plant. In addition, this system provides potable water to the plant, make-up water to the Cooling Tower for use in the Auxiliary Cooling Water System and the Circulating Water System, and make-up water to the Chilled Water Package. Service Water also serves as quenching water for the atmospheric flash tank.

I.1.22 Demineralized Water System

Demineralized water for Unit GT-5 will be provided by the existing demineralized water treatment system and stored in a new 109,000-gallon demineralized water tank. New forwarding pumps will be located at the existing demineralized water tank for GT-3 and GT-4 to forward water to the new GT-5 demineralized water tank. A bypass around the GT-3 and GT-4 tank will be provided should those units be down for service. Demineralized water pumps at the new GT-5 tank will transfer the water to users. Demineralized water is used in the condensate and bearing cooling water systems during initial fill and as make-up water, by the GTG NOx water injection and SPRINT skids, and for washing the gas turbine compressor section.

I.1.23 Potable Water System

The potable water system includes a head tank, recirculation pumps, a water heater, and emergency eyewash and shower stations as shown on the P&IDs. The emergency eyewash and shower stations are located throughout Unit GT-5 equipment area as shown on the P&IDs. Potable water is supplied by the service water system. The potable water system also includes new connections to the Control Building and Water lab

I.1.24 Chilled Water System

The gas turbine inlet air is directed through an arrangement of water coils located in the inlet air filter house, downstream of the filters. These inlet coils cool the inlet air to allow an increase in mass flow of air to the gas turbine compressor during inlet air chilling and decrease the mass flow of air to the gas turbine compressor during inlet air heating.

During inlet air chilling, the inlet air passes through the inlet chilling coils, reducing the dry-bulb temperature to a predetermined value, approximately 50-60°F. Moisture in the inlet air will condense and form droplets on the coils. These droplets of condensate are collected in a sump and pumped to the cooling tower for use as make-up water.

During inlet air heating, the chilled water is heated by high pressure steam in a shell and tube heat exchanger. The heated water is then used to heat the inlet air via the coils in the filter house.

A plate and frame heat exchanger is supplied by the PIE contractor to rapidly cool the heated water when switching over to chilling mode. The heat exchanger will be cooled by auxiliary cooling water from the cooling tower basin. An additional benefit of this heat exchanger is the operators may use it during potential icing conditions to heat the inlet air through the filter house coils, even if only using the heat from the cooling tower water.

I.1.25 Wastewater Collection System

Wastewater from Unit GT-5 includes cooling tower blow down and condensate polisher discharge during draining or flushing. This wastewater will be stored in a new 88,000-gallon wastewater storage tank prior to discharge to the Glenarm weir.

Potentially oily equipment drains from Units GT-3, GT-4, and GT-5 are another source of wastewater. These drains will be directed to the existing GT 3 & 4 oil water separator (OWS) for oil removal then pumped to the new wastewater storage tank. The OWS has a maximum flow rate of 100 gpm.

A single waste water lift station will transfer oily waste from equipment drains to the existing OWS.

A sanitary lift station will be installed near the water lab to transfer the waste from this location to the existing sewer line at Fair Oaks (tie point 28 on M1-1-6). If required due to the sanitary sewer elevation, another lift station may be required for the Control Building to enter this same tie point.

Wastewater will be discharged from the new wastewater storage tank to the Glenarm weir at a flow rate equal to or less than the permit limit of 191 gpm. The BOP is responsible for designing the wastewater system so that it will not exceed this rate. The wastewater storage tank is being provided as a ballast in the system.

Gas turbine wash water will be stored in the Turbine Water Wash Drains Tank for disposal off-site. The tank volume is 1,000 gallons to allow for storage of approximately 3 wash cycles before disposal is required.

I.2 Safety

Combination safety shower and eyewash stations shall be provided near hazardous materials as required by codes and standards. This shall include areas where chemicals are present such as battery rooms, chemical feed areas and chemical unloading and mixing areas. Safety showers shall be provided with a flow switch integral to shower fixture. The safety shower shall alarm to the control room.

I.2.1 Emergency Safety Shower and Eyewash Station (combination unit)

A free standing pedestal eyewash and drench shower combination meeting ANSI and OSHA standards shall be provided outdoors near hazardous chemical storage and use areas. The eyewash shall have a stainless steel eyewash bowl, twin surge heads with automatically releasing dust covers, dual automatic pressure regulating flow controls, chrome plated brass stay-open eyewash valve and a large stainless steel paddle for hand operation. The drench shower shall have an ABS plastic head activated by a rigid stainless steel pull rod. The combination unit shall be equipped with scald protection bleed valve and audible/visual alarm system with remote indication (Haws or equal).

At a minimum, install an emergency eyewash/safety shower as indicated on the P&IDs:

I.2.2 Emergency Eyewash Station

An emergency eyewash station shall be located indoors near hazardous chemical storage and use areas, such as electrical rooms with stationary battery systems and laboratory chemical use areas. The emergency eyewash station shall be the 15-minute gravity-fed type with two 3.75 gallon cartridges and integral fluid reservoir (Eyesaline Pure Flow 1000 with cartridges or equal).

At a minimum, install an emergency eyewash station in the following locations:

- Electrical Rooms (several locations)

I.3 Pumps

Specifications for the BOP Contractor procured pumps have been provided in Section A.2. At a minimum:

Pump selections shall be made such that the best efficiency point on the pump curve coincides with the rated design operating conditions. Pump head capacity characteristics shall be steadily rising from the operating point to the shut off head.

All pumps shall be dynamically balanced and shall operate without excessive vibration.

Pumps shall be provided with 100% or N+1 redundancy.

Pump impellers shall be at least one size larger than the minimum impeller diameter and at least on size smaller than the maximum impeller for the pump casing is preferred.

The BOP Contractor shall select suitable materials for pumps based on the fluid analysis and technical requirements.

The electric motors shall be NEMA premium efficiency, server duty, totally-enclosed with a service factor of 1.15.

Centrifugal pumps over 25 HP with variable flow requirements shall be provided with a dedicated recirculation line and orifice for pump minimum flow protection. The recirculation line shall normally be routed to the source from which the system is taking suction. Permanent or startup strainers shall be installed in the suction piping of pumps that operate with close clearances.

Each pump shall be provided with a suction and discharge isolation valves and pressure gauges. Pumps connected in parallel shall be provided with discharge line check valves.

I.4 Pressure Vessels

I.4.1 Specifications for the BOP Contractor procured vessels have been provided in Section A.2. At a minimum:

Pressure vessels shall be designed, fabricated, and stamped in accordance with ASME Section VIII, Division 1, Pressure Vessels. Pressurized vessels shall be supplied with the following features: process, vent, and drain connections for startup and maintenance; a minimum corrosion allowance of 1/16 inch for carbon steel vessels; a minimum of one manhole and one air ventilation opening on vessels where maintenance or cleaning access is required; relief valves in accordance with applicable codes.

I.5 Tanks

I.5.1 Specifications for the BOP Contractor procured tanks have been provided in Section A.2. At a minimum:

Overflow connections and lines shall be provided and shall be at least one pipe size larger than the largest input line or combination of inputs that can discharge simultaneously. Maintenance drain connections shall be provided. Overflows and drains shall be routed to the drains sump via the facility drains system (bypassing the oil water separator for clean water tanks).

I.6 Heat Exchangers

I.6.1 Specifications for the BOP Contractor procured heat exchanger have been provided in Section A.2. At a minimum:

Shell and tube heat exchangers shall be designed with provisions for either tube bundle replacement or individual tube replacement in place. The heat exchangers shall be located such that this replacement can be accomplished without disconnecting or moving the heat exchanger. Heat exchangers shall be designed to facilitate cleaning of flow surfaces. Thermal relief and pressure relief valves shall be provided for all heat exchangers in accordance with applicable codes. The piping design shall accommodate heat exchanger expansion.

I.7 Piping

I.7.1 General

A piping material service index and specifications have been provided in Section A.2. Pressure test points shall be equipped with isolation valves and caps.

Filters shall be provided as duplex type or similar type to allow for on-line cleaning/change out.

Piping and conduit risers shall be located in protected areas that will not interfere with normal access and maintenance activities. Risers located in unprotected areas shall be protected with bollards.

All gas vent piping, relief valve vent piping, and any other vents which would be hazardous to personnel or equipment shall be vented to a safe location extending at least 12 feet above the gas turbine enclosure, above grade, or above personnel access platforms as dictated by the circumstance. Process vents and relief valve vents which meet the hazardous criteria above but contain liquids shall be routed to no more than 12” above grade or respective process drain to prevent personnel or equipment from exposure to sprays or showers.

Piping material downstream of filters for the lube oil supply system, seal oil supply system, instrument air system and natural gas system shall be stainless steel. All piping for demineralized water shall be stainless steel. Piping material and wall thickness shall be designed for the most adverse anticipated service conditions.

All vent and drain valves normally used during facility operation shall be capable of being operated from ground level, by either using remote operators or secondary valve at ground level.

All piping components requiring periodic servicing or operation shall be accessible from ground level or provided with platforms.

Piping taken out of service shall be abandoned in place with tack welded plate or screen over open end.

I.7.2 Piping, Valves and Specialties

The pre-approved BOP-supplied piping and valves for each system are listed in the Service Index (Drawing M9-2). The Service Index indicates the design pressure and temperature ranges for the materials selected. The pipe specifications included in the Service Index may be found in 485100.01 Pipe Material Specifications. The valve specifications included in the Service Index may be found in 485100.03 Valve Material Specifications. BOP Contractor shall contact the General Manager for approval of any changes to the Service Index if detailed design calculations demonstrate that materials other than those listed for each system are required.

The piping and valve specifications shown on the Piping and Instrumentation Diagrams correspond to those listed in the Service Index. Pipe diameters included in the P&IDs are based on preliminary design. BOP Contractor is responsible for final piping and valve material selection and sizing to meet process design conditions and shall guarantee that line losses will not affect Power Island Equipment Performance and Noise Guarantees. Pipe diameters may be increased where needed. BOP Contractor shall obtain General Manager's approval before decreasing pipe diameters or changing the pipe or valve specifications shown on the P&IDs.

I.7.3 Noise considerations

All piping supplied by the BOP Contractor shall take into consideration the potential noise signature it may have during operation. Refer to Section 480033 Combined Cycle Balance of Plant Noise Control Performance for requirements. Sizing for pressure drop, velocity as well as the routing need to be factors considered when designing high energy or other systems that may have the potential for noise.

I.7.4 Piping Systems

Piping systems shall be designed in accordance with the Power Piping Code, ANSI B31.1. The piping material selection shall generally comply with the Service Index, M9-2 found in A.2:

All 2" and under (small bore piping) shall be minimum Schedule 80 (with the exception of stainless steel piping).

Underground gas piping shall be provided with a factory applied high-quality fusion bonded epoxy coating system. While selecting the coating due consideration shall be given for pipe handling, moisture adsorption, operating temperatures of the pipeline, nature of the soil in contact, adhesion characteristics and dielectric strength.

HDPE piping systems shall be designed and installed in strict compliance with pipe manufactures recommendations. Joint welds shall be performed by properly trained personnel using manufacturer approved equipment. The design shall consider both temperature (and associated pressure de-rating) and chemical resistance limitations of the material. HDPE pipe used in Potable Water or Fire Water systems shall have appropriate approvals (NSF or FM) and be acceptable to the local authority having jurisdiction (AHJ).

I.7.5 Piping Systems with Design Temperature Greater than 300°F

Piping in these systems, 2-1/2 inch diameter and larger, shall have the following analysis performed using computer techniques:

a. Thermal flexibility analysis.
b. Dead weight analysis that defines support points, loads and deflections.
c. Stress summaries for the above to satisfy Code requirements.

For piping in these systems, 2 inch diameter and smaller either computer analysis techniques or power piping code approved manual techniques shall be performed to assure adequate flexibility and support.

I.7.6 Piping Systems with Design Temperature Less than 300°F

Piping in these systems, shall be analyzed using either computer techniques or power-piping code approved manual techniques to assure adequate flexibility and support.

I.7.7 Pressure Boundary

The pressure integrity of all piping systems shall be designed in accordance with the power piping code with a minimum design allowance of 1/16 inch on wall thickness. Extra wall thickness shall be provided for such lines as flashing condensate returns or, as needed, for sound attenuation after pressure reducing stations.

I.7.8 Pipe Sizing

Pipe sizes shall be determined primarily on the basis of allowable pressure drop for the service, but the following velocity limits shall apply:

a.	Gases:	8” NPS and above	5000 ft/min
b.	Gases:	2-1/2” NPS to 6” NPS	4000 ft/min
c.	Gases:	2” NPS and below	3000 ft/min
d.	Liquids – Pump Suction:	8” NPS and above	6 ft/sec
e.	Liquids – Pump Suction:	2-1/2” NPS to 6” NPS	5 ft/sec
f.	Liquids – Pump Suction:	2” NPS and below	2 ft/sec
g.	Liquids – Pump Discharge:	8” NPS and above	15 ft/sec
h.	Liquids – Pump Discharge:	2-1/2” NPS to 6” NPS	10 ft/sec
i.	Liquids – Pump Discharge:	2” NPS and below	5 ft/sec
j.	Liquids – Gravity Drains:	8” NPS and above	5 ft/sec
k.	Liquids – Gravity Drains:	2-1/2” NPS to 6” NPS	4 ft/sec
l.	Liquids – Gravity Drains:	2” NPS and below	3 ft/sec

As a minimum, piping shall be standard wall 2-1/2 inch diameter and larger and Schedule 80, 2 inch and smaller. Fittings shall match pipe. Socket weld fittings shall be 3,000 lb. class minimum.

Ammonia distribution piping shall be a pre-fabricated double wall piping system such as that manufactured by Guardian Systems, a Division of IPEX (800) 490-0077, or General Manager approved equal. The system shall be designed, fabricated, installed, and tested in accordance with manufacturer’s recommendations. A leak detection system consisting of sensors at each detection riser and a monitoring panel shall be provided to detect any leaks in the carrier pipe. The leak detection system and monitoring

panel shall be zoned so that a facility operator can identify which section of piping has the leak. The monitoring panel shall be located in a convenient location, but if it is outdoors, it shall be furnished with a sunshade and shall be rated for outdoor conditions. In addition, the panel shall send all alarms to the PPCS in Control Room .

I.7.9 End Connections

Pipeline run size should not necessarily match equipment connections. Outlets from vessels that are below the water line should be at least 25% larger in diameter than the pipeline to reduce pipe inlet losses and air or vapor entrainment. Inlets to heat exchangers may be enlarged to reduce impingement velocities and obtain better distribution. Where pump suction connections are smaller than the line, an eccentric reducer (with off-set below the centerline of pump connection) shall be used to avoid an air pocket at the inlet connection.

Welded joints are to be butt welded for 2-1/2 inch diameter and larger and socket weld for 2 inch and smaller. Butt weld ends shall be prepared for welding in accordance with ANSI B16.25. Socket welds shall NOT be used in lube oil systems, only butt welds.

I.7.10 Valves

A valve specification is included in Section A.2. Valve body materials shall comply with the pressure temperature class for each system. Where stainless steel is used for stems, discs and seat facings, material shall be AISI Type 410, 420 or ASTM A182, Grade F6a.

All valves in fuel gas application shall be fire rated.

Valve bodies and bonnets shall be suitable to support valve operators (hand wheel, gear, motor or pneumatic) with the valve in any position, without external support.

Globe and gate valves shall be of the outside screw and yoke design with back seating construction. Globe valves of the T-pattern type are preferred. Check valves shall be of the swing or stop check type.

Use of reduced size ports in the main process line is not allowed.

Gear operators shall be provided for ball/plug/butterfly valves over size 8-in size and for globe and gate valves over 12-inch size.

Each valve shall be assigned a unique valve number and shall have a permanent stamped metal tag bearing the valve number securely attached to the valve.

I.7.11 Pipe Routing

Routing of piping systems shall be done using good engineering practice and shall avoid knee knockers and head bangers, shall accommodate ease of operations, and shall allow for access to all areas. As minimum, all piping 2-1/2 inch and larger shall be routed and shown on isometric drawings produced by the BOP Contractor.

The General Manager reserves the right to review and comment on the pipe routing for large-bore piping systems.

I.7.12 Pipe Supports

Supports shall be constructed to permit movement of the pipe as may be caused by thermal expansion, contraction or other causes.

Support components shall be bolted to support steel, or embedded in concrete or masonry. Bolt holes shall be drilled, not burned. Support components shall be attached where they will not damage other construction either during or after installation. Wall brackets shall not be used on metal wall panels.

Support points shall be selected on the basis of proper location and spacing for optimum load distribution and weight balance, taking into consideration available structures. Spacing shall be limited so as to prevent excessive sag, vibration, bending and shear stresses in the piping and to keep within the allowable structure loading and pipe stress limitations. Support spacing and the use of flexible couplings shall be designed to prevent the transmission of any force or torque to any piece of equipment. On non-metallic piping systems (PVC, CPVC, HDPE, etc.) pipe support spans shall not exceed five feet and shall be placed, at a minimum, at each control valve to prevent transmitting operating torque to the piping.

Insulated pipelines shall be supported on pipe supports sized to fit the outside diameter of the pipe and insulation. Protection saddles where used shall be of commercial manufacture fabricated of curved steel plate.

In general, pipe supports shall be fabricated out of standard structural steel shapes and commercially available components properly specified for the service. Unistrut or equivalent channel-type materials are not acceptable as vertical or cantilevered pipe support members.

The General Manager reserves the right to review and comment on the pipe support scheme (types and locations) for large-bore piping systems.

Welded attachments for piping supports shall be used on an exception basis that requires approval.

I.7.13 Piping Line Vents and Drains

Piping systems shall pitch to low points to provide for complete drainage of the process line. Pitch shall be in the direction of flow unless prohibited by design conditions. BOP Contractor shall provide vents (including valves and caps) at all high points, drains (including valves and caps) at low points, and any other locations necessary for proper system operation and maintenance. Valves operated during normal operation shall be capable of being operated from ground level.

I.7.14 Thermal Insulation

Insulation shall be provided to conserve heat energy, provide personnel protection from hot surfaces, and prevent nuisance water condensation on cold surfaces.

All hot parts shall be covered with calcium silicate of a suitable thickness. To avoid deformation, calcium silicate shall be used on piping or equipment that could be readily walked on. Flat surfaces, cylindrical surfaces and irregular surfaces shall be lagged with aluminum or stainless steel, properly sealed. Irregular surfaces located indoors shall be enclosed with pre-formed aluminum jackets. Equipment and valves

requiring frequent access for maintenance shall be provided with easily removable and reusable blanket insulation and lagging systems.

All hot piping insulation shall be calcium silicate. All devises or equipment insulation shall be ceramic fiber blankets with appropriate weather proofing.

Insulation thickness shall be dictated by system temperature, economic sensitivity to energy loss and outside lagging temperature limitation. Surface temperature of lagging or insulation shall not be more than 140°F when the ambient temperature is 100°F. Ambient temperature shall be measured 3 feet from the insulated surface.

Insulation shall be provided for personnel protection and shall extend from the floor or grating level to an elevation eight feet above this level. Insulation for personnel protection shall limit the exterior surface of the insulation/lagging to a maximum of 140°F.

All parts where the exposed surface temperature shall be below the expected dew point temperature and the resulting condensation would be a nuisance shall be insulated with fiberglass or polyurethane of suitable thickness and covered with vapor barrier jacketing.

Insulation required for man way covers shall be blanket insulation easily removed and re-installed for operation purposes. Insulation located at low point fittings shall be designed and installed in such a way as to facilitate regular removal for under insulation corrosion inspection.

I.7.15 Lifting Equipment

The Facility design shall accommodate the use of mobile lifting devices to service heavy items of equipment such as gas turbines, gas compressors, motors, safety valves, etc.

Sufficient space shall be included in the facility layout around equipment for mobile lifting equipment to support maintenance disassembly and physical transfer of components. Shelter roof structures above the fuel gas and air compressor skids shall be readily removable for maintenance and equipment replacement with appropriate lifting eyes.

I.8 Field Applied Coatings

The information describing the surfaces to be coated gives the approximate scope of the work and is not intended to be a detailed itemization of all work to be done as a part of the Field Applied Coating work. Unless specifically stated otherwise in these specifications, the BOP Contractor shall be responsible for all Field Applied Coating work within the areas described including all equipment base pads, curb wall, construction joints, and miscellaneous surfaces.

Exposed surfaces of equipment shall mean surfaces which are not permanently encased or covered and which are visible and accessible for painting. Motors and accessories for equipment shall be painted with the same materials specified for the equipment, provided the paint sys-tem is compatible with the shop coating.

Provide coatings meeting the following:

a. ASTM D16 Definitions of Terms Relating to Paint, Varnish, Lacquer, and Related Products. Conform to ASTM D16 for interpretation of terms used in this specification.
b. NPCA (National Paint and Coatings Association) - Guide to U.S. Government Paint Specifications.
c. SSPC (Steel Structures Painting Council) - Steel Structures Painting Manual.

Product Data: Provide data on all coating products, including MSDS sheets for each type of coating proposed.

Surfaces of the following materials or equipment shall not be field painted.

a. Aluminum surfaces
b. Brass
c. Bronze
d. Bus duct enclosures
e. Cable trays
f. Chromium plated metals
g. Electrical conductors, insulated or uninsulated
h. Galvanized structural steel
i. Galvanized handrails, grating, and miscellaneous steel
j. Galvanized embedments
k. Gauges
l. Hardware
m. Metal wall panels
n. Polished or machined surfaces
o. Porcelain bushings
p. Rotating shafts and couplings
q. Rubber belts, skirting, gaskets, and idler disks
r. Nameplates and equipment tags
s. Equipment and piping covered with aluminum lagging shall not be finish painted.

Coating Sources shall be a Company specializing in manufacturing of coating products with minimum five years documented experience. Obtain each coating system, (primer, fillers, intermediate and finish coatings, etc.) from one source from a single manufacturer, unless otherwise approved by General Manager. Materials not specified but required for successful application of the specified coating systems shall be furnished and installed as recommended by the coating manufacturer. When specified materials of a manufacturer have been discontinued, only substitutions recommended by that manufacturer will be accepted.

The painting contractor shall investigate the primed surfaces to verify compatibility with the finish coating specified. If non-compatible primers are present, apply a barrier coat prior to the application of the finish coat.

Proper surface preparation and methods of application shall be the responsibility of the painting contractor. Comply with the coating manufacturer’s written application instructions and the number of coats specified. Special attention shall be given to application of finish coats and to the protection of adjacent surfaces throughout the course of the work. Compliance with all requirements will be verified at

the site by the City. Notify the City after completion of each coat and before the application of the next coat.

Conform to applicable code for flame and smoke rating requirements for finishes.

After completion of the Work, BOP Contractor shall provide to General Manager a maintenance schedule for use in maintenance painting, indicating the type, color, mil thickness, etc. of each type of material used and the location(s) where applied.

Coatings: Ready mixed, except field-catalyzed coatings. Process pigments to a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating; good flow and brushing properties; capable of drying or curing free of streaks or sags.

Provide primers for paintwork of same Vendor as brand of the paint used in this Specification, unless specified otherwise.

Lead Free Coatings: All coatings paint specified for use under this section shall be lead free and mercury free and shall be in full compliance with Federal Hazardous Substances Act.

The BOP Contractor shall submit a schedule of recommended coating systems for all concrete surfaces, machinery, equipment and piping for review and comment by General Manager. The schedule shall address the different types of surfaces to be coated and associated requirements, detailing existing surface, preparation and application of primer and multiple coatings as necessary.

The Identification of Piping Systems shall be as per ANSI A13.1, but as a minimum shall include color coded flow arrows and system name.

Contractor shall not permit paint wash water runoff to enter storm drains. Contractor shall not clean or flush painting equipment onsite unless it is done in purpose-built apparatus which contains 100% of cleaning waste and is capable of transporting it offsite. Contractor shall be responsible for complete removal and transportation of painting equipment cleaning byproducts offsite at the completion of the Work. Neither water nor cleanout areas will be provided to the contractor for the purpose of cleaning painting equipment.
In general, the final color of equipment and piping shall be approved by the General Manager.

I.9 HVAC Systems

See Architectural section and Site Conditions document

In the battery room, an airflow sensor shall be installed in the ductwork and shall initiate an alarm to a continuously occupied location should the exhaust fan fail.

Smoke detectors shall be supplied in the HVAC ductwork as required by the specifications, code or PWP Fire Department.

I.9.1 Ductwork

Supply air ductwork shall be sized for a maximum velocity of 1000 feet per minute and a maximum of 0.08" WG friction loss per 100 feet of duct. Lower velocities and friction loss shall be used where necessary to prevent duct friction loss from exceeding the available fan pressure.

Construction and installation of ductwork shall be in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible.

Construct duct systems to the following pressure classifications:

- Recirculation System Supply: 2-inch water gauge (positive).
- Recirculation System Return: 1-inch water gauge (negative).
- Exhaust System: ½ inch water gauge (positive).
- Transfer Ducts: ½ inch water gauge (positive).

Ductwork shall be galvanized steel sheet, hot-dipped GS sheet, lock-forming grade, conforming to ASTM A-525 and A-527, having G90 zinc coating in conformance with ASTM A90.

J. ELECTRICAL REQUIREMENTS

J.1 General Requirements

The BOP Contractor shall perform detailed design engineering, procurement and installation of all electrical equipment, all tools, test equipment, lifting devices, slings, labor, consumables, and other facilities as required to perform the electrical work described herein.

The work shall be performed in a professional manner of high quality workmanship and productivity utilizing employees trained and skilled for the work to be accomplished.

J.2 Electrical Scope

J.2.1 34.5kV and 17.2kV Scope of work:

Both the BOP Contractor and PWP will have responsibilities for the 34.5kV and 17.2kV cable design and installation between the new plant and the existing 34.5kV switchyard / 17.2kV dispatch center. This includes coordinating with PWP personnel for design information, performing all engineering for sizing and specifying the cables for the anticipated load and duty. The BOP will perform all necessary grounding and electrical studies to properly design the system, confirming correct phase rotation in the system, performing thermal calculations, providing all necessary details and installation specifications in accordance with applicable codes and city standards.

J.2.2 34.5 kV Routing:

The 34.5kV connection between the new GSU transformer and the existing switchyard will be made through a combination of new ductbank, existing ductbank, and existing tunnels. Reference to drawings E6-1, E6-10, SKE-6-1 and SKE-2 should be made for additional details on the routing. Generally this route will be:

Starting from the GSU HV terminals a new duct bank will be run south and east to an existing manhole located in the south east of the GSU. At this point the new duct bank will enter an existing cable vault 4275. From this point, an existing ductbank will be used to route cables south to an existing pull box and to an existing vault to the south east. From this vault another existing ductbank will be used to another existing vault to the northwest. Another existing duct bank is used from this point to a point just north of the existing Glenarm building. At this location the existing duct bank enters an existing tunnel that crosses below Glenarm St. to an existing vault north of Glenarm St. along Edmonson Alley. From this vault another existing ductbank is used to reach the temporary connection point to the switchyard, located at the northwest corner of the switchyard. At a later phase of the project this connection point will be changed and the cables re-terminated at by PWP.

Where necessary the BOP Contractor shall perform all work including core drilling vault and tunnel entry points, installing pull ropes, constructing new duct banks necessary to interconnect the GSU HV bushings and the 34.5kV substation. PWP will install the cables, ground wires, and complete the terminations. The BOP shall size the cables as defined below in the DOR for this work. PWP will mandrel all new and existing conduits prior to installing cables to ensure they are clear of debris. PWP will purchase and install the new cables.

J.2.3 17.2 kV Routing:

The 17.2kV connection between the new step-down transformer and the existing 17.2kV switchgear in the dispatch building basement will be made through a combination of new ductbank and existing ductbank. Reference to drawings E6-1, E6-10, SKE-6-1 and SKE-2 should be made for additional details on the routing. Contractor shall coordinate with the PWP staff for final route determination. Generally this route will be:

Starting from the 17.2kV Transformer HV terminals a new duct bank will be run east to the south east corner of the Glenarm building. At this point a new concrete vault shall be installed to connect the new ductbank to an existing ductbank running from that point to the basement of the dispatch building. Please note, this new vault shall be a high point in the final paving, but shall allow for a smooth transition for vehicular travel. All new vaults will be H-20 rated.

The BOP shall size the cables as defined below in the DOR for this work. Where necessary the BOP Contractor is responsible for all work including core drilling vault and tunnel entry points, constructing new duct banks, installing pull ropes necessary to interconnect the 17.2kV transformer HV bushings with the Dispatch Center. PWP will install the cables, ground wires, and complete the terminations. PWP will mandrel all new and existing conduits prior to installing cables to ensure they are clear of debris. PWP will purchase and install the new cables.

J.2.4 Protection/Controls:

The scope shall include the design, purchase, installation, studies and commissioning of all necessary relays, cabling, terminations, CT's, and VT's for the operation and protection and coordination of the 34.5kV feeder and transformer with the 34.5kV substation as well as for the 17.2kV connection from the 17.2kV switchgear in the dispatch building to HV terminals of the 17.2kV step-down transformer. The relays will be located in a relay rack in the new PDC adjacent to the GSU. The final configuration of the relays will be completed by PWP.

A fiber connection shall be ran and terminated at both ends from the relay panel to the RIG located in the dispatch building basement. PWP will complete the configuration of the RIG using a third party.

Detailed Division of Responsibility for 34.5kV, 17.2kV, and Plant Loads

The items below summarize the scope split between the BOP Contractor and PWP Power Delivery Group.

J.3 Work to be performed by the BOP Contractor:

J.3.1 34.5kV

- Performing all engineering for sizing and specifying cables for anticipated load and duty
- Performing all necessary grounding and coordination studies for proper system design, starting from the GSU and extending to 34 kV Receiving Station
- Performing all relay protection engineering and studies starting from the GSU and extending to 34 kV Receiving Station
- Furnishing all control and protection devices

- Setting and testing relays
- Coordination with PWP Power Delivery engineers regarding engineering requirements/study parameters/relay setting standards/etc.
- Providing test reports on plant-side equipment for turnover package requirements (cable hi-pot, short circuit studies, coordination studies, protective relay studies/testing, etc.)
- Installing the duct bank from the GSU to the nearby 34.5kV vault onsite, coring existing vault to receive GT-5 cables, penetrating and sealing core holes
- Install control and protection devices in GT-5 Power Distribution Center

J.3.2 17kV to 4 kV Transformer

- Installing the duct bank from the nearby onsite utility trench to the new auxiliary xfmrs Performing all engineering for sizing and specifying cables for anticipated load and duty
- Performing all necessary grounding and coordination studies for proper system design, starting from the GSU and extending to 34 kV Receiving Station

- The BOP contract shall be responsible for the design, purchase, installation, studies and commissioning of all necessary relays, cabling, terminations, CT's, and VT's for the operation and protection and coordination of the 34.5kV feeder and transformer with the 34.5kV substation as well as for the 17.2kV connection from the 17.2kV switchgear in the dispatch building to HV terminals of the 17.2kV step-down transformer. The relays will be located in a relay rack in the new PDC adjacent to the GSU. The final configuration of the relays will be completed by PWP.
- A fiber connection shall be ran and terminated at both ends from the relay panel to the RIG located in the dispatch building basement.

J.3.3 4kV & 15kV Switchgears and Aux. Transformers

- Performing all engineering for sizing and specifying cables for anticipated load and duty
- Performing all necessary grounding and coordination studies for proper system design
- Performing all relay protection engineering and studies
- Furnishing all control and protection devices
- Setting and testing relays
- Providing test reports on plant-side equipment for turnover package requirements (cable hi-pot, short circuit studies, coordination studies, protective relay studies/testing, etc.)
- Installing all duct banks and cables
- Install control and protection devices in GT-5 Power Distribution Center

J.4 Work to be performed by PWP Power Delivery

- Inspecting the BOP installation of 34.5 and 17kV conduits/duct banks during construction
- Mousing and mandrelling the BOP-installed conduits
- Procure 34kV and 17kV cables, splices, terminators
- Installing 34.5kV cabling from GSU high side, to the first vault onsite (existing vault west of GT-3/4 GSUs), through BOP-installed duct bank
- Installing 34.5kV cabling from onsite vault to one of the tie bank positions on receiving station "C"

- Installing 17kV cabling from auxiliary xfmrs to Glenarm Unit 4 lineup (position TBD), through BOP-installed duct bank
- Testing all installed cabling
- Terminating all installed cabling at the GSU, auxiliary xfmrs, Receiving Station C, and Glenarm Unit 4
- control and protection devices at Dispatch Center Basement after receiving devices from BOP Contractor
- Program and test relays with settings furnished by BOP Contractor
- Providing test reports on distribution-side equipment for GE turnover package requirements (cable hi-pot, breakers, CT's, relays)
- Perform commission procedures to verify 34kV delivery system up to and including GSU ready for service
- PWP will complete the configuration of the RIG

J.5 Balance of Plant Electrical

In addition to the work described for the 34.5kV and 17.2kV installations, this section will define the requirements for the balance of electrical scope. The primary equipment to be detail designed, purchased and installed by the BOP Contractor shall be:

- One Power Distribution Center with switchgear, MCC's, batteries, etc.
- Two 4160V-480V auxiliary transformers
- One 13.8kV-4160V auxiliary transformer
- One 17.2kV-4160V auxiliary transformer
- Lighting Panels and transformers as needed for building and plant loads
- Bus Ducts for the 13.8kV to GSU connections

The primary feature for the BOP Contractor's electrical work will be the Power Distribution Center (PDC) located to the north of the Gas Turbine Generator, and the electrical distribution to each user from this location. Due to the lead time in manufacturing this equipment, the BOP Contractor will need to expedite its design and procurement as it is currently anticipated to be on the critical path of the project. Some of the transformers supplied under the BOP scope could also be long lead items, but not as long lead as the PDC is expected to be.

The GT-5 project's PDC will contain not only the normal balance of plant MCC loads, but will house the generator breakers, the MCC's that might otherwise by supplied by GE in a PCM/PECC, the plant batteries for the UPS and the Power Island Equipment loads, the turbine control panels for both the GTG and the STG and the plant control system. The intent is to furnish a single building that houses all of the electrical loads and the control system equipment in a single location. The BOP Contractor will be responsible for coordinating all electrical information from the PIE Contractor's equipment to ensure breakers and MCC's are supplied correctly, as well as coordinate the installation of the turbine control panels in the PDC vendor's shop. The intent is to have GE ship the turbine control panels to the PDC vendor for installation by the PDC vendor. The Power Island Equipment Contractor is not supplying any motor control centers, switchgear or batteries. These are all to be supplied by the BOP Contractor with the PDC. The final switchgear/MCC/battery/cable sizing and routing design will all be performed by the BOP Contractor as part of this scope of work.

The PDC will be a modular pre-engineered structure designed and manufactured by a vendor experienced in the supply of such equipment. A specification for the PDC, the electrical switchgear, MCC's and batteries is included with this scope of work document, along with a preliminary floorplan illustrated by E1-2. This floor plan was developed to ensure the equipment would fit in the space between the GSU transformer and the steam turbine enclosure, keeping in mind the generator rotor pull space as shown on the General Arrangement. As the design progresses, the BOP Contractor can optimize the equipment layout inside the PDC for bus duct connections, cable tray and duct bank interfaces. The contractor must keep in mind, however, the minimum space separations, the building footprint and the requirements for arc resistant gear.

The PDC will be mounted on either concrete piers or structural steel framework at the discretion of the BOP Contractor. The PDC must maintain 8'-0" clearance from the top of concrete to the bottom of the PDC support frame to allow operator access beneath the PDC. The space beneath the PDC will be for running cable tray from duct banks into the various areas of the PDC. The PDC will have fire protection consisting of FM200 dry agent in the electrical areas and dry pipe sprinkler piping below the PDC.

J.6 13.8kV System

Both the GTG and the STG generators will be connected to the generator breakers located in the PDC via underground cable routed from the generator to the PDC in duct bank. Their respective line side cubicles shall be provided for bottom penetration. After leaving the generator breakers in the PDC, the 13.8kV feed will be routed to the three winding GSU transformer in above ground non-segregated bus duct. The bus duct will be supported by structural steel to grade and not restrict walkway access on the platforms of the PDC. The bus duct may either penetrate the concrete fire wall on the east side of the GSU, or go over the top of wall. The GSU will be supplied with a flanged connection for the bus duct to mate with.

J.7 4160V System

The equipment being fed off of the 4160V system will be the larger motors such as the gas compressors, the chillers, the circulating water pumps and the boiler feedwater pumps. A single 13.8kV to 4160V auxiliary transformer will be supplied to feed this system.

A second transformer will be supplied for the 4160V system taking power from the alternate 17.2kV system. This secondary feed will be supplied to allow the PDC to be backfed if the 34.5kV system and the GSU is not ready to accept backfeed, and also provide station power should the 34.5kV system or GSU be down for maintenance.

Indoor 4,160V switchgear and MCCs will be located in the PDC. The normal auxiliary transformer is a 13.8kV—4,160V delta- medium resistance grounded wye transformer, and the alternate source auxiliary transformer is a 17.2kV – 4,160 V delta-medium resistance grounded zig-zag transformer configured to provide a 60 degree lagging phase shift from primary to secondary voltage. The 4,160V switchgear and MCCs are located in the Power Distribution Center (PDC) per the one line diagram.

The transformers shall meet the requirements of ANSI C57. 12. The transformers shall be oil filled and equipped with oil level gauge, pressure-vacuum gauge, dial-type thermostat, alarm contacts and rapid pressure rise relay. Alarms shall be connected to the PCS.

The 4,160V MCCs shall be complete with full voltage magnetic starter, isolating switch and current limiting power fuses to interrupt the short-circuit current. All components shall be front accessible, facilitating routine inspection and parts replacement. Bus bars shall be tin plated copper.

J.8 480V System

Two 4160V to 480V auxiliary transformers will be supplied to feed the motors on the 480V system, as well as the aux boiler and superheater. The buildings will be fed from buckets in the 480V MCC with dry type transformers placed locally for the building lighting and HVAC loads. The 480V system shall consist of two outdoor 13.8kV — 480V delta-solidly grounded wye transformers and an indoor 480V Switchgear located in the Power Distribution Center (PDC). The transformers shall meet the requirements of ANSI C57. 12. The transformers shall be outdoor, oil filled, equipped with an oil level gauge, pressure vacuum gauge, dial-type thermostat and alarm contacts and rapid pressure rise relay. Alarms shall be connected to the PCS. 600V non-Segregated Phase Bus Duct shall be used to connect the associated transformer to its associated 480V Switchgear.

The 480V switchgear or switchboard shall be of the indoor, metal enclosed type, rated 480V, 3 phase, 3 wire, 60 Hz with copper bus located in the PDC. The main circuit breakers shall be electrically operated while the feeder circuit breakers shall be manually operated. The power circuit breakers shall be draw-out type, with stored energy closing mechanisms, and RMS digital current sensing solid-state microprocessor based trip unit.

The 480V motor control centers shall be of the metal enclosed type for the control of 460 volt, 3 phase, and 60 Hz motors. Indoor MCC shall be NEMA 1 gasketed and outdoor MCC shall be NEMA 3R, non-walk-in type per the BOP Contractor design. Motor starters shall be combination full voltage magnetic type with adjustable trip magnetic molded case circuit breakers (motor circuit protectors). Motor starters shall have three overload devices, one per phase and contacts. Each motor control center shall contain, as a minimum, 10% spare starters and breakers and spaces for 20% future growth. Spaces shall be equipped with bus, mounting railings and all other accessories required to install a starter. Generally, all motor starters shall be located at the motor control centers. Local starters may be used for HVAC and some skid-mounted equipment. Power panels, lighting transformers and panels, and miscellaneous load feeder circuits shall be connected to the thermal magnetic circuit breakers.

General building power and miscellaneous loads shall be supplied from the 480V system. Small loads, convenience receptacles, incandescent lighting, and motors smaller than ½ horsepower shall be single phase and supplied from the 208Y/120V, 3-phase, 4-wire system. Note that it is anticipated that two 480V feeds will be required to the air compressors.

The following is a list of the major work to be performed:

a. Engineering, calculations, designing, procuring and installing the complete electrical system required by this Project.
b. Receive and uncrate all electrical equipment and material delivered to job site including that furnished by General Manager and submit receiving and damage reports as required.
c. Install all electrical equipment and material described herein.

d. Perform all electrical work associated with equipment and systems installed by others described herein.
e. Provide and install all balance of plant (BOP) equipment, material and systems.
f. Startup, test and commission all electrical equipment, material, and systems described herein in order to put the work into commercial operation.
g. Identify coordinating and complete all electrical system interfaces with General Manager furnished equipment.
h. Installation of PI Equipment

All electrical work shall be performed in accordance with the BOP Contractor's "Approved for Construction" installation drawings, the BOP Contractor's Construction Specifications, and the equipment manufacturer's "Installation Instructions". The BOP Contractor will be responsible for coordinating with the local building inspectors as required.

J.9 Electrical System Criteria

The electrical system shall supply the electrical power required for the Project and shall export the excess generated power to the Glenarm 34.5kV Receiving Station "D".

Voltage insulation levels, interrupting capacities, continuous current capacities, circuit protection, and mechanical strengths shall be selected and coordinated in accordance with calculations and the recommendations of IEEE, NEMA, ANSI and NFPA. The BOP Contractor is required to provide calculations for all material and equipment selection.

System protective devices (relays, fuses, breaker trip units, etc.) shall be selected and coordinated to insure that the interrupter nearest the point of short circuit (or high overload) shall open first and minimize disturbances on the rest of the system.

J.10 Generator Control

The generator controls will be provided with the gas turbine generator. Generator controls and indication shall provide an interface for the General Manager operators to monitor and control the GTG. The equipment to provide this control and monitoring signals shall be located in the Control Room.
Synchronizing Control

The synchronizing controls will be provided with the gas turbine generator. The controls will allow manual and automatic synchronizing of the generator to the output bus. During normal conditions, the GSU will be energized via the 34.5kV Receiving Station and provide a 13.8kV voltage level at the output bus. The 13.8kV generator breaker shall be the only circuit breaker with the means to synchronize the GTG to the output bus and PWP system.
The 34.5kV circuit breakers at the GSU side of the interconnection and the circuit breakers at the Receiving Station "D" (all provided by the General Manager) will have the minimum means to sense synchronism as a check. Contractor shall coordinate with the General Manager with respect to design standards and any interface requirements during the design phase of the protective relays furnished under these specifications.

J.11 Generator Step Up Power Transformer

Reference GSU Specification (see Section A.3)

The GSU installation shall be in accordance with the manufacturer's recommended procedures. The procedure shall include, but not be limited to, installation of oil, fans, pumps, radiators, bushings, surge arrestors, ground bus assemblies, bussing, wiring, throat assemblies, and any other ancillary devices to form a complete installation. Additionally, the BOP Contractor shall filter press, preheat oil (if necessary), vacuum fill and reestablish any nitrogen blanket (if applicable) for the power transformer unless specifically stated otherwise. The transformer shall be placed ± 1/4" of the actual centerline of position indicated on the drawings.

The GSU transformer shall be tested in accordance with ANSI/IEEE C57.

A Concrete oil spill containment pit shall be provided around the GSU transformer. Coordination with the General Manager will be required to assure there are no conflicts between the GSU oil containment pit and the interconnection equipment or structures. Coordination will take place in the initial design phase of Project. Design of GSU control conduits will also require initial design coordination with the relocated storm drain. See example of GT 3 & 4 GSU foundation provided in Section A.3 for expected grating and containment design for the GSU.

J.12 Protective Relaying

A fully integrated relay scheme for the protection of the gas turbine generator, power distribution equipment, step-up transformer, and all other generation plant equipment as specified herein shall be provided. The relaying scheme shall cause a rapid and coordinated response to electrical and mechanical faults so as to minimize equipment damage while maintaining continuity of service of unaffected systems. Safety of personnel and of the general public, whenever involved, shall be considered of paramount importance in the design. Utility relaying requirements for interconnection must also be satisfied.

The BOP Contractor is responsible for the protective relaying systems from the GTG up to and including the GSU and cables back to the switchyard, along with the auxiliary power distribution systems. This includes GSU differential, overall generator differential, over current, generator breaker failure, etc. The General Manager will be responsible for the relaying systems in the Receiving Station "D". The BOP Contractor shall coordinate GSU and interconnection protective relaying with the General Manager. The BOP Contractor shall provide the required GSU current transformers to support General Manager protective relaying. The BOP Contractor shall coordinate the rating and quantity of current transformers required on the GSU bushings with the General Manager.

Protective relaying instrument transformer signals or control signals between the 34.5kV interconnection and the GSU will be necessary. The BOP Contractor shall determine and coordinate protective relaying interface meetings with the General Manager throughout the design and construction phase to ensure proper schemes and installation.

The BOP Contractor shall retain responsibility for final design of plant protection in accordance with recognized standards of good engineering practice for utility systems. The final relay scheme shall be subject to review and approval by the General Manager. The BOP Contractor is responsible for development of all one line diagrams, three line diagrams, phasing diagrams, schematics, wiring

diagrams, control panel drawings and various schedules to develop a fully function electrical protection scheme for the generation facility.

The BOP Contractor is responsible for providing relay settings for relays designed by BOP Contractor. The BOP Contractor shall also coordinate interface schemes with the General Manager to assure Project protection and interconnection protection operates properly together.

J.13 Metering

The net generated power and energy output will be metered at the 34.5 kV level by the General Manager for regulatory and periodic performance testing purposes. The metering instrument transformers will be located on the GSU side of the interconnection. The voltage signal shall be provided via 3Ø PTs located on the line side of the 34.5kV GSU circuit breaker. The current signals shall be provided via the bushing current transformers located in the 34.5kV line side bushings of the GSU. All 34.5kV metering equipment shall be engineered, procured, and constructed by the BOP Contractor. This metering shall be revenue grade.

The net generated power output will also be metered at the 34.5 kV level, at the receiving station, by the General Manager for CAISO purposes. CAISO metering and communication systems are required for this Project but will be furnished and installed by others.

The generator will have gross power output metered by the standard power meter supplied with the GTG.

J.14 Distribution

The distribution system shall be designed with a sufficient kVA capacity to carry the maximum kVA output of the gas turbine-generator, plus the maximum kVA required for station service. Circuit breakers shall have sufficient continuous current capacity and short-circuit capacity for system operation and protection and shall be electrically operated with DC close and trip.

Optimum design of the 13.8kV and 4,160V distribution systems as well as of power distribution equipment for lower voltage levels (480V and 120V) must be demonstrated by the BOP Contractor's calculations and submitted to General Manager prior to final selection of equipment. This design shall coordinate selection of switchgear interrupting ratings, voltage ratios and impedances of main and auxiliary transformers, cable sizes and load equipment ratings to meet the following criteria.

Switchgear and circuit interrupting devices at all voltage levels shall have adequate interrupting and close and latch capability for the calculated available three phase and line-to-ground fault currents. Design shall be in accordance with ANSI C37 series standards.

It shall be possible to start the largest motor on an otherwise fully loaded system without depressing any bus voltage to a level where running motors stall or where motors or driven equipment are at danger of risk of damage. Interaction between the different voltage level systems (13.8kV, 4,160V and 480V) must be considered.

Under normal operating conditions, the 13.8kV system shall have a voltage spread of no more than 95% to 105% of nominal rating.

Under normal operating conditions, the low voltage systems (480V and 120V) shall have a voltage spread of no more than 90% to 110% of nominal rating.

The voltage at the terminals of the gas turbine generator shall fall within the generator manufacturer's stated permissible values (typically 95% to 105% without derating).

J.15 DC System

The BOP Contractor shall design and supply a DC system for all equipment requiring DC power in accordance with the equipment specifications.. UPS System

A reliable source of power to items such as (but not limited to) control systems, critical instruments, and shutdown networks shall be furnished as dictated by process control requirements. This power supply shall be a static solid-state UPS (uninterruptible power supply) system consisting of an N+1 rectifier-inverter unit with integral battery backup. The UPS system capacity shall be at least 200% of the load and sized for 120 minutes of running time upon power failure.

Additionally, a reliable source of power for all critical loads, to be determined jointly by the BOP Contractor and General Manager, in the new control and operations center furnished by the BOP Contractor under these specifications shall be provided. The UPS system capacity shall be at least 200% of the load and sized for 120 minutes of running time upon power failure.

The BOP Contractor shall choose the loads assigned to the UPS in accordance with good engineering practice. Prior to final system sizing, the BOP Contractor shall submit a list of the proposed UPS loads to General Manager for approval.

J.16 Grounding

Grounding shall be provided to ensure safety to personnel and equipment in case of electrical equipment failures and to prevent fires and damage from lightning and/or static electricity and shall be in accordance with IEEE 80 and 142. Maximum resistance to ground shall be established in accordance with the referenced IEEE standards and determined in detailed engineering after electrical fault levels, soil resistivity, etc., has been determined. The new grounding system shall have a minimum of two links to the Facility ground grid.

All equipment enclosures and/or equipment ground buses shall be grounded through the facilities ground loop that shall consist of buried ground wire with driven ground rods located strategically throughout the Facility.

Grounding calculations shall limit touch and step potentials to acceptable limits as specified in IEEE 80. Calculations shall use 18-inch conductor burial depth. Six inches of crushed granite rock or asphalt roadways shall be considered and shown in the calculations. Ground cables and connections shall be of a suitable cross section to withstand short circuit thermal performance requirements as defined in appropriate standards. Minimum conductor size for ground grid, major equipment grounding and structure ground shall be 4/0 AWG.

All structural steel, equipment enclosures and/or electrical equipment ground buses shall be grounded through the facilities ground system. Switch operator handles shall be grounded and grounding platforms

shall be provided under each switch operator handle. Non-current carrying part of electrical equipment shall be grounded from the source by a separate wire to the equipment. A minimum of two connections shall exist on all switchgear, transformers and generator casings with connections on opposing corners (where available). Burndy Hyground connectors shall be used.

Cable tray shall be grounded by a continuous ground conductor running the length of the tray. The ground conductor shall be connected to the tray at no more than 50-foot intervals. Also the ground conductor shall connect to the ground system at each end or to the incoming line end of the ground bus in each switchgear and/or MCC, which the tray serves.

Conduit runs terminated at tray shall be connected to the tray ground with bare copper conductor (No. 8 AWG minimum).

Each metallic conduit run shall be solidly grounded to the station grounding system. Ground wires between conduit grounding bushings, clamps, and other conduit grounding attachments linking conduits of a group, and the extension of ground wires in an approved manner to the station grounding system shall be installed as a part of the Work under this specification. Bonding and grounding of metallic conduit terminating in manholes, handholes or within equipment enclosures upon emergence from floor concrete, and of metallic conduit terminating at a metallic enclosure shall be in accordance with the requirements of the project design documents.

Grounding conductors in conduit shall be insulated and shall be terminated on the tray ground. Conduit shall not be considered a grounding conductor except for itself and for lighting fixtures.

Any electrical discontinuities in metallic conduit runs, such as caused by non-metallic boxes, gaps in conduit, plastic conduit sections etc., shall be bonded.

When a metallic conduit crosses a structural expansion joint, a flexible conduit with flexible grounding jumper shall be utilized.

Ground conductors on power circuits shall be connected to equipment grounds and to the source ground bus.

The grounding system calculations shall be based upon the soil analysis results outlined in the project geotechnical investigation.

The aboveground fuel gas piping shall be grounded. The underground fuel gas piping shall be connected to ground through over voltage protection (OVP) devices installed across the insulating flange the aboveground to underground transitions. A PCR device shall be installed at the fuel gas piping interface between the facility and utility.

J.17 Lightning Protection System

Lightning protection shall be provided in accordance with the requirements of NFPA 780, IEEE 998 and General Manager. Any system provided shall comply with the following:

a. Intercept a lightning stroke before it strikes the structure.

b. Provide a low-resistance path to ground for the high currents associated with lightning discharges.
c. Prevent damage to structures and hazards to people.
d. Geometric coverage may be used

J.18 Cathodic Protection System

Buried pipe shall be protected by coating and wrapping the pipe with suitable corrosion resistant materials. A passive cathodic protection shall be used. The cathodic protection system design shall take the facility and substation grounding systems into consideration to prevent deterioration of the ground grid or other metallic objects within or near the facility.

Cathodic protection for all underground or submerged piping shall conform to the latest edition of NACE RP01-69 Control of External Corrosion based upon the soil analysis results outlined in the project geotechnical investigation. The BOP Contractor is responsible for determining what protective measures are required, subject to the General Manager review and approval.

The interface between the General Manager and the Southern California Gas Company cathodic protection systems is at the insulated flange on the outlet of the respective meter stations.

J.19 Freeze Protection System

No electric freeze protection is required. However, equipment and piping systems potentially susceptible to freezing shall be insulated.

J.20 Lighting

Illumination levels shall be as follows (foot-candle values are minimum required):

J.20.1 Outdoor Facilities

a.	Catwalks and general area	2 fc
b.	Stairs and platforms	10 fc
c.	Ground level areas around all equipment	10 fc
d.	Substation (equipment and control shelter areas)	10 fc
e.	Substation (remaining area)	2 fc
f.	Roadway & parking areas	1 fc
g.	Truck unloading areas	10 fc

J.20.2 Electrical Generating Station (Interior)

a.	Equipment areas	50 fc
b.	Control room	50 fc
c.	Office and laboratories	70 fc
d.	Restrooms	30 fc
e.	Warehouse	40 fc
f.	Instrument Areas	30 fc

The lighting system shall be 277V and high-pressure sodium (HPS) type fixtures shall be used throughout the Plant, except in the PDC where fluorescent type fixtures shall be used.

In addition, roadway lighting, fence security lighting and power block platform, operation and maintenance area lighting shall be provided.

The outdoor HPS systems shall be provided a manual and automatic control system. An H-O-A selector switch with contactor and Photo Electric (PE) cell shall be provided. In the hand position the outdoor lights shall be on continuously. In the off position the light shall be off. In the auto position the PE cell shall turn the lights on at dusk and off at dawn. The BOP Contractor shall provide as minimum three (3) independent outdoor lighting control systems as follows:

a. Roadway lighting.
b. Fence security lighting (including illumination for security cameras).
c. Power block platform, operation and maintenance area lighting.

Emergency lighting shall be provided in areas where such lighting may be required on failure of the normal power source, except in the Control Room. Emergency lighting fixtures shall include minimum one (1) hour battery pack for a source of emergency power, and they shall activate immediately upon loss of power.

A 125VDC emergency lighting system shall be provided for the Control Room. The system shall be powered from the existing station battery system.

Exit lighting fixtures shall be provided in the manned buildings and warehouse building. Exit lighting fixtures shall include minimum one (1) hour battery pack for a source of emergency power, and they shall activate immediately upon loss of power.

Access lighting shall be provided on the ECM and exhaust stack.

The AC and DC lighting system, especially in the control room requires General Manager approval.

The BOP Contractor furnished enclosures shall be provided with 120V lights and 120VAC receptacles as required.

All outdoor platforms shall have a minimum of one (1) outdoor, GFI type 120VAC receptacle. The BOP Contractor shall provide GFI type receptacles as required by the NEC. In addition, 120VAC receptacles shall be located throughout the power block as required by the BOP Contractor design and as approved by General Manager. In addition, as a minimum, outdoor, GFI type 120VAC receptacles shall be located near the air compressor, ammonia storage area, near each GSU and various logical locations around the power block.

In addition, a 120VAC receptacle shall be located with each air and water service location and it shall be suitable for the environment in which it is installed.

The BOP Contractor design shall provide 120VAC receptacles within reach of a 100-foot extension cord around major equipment areas. Receptacles shall also be located on above ground platforms for the OTSG and exhaust stack.

The BOP Contractor shall provide 480-480Y/277V lighting panel transformers and 480Y/277V lighting panels and 480-208Y/120V power panel transformers and 208Y/120 power panels as required per the BOP Contractor design.

J.21 Communications

The BOP Contractor shall design raceway for telephone circuits and computer network cables from the Facility communication room and all in-facility telephone and computer network systems.

J.21.1 Telephone System

Raceway shall be provided for routing and installation of telephone circuits in each of the following areas:

a. One (1) in the Power Distribution Center (PDC)
b.
c. One (1) in the CEMS enclosure

All wire and cable shall be furnished and installed by the BOP Contractor. A minimum of 20% spare pairs shall be provided to each location above. Termination of telephone cable and installation of equipment shall be by the BOP Contractor.

J.21.2 Computer Network System

The Facility computer network system shall be extended to accommodate the new equipment.

The BOP Contractor shall design raceway for computer network systems. Raceway shall be provided for routing and installation of computer extensions in each of the following areas:

a. Two (2) in the Power Distribution Center (PDC)
b. Two (2) in the CEMS enclosure

J.21.3 Intercom System

A Gaitronics system with weather proof speakers and phone box shall be distributed evenly throughout the new Glenarm plant and the existing Broadway facility at10 locations. Final locations to be agreed to with the BOP Contractor and the General Manager. A base Gaitronics control station will be located at the Control Room operating console.

J.21.4 Raceway System (Conduit, Boxes, and Tray)

The Raceway System shall remain functional throughout the service life of the facility. The design of the BOP Contractor's raceway system should be underground for the greatest extent possible. Overhead raceway systems should be kept to a minimum.

J.21.5 Cable Tray Systems

All cable trays shall be either ladder tray for power and control cables or covered solid bottom tray for low-level signal cables.

The raceway systems shall be divided into distinct energy levels as follows:

a. 13.8kV or 4160V power
b. Low voltage power including 480, 240, 120V ac for miscellaneous power requirements and 125V dc circuits (with a barrier between ac & dc sections if dc is routed in tray)
c. Control and facility paging
d. Low level signal (instrumentation and communication)
e. High speed data acquisition, fiber optic highways and data links (conduit only)
f. Telephone (conduit only)

The cable tray systems shall meet, as a minimum, the following criteria:

a. The cable trays shall be designed and installed as a complete system with all the necessary fittings, and accessories to minimize undue stress or damage to the cables they contain. Generally cable trays shall be supported in 10 to 12 foot (max.) spans.
b. Cable trays containing control or instrumentation cables shall be designed not to exceed 40 percent fill by cross-sectional area.
c. Vertical ladder and solid type trays in enclosed areas shall be provided with fire stops at floor penetrations.
d. The Gas Turbine Generator vendor tray separation criteria shall be used. If none is available, BOP Contractor shall submit their separation criteria for General Manager approval. Where cable trays are stacked above each other they shall be separated by function in the following top to bottom order:

    - Medium voltage power trays or bus duct
    - Low voltage power trays
    - Control cable trays
    - Low-level signal trays

e. Hot dipped galvanized steel after fabrication ladder type trays shall be used for power and control cables and hot dipped galvanized steel solid bottom trays with securely fastened covers shall be used for low-level signal cables. Access space for servicing cables shall be provided with a clearance of 1 ft - 3 in. to 2 ft for adjacent wall, pipe, tray or other objects.
f. Cable trays shall generally be used where more than four cables are routed in the same direction except for runs to equipment cabinets. For a fewer number of cables conduits shall be used.
g. Low-level signal cables shall be installed in the low-level tray system. These cables shall be run in their own conduits when leaving the tray. Thermocouple and other low-level signal cables shall also be installed in the low-level tray system.
h. Vertical cable trays shall be protected with covers for a minimum distance of 6 ft above the floor level. Vertical ladder trays shall be provided with covers on both sides in such locations.
i. Separation of cable trays for redundant circuits shall be such that a fire on one tray will not ignite the cables in the other tray. Redundant circuits shall not be installed in the same (vertical) tray corridor with each other. Horizontal separation of redundant circuits shall be 3 feet minimum. Separation may be achieved by physical distance or fire barrier.
j. Cable shall be neatly trained or laid in the cable tray and tied down using tie wraps as required. Power cables especially shall be trained with maintained spacing as required by

the NEC. Random lay is not an acceptable method of installing power cable in the tray system.

k. The BOP Contractor shall route the under floor cable tray(s) on the recessed concrete floor in the floor support "bay" (or row) that runs directly under the appropriate location in the Control Room.
l. All indoor cable tray shall be aluminum.
m. Cable trays shall be labeled with tray number, voltage level and purpose.

J.21.6 Conduit Systems

All conduits shall be hot dipped rigid galvanized steel, EMT for use within finished office area walls or in block walls only, or PVC. Galvanizing that has been removed by thread cutting shall be cleaned and recoated. PVC conduits shall be limited to use in underground duct banks, “RED” concrete embedment, or short runs in corrosive areas.

The conduit systems shall meet, as a minimum, the following criteria:

a. All bends shall be no less than the radius required by the size of cables they contain.
b. Liquid tight flexible metal conduit of minimum practical length shall be utilized between conduit and conduit boxes of all motors and any other equipment where vibration may be a problem. In these cases bonding jumpers shall be provided for grounding continuity per the requirements of NFPA 70 Section 250-91(b). Regardless of the conduit box or enclosure rating, a liquid tight neoprene-sealing gasket shall be provided for all flexible conduit connections.
c. A low point drain shall be installed to prevent the accumulation of water.
d. Outdoor conduit connections to any enclosures or boxes shall use Meyers hubs and enter the enclosure from bottom or side below the lowest live part. Top entry into enclosures and boxes shall not be permitted. Indoor conduit connections shall use either Meyers hubs or double locknuts.
e. Conduit in corrosive environments shall be heavy wall PVC conduit rated for exposed location or rigid galvanized steel with a 40 mil PVC exterior coating and urethane coated threads.
f. Sealing fittings shall be installed in all conduit runs at the boundary between non-hazardous and hazardous areas in accordance with NESC ANSI C2 requirements for Class I and Class II areas. Sealing fittings shall also be installed at boundaries where it is desirable to prevent the transference of different atmospheric conditions between areas.
g. Fiber optic highways and data links shall be installed in dedicated conduits and separate routes.
h. The main power feeds to the UPSs shall be in dedicated conduit.
i. The communication system (phones, etc.) shall be in dedicated conduit.
j. The underground duct bank systems shall have at least 20% spare conduits. As a minimum one (1) 4” PVC power and one (1) 2” hot dipped rigid galvanized steel control conduit shall be provided in each duct run.
k. The Gas Turbine Generator conduit separation criteria shall be used. If none is available, then separation per the NEC shall be used. BOP Contractor shall submit their separation criteria for General Manager review and comment.
l. The conduit shall be labeled with conduit number, voltage level and purpose.
m. Maximum conduit fill shall be 40% or less depending upon pulling tension calculations.

All underground duct banks shall consist of plastic conduit (type DB PVC) or hot dip galvanized steel conduit encased in reinforced "red" concrete. The conduit sizes shall be limited to 2, 3, 4, 5, and 6 inches for underground duct bank conduit, both PVC and hot dip galvanized steel. Hot dip galvanized steel conduit shall be used for digital and analog low level circuits, data highways or communication cables requiring noise immunity from adjacent power circuits. Hot dip galvanized steel conduit elbows with long radii shall be used for all duct bank riser turnups.

The duct bank shall be designed to prevent cable pulling tensions from exceeding the cable manufacturer's maximum allowable limits of any cable used.

The "red" concrete duct bank shall be re-enforced with rebar under all road crossings and other area subject to maintenance traffic as required by the BOP Contractor's design.

Electrical manholes shall be precast or cast-in-place, reinforced concrete construction. Manholes shall be provided with a lift-off top for cable installation, a manhole ring and cover for personnel access after construction, removable access ladder, sump, pulling eyes, and concrete inserts for cable supports.

J.21.7 Junction and Pull Boxes

All new junction boxes and pull boxes shall be sized such that all wiring contained within the box or terminated on terminal blocks within the box shall be easily accessible. Minimum size shall be in accordance with the requirements of the latest revisions of NFPA 70. Junction and pull boxes shall have barriers, as required, to maintain separation of circuits.

Enclosures for junction boxes, pull boxes, cabinets, control drive units, control stations and electrical devices shall be as follows:

Area	Type
Indoor, dry	NEMA 12
Indoor, wet or wash down	NEMA 4
Indoor, corrosive	NEMA 4X (stainless steel)
Outdoor	NEMA 4X (stainless steel)
Hazardous, indoor or outdoor	NEMA type suitable for hazard area where located

Installation of heat sensitive components in outdoor enclosures shall be avoided if possible.

J.22 Conductors (Electric Cables)

The electric cables shall remain functional throughout the service life of the facility. Electric cables shall perform satisfactorily during start-up, operation, and normal or emergency shutdown of the facility.

System reliability shall be accomplished through the use of redundant trains and systems where practical. Thus, a failure of a single part of the system (e.g. a feeder cable or transformer failure) shall not render the whole system or facility inoperable.

Electric cables shall reliably withstand normal voltages, design basis, abnormal voltages (including ground fault transients), environmental effects, and have the required ampacity. In determining the cables required, the following criteria, shall be followed:

a. Cables shall be specified as being suitable for installation in wet or dry locations indoors and outdoors in tray, conduit or duct bank.
b. Conductors shall consist of annealed, coated or uncoated stranded copper per UL 44, Parts 4-10, and Class B stranding (7 strands).
c. The ampacities selected shall ensure that no loss of operability shall result from equipment loads, and that the proper derating factors have been applied to maintain the integrity of the cables and operability of the circuit(s). The selection of cable ampacities shall be based on ICEA Publication P-46-426, "AIEE-ICEA Power Cable Ampacities for Copper Conductors" for copper cables installed in conduit and ICEA Publication P-54-440 "Ampacities for Cables in Open Top Trays" for cables installed in trays.
d. The cable jacket shall be tough, heat-resisting CPE or CSPE sheath compound suitable for 90°C service and meeting all requirements of UL 1277 Parts 9 and 10. Nominal thickness per UL 44, Table 21.3. Conductor insulation for 600V cable shall be 30 mils nominal cross-linked polyethylene meeting UL 44, Part 17. Conductors shall be cabled concentrically round using non-hygroscopic fillers and bound with polyester tape with 10% minimum overlap. Conductor lay shall be per ICEA S-66-524. All cables shall be rated for 90°C conductor operating temperature rating.
e. Cables shall be checked for short circuit capability. For each service, the expected actual short circuit current magnitude and duration or 10 cycles, whichever is greater, shall be considered to make certain that the insulation and conductor are not damaged when a short circuit occurs at the cable termination point. ICEA Publication P32-382 details the procedure. If a delayed tripping scheme is used on selected equipment, cable shall be sized for proper duration of short circuit.
f. Instrumentation cable shielding shall be grounded at one point only with shield isolation and continuity maintained at all other points. Medium voltage system cables (13.8kV and 4160V) shielding shall be grounded at both ends.
g. All 13.8kV and 4160V system power cables shall be shielded and terminated with stress relief cones of the heat shrink type.
h. Low voltage (600V and less) system power cables shall not be shielded or have stress relief cones. NEMA two (2) and one (1) hole compression lugs shall be used, similar to Burndy type “YA” for copper conductors.
i. Secure spade type lugs shall be used to terminate low voltage control and instrument cables.
j. All wires, jumpers and conductors shall be labeled on both ends to allow testing and trouble shooting, especially in MCC buckets, control panels, etc. The internal wires, jumpers and conductor shall match the vendors wiring diagrams. All external wires, jumpers and conductor shall be labeled per the BOP Contractor’s design.
k. A minimum of 10% spare space shall be provided all equipment terminal block, i.e. a twelve (12) point block shall have 2 spare points for future use.
l. All general terminal blocks shall be General Electric Type EB-25, CR151 or General Manager approved equal with studs to accommodate ring type wire lugs of proper size for wire and terminal blocks. Terminal blocks for control power wiring shall be heavy duty with boots or barriers to protect against accidental shorts. Terminal blocks for current transformer circuits shall be 4-point short circuiting type, equal to General

Electric Type EB-27 or Penn-Union Type 6004-SCS, supplied with all necessary shorting screws.

m. No terminal blocks shall be mounted within 6 inches of floor. Terminal blocks shall be installed with adequate spacing to side sheets or mounted devices, to allow ample space for external connections and cable runs. Parallel rows of terminal blocks shall be spaced a minimum of 14 inches.

n. All wiring shall be terminated using the approved wire lugs. Wire splices, fork type lugs, locking fork lugs or wire nuts shall not be used. Wire lugs shall be insulated, Burndy Type YAEV or approved equal ring type wire lugs of proper size for wire and terminal blocks. Wire lugs shall be installed using a ratcheting type crimping tool to insure adequacy and uniformity of crimp.

o. Control and instrumentation cables for the substation equipment shall be General Manager standard 2/c, 3/c, 4/c, 7/c and 9/c, rated 600V. Conductor identification by Method I, ICEA (spiral tracer) S-66-524 Appendix K, Para. K3.1, colored compounds with tracers as follows: SCADA cables shall be shielded. All other cables shall be unshielded unless deemed otherwise. Fiber optic cables shall be jacketed. Cables shall be UL Listed and Labeled and shall be certified to be in conformance with all applicable requirements of UL 1277. Cable tests per UL 1277 are required as a minimum.

p. DC power supply cables shall be RED (+) and BLACK (-).

J.23 Motors

Motors above 2000 horsepower shall be rated 13.8kV and supplied by captive transformers from 13.8kV buses. In general, motors rated 250 horsepower through 2000 horsepower are rated 4160V and motors rated below 250 horsepower and above 1/2 horsepower are rated 460V.

Motors shall be suitable for the high ambient temperatures and dusty environment. Motors shall be NEMA premium-efficiency, server-duty, totally-enclosed with 1.15 service factor rating. Motors shall be sized to start and accelerate the attached load without experiencing extended overload conditions.

The use of DC motors shall be restricted to 110 - 120 Volts and to emergency applications only.

J.24 Welding Outlets

The design shall include 480 volt, 60-ampere welding outlets each with a non-fused disconnect switch throughout the facility located near major pieces of equipment, as agreed to with General Manager. Contractor shall assume twelve locations. These locations shall coincide with the twelve locations for service air and low voltage receptacles described in this Specification.

In addition, the BOP Contractor shall provide additional receptacles as required by the Design Criteria. Contractor shall assume twelve locations. The outlets shall be suitable for the environment in which they are installed. These outlets shall be placed within reach of a 100-foot extension cord length throughout the facility.

Power receptacles shall be supplied from motor control centers or 480V power panels.

A maximum of four receptacles shall be allowed on any one circuit.

J.25 Instrumentation Requirements

Refer to Sections L.9.3 and L.9.5 for additional electrical requirements that apply to instrumentation installations.

The replacement cable shall be in accordance with this specification and the size will be the same as currently installed.

K. INSTRUMENTATION & CONTROLS REQUIREMENTS

K.1 General

The BOP Contractor is responsible for furnishing and installing a new BOP control system along with all the required programming and instrumentation for the operation of the GT-5 Combined Cycle Installation Project. This new control system shall be as specified in the PCS/ Control System Specification referenced below and fully integrated with the existing plant controls as described on the below referenced Control System Architecture Drawing. The estimated quantity of I/O points, including hardwired I/O is contained in the PCS/Control System Specification.

Reference Drawing I1-1: Control System Architecture

Reference PCS/ Control System Specification

The PCS architecture and equipment must be approved by the General Manager prior to purchase and installation.

The BOP Contractor shall provide marshalling terminal strips between the field I/O and the PCS I/O modules, and dedicated terminal strips for 24VDC/12OVAC power distribution. Terminal strips and converters/switches shall be mounted on DIN rails. Wiring shall be segregated by signal type and voltage level, including field interconnect wiring and wiring within PCS panels. Each digital signal (DI or DO) shall be provided with a fused terminal block on one leg and a pass-through terminal block on the other leg. Each analog signal (AI or AO) shall be provided with a disconnect terminal block on one leg and a pass-through terminal block on the other leg.

K.2 Instrumentation

K.2.1 General

The instrumentation and control equipment/systems and materials and their installation shall be designed in accordance with applicable codes, industry standards. Instruments and valves shall be pre-calibrated, tagged and/or programmed by the supplier. Contractor shall provide factory calibration records in equipment and/or system turnover packages. Function process controls shall be shown on the piping and instrument diagrams (P&ID's) in sufficient detail to fully illustrate each instrument loop and its components.

Pneumatic signal levels, where used, shall be 3-15 psig for pneumatic transmitter outputs, controller outputs, modulating control electric-to-pneumatic converter. Valve positions outputs may be 3-15 or 6-30 psig. On/Off control valves shall be per manufacturer requirements with a filter regulator as required.

Electronic transmitters and controllers shall be designed for proportional output of 4-20 mA DC with 24V DC power supply into 600-OHM maximum loop resistance. No primary sensor full-scale signal level, other than thermocouples, shall be less than 10mV or greater than 125V. Transmitters requiring an external power supply shall be connected to 24 VDC.

All electric transmitters shall have local indication; the final orientation of the transmitters shall be north/south to avoid directly sunlight. Transmitters shall also be Rosemount smart transmitters, supporting HART foundation protocol.

An identification tag showing the purchaser's identifying tag number as per the data sheets shall be attached to each field instrument. The tag and wire shall be stainless steel and riveted to the device with a character height of 0.125", 90 characters maximum or permanently stamped on the instrument with 65 characters maximum. As a minimum the tag should have the unit number, service description, instrument tag number, and manufacturer name, model number and purchase order number.

Sunshades/rain shields shall be provided for all outdoor panels.

All outdoor panels and its components shall be protected from adverse atmospheric and hazardous conditions by providing adequate cooling and air purging respectively.

Instruments and transmitters shall be wired back individually to the control system I/O Point, without the use of field buses or similar communication protocol.

The PCS and field instruments shall be configured for the following engineering units:

Temperature	Degrees F
Pressure	
Near Atmos.	In. of water
Above Atmos.	PSIG
Below Atmos.	In. of Hg Absolute
Level	Percent of range for process
Flow	
Liquids	GPM and LB/HR
Water	GPM and LB/HR
Gas or Vapor	SCFH* and LB/HR
Air & Nitrogen	SCFH*
Analyzers	pH, %, µs

* Defined at 60˚ F and 14.7 PSIA

The flow, level, pressure and temperature transmitters are to be "Smart" Hart® devices equipped with LED indicators calibrated in process engineering (lbs./hour, inches, inches H2O, °F, PSIG, etc.) The transmitters shall be custom calibrated and calibration certificates are to be furnished. Each transmitter shall be electronically encoded with the instrument tag number. Also, the flow level and pressure transmitters are to be installed using the appropriate 2 or 3 valve manifold with the appropriate manifold-mounting bracket.

K.2.2 Pressure Instruments

Industrial-type 4-1/2 inch-diameter pressure gauges with white faces and black scale markings or indicating pressure transmitters shall be provided where necessary for operation. In general, pressure

instruments shall have linear scales with units of measurement in pounds per square inch gauge. Pressure gauge accuracy shall be 0.5 percent of full range per ANSI Specification B40.1, Grade 2A. Pressure gauge stem connection shall be generally ½" NPT.

Pressure gauges shall have either a blowout disk or a blowout back and an acrylic or shatterproof glass face.

Pressure gauges on process piping shall be visible 10 feet from an operator's normal stance at the floor level and shall be resistant to facility atmospheres.

Connections to piping or equipment shall be in accordance with piping specification and instrument installation details.

Pressure test points shall have isolation valves and caps or plugs. Pressure devices on pulsating services shall have pulsation dampers.

Fire protection system pressure gauges shall be designed in accordance with UL standards.

Gauges in high vibration areas or pulsation process fluids shall be liquid filled.

Diaphragm seals shall be provided for aqua ammonia and chemical lines to avoid any direct contact of corrosive fluids with the gauge elements.

K.2.3 Temperature Instruments

In general, temperature instruments shall have scales with temperature units in degrees Fahrenheit. Exceptions to this are electrical machinery RTDs and transformer winding temperatures, which are in degrees Celsius.

Dial thermometers shall have 4-1/2 inch-diameter (minimum) dials and white faces with black scale markings and shall be every-angle type and bimetal actuated. Dial thermometers shall be visible 10 feet from an operator's normal stance at floor level (viewing area) and shall be resistant to facility atmospheres.

Temperature elements and dial thermometers shall be protected by thermowells except when measuring gas or air temperatures at atmospheric pressure. Temperature test points shall have thermowells and caps or plugs.

Thermowells for dial thermometers, temperature elements and filled system instruments shall be purchased with the instruments to assure proper fit. Thermowells shall be constructed of one-piece stainless steel except where conditions warrant use of main line class material. All thermowells shall be drilled bar stock (not built-up-type) except pipe type wells for use in fired heaters.

All thermowells shall have lagging extensions when used with insulation for high temperature. Consideration shall be given to thicker insulation in cold services.

RTDs shall be dual, 100-ohm platinum, ungrounded, three-wire circuits (R100/Ro-1.390). The element shall be spring-loaded, mounted in a thermowell, and connected to a cast iron head assembly.

Thermocouples shall be type K dual element, ungrounded, spring-loaded. For general service, the materials of construction shall be dictated by service temperatures. Thermocouple heads shall be the cast type with an internal grounding screw. If a thermocouple is inaccessible the leads shall be brought to an accessible junction box. When temperature transmitters are used they shall be mounted on the sensor assembly.

Where ASME Performance Test Codes (e.g., PTC-22 Gas Turbines) are applicable to, they shall be used as the criteria for determining well lengths.

Gauges in high vibration area shall be liquid filled.

K.2.4 Level Instruments

Reflex-glass or magnetic level gauges shall be used. Level indication for corrosive service (if required) shall use devices other than reflex-glass gauges. Level gauges for high-pressure service shall have suitable personnel protection. Transparent type gauge glasses shall be used up to 600 psig. Above 600 psig, bi-color, direct reading ported gauges shall be used.

Gauge glasses used in conjunction with level instruments shall cover a range that includes the highest and lowest trip/alarm set points.

Level transmitters for measuring the level in storage tanks vented to atmosphere (e.g., demineralized water, waste water storage, condensate, etc.) shall generally be the flanged differential pressure type and shall have local indication. Differential pressure type level instruments shall normally be furnished for pressure vessels in level ranges that exceed 48 inches. External displacer type level transmitter and controllers shall be normally furnished for all pressure vessels in level ranges equal to or less than 48 inches. Ultrasonic, internal displacer or ball float level instruments shall be furnished for open sumps and tanks and for services where draining of the tank for maintenance can be easily accomplished.

Sump pump motors shall be controlled with a lead-lag controller with displacer or float-type level (no mercury) switches supplied by the sump pump manufacturer.

K.2.5 Flow Instruments

K.2.5.1 Transmitters

Flow transmitters shall be the differential pressure type with the range matching (as closely as practical) the primary element. In general, linear scales and charts shall be used for flow indication and recording, with flow units as follows:

- Liquids-gpm and lbm/hr
- Gases-scfh and lbm/hr

K.2.5.2 Primary Elements

Concentric type orifice plates shall be used as the primary elements for flow measurement. In general, 316 SS orifice plates shall be provided. For clean fluids the square edge orifice shall be used. The orifice plates shall be in accordance with API 2530, Chapter 14, Section 3, orifice metering of natural gas and

other related hydrocarbon fluids. Each orifice plate shall be stamped with the tag number, plate material, plate thickness, and orifice diameter and design conditions. Primary element calculations shall conform to the requirements established in Principals and Practices of Flow Meter Engineering by L.K. Spink, and in the Flow Measurement Engineering Handbook by R.W. Miller.

Orifice meter differential range shall be selected for a beta ratio (d/D) of between 0.3 and 0.7 for flow control elements and between 0.4 and 0.6 for other critical flow measurements. Standard range differentials for orifice taps shall be:

- 0-5, 0-20, 0-50, 0-100, 0-200 inches of water.

K.2.5.3 Meter Runs

Orifice runs shall utilize orifice flange taps and shall be installed in a horizontal line if possible. Integral orifice meters, variable area meters (armored rotameters) should be installed in lines less than 2 inches.

Flow transmitters shall be the differential pressure type with the range matching (as closely as practical) the primary element. All flow differential pressure transmitters shall be furnished and shipped with integral three or five valve manifolds.

Vortex-shredding meters or orifice plates may be used for flow measurements.

Air flow measurements shall be temperature compensated. Gas flow measurements shall be temperature and pressure compensated. All compensation instrumentation shall be installed in close proximity to flow elements.

K.2.6 Control Valves

A specification has been provided for BOP supplied control valves in section A.2. Control valves in throttling service shall be the globe-body cage type with body materials, pressure rating, and valve trim suitable for the service involved. Wherever practical, control valves shall be of the pneumatically actuated spring and diaphragm type. Other style valve bodies may also be used when suitable for the intended service. No spilt-body valves or separate flange styles shall be used without specific approval from General Manager. Butterfly valves shall be of the lug body type.

Valves shall be designed to fail in a safe position.

Control valve body size shall not be more than two sizes smaller than line size, unless the smaller size is specifically reviewed for stresses in the piping.

Control valves in the 300# class service and below shall be flanged where economical.

Critical service valves shall be defined as ANSI 600# Class and higher valves in sizes larger than 2 inches.

Severe service valves shall be defined as valves requiring anti-cavitations trim, low noise trim, or flashing service, with differential pressures greater than 100 psig.

Modulating valves shall be supplied with a PMV positioner purchased and mounted on the valve by the vendor.

Each control modulating valve shall be specified on the data sheet and shall be sized per the manufacturer's method based on the ISA-S75.01 sizing equations. All actuators, positioners, I/P's solenoid valves, air sets, limit switches, etc. shall be mounted on the valve by the vendor. Each control modulating valve shall be checked for sizing cavitations and flashing by the BOP Contractor.

On-Off valves shall be full-port, line size and selected to produce minimum pressure drop.

Pneumatic positioners shall be furnished with three gauges and a bypass valve, except the bypass valve shall be omitted on split range or reverse acting positioners. All valve tubing shall be 316 SS, minimum ¼" by 0.049" wall thickness.

Below seal bonnets shall be used for highly toxic or volatile fluids. Teflon or approved non-asbestos alternate packing material may be used for temperatures between - 40˚F and 450˚F. Grafoil packing shall be used as a minimum for temperatures 450˚F and above.

In general, control valves shall be specified for a noise level no greater than that specified in the 480033 Combined Cycle Balance of Plant Noise Control Performance when measured 3 feet downstream and 3 feet away from the pipe surface. For valves where the noise level is greater than 85 dBA, the vendor shall suggest methods of noise attenuation and the predicted noise level.

Valve actuators shall use positioners and the highest pressure, smallest size actuator, and shall be the pneumatic-spring diaphragm or piston type. Actuators shall be sized to shut off against at least 110 percent of the maximum shutoff pressure and designed to function with instrument air pressure ranging from 80 to 125 psig.

Hand wheels shall be furnished on all modulating control valves.

Flow direction shall be clearly indicated by arrow on the body as part of casing or permanently attached plate.

Control valves shall be sized to operate normally between 40% – 60% of range.

Full-flow manual bypasses with isolation valves for on-line maintenance shall be provided for all modulating control valves. Bypass valves around modulating control valves shall be globe type capable of manually modulating flow over extended periods of time without suffering seat damage.

Control valves accessories, excluding controllers, shall be mounted on the valve actuator unless severe vibration is expected.

Solenoid valves supplied with the control valves shall have Class H coils 120 VAC UPS powered. The coil enclosures shall normally be a minimum of NEMA 4 but shall be suitable for the area of installation. Terminations shall typically be by pigtail wires.

Valve position feedback (with input to the control system for display) shall be provided for control valves (analog feedback for modulating valves). When valve position feedback is required, utilize digital valve controllers to provide a Foundation Hart signal back to the control system superimposed on the valve

analog output. This signal shall be split off the analog valve position output by a Foundation Hart Tri-Loop for a 4-20 mA input into the control system.

K.2.7 Instrument Tubing and Installation

Tubing used to connect instruments to process line shall be 3/8 inch OD x 0.049-inch wall seamless 316 stainless steel for primary instruments and sampling systems.

Instrument tubing fittings shall be the compression type. Swagelok fittings shall be selected for use and shall be standardized as much as practical throughout the facility.

Differential pressure (flow) instruments shall be fitted with three-valve manifolds; two-valve manifolds shall be specified for other instruments as appropriate.

Instrument installation shall be designed to correctly sense the process variable. Taps on process lines shall be located so that sensing lines do not trap air in liquid service or liquid in gas service. Taps on process lines shall be fitted with a shutoff (root or gauge valve) close to process line. Root and gauge valves shall be mainline class valves.

Instrument tubing shall be supported in both horizontal and vertical runs as necessary. Expansion loops shall be provided in tubing runs subject to high temperatures. The instrument tubing support design shall allow for movement of the main process line.

Instrument impulse tubing installation shall not be designed for blow down service.

K.2.8 Pressure and Temperature Switches

Field-mounted pressure and temperature switches shall have either NEMA type 4 housings or housings suitable for the environment.

In general, switches shall be applied such that the actuation point is within the center one-third of the instrument range.

Switch contacts shall have a dual form “C” configuration where appropriate.

K.2.9 Field-Mounted Instruments

Field-mounting instruments shall be of a design for the area in which they are located. They shall be mounted in areas accessible for maintenance and relatively free of vibration and shall not block walkways or prevent maintenance of other equipment.

Field-mounted instruments within close proximity shall be grouped on racks. Supports for individual instruments shall be prefabricated, off-the-shelf, 2-inch pipe stand. Instrument racks and individual supports shall be mounted to concrete floors, to platforms, or on support steel in locations not subject to excessive vibration.

Individual field instrument sensing lines shall be sloped or pitched in such a manner and be of such length, routing, and configuration that signal response is not adversely affected.

Liquid level controllers shall generally be the non-indicating, displacement type with external cages.

Weather Station
An Orion LX Weather Station shall be provided including the items located below. Location to be coordinated between the BOP Contractor and the General Manager. The website below provides more information on this station. http://www.columbiaweather.com/products/weather-stations/fixed-mount/orion-weather-station/

Orion LX Weather Station
Standard System Includes:
Orion Transmitter housed in a Self-Aspirating Radiation Shield with Bird Spike kit
100-ft sensor cable
Sensors include:
Temperature Sensor
Relative Humidity Sensor
Digital Barometer
Ultrasonic Wind Direction & Speed Sensor
Impact Rain Sensor
Weather MicroServer, 200MHz ARM Processor, 512 MB Flash Memory
32 MB Datalogger
FTP output to Internet
XML Webserver
Ethernet Network Connection
Modbus TCP/IP and Modbus RTU (RS-232) Communications
SNMP Interface
Dual RS-232 ports
Mounting Adapter
Orion Interface Module
Comprehensive user manual
Lightning Arrestor, Three Stage Surge Protector, for Orion Data and Power Signals
Superior three-stage, transient surge protection
Tolerates up to 10 kA surge currents
Noise filtering against HF and RF interference
Robust structure, IP66 housing
Differential and common mode protection for each channel
Mast mounting hardware

K.2.10 Instrument Air System

Branch headers shall have a shutoff valve at the takeoff from the main header. The branch headers shall be sized for the air usage of the instruments served, but shall be no smaller than 3/8 inch. Each instrument air user shall have a shutoff valve, filter, and regulator (where appropriate) at the instrument.

K.2.11 Raceway Installation

Exposed conduit shall be installed parallel with, or at right angles to, walls, columns, etc. Diagonal conduit routing shall not be permitted without specific approval of the General Manager.

Conduit routing between platforms shall follow access ladders. The conduits shall be installed parallel to the ladder side rails. Conduits shall not cross in back of the ladder within seven (7) inches of the ladder rungs.

Conduits shall be attached to supports with "U" bolts, or conduit clamps.

Expansion fittings shall be installed in straight conduit runs every 200 feet. The Contractor shall provide and install sliding conduit guides to maintain conduit runs straight and true.

The Contractor, in accordance with the National Electrical Code shall install explosion proof conduit seals.

Drain fittings or drain seals shall be installed in all low points of the conduit system. Drain fittings shall be installed in the bottom of all pull boxes, terminal boxes, local panels, etc.

Conduit shall be arranged to enter all field located panels, terminal boxes, etc., from the bottom or sides, unless specific situations prevent this method. Conduits entering control system equipment from the top or bottom and must have written approval from the General Manager.

Conduit openings, into which dirt, plaster, or any construction debris may fall, shall be closed with caps or plugs during the construction period.

Rigid metal conduit shall be supported in accordance with the applicable section of the National Electrical Code.

All conduits shall be swabbed clean and must be free of burrs or obstructions that may damage cables.

Conduits shall not be supported from piping or other structures, which may be removed from time to time for maintenance and/or repair.

Where flexible metallic conduit is used, the manufacturer's standard bending radius must not be exceeded.

The minimum size of rigid metallic conduit shall be ¾ inches unless the conduit is in or on a control or instrument panel, in which case ½ inch conduit is permitted.

One-hole clamps may be malleable iron on aluminum with backing spacers.

Contractor shall permanently tag all conduits at termination points; no stick-on labels are permitted.

Factory manufactured conduit bend shall be used wherever practical. Field conduit bends shall not be made with a radius less than that specified in the National Electrical Code and shall be bent with a manufactured device specifically made for that purpose.

Factory elbows, nipples and couplings shall be of the same type as the conduit.

It is the responsibility of the subcontractor to furnish and install, for each wiring system, the necessary number and size of conduit fittings or pull boxes in conduit runs wherever additional intermediate pulling points are required per the National Electrical Code.

An anti-galling conductive thread lubricant shall be used for all joints and connections.

Seals shall not be poured until wiring is tested and functionally checked.

Route conduits around beams, columns, piping and other obstacles with bends or fittings providing a minimum of 6 inches clearance to hot pipes, ducts, etc. Structural steel shall not be cut, drilled or burned in any manner for the installation of conduit.

Conduit serving an instrumentation device mounted on the boiler, heat exchanger, etc. shall be spaced 6 inches from the outer surface of this type of extremely hot equipment, except where necessary to connect to the instrumentation device.

No running threads shall be permitted. When it is necessary to complete a conduit run and neither end can be turned, a conduit union shall be used.

Bushings shall be provided on all conduit terminations at fittings, pull boxes, equipment enclosures, etc., to protect the wire from abrasion unless the design of the fittings, box, equipment enclosures is such as to protect the conductors from abrasion. Install watertight hubs at each conduit entering an outdoor enclosure or entering NEMA Type 4 enclosures. Only enter boxes from the side or from the bottom. Top entry will not be allowed.

Conduits terminating at cable rack or equipment enclosures shall be connected to the equipment so that electrical continuity is insured.

Gaskets for standard conduit fittings shall be solid for size 1-1/2” and below.

Conduit fittings wherever installed outdoors shall be provided with suitable weatherproof gaskets. All threaded connections shall be painted with waterproof sealing compound.

Vertical riser conduits shall be fitted with conductor support as specified by Article 300-19 of the National Electrical Code.

At all connections to transmitters, pressure switches, and similar field electrical devices, a minimum length of 12 inches and a maximum length of 36 inches of liquid-tight flexible metal conduit shall be installed between the rigid conduit and the box or device to be connected to.

All field sized instrument signal conduits for 4-20 mA signals shall be sized per the National Electrical Code.

K.2.12 Cable Tray Installation

Cable tray systems shall be used to support only approved wiring methods.

Cable support systems shall not be supported by, or attached to, process piping or other structures, which may be removed from time to time for maintenance and/or repair.

Cable tray shall be installed as a complete support system with each run of tray completed before installation of cables.

Cable tray shall be of the ladder type of 9-inch rung spacing, unless otherwise specified.

When cable trays are installed in tiers, the minimum vertical clearance between tiers shall be 12 inches. When the combined width of a tier exceeds 36 inches, the minimum vertical spacing shall be 24 inches.

Enough horizontal separation shall be provided between adjacent cable trays so that there is sufficient room to attach hold-down clips and bolts to the supports. A minimum of 2-inch space between side rails and a 1-inch space between side rail and any vertical support shall be maintained.

Install and support cable trays in such a manner so that not more than four 24 inch or four 30 inch wide trays are located adjacent to each other on one horizontal plane or tier. In case this must be exceeded, provide 18 inches of access spacing between every four horizontal trays or some other method of access.

A minimum vertical clearance of 12 inches shall be maintained from top of cable tray to ceiling, beams or other obstructions for 30 inches and smaller tray and 18 inches for 36-inch tray.

Support for cable trays shall provide strength and working load capacity sufficient to meet the static load and the dynamic loads during cable installation. Horizontal and vertical tray supports shall provide an adequate bearing surface for trays and shall have provision for hold-down clamps and fasteners. Vertical tray supports shall be provided with secure means, other than friction, for fastening trays to supports.

Supports shall be located, whenever practical, so that connectors between horizontal straight sections of cable tray runs fall between the support point and the quarter point of the span. Unspliced straight sections shall be used on all simple spans and on end spans of continuous span arrangements.

K.2.12.1 Horizontal Cable Tray Fittings

Supports for horizontal tray fittings shall be placed within 2 feet of each fitting.

Supports for horizontal tee tray fittings shall be within 2 feet of the three openings connected to other cable tray items for 12-inch radius. On all other radii, at least one support shall be placed under each side rail of the horizontal tee.

Supports for horizontal cross tray fitting shall be within 2 feet of the four openings connected to other cable tray items for 12-inch radius. On all other radii, at least one support shall be placed under each side rail of the horizontal cross.

K.2.12.2 Vertical Cable Tray Elbows

Vertical cable tray elbows at the top of runs shall be supported at each end. Vertical tray elbow at the bottom of runs shall be supported at the top of the elbow and within 2 feet of the lower extremity of the elbow.

K.2.12.3 Vertical Straight Lengths

Vertical straight lengths shall be supported at intervals dictated by supporting and building structures and design drawings but not exceeding 24 feet on centers.

K.2.12.4 Sloping Trays

Sloping trays shall be supported at intervals not exceeding those of horizontal trays of the same design for the same application.

K.2.12.5 Fitting At End of Run

A fitting, which is used as end of the run dropout shall have a support attached to it, firmly reinforcing the fitting.

K.2.12.6 Expansion Joints

Expansion joints shall be installed every 100 feet and in applications where the tray spans between structures.

K.2.12.7 Conduit And Cable Tray Supports

Furnish and install a complete support system for all conduit and cable tray which consists of beam channels, hanger rods and the necessary fittings for assembling and hanging.

The beam channel sections shall be 12-gauge, 1-5/8" square formed steel channel with one side open to form a continuous slot complete with spring held nuts, suited bolts, and metal end caps. Channels shall be galvanized inside and outside. Channels shall not form closed pockets that could hold liquids. Beam channels shall be similar to Unistrut P1000 and P1001.

Hanger rods shall have full threads and be galvanized with minimum size of ½ inch diameter. Maximum spacing of hanger rods shall be 7 feet. Clamps for conduits, shall be galvanized steel straps with Everdur (or equivalent) bolts, nuts and lock washers.

Single conduits supported on the building steel shall be by means of malleable iron fittings; similar to T&B adjustable combination beam clamps and supports Nos. 690-693. Single conduits supported to masonry building walls and ceilings shall be by means of heavy-duty galvanized conduit straps (two holes for conduits 1-1/2 inch and larger similar to Kindorf (C144) with suitable concrete expansion anchors. Conduit suspended from ceilings or beams shall be hung by means of hanger rods with suitable galvanized conduit hangers similar to Kindorf C149 or C150. Beam clamps shall be of the adjustable galvanized type with swing connector similar to Unistrut P2676 with swivel nuts and clevises. Ceiling clamps shall be of the adjustable galvanized swinging hanger flange type similar to Kindorf E170. It shall be the Contractor's responsibility to space consecutive hanger supports to that hanger hardware is not loaded beyond its safe structural limits.

Welds are not permitted across the face of any structural steel member. Supports that must be fastened to structural steel shall be held firmly by clamps, which suit the application; for example, Unistrut P1796S for fastening 1-5/8 inch square formed steel channel.

Assembled conduit, racks and supports shall be set true to line and level. Bracing to building structure shall be provided in the field as necessary to provide proper strength and rigidity for the complete system of supports. All support materials shall be hot dipped galvanized.

K.2.13 Grounding

The control system shall be grounded per Article 250 of the National Electrical Code and the design drawings. Soil resistivity testing will need to be performed after over excavation and compaction activities are completed.

An alternate current (safety) ground shall be provided for all control system equipment.

This ground shall be made on each system cabinet by connecting the ground conductor, which is routed with the power conductors to the system cabinet, to the chassis ground lug located in each cabinet. The size of this ground conductor shall be the same size as the system cabinet power feed conductors.

If no power is required in a cabinet, such as an I/O cabinet, a bonding conductor from a powered cabinet shall be provided. This ground conductor shall be a minimum of No. 12 AWG green insulated conductor.

A direct current signal ground shall be provided at all system cabinets.

This ground shall be made by connecting a grounding conductor at each isolated system common bus located at the bottom of each cabinet to a separate dedicated grounding electrode.

When multiple system cabinets are provided, one cabinet can be made the common tie point where individual conductors from each other system cabinet are connected to the isolated bus. Then the common cabinet is connected to the dedicated grounding electrode. This method is known as a radial system. Daisy chaining the cabinets with one conductor shall not be allowed.

The size of this ground conductor shall be No. 6 AWG green insulated conductors in a star configuration between cabinets and a common No. 2 AWG green insulated conductor to the dedicated grounding electrode.

The dedicated grounding electrode shall have a resistance of 5 ohms or less. The BOP Contractor shall test and verify the actual ground resistance.

Excluding grounded thermocouples, all instrumentation and control cable shields shall be grounded only at the vertical ground bus provided in the PCS cabinet and shall be continuous throughout the cable length.

K.2.14 Panel Mounting

All control system cabinets shall be securely fastened to the floor using ½ inch diameter bolts.

Anchor bolts shall be installed using expanding type anchor inserts and ½ inch diameter bolts.

When no cable tray is provided above the system cabinets, the system cabinets shall be mounted on a 6-inch channel. This channel shall be securely fastened to the floor. The purpose of this channel is to

provide a raceway for the interconnecting system cables. The channel shall be covered with black plastic molding.

K.2.15 Wiring Methods

All cable shall be installed in conduit or in cable tray. Proper rollers, pulleys, pulling eyes, grips, etc. shall be used when installing cable in the raceway system to prevent damage to the cable. Pulling compound shall be used for all cable pulls within conduits.

Separate conduit/cable tray systems shall be provided as follows:

Level 1 Signals
Thermocouple
RTD (Resistance Temperature Device)
DC Common
0 to 50 VDC Analog
0 to 15 VDC Digital
Loop Communication Signals

Level 2 Signals
24 VDC Control < 250 mA

Level 3 Signals
24 VDC Control, $\geq$ 250 mA and < 3 Amps
125 VDC Control, < 50 mA
120 VAC, < 20 Amps

Level 4 Signals
125 VDC Control $\geq$ 3 Amps
AC Bus Lines $\geq$ 800 Volts and $\leq$ 800 Amps

Level 4S Signals
AC Bus Lines > 800 Volts or > 800 Amps

Individual conduits or shielded cables shall be provided for signal wires used with turbine meters, magnetic flow meters, or telemetering equipment.

Provide minimum separation of instrument wiring from power wiring in accordance with the following:

Cable tray spacing shall be as follows: INCHES (MM)

From Level	1	2	To level 3	4	4S
1	0 (0)	1 (25)	6 (155)	26 (660)	26 (660)
2	1 (25)	0 (0)	6 (155)	18 (460)	26 (660)
3	6	6	0	8	12

	(155)	(155)	(0)	(203)	(305)
4	26 (660)	18 (460)	8 (203)	0 (0)	0 (0)
4S	26 (660)	26 (660)	12 (305)	0 (0)	0 (0)

Routing of overhead instrument conduit and cable shall be arranged to minimize exposure to fire hazard. Maintain a lower limit of 15 feet above pumps and exchangers.

Terminal boxes shall be located so that they may be reached without ladders.

Wire and cable shall be sized per the National Electrical Code.

Control cables installed in cable tray shall be arranged neatly and laid side-by-side in layers. In a vertical trough, the cables shall be tied to the rungs at maximum intervals of 3 feet.

Install RTD and low level signal wiring in conduits (Level 1 Signals) separate from power and control wiring. When installing in cable trough, a metal divider shall be installed for separation from other circuits.

Cables that are not enclosed in conduit entering equipment from below the floor shall be supported near, at or above the floor with cable clamps or trays secured to metal channels that are anchored to the floor or equipment. Cables shall be supported to prevent any strain on the conductor terminations.

The BOP Contractor shall be responsible for confirming proper sizing of the conduits before installation.

Wire color-coding shall be as follows:

AC Support – Hot	Black
AC Switch Leg	Black
AC Support – Neutral	White
DC Power Supply	(-) White; (+) Black
Ground	Green
Alarm Wires	Yellow
Control Wires	Red
Electronic Pair (Except thermocouple signals)	(-) White

Instrument power wires shall be minimum #12 Gauge with 600 V insulation, color-coded and identified with printed sleeves.

Field signal wiring provided for 120 VAC control shall be #14 Gauge 600 V insulation single conductor.

All wire and cable used on or in the close proximity of the boiler front shall be suitable for this high temperature location. Cable insulation shall have a minimum temperature rating of 125 degrees C.

The minimum bending radius for control cable (19/C and larger) shall be 8X the cable diameter.

Cable splices and taps shall be made only in junction boxes or fittings approved for the purpose.

K.2.15.1 Terminations

Conductors terminating on screw-type terminals shall have pre-insulated keeper-type, crimp-type spade lugs. The only exception to this is when terminating thermocouple wire. No lugs would be permitted unless of the same alloy. Terminate wire directly to terminal.

Thoroughly clean conductors before installing lugs.

Use commercially available wire stripping tools to avoid nicking conductors.

No splices or intermediate terminations shall be permitted in any signal conductor.

Field mounted terminal strips must be on mounting plates or brackets. Direct mounting on the back of terminal boxes is not permitted.

Shield signal leads must maintain shield or drain wire continuity to a signal ground connection. This signal ground connection shall be at the control system cabinets.

Care must be taken to avoid accidental ground of shield or drain wire. Cut drain wire as close as possible to cable jacket at ungrounded end of cable and tape.

Excluding grounded thermocouple, the thermocouple extension lead wires shield shall be grounded at the control equipment end only, not at the thermocouple head.

Cable and/or wire shall be identified by numbers corresponding to schematic/wiring diagrams or loop drawings. Printed sleeves shall be affixed at each end of every cable and/or wire. The sleeves shall be easily readable and indelible.

All control signal cable terminating in the control system cabinets shall be neatly bundled and tie wrapped in a professional manner.

Where multi-single pair cable or a multi-conductor cable enters a panel or a cabinet, the outer jacket of the cable that shall be terminated, shall be stripped from the cable only to the extent necessary for proper installation and connection. The cable shall not be stripped beyond the point where the single or first conductor leaves the cable to connect to the terminal strip. Each single conductor or multi-conductor cable that is terminated shall be terminated with approximately 6 to 8 inches of slack allowed in the conductor between the terminal point and the outer jacket. Spare conductors of a multi-conductor cable shall be left un-terminated with maximum length.

K.2.15.2 Junction, Terminal And Pull Boxes (Non-Hazardous Locations)

Furnish and install, for each wiring system, the necessary number of junction or pull boxes in conduit runs wherever additional intermediate pulling points are required or as required by code. Boxes shall be sized per National Electrical Code requirements, but minimum size shall be 6 x 6 x 3 inches. Securely anchor all pull and junction boxes.

All boxes installed outdoors shall have NEMA Type 4 rating.

All boxes installed indoors shall have a NEMA Type 12 rating.

All boxes shall be constructed of 12 Gauge (minimum) steel and shall be corrosion resistant.

All NEMA Type 4 junction and pull boxes shall be of the deep type, surface mounted, with mounting lugs and threaded hubs. JIC boxes utilizing "Scru-Tite" hubs may be used in lieu of boxes with threaded hubs as long as a NEMA Type 4 enclosure is retained and assured.

Covers shall be secured by stainless steel screws or bolts.

Terminal boxes shall be mounted where access by ladder is not required. They shall be provided with sub-panels for mounting screw type terminal blocks.

K.2.16 Instrument Installation

Instrument installations shall be in accordance with API RP550, except as modified by this specification.

Instruments shall be installed in such a manner as to insure efficiency of operation, minimum maintenance, and adequate accessibility per manufacturer's recommendations.

All instruments shall be accessible from grade, platform, permanent ladder or stairway, in accordance with the following conditions:

Instruments shall not be more than 10 feet above grade, 7 feet 7 inches directly above a platform or more than 1 foot away from a permanent ladder or stairway.

Instruments may be located outside of platform handrails providing they are not more than 4 feet 6 inches above the platform level, or more than 2 feet away from the handrail.

Instruments shall not be mounted on handrails or within 6 inches of a handrail.

Instruments shall be located in such a manner as not to interfere with removable handrails or grating.

Instruments and connecting piping shall be installed in such a manner as not to interfere with walkways, process piping, ductwork, electrical boxes, conduit and trays, or with access required for plant maintenance.

Local controllers, except those integrally mounted with displacement level units, recorders, differential indicators, transfer switches or other local control apparatus, requiring attention during normal unit operation, shall be mounted at grade, located in areas where the operator normally works and, where possible, shall be mounted together to minimize supports.

K.2.16.1 Connecting Piping and Tubing to Instruments

Except for the line mounted pressure gauges, displacement level instruments, and gauge glasses, connecting piping from first block valve for instruments shall be ½ inch OD x 0.049 inch wall tubing. If instrument connection is smaller than ½ inch, the reduction shall be made at the instrument.

Where pipe and pipe fittings are required immediately after the first block valve, (such as for rod out connections), they shall be in accordance with the line specifications, except threaded.

Connecting tubing shall slope at least 1 inch per foot between a take-off connection and instrument. Slope shall be continuous and in the same direction with no dead legs.

In general, the use of condensate or seal pots shall be in accordance with installation details or tubing shall be so installed as to allow the tubing to suffice as a filled leg.

All filled installations shall be provided with a ½ inch fill connection.

Instruments in liquid, steam or sealed service shall be located below the process connection; instruments in hydrocarbon vapor, gas or air service shall be located above the process connection.

If instruments in liquid, steam or sealed services must be mounted above the process connection, the tubing leads shall extend a minimum of 12 inches above the instrument connection before being brought down to connect to the instrument. A fill connection shall be provided at the highest elevation of the installation.

If instruments in hydrocarbon vapor, gas or air service must be located below process connection, a 12-inch long drip leg of 1-1/2 inch pipe shall be provided before the instrument connections. Half-inch shutoff valves shall be provided above and below the drip legs.

Secondary shutoff valves shall be provided for all instruments not having an instrument manifold if the instrument is located more than 10 feet away from the process connection or where the process connection is not directly accessible from the instrument.

Drain or vent valves shall be provided for all instruments located more than 10 feet away from the process connection and for all instruments not supplied with integral bleed fittings.

All drain and vent valves shall be provided with solid hex head threaded plugs.

All D/P cell type instruments, except D/P cells in level service with liquid reference legs, shall have 3-valve or 5-valve type manifolds bolted directly to the instrument body.

All bellows type differential type measuring instruments, except those in level service with liquid reference legs, shall have a 3-valve or 5-valve manifold installed in the tubing runs at the instrument.

Rod-out connections shall be furnished at all orifice flange connections and all instrument connections in dirty or plugging type services.

All differential type instruments in liquid, steam or sealed services shall have both leads brought to the same elevation before dropping to the instruments, except for installations where only one lead is used as the reference leg.

K.2.16.2 Instrument Air Supply Piping

The instrument air distribution system shall be independent and separated from plant air, utility air or other systems. Instrument air shall not be used for other purposes such as utility air or plant air. Instrument air line shall be stainless steel material that must be approved by the General Manager.

All instrument air branch headers from the main distribution header shall be provided with a ball valve, of the same size as the branch distribution header, located at the point of take-off. Reduction to branch size shall be made before the valve.

All take-offs from the main or branch distribution headers shall be from the top of the header, including take-offs to individual instruments.

Individual instrument air supply take-offs shall be ½ inch size and shall have a ¼ inch ball valve before the combination filter-regulator. A reducing tee shall be provided for reducing to the valve. The unused run tap shall be plugged.

The combination filter-regulator may be supplied mounted to the instrument by the manufacturer.

When the combination filter-regulator is supplied as a loose item, it shall be connected to the ball valve with ¼ inch pipe and a union.

Field mounted combination filter-regulators shall be connected to the instrument with ¼ inch OD tubing.

Teflon tape shall not be used for any instrument air supply piping connections. All connections shall be sealed with a liquid pipe thread sealing compound.

Instrument air connections to all control valves will be connected with flexible tubing suited for outdoor service at the pressure rating required.

K.2.16.3 Instrument Pneumatic Piping

All field pneumatic lines shall be ¼ inch OD x 0.049 inch wall 316 stainless steel tubing.

Teflon tape shall not be used for any pneumatic connections. All connections shall be sealed with a liquid pipe thread sealing compound.

If more than one instrument is connected into any transmission or control line, each instrument shall have an isolation valve to allow servicing of any component without disrupting the control of the loop.

Electro-pneumatic transducers shall be grouped on pipe stands or racks with a maximum of six units on each pipe stand or rack, providing that the instrument design meets the hazardous area classification. The maximum allowable tubing run from the transducer to the control valve or controlled device shall be 25 feet.

K.2.16.4 Instrument Mounting

Close-coupled transmitters shall be mounted directly to the process line utilizing a pipe saddle and 2-inch mounting pipe. Open pipe ends shall be capped.

The BOP Contractor shall employ instrument mounting methods and locations such that vibration will not affect the operation of the instrument.

All instrument supports shall be hot-dipped galvanized, after fabrication.

Instruments that are not line mounted shall be supported on 2-inch galvanized pipe stanchion. Stanchions shall be designed such that they may be bolted to concrete pads at grade, to platform steel or to suitable brackets outside of handrails.

The centerline of non-line mounted instruments shall be 4 feet 6 inches above grade or platform wherever possible.

Where mounting plates are used such as for local relays, gauges, etc., the mounting plates shall be 3/16 inch thick, hot dipped galvanized steel. Mounting plates shall be bolted to structural members wherever possible.

L. DRAWING REQUIREMENTS

L.1 Reference Drawings and Heat Balance Diagrams Included in A.2 and A.3

The drawings located in section A.2 have been prepared by the General Manager's Engineer. These drawings illustrate the conceptual design and provide, in conjunction with this document, the functional requirements for the Facility.

A partial set of existing Facility reference drawings has been assembled for information only (see A.3).

L.2 Drawing & Document Submittals

The plant shall be designed using a 3D model. Please explain the BOP Contractor's preferred platform with bid. All drawings shall be submitted as PDF's or in CAD when requested. Approved IFC drawings shall also be issued hardcopy. CAD files shall utilize the latest version of AutoCAD or Microsoft Office software as appropriate. Documents not available in CAD or Microsoft Office software shall be submitted as Adobe Acrobat PDF files. Hardcopy drawings submitted for approval shall be in full D-size sheets of 22 inches by 34 inches.

All drawings shall use English language. All dimensions and units of measurements shall be in US Standard units and shall conform to the latest revision of ANSI Standard Drafting Practices. Drawing nomenclature and graphic symbols shall conform to General Manager's standards, or in the absence of a General Manager standard, with the latest version of ANSI/IEEE standards. General Manager requires the BOP Contractor to submit legend drawings showing all nomenclature and symbols used on the Vendor's drawings.

BOP Contractor and their design subcontractor/architect shall participate in the required Pasadena Design/Planning Commission meetings as part of the submittal, design review and permitting processes. Contractor and their design subcontractor/architect shall anticipate as many as six (6), three-hour on-site meetings (which may occur at the power plant or the Pasadena City Permit Center adjacent to City Hall) and/or after-hours open session meetings with the Design and/or Planning Commissions.

Due to the nature of this project and the extent of preliminary engineering already performed, the traditional 30/60/90 percent review cycles may not necessarily apply, but the General Manager's team will like to have an early review of the BOP Contractor's design. A kick-off meeting will be scheduled with the successful bidder to discuss Permitting, Demolition, Engineering, Procurement, Construction, Commissioning, Performance Testing and Turnover. In addition to the engineering kick off meeting, the BOP Contractor should assume an early engineering review to assure the scope intent is being met, information from the PIE Contractor is being properly implemented, then a 60% and 90% review cycles will apply, along with normal submittal processes as a course of business. The schedule for submittals, milestones, etc., will be coordinated and agreed to with the General Manager, Owner's Engineer and the BOP Contractor prior to project award.

L.3 Design Submittals

The BOP Contractor shall submit electronic copies of the following drawings and calculations to General Manager (who will provide a distribution list) for formal review (both Issued for Review - IFR and Issued

for Construction - IFC stages). General Manager shall examine each document submitted for review and comment and will, within fifteen (15) calendar days, return one set marked with the following:

- Reviewed
- Reviewed with Comments
- Review Not Required
- Resubmit

The BOP Contractor shall revise and resubmit for review and comment any drawings marked "Resubmit". If the BOP Contractor engineering, procurement and construction activities continue without addressing General Managers comments, the BOP Contractor will be proceeding at risk.

Documents received that obviously were not processed through the BOP Contractor's Quality Assurance Program will be marked "Resubmit". The BOP Contractor shall consider the time and costs associated with reviewing drawings and documents, and only submit quality deliverables for review.

The following drawings and documents shall be submitted for General Manager Review and Approval (engineering activities shall hold for review comments):

- Design Criteria
- General Arrangement
- Water Balance
- P&IDs
- Electrical One Line Diagrams
- Control System Architecture
- Equipment and System Sizing Calculations
- List and Example of System Turnover Packages (refer to Appendix D)
- List and Example of Operation and Maintenance Manuals
- System Turnover Packages
- Startup and Commissioning Plan by System (See Section N)
  O&M Manuals

The following drawings and documents shall be submitted for General Manager Review only (engineering activities shall progress during review period):

- Equipment Procurement Documents (technical only)
- Equipment Vendor Submittal Documents
- Electrical Relay and Protection 3-Lines
- Site Grading and Drainage
- Major Foundation Design
- Major Structure Design
- Equipment List
- Mechanical Line List
- Specialty Item List
- Material Specifications
- Instrument List
- Control Building Layout
- 120V UPS Load List

- Grounding Plans and IEEE 80 Study
- Hazardous Area Classification drawings
- Outdoor Lighting Plans
- Logic Diagrams
- HMI Interface Screens

Custom O&M Manuals

Prior to Final Completion, the BOP Contractor shall submit five (5) copies of record drawings and two (2) copies of all engineering calculations. Unless otherwise required or approved by General Manager, all drawings shall be computer generated using Microstation or AutoCAD. The record drawings shall be submitted in the latest version AutoCAD format. All record documentation shall be provided and accepted by the General Manager prior to achieving the Final Completion milestone. All CAD files shall be editable.

The quality and completeness of the System Turnover Packages is of great importance to the General Manager. These packages will be the primary documentation supporting General Manager acceptance of equipment and systems. It is essential that these packages are accurate, complete, well organized and formally assembled. The BOP Contractor shall understand that any delays caused by submittal of unacceptable system turnover packages will be the sole responsibility of the BOP Contractor.

L.3.1 Project Master File Turnover Procedures

It is anticipated that the BOP contractor shall perform all the necessary services to pre-commission, commission, start-up and performance test the plant. While it is the intent for the City of Pasadena to receive a fully tested, operating facility, the PWP operations personnel as well as the General Manager will be actively involved with reviewing turnover procedures to assure the equipment is properly installed and prepared prior to energizing or operating equipment. For this reason, this section will serve to define the minimum documentation to be included in the turnover documents.

- System description that includes discussion of the system operation, key equipment, valves and instruments identified
- A scoped P&ID of the system showing limits of what is being turned over.
- Equipment list sorted to include that equipment being turned over
- Piping line list sorted to include the lines in the package
- An instrument list sorted to only include the instruments in the package
- Instrument data sheets showing the designed range of the system
- Calibration sheets for the included instruments and valves (includes relays where necessary)
- A valve list sorted to only include the valves in this package
- Control valves should have completed cut sheets for the valves included
- Ring out and functional testing of any transmitters/control valves
- Hydrostatic / Pneumatic test reports
- Flushing / Blow reports – no gas blows on site.
- Vessel closure / inspection reports
- Alignment sheets for rotating equipment
- Grout records – mainly to confirm they were done (don’t want to start up machinery sitting on shims).

- Lubrication information (fills, flushes, etc) and tank inspections
- Preservation records, removal of desiccants, heater maintenance, etc.
- Power termination information. Some circuits require torquing of the connections
- Cable list sorted for cables included in the system
- Grounding tests
- Meggers / hi-pots as needed
- Motor bump checks / rotation confirmation (uncoupled run-in as well)
- Switchgear / MCC's to be turned over in the package
- High/medium voltage electrical testing reports (usually subcontracted)
- Punch list items identified by A, B, C. Only "C" items (cosmetic) are acceptable for equipment operation.
- RFI's / Design Change Notices that supercede current drawings should be included.
- Pipe Hanger information (are the springs at proper setting, etc.) and are they properly set.
- Ensure seals are still in place on relief valves and hydro gags are removed. Verify correct relief valve is installed for the system (set pressures match the data sheets and P&ID's).

A Master Project Drawing and Document Index database shall be established and maintained throughout the project and finish with the Record Drawing Index. The BOP Contractor shall maintain in good order at least one up-to-date (red-lined) copy of all drawings, specifications, manuals, and submittals at the Job Site and shall make them readily available to the General Manager or its representatives.

The BOP Contractor shall provide and manage a web-based document access management system.

L.4 System Descriptions

System Descriptions consisting of a narrative description of each system summarizing normal, start-up and shut down operations as well as operating precautions and limitations. In addition, alternate (emergency) modes of operation. The System Descriptions shall include the P&IDs, equipment capacities, pump curves, and other data peculiar to the system. Detailed descriptions of plant systems shall be provided for all systems developed by the BOP Contractor and describe the Plant on a system basis where the Equipment, Piping, Electrical and Controls constitute a defined system.. The system descriptions will be used by the start-up and operations groups to understand the basic function of each of the systems. Package system descriptions will be provided by the equipment supplier of each packaged system. The system description shall:

- Explain the function of the system
- Define the equipment in the system
- Describe the control process of the system

Contractor shall prepare site specific system descriptions, which is composed of the following sections as a minimum:

- System overview to present a general discussion of each defined system
- including major components, flow paths, operating and alternative operating
- modes and special considerations.
- Major components breakdown to include function, detailed description,
- operation and safety, controls and technical design data.
- Description of the power supplies and controls for the system and system
- equipment.

- List of system alarms and setpoints.
- Each system description shall include color-coded flow diagrams, which depict and
- identify by number the system equipment, valves, instruments, breakers and power
- panels if applicable. Each system description shall be accompanied by a list of
- references including but not limited to:
- P&ID's
- Control Logic and Loops
- Electrical Single Line Drawings
- Electrical Schematics
- Instruction Manuals

L.5 Facility Operation and Maintenance Manuals

The BOP Contractor shall furnish ten (10) hardcopy sets in premium 3-ring binders and one electronic (CD) version of the Unit specific Operation and Maintenance Manuals. The Operation and Maintenance Manuals shall address the complete systems and components that were added or modified by the BOP Contractor.

The final Glenarm Repowering Project, GT-5 Combined Cycle Installation Project Repower Project Operation and Maintenance manuals shall be comprehensive documents, address all new and reused equipment and systems.

As a complete set, the Operation and Maintenance Manuals shall be composed of the following:

The O&M Manuals should be consistent with the training (content, sequence, material) provided by the BOP Contractor. The O&M manuals should include detailed preventive maintenance procedures, lubrication schedules, and spare part lists.

Prior to starting wholesale production, a "pilot" version of an O&M Manual for one system (e.g., steam, feedwater, 13.8 kV, 4.16 kV, or 480 V) shall be developed for review and comment by the General Manager to maximize the ability of the BOP Contractor to generate the complete set with minimal comments. One set of O&M Manuals shall be available in the Control Room prior to the start of Acceptance Testing.

L.6 Equipment Vendor Instruction Manuals

The BOP Contractor shall furnish ten (10) hardcopy sets in premium 3-ring binders and one electronic (CD) version of detailed instruction books, and factory maintenance manuals for installing, operating, and maintaining all equipment furnished under this Specification. These manuals shall provide General Manager with comprehensive information on all components to enable operation, service, maintenance, and repair.

The instruction and maintenance manuals shall include all proprietary drawings, and all detailed drawings and/or illustrations with parts numbered for identification including but not limited to installation, as-built process and instrumentation diagram, logic diagrams, program listings, internal wiring diagrams, component locations, connection operating, troubleshooting, maintenance, vendor literature and overhaul instructions in complete detail. The instruction books shall apply to the particular equipment being

furnished, and will be the manufacturer's original copies. No copies of manufacturer's originals will be accepted. Instruction books covering only the general class of equipment will not be acceptable.

In the event that changes in design, erection, operation, or assembly are made, the BOP Contractor without undue delay or inconvenience to General Manager shall correct all drawings and instructions affected by such changes.

The BOP Contractor may be required to furnish supplemental drawings of equipment, if deemed necessary by General Manager.

The Instruction Manuals shall be available on-site 30 days before installation of the subject equipment.

M. SPARE PARTS AND SPECIALTY TOOLS

M.1 General

The BOP Contractor's procurement specifications shall request that vendors provide a startup spare parts list, an operational spare parts list (recommended for 2 years of operation), and price sheets with their bid on equipment.

M.2 Startup Spare Parts

The BOP Contractor shall be responsible for supplying all spare parts necessary during commissioning and testing through Substantial Completion for the equipment supplied under this contract.

M.3 Operational Spare Parts

The operational spare parts list shall be provided to General Manager at the time an equipment purchase order is issued. General Manager will decide whether or not to purchase, at General Manager's expense, any of the operational spare parts. General Manager shall, at his option, request BOP Contractor to purchase operational spare parts on General Manager behalf via a change order. The operational spare parts must be turned over to General Manager and may not be used by the BOP Contractor without prior written authorization of General Manager.

M.4 Specialty Tools

The BOP Contractor's procurement specifications shall require equipment suppliers to provide any special tools, equipment, or lifting devices required to install, test, clean, or maintain the equipment. These items shall be procured by the BOP Contractor and turned over to General Manager prior to Substantial Completion in good working order.

M.5 Storage

The BOP Contractor shall provide adequate and secure storage space for startup spare parts – both those procured by the BOP Contractor and those associated with the Power Island Equipment. Operational spare parts, both those procured by the BOP Contractor and those associated with the Power Island Equipment, shall be provided directly to the General Manager for storage in the General Manager's warehouse. The BOP Contractor shall receive and place into storage all spare parts received. Startup spare parts shall be stored separate from operational spare parts. The spare parts packaging shall be clearly marked with the associated, exactly what parts are in the container and with the words "Startup Spare Parts" or "Operational Spare Parts - Not to Be Used by BOP Contractor".

N. CONSTRUCTION REQUIREMENTS

The following provides general requirements for the BOP Constructor. In addition to these general requirements the BOP Contractor shall comply with all other regulatory agency specific requirements included in the Contract.

N.1 Safety

Work shall be conducted in a manner to safeguard all persons from injury and property from damage. The project safety program shall include procedures to assure that the BOP Contractor's activities, along with those of any subcontractors, vendor personnel, or authorized visitors, are conducted in a safe manner and in compliance with the requirements of (a) OSHA, (b) incorporate and comply with the latest edition of the American Public Power Association Safety Manual, (c) meet or exceed the standard of care for such programs as established by nationally recognized firms which provide goods and services of a similar nature, and (d) strictly comply with all Applicable Legal Requirements.

The BOP Contractor shall develop a Project Safety Manual that shall be submitted to the General Manager for. The Project Safety Manual should address topics such as, but not limited to:

- Federal and State OSHA Compliance

- Written Injury and Illness Prevention Program
- Emergency Response Plan
- Written Safety Manual
- First Aid and CPR Certifications
- Contractor Solely Responsible for Employee, Subcontractor and Visitor Safety
- Daily "tailgate" Safety Meeting - Meeting Minutes with Attendance List
- Material Safety Data Sheet Management Program
- Usage of safety equipment
- First Aid
- Emergency Contacts
- Electrical Safety
- Fire Protection
- Rigging
- Fall Protection
- Traffic Control
- Confined Space Entry
- Equipment Clearances
- Smoking Policy – note smoking areas shall be coordinated with an approved by the General Manager. Smoking will not be allowed outside of these designated areas.
- Others

The BOP Contractor is responsible for providing and maintaining adequate First Aid supplies as required by applicable safety order of the California State Department of Industrial Relations, Division of

Occupational Safety and Health (OSHA) or as required by other federal, state, or local laws, rules or regulations.

Hard Hats and Safety Glasses shall be worn at all times in areas other than offices and parking area. Other Personnel Protective Equipment (PPE) may be required depending on the type of work being performed. The BOP Contractor shall provide all approved Personnel Protective Equipment.

High noise level areas shall be posted. All personnel working in these areas shall wear ear protection supplied by BOP Contractor.

Approved Fall Protection shall be worn when any work is being done in unprotected areas greater than six feet in elevation, such as on a beam or other unguarded equipment.

There are overhead distribution and transmission lines in the vicinity of the Project. In areas where cranes, lifts, mobile cranes, etc., are to be used, a careful check for overhead lines and other obstructions shall be made. Where overhead high-voltage wires or other obstructions exist, clearance shall be obtained from General Manager before work can proceed. Where needed, General Manager may be able to take a short clearance on the line for construction activities. All personnel working within a confined space shall be instructed in the safety requirements for such work.

While the General Manager will review the BOP Contractor's Project Safety Manual, the BOP Contractor is solely responsible for the safe conduct of its employees, subcontractor and all site activities. If the General Manager, in its reasonable opinion, believes that the Project Safety Manual does not meet the foregoing standards, it shall notify the BOP Contractor of such deficiencies in writing and the BOP Contractor shall immediately correct such deficiencies in the Project Safety Manual and implement the corrections into all aspects of its scope of work. The BOP Contractor shall initiate, maintain and supervise all reasonable safety precautions and programs in connection with the performance of the Work in accordance with the Project Safety Manual and Applicable Legal Requirements and shall take all reasonable precautions for the protection and safety of, and shall provide all reasonable protection to prevent harm, damage, injury or loss (including ecological harm or nuisance resulting from contamination, noise or other causes arising from the performance of the Work) to: (i) all Persons employed by the BOP Contractor or Subcontractors or any other contractors in connection with the Work and all other Persons who may be affected thereby; (ii) all materials and equipment or other personal property on the Facility Site or in the vicinity thereof; and (iii) the real property that comprising the Facility Site and any real property in the vicinity thereof.

The General Manager will be continuously occupying areas adjacent to the BOP Contractor's construction activities. The BOP Contractor shall conduct construction work in a manner that will minimize need for disruption of General Manager's normal operations including:

- Ensuring the safe passage of persons around the area of construction,
- Conducting operations to prevent injury to adjacent buildings, structures, other facilities, and persons
- Conducting operations to prevent accidental actuation of switches, push buttons, etc. for operating equipment
- Erecting temporary covered passageways

N.2 Use Of Premises and Housekeeping

The BOP Contractor shall instruct its personnel, subcontractors, and vendors that access to the operating areas of the plant, except as required for the work of this Project, is strictly prohibited unless otherwise authorized by General Manager.

The BOP Contractor must allow General Manager access to the Glenarm Repowering Project, GT-5 Combined Cycle Installation areas that are required for operation of the existing Units GT- 1 through GT-4.

The BOP Contractor is responsible for maintenance of the Project Site under its control. Good housekeeping is to be practiced with the Project Site with work areas maintained in a neat, orderly manner. Particular attention shall be paid to housekeeping in areas around operating equipment or where welding or burning operations are conducted. Tool boxes used by the BOP Contractor shall be so identified to differentiate them from the General Manager's tool boxes.

BOP Contractor shall maintain the work area in a clean condition, and shall remove waste material from the work site daily or as directed by General Manager. The BOP Contractor shall not allow debris to remain at the Project Site and it shall be disposed of as it accumulates. This shall include the continuous clean up and disposal of loose debris on ground around equipment in work areas. BOP Contractor shall supply dump boxes for rubbish and haul them away from the jobsite.

General Manager will purchase and store materials at the Project Site, the location of such storage will be coordinated with the BOP Contractor.

If the BOP Contractor and/or its subcontractors, in the opinion of General Manager, do not maintain "good housekeeping" or does not cleanup when requested to do so, General Manager will have the cleanup performed by others, at the expense of BOP Contractor. Any delays caused as a result will not be allowed as a basis for delay charges.

Upon completion of the work, BOP Contractor shall remove its tools, materials of construction, and construction equipment from the work site and shall leave the site in a clean and orderly condition.

N.3 Construction Services

The BOP Contractor shall provide all necessary project management, supervision, labor, tools, equipment, materials, equipment, rigging, specialties, temporary facilities, support engineering, to perform all work defined under this scope.

Major components of this work under this contract include, but are not limited to the following:

- Mobilization of the site, securing the property for laydown, parking, temporary office facilities, connecting necessary temporary infrastructures (water, power, phone, sewer, internet, etc.) and establishing site security. Contractor shall assume that there is no nearby tie-in location for sewer connections from the temporary trailers in the areas designated for the trailers shown on the drawings. If deemed by the contractor to facilitate its work, offsite laydown and staging areas shall be secured as part of this work scope.

- Maintaining an approved Health and Safety Plan in accordance with local, state and federal requirements. The BOP contractor shall ensure a construction fire protection/prevention program is in place as part of its safety program. The BOP contractor shall adhere to all PWP site safety requirements and limit access to permitted areas. Work in areas outside of the primary project site shall be accessed only through daily issued hot work permits.

- Maintaining an approved Quality Control / Quality Assurance plan and delivering all necessary plant documentation.

- Securing necessary construction permits from the City Planning Department and the Pasadena Fire Department, as well as any other construction related permits, such as transportation permits for the components procured by the BOP Contractor. Joint meetings with these entities and the PWP Construction Manger are highly recommended to understand project submittal requirements, schedule and to fully understand the local official installation requirements upon project kickoff. Receiving these permits is critical path to meeting the targeted completion date. **The BOP Contractor needs to include plan review cycle times in their schedule. The City Planning Department last reported they were on an eight week review cycle.**

- Obtaining all necessary Certificates of Occupancy and/or final acceptance from the City Planning Department and Pasadena Fire Department.

- Assuring the BOP supplied piping and equipment meet or exceed the project noise requirements per the included specification.

- Performing site surveying and establishing permanent control monuments (minimum of three) that will be maintained and left in place as part of the permanent plant installation. If these monuments are disturbed during the course of construction, they shall be repaired at the Contractor's expense.

- Clearing and grubbing of the site. The site is essentially graded, but there is some stockpiled soil/grave, existing debris, unsuitable material, etc., which shall be removed prior to start of construction. Some of the oleander bushes on the west side of the property may need to be removed to facilitate installation of the new 10'-0" high concrete wall. Some trees will need to be removed as part of the project scope. These are noted on the civil drawings included in this scope of work package. Some trees need to be protected, and some trimming of branches will be performed by the City. The BOP contractor must coordinate with the City prior to removal of any vegetation on site.

- Dust Control and Noise Mitigation during construction must be implemented. Street sweeping shall be provided on the existing plant drives and as needed on adjacent access street(s) to maintain cleanliness of the streets. The General Manager reserves the right to direct the BOP Contractor to perform street sweeping if, in the opinion of the General Manager street cleanliness is not being maintained or prior to City special events or an anticipated weather event.

Section 9.36.070:
http://library.municode.com/HTML/16551/level3/TIT9PUPEMOWE_ARTIVOFAGPUPE_CH9.36NORE.html#TIT9PUPEMOWE_ARTIVOFAGPUPE_CH9.36NORE_9.36.070COPR provides for City standards regarding noise during construction.

9.36.070 Construction projects.

A.

No person shall operate any pile driver, power shovel, pneumatic hammer, derrick power hoist, forklift, cement mixer or any other similar construction equipment within a residential district or within a radius of 500 feet there from at any time other than as listed below:

1. From 7:00 a.m. to 7:00 p.m. Monday through Friday;
2. From 8:00 a.m. to 5:00 p.m. on Saturday;
3. Operation of any of the listed construction equipment is prohibited on Sundays and holidays.

B.

No person shall perform any construction or repair work on buildings, structures or projects within a residential district or within a radius of 500 feet there from in such a manner that a reasonable person of normal sensitiveness residing in the area is caused discomfort or annoyance at any time other than as listed below:

1. From 7:00 a.m. to 7:00 p.m. Monday through Friday;
2. From 8:00 a.m. to 5:00 p.m. on Saturday;
3. Performance of construction or repair work is prohibited on Sundays and holidays.

C.

The prohibition against construction on Sundays and holidays as set forth in subsection B of this section shall not apply under either of the following conditions:

1. The construction is actually performed by an individual who is the owner or lessor of the premises and who is assisted by not more than two individuals;
2. The person performing the construction shall have provided the building official with a petition which indicates the consent of 65 percent of the households residing within 500 feet of the construction site and the unanimous consent of the households adjacent to the construction site. Said petition shall be on a form promulgated by said building official and shall be accompanied by a fee, the amount of which shall be established by resolution by the city council.

D.

The prohibitions of this section shall not apply to the performance of emergency work as defined in Section 9.36.030

E.

For purposes of this section, holidays are New Year's Day, Martin Luther King Jr. Day, Lincoln's Birthday, Washington's Birthday, Memorial Day, Independence Day, Labor Day, Veterans Day, Thanksgiving Day, Day after Thanksgiving, and Christmas.

(Ord. 7150 § 2 (part), 2008)

9.36.080 Construction equipment.

It is unlawful for any person to operate any powered construction equipment if the operation of such equipment emits noise at a level in excess of 85 dBA when measured within a radius of 100 feet from such equipment.

(Ord. 7150 § 2 (part), 2008)

9.36.090 Machinery, equipment, fans and air conditioning.

Except for emergency work, as defined in this chapter it is unlawful for any person to operate any machinery, equipment, pump, fan, air conditioning apparatus or similar mechanical device in any manner so as to create any noise which would cause the noise level at the property line of any property to exceed the ambient noise level by more than 5 decibels.

(Ord. 7150 § 2 (part), 2008)

9.36.100 Motor driven vehicles and vehicle repairs.

A.

It is unlawful for any person within any residential area of the city to repair, rebuild or test any motor vehicle between the hours of 10 p.m. of one day and 8 a.m. of the next day in such a manner that a reasonable person of normal sensitiveness residing in the area is caused discomfort or annoyance.

B.

It is unlawful for any person to operate any motor driven vehicle within the city in such a manner that a reasonable person of normal sensitiveness residing in the area is caused discomfort or annoyance; provided, however, any such vehicle which is operated upon any public highway, street, or right-of-way shall be excluded from the provisions of this section

- A storm water and erosion control system will need to be designed and maintained throughout the project. No soil shall be tracked onto public roadways or within operating areas of the plant. The BOP contractor must provide a SWPPP and update the SUSMP permit as necessary.

- The BOP Contractor shall be responsible for general housekeeping, ensuring debris does not collect on site, and prompt disposal of all construction waste in accordance with local and state requirements.

- The plant has zero liquid discharge permit. BOP Contractor shall not discharge liquid to the storm drains at all times.

- Install temporary fencing to limit craft personnel travel into the operating areas.

- Coordination with PWP's Construction Manager and City Authorities or all required inspections. Note: Some notifications may require 72 hours or longer.

- Installation of all new underground piping, grounding, conduits and duct banks as required by the BOP Contractor's engineer. Please note some underground facilities will need City and /or Fire Department inspections

- Installation of all new foundations. This includes major, minor, piers, light stanchions, paving, stoops, sidewalks, etc. All necessary reinforcing steel, embedments, forms, etc. Refer to DOR for embedments not provided by the BOP contractor. Installation of new piperack structural steel, platforms, walkways, stairs, ladders, etc., to provide safe access to normally operated areas. Please note: The piperack shown on the General Arrangement drawings is only indicative of the routing. The BOP contractor understands that there will also be piperack servicing the condensate polisher area east of the STG enclosure, as well as entering the STG enclosure for the new steam header, drain lines, condensate lines, etc. There will need to be a support provided by the BOP for the turbine bypass valve and other letdown valves. The BOP Contractor needs to include all piperack steel and foundation necessary to support the design.

- Installation of all new above ground and below ground piping. Using the best information currently available, above ground and below ground piping systems have been identified on the preliminary P&ID's, as well as the vendor P&ID's. Not every connection within the plant boundary can be defined without the BOP engineer's design being complete. It is understood that the BOP Contractor's scope includes all systems identified on these preliminary drawings, including the tie-point drawing and list for installations outside of GT-5 battery limits, as well as any piping required to complete and provide a fully functioning plant. A material service index and line list are provided for contractor reference.

- Installation of all above grade and below grade electrical and control systems from 34.5kV down. This includes running of conduit, tray, grounding, power, signal, control cabling, etc.

- Installation of new 34.5kV duct bank from the high side of the three winding GSU transformer to a vault near the existing GT 3 & 4 transformers. Cable will be pulled and terminated by PWP.

- Receiving, transporting as necessary, and installing all Power Island Equipment (PIE) procured by Pasadena Water and Power, as well as installation of all BOP Contractor procured equipment. The PIE equipment is to be delivered FOB jobsite, but due to the nature of the project (size and limited access), some of this equipment may be required to store off site. This equipment scope of supply is identified in the equipment list and the Division of Responsibility (DOR). Note: All "By Others" in the PIE Equipment specifications shall be assumed to be by the BOP Contractor unless noted otherwise.

  Note: Some equipment provided by PWP requires special handling and storage provisions, such as SCR catalyst, inlet filter media, etc. The Glenarm Building may be used for dry storage provided the Contractor creates a secure, fenced-in area for storage and prohibits access of its

personnel into any area other than the storage area. . If necessary, the BOP Contractor shall provide for additional conditioned dry storage.

- Performing all electrical terminations and testing.
- Designing and installing a water lab building equipped with a refrigerator, sink, exhaust hood, etc. as further defined in the specifications.
- Performing all instrumentation bench calibration, installation and testing.
- Performing all finish painting. Note the EIR makes reference to low odor paint.
- Performing all heat conservation, anti sweat and personnel protection insulation and lagging.
- Performing the Maintenance Building improvements
- Performing the Glenarm Building external features demolition.
- Performing all finish asphaltic and concrete paving.
- Performing all required traffic signage.
- Performing all pipe labeling and device tagging.
- Installing all permanent fencing, gates, intercoms, card readers and operators.
- Installing all new site lighting. Note, the EIR and local regulations dictate size, height and type of lighting that may be used. The BOP engineer shall provide ample lighting to meeting code and provide for the safe operation of the plant.
- Installing conduits for all new site security systems. PWP will supply and install the new systems, cameras and monitors in BOP installed conduits. Coordinate with the General Manager for locations. **An addendum will be issued further clarifying these requirements as well as how to address existing cameras that need to be relocated to support construction.**
- Installing all specified fire protection, detection and alarm systems. A very thorough fire protection specification has been developed and shall be followed. All fire safety installation must be approved by the Pasadena Fire Department.
- Providing and integrating the new GT-5 Plant Control System. The PIE vendor is providing turbine control panels for both the GTG and STG. These shall be integrated, but not replicated into the plant control system. A PCS specification and control system architecture diagram further defines the control system scope.
- Providing conduits for future GT 1 & 2 Gas turbines operation from both the new Power Distribution Center and the Control Building Control Room

- Providing conduits for future GT 3 & 4 gas turbines operation from both the new Power Distribution Center and the Control Building Control Room

- Performing all pre-commissioning, commissioning, and testing of the plant. The BOP Contractor will be responsible for performing the performance test of all PIE and BOP supplied equipment. The CEMS certification and stack source testing will be associated with the performance test. All acceptance testing is the responsibility of the BOP Contractor, with exception of the Noise Testing, however the BOP Contractor will need to work with the noise test official until the plant is accepted by the City. The PIE Contractor and BOP Contractor will have Liquidated Damages associated with not meeting projected performance, so all necessary coordination, cooperation, preparations and documenting will be part of the BOP Contractor scope, working with the PIE and PWP representatives. ***Note: The number of hours associated with commissioning activities are defined in the EIR.***

- Assembling and completing turn-over packages.

- Assembling operating manuals and providing operator training for systems and equipment supplied by the BOP Contractor. The PIE Contractor is responsible for proving operator training and manuals for equipment supplied under its scope of work.

- Maintaining all required vendor installation manual sign-offs, working with the PWP Construction Manager, the on-site PIE Project Manager and BOP vendors.

- Recording all field modifications and delivering Record Set As-Built drawings at the end of the project. These drawings will be delivered in CA PE stamped versions as well as in PDF and the latest version of AutoCAD formats. The CAD files must be editable.

- Assist the General Manager in obtaining Boiler Operating permits by providing completed ASME code documentation and signatures.

- Equipment Vendor Technical Representatives for equipment supplied by the BOP Contractor. Coordinate use of PIE Contractor Technical Representatives with the Construction Manager.

- Project work hours will be in compliance with the City ordinances. Section 9.36.070: http://library.municode.com/HTML/16551/level3/TIT9PUPEMOWE_ARTIVOFAGPUPE_CH9.36NORE.html#TIT9PUPEMOWE_ARTIVOFAGPUPE_CH9.36NORE_9.36.070COPR

- All interconnecting mechanical, electrical, and structural materials between Contractor supplied items (pipe, pipe rack, pipe supports, tubing, fittings, piping accessories, etc.).

- Foundations and anchor bolts

- Initial fill of lubricants and chemicals for BOP Contractor supplied equipment and PIE equipment, except for the GSU insulating fluid.

- All control room furniture required for Contractor supplied terminals, keyboards and printers

- Bus duct between the generator circuit breakers and step-up transformer
- Current transformers (CTs) and voltage transformers (VTs) not integral to generator and terminal compartment
- Field wiring, cable and conduit connecting Contractor supplied components
- Finish painting of all enclosures, ducting, stacks and inlet filter house
- Receipt and off-loading at site
- Onsite installation labor and equipment
- Material lay-down area defined by the General Manager
- Balance of plant control system, configuration and graphics programming
- Electrical, instrumentation and controls wiring up to Contractor's connection points
- Field labor and plant operator support of Contractor's commissioning and testing engineers
- Construction Utilities including Power (construction power source provided by General Manager at no cost), Water (construction potable, raw, and treated water sources provided by General Manager at no cost), Sanitary, Voice and Data Communication
- Improvements at all Project Site entrances
- Construction area and Construction Office, Laydown and Parking Area Identification, Improvements and Maintenance, Security and Access Control
- Contractor Office Space including Supply, Installation and Maintenance
- General Manager Office Space including supply, installation and maintenance
- Power Island Equipment Project Manager Office Space including supply, installation and maintenance
- Project Site Preparation, Surveying and Grading
- Erection of Equipment (including the PIE and accessories)
- Construction of structures
- Asphalt, Concrete and Crushed Rock surfacing of the Project Site (per the specifications and drawings)
- Insulating of Equipment and Piping

- Painting of Structures, Equipment and Piping
- Construction Site Fire Protection
- Treatment and Disposal of Wastewater Generated during Construction and Startup
- Construction Site Storm Water and Pollution Management – Note, concrete wash out areas will be coordinated with the Construction Manager and will prevent cement from entering storm drains or other underground structures. All concrete washout will be removed from site as needed, and completely at the end of the project.
- Consumables during Construction Activities (excluding power and water)
- Consumables during Startup, Testing and Initial Operation (excluding power, natural gas, and demineralized/RO/raw water)
- System Flushing including Supply and Disposal of Associated Fluids. Contractor shall be fully responsible for containing, treating if necessary, and disposing of flushing fluids in a manner acceptable to the City. Flushing fluids shall not be permitted to enter the storm drain.
- Transformer insulating oil for the auxiliary transformers
- Dressout and filling of the GSU transformer (TA will be provided by GSU Vendor)
- Erection of the PIE supplied cooling tower
- Daily Construction Site Cleanup
- Construction mitigation activities required by the County or local jurisdiction

N.4 Site Access and Road Ways

A site plan showing access, construction facility areas, and lay down areas is shown on C3-4. Parking for the BOP Contractor's employees shall be the responsibility of the BOP Contractor. Maintenance of these areas shall be the responsibility of the BOP Contractor. The General Manager will provide the parking areas indicated on Drawing C3-4. Any additional parking areas required by the BOP Contractor shall be their own responsibility to obtain.

Dust shall be controlled by sprinkling or other appropriate means. Dust control shall include not only the Project Site, but drive outs and immediate road approaches.

BOP Contractor shall not allow Subcontractors, agents, or employee personnel to trespass on premises (including operating portions of the Facility) or lands in vicinity of the work or along the access roads, to create any nuisance or commit acts of vandalism thereon. BOP Contractor shall not allow private automobiles of BOP Contractor's employees on any part of the construction site except for employee parking or as authorized by General Manager.

N.5 Traffic and Transportation

The designated construction routes shall be enforced by the BOP Contractor for all construction traffic.

N.6 Temporary Facilities

The BOP Contractor shall furnish, install, and maintain temporary facilities, and unless specified otherwise, promptly remove all such facilities promptly upon completion of construction or when directed by General Manager. Trailers, field offices, sheds, and all required temporary structures for the BOP Contractor's employees, material or equipment services shall be constructed and maintained to provide a safe work area in compliance with applicable codes and standards and present a neat suitable appearance at all times. Contractor shall secure temporary trailer permits from the City of Pasadena Building department, for all trailers furnished as part of the work. The BOP Contractor shall provide one (1) double wide trailer dedicated for the use of the City's Project Management and Construction management contractor. This trailer shall have; four (4) offices; a kitchen; and one conference room/area capable of accommodating twelve (12) people. This trailer shall also be provided with; office equipment and furniture including desks, chairs and phones in each office; two (2) full-size drawing plan tables; two (2) sets of stick files for drawings; a color copier/scanner/printer/fax machine capable of reproducing up to 11 x 17 drawings; six (6) locking filing cabinets with no less than four drawers each; a conference table with chairs which can accommodate twelve (12) people with a phonebridge speakerphone with two remote microphones. . Internet and phone service for this trailer and the Contractor's trailers shall be provided by the City. This trailer shall be made available no later than when the Contractor's trailers are available through the completion of the project.

The BOP Contractor shall also provide one (1) single wide trailer dedicated for the use of the Power Island Equipment Contractor and their vendors. This trailer shall have; four (4) offices; a kitchen; and one conference room/area capable of accommodating six (6) people. This trailer shall also be provided with; office equipment and furniture including desks, chairs and phones in each office; a color copier/scanner/printer/fax machine capable of reproducing up to 11 x 17 drawings; a conference table with chairs which can accommodate twelve (6) people with a phonebridge speakerphone with two remote microphones. . Internet and phone service for this trailer and the Contractor's trailers shall be provided by the City. This trailer shall be made available one month prior to the first shipment of Power Island Equipment through commissioning of the plant.

The BOP Contractor shall provide and maintain suitable temporary enclosures as may be required to protect all parts of the work, including material and equipment stored on the Site, from weather, theft, and against damage during construction.

The BOP Contractor shall provide temporary heating facilities, including fuel and energy, that may be required for the execution of its work and as may be required to prevent damage to the work. Salamanders, open fires or other methods that constitute a hazard to personnel or property shall not be used. All heating equipment shall be provided with adequate safeguards and shall meet all applicable codes and regulations.

BOP Contractor shall prepare and issue a schedule for planning and setting up temporary construction site facilities.

N.7 Temporary Sanitary Facilities

The BOP Contractor shall furnish and maintain all necessary sanitary facilities, including chemical toilets, for the use of all persons engaged in the project. Sanitary facilities shall comply with all regulations of agencies having jurisdiction. Any facilities or methods that are not in compliance will be upgraded promptly to achieve compliance. All site construction personnel, including General Manager and its representatives, shall use the facilities provided.

N.8 Temporary Utilities

The BOP Contractor shall provide, maintain, and service temporary utilities required for construction operations including all distribution systems complete with piping, valves, hoses, wiring, outlets, fixtures, fuses, transformers, and other equipment as necessary to complete to the point of use.

The General Manager will provide the BOP Contractor access to construction power during the construction activities through Substantial Completion. The BOP Contractor shall be responsible for distributing the construction power through the job site as required. BOP Contractor shall furnish all other services and utilities required for the work. Compressed air required for the use of air tools, air cleaning, air pallets and other similar items should be supplied by the BOP Contractor, including compressors, piping and valves, hoses, etc. General Manager's approval is required for air compressor motors over 50 BHP.

N.9 Compliance With LORS

The BOP Contractor's activities shall be in conformance with the lawful requirements of governmental bodies, authorities, and regulators having jurisdiction over the work. Such conformances consist of, but are not limited to, the following:

- Professional Engineering Licensure
- Resident Engineer Licensure Requirements
- OSHA Requirements
- EPA Requirements
- EEO and Affirmative Action Requirements
- Contractor Licensure Requirements

N.10 Environmental Compliance During Construction

The BOP Contractor shall be responsible to maintain the requirements outlined in the Mitigation Summary contained in Section A.3.

N.11 Security

The BOP Contractor shall provide and establish a Security Plan to maintain a secure site to prevent loss of material, unauthorized access, and protection of the construction site. The BOP Contractor's security plan shall recognize existing nearby General Manager operations and provide for isolation of construction activities from ongoing operations. The BOP Contractor's Security Plan shall be submitted to General Manager for review.

The BOP Contractor shall furnish, as part of these requirements, unarmed security personnel and temporary guard facilities for the purposes of maintaining project security. Services shall include site access control at the State Street gate during normal working hours. Contractor shall also be responsible for access control at the temporary trailer/laydown area to the west of the designated craft parking area. Contractor may employ a second security person for this purpose or control access with existing staff.

At a minimum, the BOP Contractor's Security Plan shall (a) meet or exceed the standard of care for such plans as established by nationally recognized firms which provide goods and services of a similar nature, (b) include measures for heightened security as necessary due to the nature of the area in which the Facility Site is located, and (c) strictly comply with all Applicable Legal Requirements. Such plan will include a method acceptable to the General Manager for controlling, identifying and monitoring the employees of the BOP Contractor and the Subcontractors in all areas in which the Work is to be performed. If the General Manager, in its reasonable opinion, believes that the Security Plan does not meet the foregoing standards, the General Manager shall notify the BOP Contractor of such deficiencies in writing and the BOP Contractor shall immediately correct such deficiencies in the Security Plan and implement the corrections into the performance of the Work. The BOP Contractor will implement, maintain and at all times cause the BOP Contractor's personnel and subcontractors to comply with the Project Security Plan.

It is required that the site be fenced during construction. Access to and egress from the Project Site shall be monitored and controlled. General Manager shall have ability to access to site at all times. Construction parking and traffic shall be monitored and controlled. The BOP Contractor's personnel shall obtain appropriate passes to carry tools, personal property, scrap materials, or General Manager's property from the Project, in accordance with the BOP Contractor's security plan.

The conduct of all Site personnel shall be monitored and controlled in accordance with established standards of conduct for the Site.

A loss prevention program shall be established to minimize loss due to theft and vandalism. Loss of the BOP Contractor's tools, supplies, equipment, etc. will not be chargeable to the General Manager. Loss of General Manager's tools, supplies and equipment will be chargeable to the BOP Contractor.

Establish and maintain relations and cooperate with local law enforcement agencies. The BOP Contractor shall conform to traffic control requirements of BOP Contractor's Safety Plan.

N.12 Equipment Rigging

BOP Contractor shall erect debris barriers over any of General Manager's transformers, pumps, electrical equipment, and any other equipment that may be damaged from droppage of tools or materials.

Heavy lifts (greater than 50k lbs) and/or critical lifts (greater than 80% of the crane's capacity chart for the given configuration) shall require lifting plans for review and comment by General Manager prior to lifts. Additionally, BOP Contractor shall submit lifting plans for the rigging and hoisting of the Gas Turbine Generator (one for the each of the turbine and generator), Steam Turbine Generator (one for each of the turbine and generator), and PDC. BOP Contractor's rigging plans shall include details of the methods that demonstrate that the ground or roadway along equipment movement paths are within the allowable loads. BOP Contractor shall certify as part of the lifting plan that the ground beneath the outriggers is competent

and will not fail during the lift. BOP Contractor's rigging supervisor(s) shall be present during equipment movement.

BOP Contractor shall follow manufacturer's and safety codes and standards for rigging/handling requirements/procedures when moving manufacturer's equipment. BOP Contractor's rigging plans and procedures shall include features required to avoid excessive torsional stresses and local damage to any equipment being lifted. Damage and subsequent repair thereto will be the responsibility of the BOP Contractor.

N.13 Fire Protection During Construction and Start-up

BOP Contractor shall comply with NFPA fire protection requirements. These requirements shall be included in the Safety Plan. The following are examples, but are not a comprehensive list of items to be addressed.

- Engineered facility fire protection features – detection and suppression - shall be tested and operational prior to testing or placing in service the systems, structures, or components they protect.
- Certain areas are posted with "No Smoking" or "No Open Flame" signs. No welding, cutting, or other spark-producing work shall be performed in these areas unless authorized in accordance with the Safety Plan. Each separate event shall require a new approved written authorization.
- Where welding or gas cutting is being performed, approved portable fire extinguishers shall be provided by BOP Contractor and kept available to put out small fires. Flammable waste material shall be removed from areas where welding and/or cutting are in progress.
- BOP Contractor shall provide full time fire watch personnel for welding and open flame work at all times. These personnel shall be trained in fire watch duties in accordance with Safety Plan. Fire watch personnel shall remain on duty for at least one half hour following welding or open flame operations and be in visible contact with cutting, welding and grinding in accordance with good safety practice.
- BOP Contractor shall provide fireguard material to be placed over wooden scaffolds prior to cutting, burning, or welding. BOP Contractor shall clean up cutting, burning, and welding debris on a continuous basis. Lumber with a cross section less than 2-inch actual thickness shall be pressure impregnated with fire retardant chemicals of a listed fire spread rating of 25 or less.
- BOP Contractor shall maintain flammable and hazardous materials in suitable storage facilities outside buildings.
- The BOP Contractor shall maintain a list with associated MSDS documentation for all flammable and hazardous material it wishes to bring onsite prior to entering the jobsite and have available onsite for General Manager review.
- Combustible gas hoses shall be secured at all times and be disconnected at the cylinder end when not in use.

N.14 Material Requirements

BOP Contractor is responsible for receipt of all construction materials and facility equipment, including Power Island Equipment. The Power Island Equipment Components shall be delivered by General

Electric to the Project Site. The BOP Contractor will be responsible for unloading all equipment. The BOP Contractor shall maintain care and custody of all material from receipt through installation and turnover. All material and equipment shall be stored in accordance with supplier's recommendations. The BOP Contractor shall be held responsible for any loss, damage, or subsequent required cleaning of material, apparatus, or equipment at the Project Site and shall bear full costs of repair, replacement, or cleaning of these items.

Any material or equipment furnished by General Manager that is not used in the work shall be returned to General Manager in good condition upon completion of the project with sufficient information to allow General Manager's receiving clerk to properly identify the material or equipment. BOP Contractor shall handle and load this material or equipment as necessary for return to General Manager's storage facility

N.15 Deliveries

The BOP Contractor shall be responsible for the transport of all equipment and materials furnished by the BOP Contractor under these Specifications, including the receipt, unloading, demurrage, and freight damage claims. Deliveries of equipment and materials shall be scheduled in such a way that the Contractor is available at the job site to receive the shipment. The City will not accept, sign for, or be responsible for any equipment or materials delivered to the job site for the account of the Contractor.

The BOP Contractor shall be responsible for unloading and storing of all equipment and materials furnished by the Contractor under these Specifications. All materials received shall be stored in an orderly manner in the designated laydown area. The existing access roadway near the designated laydown area within the property shall always remain unobstructed for traffic or fire trucks in case of fire.

The Contractor shall be responsible for the protection of all equipment and materials while in storage. The Contractor shall provide all necessary equipment, tools, and devices required for all lifting, hauling, and handling activities.

O. CONSTRUCTION TURNOVER PACKAGE REQUIREMENTS

A Construction Turnover Package Procedure shall be developed by the Contractor and submitted to the PWP General Manager for review and approval 120 days prior to the start of the pre-operational testing phase.

Each System Construction Turnover Package(s) shall consist of three (3) sections/components identified as Mechanical, Electrical, and Instrumentation. Each section shall contain (but not limited to) the following documentation:

- Mechanical Package
- Construction System Release Sheet with signoffs by Construction, QC, and
- Turnover Coordinator.
- Completion Work List
- P&ID's scoped to indicate system boundaries and "As Built"
- Equipment List
- Valve List
- Pipe Line List
- Test Records for all NDE

- Alignment Sheets
- Equipment Lubrication Records
- Equipment Rotation Records
- Copies of all Engineering Changes-RFI's, DCN's
- Vendor Services Reports
- Factory Test Data Sheets
- Electrical Package
- Same as Mech.
- Same as Mech.
- Single Lines scoped to indicate system boundaries and "As Built"
- Equipment List
- Cable List
- Test Records of all NDE
- Relay Settings
- Lifted wire logs
- Copies of all Engineering Changes-RFI's, DCN's
- Vendor Service Reports
- Megger Data Sheets
- Continuity Test Results
- Factory Test Data Sheets
- Instrument Package
- Same as Mech.
- Same as Mech.
- P&ID's scoped to indicate system boundaries and "As Built"
- Instrument List
- Instrument Data Cards
- Copies of all Engineering Changes-RFI's, DCN's
- Vendor Service Reports
- Safety and Relief Valve Test Records
- Factory Test Data Sheets

The System Construction Turnover Packages shall be complete and delivered to PWP General Manager in accordance with the Project System Turnover Schedule.

P. START UP, COMMISSIONING AND PERFORMANCE TESTING

The BOP Contractor shall be responsible for the start up, commissioning and performance testing of the GT-5 Combined Cycle Installation as defined in the following documents:

Specification 480032.10 BOP Contractor Performance Testing
Glenarm Repowering Project Commissioning Scope of Responsibility Matrix