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TVC Systems

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November 15, 2005

Total Energy Plant, LLC
PO Box XXX
Portsmouth, NH 03802

Attention: Mr. Jack Smith

Subject: Total Energy Plant, LLC – Plant BOP PLC Control System
TVC Systems Budgetary Proposal Number XXXX

Dear Mr. Smith:

TVC Systems is pleased to provide this proposal for the Total Energy Plant, LLC Cogeneration Upgrade Project Plant BOP PLC Control System. This proposal is based on the information contained in the following documents provided to TVC:

Issued Document Tag	**Title**	**Rev.**	**Date**
Spec #01010 (BOP PLC)	Instructions to Bidders	0	12/11/04
Spec #01015 (BOP PLC)	Work Scope	0	12/11/04
Spec #01020 (BOP PLC)	General Bid Form	0	12/11/04
Spec #01020 (BOP PLC)	Milestone Schedule Dates	0	12/11/04
	Corporate Bidder's Certification Form	0	12/11/04
Control System; Spec # XXX-4-800	Technical Specifications for Balance of Plant	0	12/12/04
PLC Equipment List	Appendix A	0	12/12/04
System Architecture Drawing XXX-1-DW-4-100	Appendix B	0	12/12/04
Input/Out List	Appendix C	0	12/12/04
Sequence of Operation Narratives	Appendix D	A	12/11/04
P & I Diagrams; sheets 101-115 & 117	Appendix E		11/15/04
Spec #01000 Combustion Turbine Project (BOP PLC)	Questions and Answers Document 1		12/19/04
Addendum 1	Total Energy Plant, LLC Spec Modifications		01/16/05

We feel that TVC Systems is uniquely qualified to address the needs of this project, for the following reasons:

- TVC Systems has extensive background in Central Utilities and Cogeneration Control Systems. In New England alone, our systems control and monitor over 75,000 Tons of chilled water capacity; 1.5 million PPH of steam; 100 MMBTU/H of hot water and 350 MW electricity. In particular, one of our cogeneration control systems supports a hospital in Hartford Connecticut.
- We would work closely with all parties to develop a system which meets the desired control needs and reliability demands of the system.
- We are a Registered Member of the Control System Integrators of America (CSIA), which indicates that we have undergone and passed a third party audit insuring that we adhere to stringent procedures for project methodology and best business practices.
- We have a long proven track record in the Systems Integration field, and are recognized as one of the longest, continually operating, independent system integrators in the country.
- TVC Systems is the only New England based integrator which is CSIA Registered; maintains a UL registered shop; employs a Multi-New England States licensed Master Electrician; and performs all of its engineering, design, panel fabrication, testing and documentation in its own facility, using its own employees.
- Our Portsmouth, NH facility is in close proximity to many New England project sites, therefore we can quickly respond to emergency needs.

In general, the purpose of this project is to provide two redundant Balance of Plant PLC control systems capable of monitoring and controlling two 12 MW combustion turbine generators, duct burners, gas compressors, VFD pumps and various pieces of balance of plant equipment. Communication protocols will include ControlNet, DeviceNet, Ethernet, DH+ and Modbus.

A. Scope of Work:

- Furnish and fabricate two (2) BOP control panels each equipped as follows:
  - Hoffman Proline Series, 1800mmH X 1200mmW X 600mmD NEMA 12 Enclosure with overlapping doors, Lexan Window, key locking handle, grounding bar system, cooling fan package with temperature switch, light fixture and data pocket
  - Redundant Allen-Bradley ConrtolLogix PLC System with L555M23 CPUs, two (2) 4-slot and two (2) 10-slot chassis, redundant power supplies and redundant ControlNet communication modules, Ethernet, and DH+ communication modules, and I/O modules to support the following I/O types and quantities:
    - 64 Digital Inputs, 120VAC
    - 32 Isolated Digital Outputs, 120VAC
    - 48 Analog Inputs, current or voltage
    - 16 Analog Outputs, current or voltage
  - 24VDC redundant power supplies for analog signal loops
  - Terminal blocks, relays, wire duct, etc. to support the above equipment
  - Fiber Optic Patch panel

- Furnish and fabricate one (1) Remote I/O control panel for XXX-64 equipped as follows:
  - XXX 60”H X 36”W X 12”D NEMA 4X Wall Mountable Enclosure, with key locking handle, cooling fan with temperature switch, and data pocket
  - XXX communication modules to support the following I/O types and quantities:
    - 48 Digital Inputs, 120VAC
    - 40 Isolated Digital Outputs, 120VAC
    - 24 Isolated Analog Inputs, current or voltage
    - 12 Isolated Analog Outputs, current or voltage
  - 24VDC redundant power supplies
  - Terminal blocks, relays, wire duct, etc. to support the above equipment

- Furnish and fabricate one (1) Remote I/O control panel for XXX-52-1 equipped as follows:
  - XXX Series 42”H X 36”W X 12”D NEMA 12 Wall Mountable Enclosure, with key locking handle, cooling fan with temperature switch, and data pocket
  - XXX communication modules to support the following I/O types and quantities:
    - 32 Digital Inputs, 120VAC
    - 24 Isolated Digital Outputs, 120VAC
    - 16 Isolated Analog Inputs, current or voltage
    - 16 Isolated Analog Outputs, current or voltage
  - 24VDC redundant power supplies
  - Terminal blocks, relays, wire duct, etc. to support the above equipment

- Provide two (2) XXX Operator Interface Workstations with the following minimum specifications:
  - 2.80GHz, XEON/533 Processor, 512K Full Speed Cache
  - 512MB, 266MHz, Double Data Rate SDRAM, ECC (2 DIMMS)
  - PS/2 Keyboard
  - Flat Panel 20” Color Monitor with DVI
  - 128MB VGA and DVI Graphics Card
  - 146GB Dual SCSI Hard Drives with RAID 1 Controller
  - Mouse
  - V.92 Data/Fax Modem
  - 32X DVD+CD-RW Combo Drive
  - 48X CD-ROM Drive
  - 4 PCI Spare slots
  - 1 4X-AGP spare slot
  - 10/100mbps Network Card
  - Windows XP Professional Operating System
  - 3-year parts and labor with 1 day response

- One (1) XXX Development 60K Tag Operator Interface Software Package, one (1) XXX Runtime 60K Tag Software Package and one (1) XXX Top Server License
- One (1) RSXXX Professional Software Package
- Provide one (1) XXX Dot Matrix Printer
- Provide one (1) XXX Color LaserJet Printer
- Provide two (2) Ethernet Device Servers, with six 10/100BaseTX ports and two multimode 100BaseFX ports
- Provide manufacturers submittal data sheets for each enclosure provided by TVC Systems, software program, graphic screens and FAT and SAT Test Plans
- Provide the following design documents for approval:
  - Functional Specification, which describes all of the major hardware items to be used, along with a complete I/O listing for the system modifications performed under this proposal
  - Sequence of Operations, which describes all of the software functions to be performed in the PLC and Operator Interface for the system modifications performed under this proposal
- Provide AutoCAD 2002 project drawings to include panel layouts, point to point wiring diagrams, power distribution and grounding drawings, and system architecture drawings for the system with an initial submittal within four weeks of purchase order
- Configure the new PLC control systems to provide the control functions defined in the approved Sequence of Operations
- Modify the two Operator Workstations located in the CTG Control Room and provided by Alstom to incorporate the graphics/controls for the Balance of Plant controls
- Perform a Factory Acceptance Test at TVC's Portsmouth, NH facility to be witnessed by the customer
- Provide up to one hundred twenty (120) hours of on-site technical services and up to one hundred twenty (120) hours of engineering services to startup, test, and commission the system. Technical services will include field wire terminations of all I/O internal to TVC's control panels and I/O checkout. Engineering services will include I/O checkout, communications setup, sequence of operations testing and SAT. Any additional on-site services will be billed at TVC's standard rates (see Rate Schedule Attachment to this proposal).
- Provide up to eight (8) hours of on-site technical and engineering training services. If additional training services are required they will be billed at TVC's standard rates (see Rate Schedule Attachment to this proposal).
- Provide three (3) sets of Operation and Maintenance Manuals within 30 days of Site Acceptance by the customer.

B. Work Not Included:

- All on-site electrical installation associated with the above equipment. This proposal does not include conduit, field wiring/cabling, and mechanical supports. However, TVC will make all terminations at the PLC and Remote I/O panels
- Mechanical installation of all field instruments and control panels
- Any and all other items not explicitly identified above

C. Assumptions, Clarifications and Exceptions:

TVC has thoroughly reviewed the terms and conditions set forth in the Request for Proposal documents listed on page one of this proposal and has the following comments and/or exceptions.

RE: Balance of Plant Control System Specification

SECTION 12: Documentation

Subsection 12.1.3

States that System Integrator shall furnish certified copies of project drawings.

TVC will provide signed "as-built" drawings on 11" x 17" paper as well as on CD with final documentation package.

SECTION 12.2: Submittals, Drawings and Manuals

Subsection 12.2.1.1

States that Cut sheets for Enclosures and Cabinets shall be submitted with the Bid.

Equipment cut sheets will be provided during the Submittal process after contract award.

Subsection 12.2.2.3

States "System Integrator shall surrender all rights of ownership for developed configuration files and related documents to the Owner at the conclusion of the project."

TVC takes exception to any and all modifications to software prior to warranty expiration. Additionally, TVC will retain all rights, titles and interests in all intellectual property created by TVC and its employees including, but not limited to all drawings, specifications, software prepared by Seller, all copyrights, patents and other intellectual property rights. The Buyer shall not use any drawings or specifications prepared by Seller, except for the purpose of confirming the quality of design and manufacturing of the products set forth in the proposal. The Buyer shall not sell, license, assign or transfer the intellectual property or any interest therein to anyone.

Subsection 12.2.2.4

States, "These terms shall supersede the System Integrator's standard "Terms and Conditions of Sale", where applicable.

TVC takes exception to this clause. Please refer to TVC's response to Subsection 12.2.2.3.

SECTION 1: Items and Services to be Supplied by the System Integrator

Subsection 1.4.3

States that the Operator Workstations will be equipped with Windows NT 4.0 workstation operating system.

TVC has substituted the operating system with Windows XP since Windows NT 4.0 is not readily available at this time and is due for withdrawal of support by Microsoft in the near future. In addition, XXX recommends using Windows XP.

Subsection 1.4.3.1

States that the Operator Workstations will be equipped with Pentium 4 processors.

TVC will supply computers with XEON 2.8GHz processors since RAID 1 is not supported on systems with Pentium 4 processors.

Subsection 1.4.3.4

States that the Operator Workstations will be equipped with dual 80 GB hard drives.

TVC will supply computers with dual 146GB hard drives to support the RAID 1 requirement.

SECTION 3: Supplemental Specifications and Information Control System Requirements

Subsection 3.3.4

States that the Systems Integrator supplied control system shall be furnished with 20% spare I/O card slot capability.

Based on the number of I/O and communication models required to support the system, two 10-slot chassis will not sufficiently allow for 20% spare I/O card slots. Therefore TVC has substituted 13-slot racks for the 10-slot racks.

Subsection 3.7.2

States that the enclosures for XX-52-1, XXX-64-1 and XXX-64-2 shall have the following dimensions: 36"W X 10"D X 36"H.

Based on the amount of equipment which needs to be installed in each cabinet and Addendum 1 which removes XXX-64-2, TVC recommends increasing the cabinet size for XX-52-1 and XXX-64 to 36"W X 12" D X 42"H.

Subsection 3.7.6

States all power supplies shall be redundant.

TVC will provide redundant 24VDC loop power for analog signals and redundant power for PLC chassis. Power for 120VAC digital I/O signals and I/O chassis is not redundant.

Subsection 3.9

States that the system reliability is of the utmost importance.

Based on this statement, TVC recommends that a XXX processor with non-volatile memory be used. Therefore, we have substituted the XXX processors with XXA processors. This allows for the PLC logic programs to be written to EPROMM removing the possibility that the logic will be lost upon failure of the CPU battery.

D. Project Methodology and Schedule:

A timely and successful engineering project requires a fundamentally sound approach to design and implementation. TVC Systems subscribes to the concept that all engineering functions must be completely defined before fabrication, scope development and implementation can begin.

TVC Systems requires its employees and designated representatives to follow the methodology outlined in our Project Milestones document. This time tested philosophy of project execution provides a smooth transition between the concept, design and implementation of the project.

TVC offers the following preliminary schedule based on a November 30, 2005 award date:

	PROJECT MILESTONE	ESTIMATED START/FINISH DATES
1	Letter of Intent issued by XXX Constructors to TVC Systems	30Nov05
2	TVC submits on Field Instrumentation and Control Valves and System Architecture Drawing for approval	16Dec05-30Dec05
3	*Purchase Order issued by XXX Constructors to TVC Systems*	*07Dec05*
4	TVC receives submittal approval of Field Instrumentation and Control Valves and System Architecture Drawing	30Dec05-13Jan06
5	*TVC submits Functional Specification and Panel Layout Drawings for approval*	*13Jan06-27Jan06*
6	TVC receives submittal approval of Functional Specification and Panel Layout Drawings	27Jan06-10Feb06
7	*TVC submits Sequence of Operations for approval*	*24Feb06-10Mar06*
8	TVC receives submittal approval of Sequence of Operations	*10Mar06-24Mar06*

	PROJECT MILESTONE	ESTIMATED START/FINISH DATES
9	*TVC submits Point to Point Drawings for review and comment*	*24Mar06-07Apr06*
10	*TVC issues Point to Point Drawings " For Construction"*	*14Apr06-21Apr06*
11	*TVC submits graphic screens for review*	*21Apr06*
12	*TVC ships Field Instrumentation and Control Valves to jobsite*	*21Apr06-07Jun06*
13	*TVC performs Factory Acceptance Testing (FAT) at TVC's Portsmouth, NH facility*	*12May06-26May06*
14	*TVC ships Control Panels to jobsite*	*31May06-07Jun06*
15	*TVC begins field wiring and checkout*	02Jun06-28Jul06
16	Field wiring checkout complete	28Jul06-25Aug06
17	*On-site Startup and Comissioning completed, TVC performs Site Acceptance Testing (SAT) and training*	*29Sep06*
18	*Final documentation delivered*	*31Oct06*

Note: Payment milestones will be identified during contract negotiation. The above schedule is based on our normal turn around time for a project of this size and estimated field equipment delivery quoted from our vendors. TVC is open to negotiations upon contract award.

E. Commercial Terms and Conditions:

The price to provide the above scope of work is **$XXXXXX.XX. Payment of invoices is Net 30 days.**

Timely remittance of invoicing is expected. If Total Energy Plant, LLC delays submittals, shipments, or site work, TVC may request payments due at the time when TVC was prepared to submit, ship or perform work, per the contracted project schedule.

Total Energy Plant, LLC, herein referred to as the Buyer, agrees to make payment in full to TVC Systems, the Seller, for all amounts due according to Seller's invoice(s). Buyer also agrees to pay to Seller, as interest, an amount equal to 1.5% per month or the maximum provided by law (whichever is less) for invoices outstanding after 30 days. In the event Seller should commence any action or otherwise seek to enforce this agreement against Buyer, Buyer agrees to pay reasonable attorney(s) fees, court costs, and other expenses incurred by Seller, whether or not suit is filed.

Total Energy Plant, LLC agrees that directly or indirectly, it will not solicit any TVC employee for employment, without written consent from TVC. This agreement is in force during contracts between Total Energy Plant, LLC and TVC and for a period of one year after completion of all contracts.

Copyright and ownership in all designs and other information provided or prepared by TVC Systems, under this project contract will remain with TVC. Total Energy Plant, LLC will have a license to use project designs and information for any purpose associated with this project before or after its completion.

This proposal is exclusive of any and all state and local taxes of any kind or type. TVC Systems will not be responsible for the payment, collection, accounting, and/or forwarding of any such items; nor is the intended contract between TVC Systems and Total Energy Plant, LLC to include this item.

TVC shall not be held liable for more than the costs of materials sold and/or services provided. TVC will not be held liable for damages resulting from loss of data, loss of profits, incidental, and consequential or indirect damages in any way during or after this contract.

This contract may not be cancelled or changed after award, without written agreement between TVC and Total Energy Plant, LLC.

The commercial costing contained in this proposal is based on an anticipated project schedule that assumes a relatively continuous effort throughout the project lifecycle. If Waldron Engineering, Inc. requests a decelerated pace of project execution, Total Energy Plant, LLC shall bear the additional costs associated with such deceleration. TVC may also request additional costs for subsequent “spin-up” time (inefficiency caused by starting and stopping) at the prevailing TVC rates.

In the event that Total Energy Plant, LLC requests changes to designs, TVC will advise Total Energy Plant, LLC of additional costs for materials, services and delivery schedule. No verbal change requests will be accepted, and Total Energy Plant, LLC and TVC must approve all written requests for changes.

If TVC is unable to perform the obligations of this contract due to wars, acts of terrorism, riots, acts of governmental authorities, acts of God, or civil disturbances, TVC may terminate without liability under the terms of this agreement.

The terms and conditions herein are construed in accordance with the laws of the state of New Hampshire.

FOB is jobsite, shipped direct by TVC Systems. This price is firm for customer acceptance for a period of 30 days unless extended in writing by TVC Systems.

TVC Systems warrants its products to be free from defects in materials and workmanship when used under TVC Systems design conditions and service for a period of twelve (12) months, from the date of acceptance of the system by the Owner, but no longer than fifteen (15) months from the initial date of the system shipment from TVC Systems. Any defect discovered or reported during the warranty period will be repaired, during normal working hours, at no charge to the Owner. If the Owner requires service outside of normal working hours, or if it is determined that the defect is the problem or responsibility of others, it will be deemed billable. Any defect discovered or reported after the warranty period has expired will be deemed outside the coverage of this warranty. Warranty services are performed during TVC Systems normal business hours; Monday-Friday, 8:00 AM to 5:00 PM EST.

Equipment and parts purchased by TVC Systems and included in this system have a warranty from the original manufacturer to the extent available, passed through from the original manufacturer. **TVC Systems is not responsible for administering warrantees on customer furnished equipment, programming and materials.**

THIS EXPRESS WARRANTY SUPERCEDES AND IS IN LIEU OF ANY AND ALL OTHER REMEDIES AND WARRANTIES, INCLUDING ANY IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS, AND LIABILITY FOR NEGLIGENCE. IN NO EVENT SHALL TVC SYSTEMS BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL LOSS, EXPENSES, OR DAMAGES.

Upon delivery, if a defect or a shortage of an item is received in the manufacturer's original container, deliver a written notice detailing the basis of the claim for defect or shortage to the seller's main office at: 284 Constitution Avenue, Portsmouth, NH 03801. If after the investigation the claim is determined to be valid by TVC Systems, TVC may discharge its entire obligation to the purchaser by either repairing or replacing the item at TVC Systems. All other costs and/or expenses are for the account of the buyer.

TVC would like to thank you for this opportunity to quote. If you have any questions regarding this proposal, please don't hesitate to call.

Sincerely,
TVC Systems
Joanne Morrill
Joanne Morrill
Vice President of Engineering

Cc: N. Tyring
file-XXXX

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TOTAL ENERGY PLANT
Portsmouth, New Hampshire

COGENERATION UPGRADE PROJECT

FUNCTIONAL SPECIFICATION
REV. 0 – WORKING COPY

TVC WORK ORDER NO. XXXX

CUSTOMER REVIEW			
Printed Name	**Signature**	**Title**	**Date**

XX August, 2004

RALPH SPINELLI
PROJECT ENGINEER

TOTAL ENERGY PLANT
PORTSMOUTH, NEW HAMPSHIRE
COGENERATION UPGRADE PROJECT
FUNCTIONAL SPECIFICATION

Document Revision History

Revision	Description	Date
A	Initial Issue for Customer Approval	XXAUG04
B	Incorporates Customer Review Comments Received During Design Review Meetings at TVC on XXAUGO4 and XXAUG04.	XXAUG04
C	Incorporates Customer Review Comment Received on XXAUG04, XXAUG04, and TBD	XXAUG04
0		XXAUG04

Table of Contents

TOTAL ENERGY PLANT
PORTSMOUTH, NEW HAMPSHIRE
COGENERATION UPGRADE PROJECT
FUNCTIONAL SPECIFICATION

1. Introduction

This document specifies all the hardware and software to be interfaced with the Allen-Bradley ControlLogix Programmable Logic Controllers (PLC's) and the Wonderware Supervisory Control and Data Acquisition (SCADA) software. Alterations to this document will not be made without the consent of Total Energy Plant, LLC and TVC Systems.

2. Applicable Documents

The following documents are recognized as acceptable sources of information to be used in the development of the Control System:

A. TVC generated Functional Specification (this document)
B. TVC generated Sequence of Operations
C. TVC generated Project Drawings
D. All drawings and specifications developed by XXX Engineers and XXX Engineers, LLC

3. Overview

This document describes and defines equipment that controls and interfaces with the Allen-Bradley ControlLogix PLC's and the Wonderware Operator Interface System. The purpose of this document is to identify all of the system hardware and I/O points, and to assure that all the hardware associated with the process is or can be made compatible with the PLC control system.

Please see TVC's System Architecture Drawing, XXXX-700, and section 6.3. for details regarding communication between the control panels and equipment identified in this document.

Items that are not known are shown as "TBD" (to be determined). Please fill in the appropriate information.

Customer review blocks are provided at the beginning of each of the sections for the remainder of this document. Please sign, date, and check the appropriate box. Space is available for comments if they are required.

4. Control Panels and Equipment

CUSTOMER REVIEW	
Signed:	**Date:**
❑ **Approved** ❑ **Approved as Noted** ❑ **Revise and Resubmit** **(please check one)**	**Comments:**

4.1. BOP100 PLC Panel

The following section is a bill of materials for the BOP100 PLC Panel. Please reference panel layout drawings XXXX-001 and 002.

Part Number	Manufacturer/Description	Qty.
P-F18126	Hoffman; ProLine Double Bay Frame 1800mmH X 1200mmW X 600mmD NEMA 12	1
P-TD1812	Hoffman; Overlapping Solid Doors	1
P-SS186	Hoffman; Solid Side	2
P-CS186	Hoffman; Solid Cover	2
P-T126	Hoffman; Solid Top	1
P-B1126	Hoffman; 100mm Solid Base	1
P-FHKBL	Hoffman; Keylocking Flush handle	1
P-PF1812	Hoffman; Full Subpanel	1
P-PFSM146	Hoffman; Side Panel	2
P-GS6K	Hoffman; Grounding Bar System	1
P-GK	Hoffman; Grounding Kit	6
A-LF16D18	Hoffman; Enclosure Light w/Door Switch	1
T-FP101UL12	Hoffman; Cooling Fan Package	1
T-EG10UL12	Hoffman; Exhaust Grill	1
A-TEMNO	Hoffman; Temperature Control Switch	1
A-DP2	Hoffman; Data Pocket	1
A-HCI10E	Hoffman; Corrosion Inhibitor	5
Custom	Glass Pro; Lexan Window	2
1756-L55M23	Allen-Bradley; ControlLogix5555 Processor, 1.5MB Memory	2
1757-SRM	Allen-Bradley; ControlLogix System Redundancy Module	2
1757-SRC1	Allen-Bradley; ControlLogix System Redundancy Module Cable	1
1756-A4	Allen-Bradley; ControlLogix Chassis, 4 Slot	2
1756-PA72	Allen-Bradley; Chassis Power Supply	2
1756-PAR	Allen-Bradley; Redundant Power Assembly	2
1756-CNBR	Allen-Bradley; ControlNet Bridge Module, redundant	4

Part Number	Manufacturer/Description	Qty.
1756-ENBT	Allen-Bradley; Ethernet/IP 10/100 Bridge Module	2
1756-DHRIO	Allen-Bradley; DH+ Remote I/O Bridge Module	1
MVI 56-MCM	Prosoft Technologies; Modbus Master/Slave Communications Module	1
1756-A10	Allen-Bradley; ControlLogix Chassis, 10 Slot	2
1756-IA16I	Allen-Bradley; Isolated Digital Inputs, 120VAC, 16 pts	1
1756-IB16	Allen-Bradley; Digital Inputs, 24VDC, 16 pts	3
1756-OW16I	Allen-Bradley; N.O. Isolated Relay Outputs, 16 pts	2
1756-IF16	Allen-Bradley; Analog Inputs, Current/Voltage, 16 pts	3
1756-OF8	Allen-Bradley; Analog Outputs, Current/Voltage, 8 pts	2
1756-TBCH	Allen-Bradley; 36 Pin Screw Clamp Block with Standard Housing	5
1756-TBNH	Allen-Bradley; 20 Position NEMA Screw Clamp Block	5
1756-N2	Allen-Bradley; Slot Filler	3
1786-TPS	Allen-Bradley; ControlNet T-Tap	8
1786-XT	Allen-Bradley; ControlNet 75 OHM Terminator Plug	2
1412400	Marathon; Power Distribution Block, 2 pole, 115Amps, 600VAC	1
1492-CB1G200	Allen-Bradley; Circuit Breaker, 20A, 1 pole	2
ED6008-MM-SC	Moxa; EtherDevice Server with 6 port Ethernet/2 port Fiber	2
36359	Black Box; Fiber Optic Distribution Panel 24 port	1
SDN2.5-24-100RED	Sola/Hevi-Duty; 24VDC Power Supply, 2.5A	2
Q501-1B00	Action-Instruments; Ultra SlimPak Signal Isolator	1
5600462	Phoenix; GFCI Receptacle	1
----------	Various; Terminal Blocks, wire, etc.	Lot

4.2. BOP200 PLC Panel

The following section is a bill of materials for the BOP200 PLC Panel. Please reference panel layout drawings XXXX-003 and 004.

Part Number	Manufacturer/Description	Qty.
P-F18126	Hoffman; ProLine Double Bay Frame 1800mmH X 1200mmW X 600mmD NEMA 12	1
P-TD1812	Hoffman; Overlapping Solid Doors	1
P-SS186	Hoffman; Solid Side	2
P-CS186	Hoffman; Solid Cover	2
P-T126	Hoffman; Solid Top	1
P-B1126	Hoffman; 100mm Solid Base	1
P-FHKBL	Hoffman; Keylocking Flush handle	1
P-PF1812	Hoffman; Full Subpanel	1

Part Number	Manufacturer/Description	Qty.
P-PFSM146	Hoffman; Side Panel	2
P-GS6K	Hoffman; Grounding Bar System	1
P-GK	Hoffman; Grounding Kit	6
A-LF16D18	Hoffman; Enclosure Light w/Door Switch	1
T-FP101UL12	Hoffman; Cooling Fan Package	1
T-EG10UL12	Hoffman; Exhaust Grill	1
A-TEMNO	Hoffman; Temperature Control Switch	1
A-DP2	Hoffman; Data Pocket	1
A-HCI10E	Hoffman; Corrosion Inhibitor	5
Custom	Glass Pro; Lexan Window	2
1756-L55M23	Allen-Bradley; ControlLogix5555 Processor, 1.5MB Memory	2
1757-SRM	Allen-Bradley; ControlLogix System Redundancy Module	2
1757-SRC1	Allen-Bradley; ControlLogix System Redundancy Module Cable	1
1756-A4	Allen-Bradley; ControlLogix Chassis, 4 Slot	2
1756-PA72	Allen-Bradley; Chassis Power Supply	2
1756-PAR	Allen-Bradley; Redundant Power Assembly	2
1756-CNBR	Allen-Bradley; ControlNet Bridge Module, redundant	4
1756-ENBT	Allen-Bradley; Ethernet/IP 10/100 Bridge Module	2
1756-DHRIO	Allen-Bradley; DH+ Remote I/O Bridge Module	1
MVI 56-MCM	Prosoft Technologies; Modbus Master/Slave Communications Module	1
1756-A10	Allen-Bradley; ControlLogix Chassis, 10 Slot	2
1756-IA16I	Allen-Bradley; Isolated Digital Inputs, 120VAC, 16 pts	1
1756-IB16	Allen-Bradley; Digital Inputs, 24VDC, 16 pts	3
1756-OW16I	Allen-Bradley; N.O. Isolated Relay Outputs, 16 pts	2
1756-IF16	Allen-Bradley; Analog Inputs, Current/Voltage, 16 pts	3
1756-OF8	Allen-Bradley; Analog Outputs, Current/Voltage, 8 pts	2
1756-TBCH	Allen-Bradley; 36 Pin Screw Clamp Block with Standard Housing	5
1756-TBNH	Allen-Bradley; 20 Position NEMA Screw Clamp Block	5
1756-N2	Allen-Bradley; Slot Filler	3
1786-TPS	Allen-Bradley; ControlNet T-Tap	8
1412400	Marathon; Power Distribution Block, 2 pole, 115Amps, 600VAC	1
1492-CB1G200	Allen-Bradley; Circuit Breaker, 20A, 1 pole	2
ED6008-MM-SC	Moxa; EtherDevice Server with 6 port Ethernet/2 port Fiber	2
SDN2.5-24-100RED	Sola/Hevi-Duty; 24VDC Power Supply, 2.5A	2
Q501-1B00	Action-Instruments; Ultra SlimPak Signal Isolator	1
5600462	Phoenix; GFCI Receptacle	1

Part Number	Manufacturer/Description	Qty.
----------	Various; Terminal Blocks, wire, etc.	Lot

4.3. FCP-64 Remote I/O Panel

The following section is a bill of materials for the FCP-64 remote I/O Panel. Please reference panel layout drawings XXXX-005 and 006.

Part Number	Manufacturer/Description	Qty.
C-SD603612	Hoffman; Concept Wall Mounted Panel 60X36X12, NEMA 12 with feet	1
C-P6036	Hoffman; Back Panel for Above	1
C-WHK	Hoffman; Locking Handle	1
A-FK1212	Hoffman; Floor Standing Kit	1
T-FP41UL12	Hoffman; Cooling Fan Package	1
T-EG4UL12	Hoffman; Exhaust Grill	1
A-TEMNO	Hoffman; Temperature Control Switch	1
A-DP2	Hoffman; Data Pocket	1
A-HCI10E	Hoffman; Corrosion Inhibitor	1
PK27GTA	SquareD; Ground Bar Kit	4
PKGTAB	SquareD; Ground Bar Standoffs	4
1794-ACNR15	Allen-Bradley; Redundant Media Adapter for ControlNet	2
1794-IB16	Allen-Bradley; Digital Input, 24VDC, 16 pt.	2
1794-OW8	Allen-Bradley; Digital Relay Output, 8 pt.	2
1794-IF4I	Allen-Bradley; Analog Input, Current/Voltage, isolated, 4 pt.	8
1794-OF4I	Allen-Bradley; Analog Output, Current/Voltage, isolated, 4 pt.	2
1794-TB3	Allen-Bradley; Terminal Base, 3 wire	14
1786-TPS	Allen-Bradley; ControlNet T-Tap	4
1412400	Marathon; Power Distribution Block, 2 pole, 115Amps, 600VAC	1
1492-CB1G200	Allen-Bradley; Circuit Breaker, 20A, 1 pole	1
SDN2.5-24-100RED	Sola/Hevi-Duty; 24VDC Power Supply, 2.5A	2
5600462	Phoenix; GFCI Receptacle	1
----------	Various; Terminal Blocks, wire, etc.	Lot

4.4. CP-52-1 Remote I/O Panel

The following section is a bill of materials for the CP-52-1 remote I/O Panel. Please reference panel layout drawings XXXX-007 and 008.

Part Number	Manufacturer/Description	Qty.
P-F1886	Hoffman; ProLine Single Bay Frame 1800mmH X 800mmW X 600mmD NEMA 12	1
P-DS188	Hoffman; Solid Door	1
P-SS186	Hoffman; Solid Side	2
P-CS188	Hoffman; Solid Cover	1
P-T86	Hoffman; Solid Top	1
P-B086	Hoffman; 0mm Solid Base	1
P-FHKBL	Hoffman; Keylocking Flush handle	1
P-PF188	Hoffman; Full Subpanel	1
PK27GTA	SquareD; Ground Bar Kit	2
PKGTAB	SquareD; Ground Bar Standoffs	2
T-FP41UL12	Hoffman; Cooling Fan Package	1
T-EG4UL12	Hoffman; Exhaust Grill	1
A-TEMNO	Hoffman; Temperature Control Switch	1
A-DP2	Hoffman; Data Pocket	1
A-HCI10E	Hoffman; Corrosion Inhibitor	5
1794-ACNR15	Allen-Bradley; Redundant Media Adapter for ControlNet	1
1794-IB16	Allen-Bradley; Digital Input, 24VDC, 16 pt.	1
1794-OW8	Allen-Bradley; Digital Relay Output, 8 pt.	1
1794-IF4I	Allen-Bradley; Analog Input, Current/Voltage, Isolated, 4 pt.	1
1794-OF4I	Allen-Bradley; Analog Output, Current/Voltage, Isolated, 4 pt.	1
1794-TB3	Allen-Bradley; Terminal Base, 3 wire	4
1786-TPS	Allen-Bradley; ControlNet T-Tap	6
1786-XT	Allen-Bradley; ControlNet 75ohm Terminator Plug	2
1412400	Marathon; Power Distribution Block, 2 pole, 115Amps, 600VAC	1
1492-CB1G200	Allen-Bradley; Circuit Breaker, 20A, 1 pole	1
ED6008-MM-SC	Moxa; EtherDevice Server with 6 port Ethernet/2 port Fiber	2
1786-CTK/B	Allen-Bradley; ControlNet RG6 Toolkit	1
36359	Black Box; Fiber Optic Distribution Panel 24 port	1
SDN2.5-24-100RED	Sola/Hevi-Duty; 24VDC Power Supply, 2.5A	2
5600462	Phoenix; GFCI Receptacle	1
----------	Various; Terminal Blocks, wire, etc.	Lot

5. Operator Interface Stations and Software

CUSTOMER REVIEW	
Signed:	**Date:**
❑ **Approved** ❑ **Approved as Noted** ❑ **Revise and Resubmit** **(please check one)**	**Comments:**

5.1. Main Control Room SCADA Nodes

The following section is a bill of materials for the Main Control Room SCADA Nodes.

Part Number	Manufacturer/Description	Qty.
Precision	Dell; Precision 650 MiniTower, 2.8GHz Intel XEON Processor, 512MB RAM, 3.5” 1.44MB Floppy Drive, 2x146 GB Hard Drive, 20” Flat Screen Monitor, 10/100 NIC, 128MB Video RAM, Windows 2000 Professional, 8/4/32X DVD and CD-RW, 8/4/48X CD-ROM, V.92 Data/Fax Modems	2
ML395C	Okidata; Dot Matrix Printer	1
2500N	HP; Color Laserjet Printer	1
41233150	Wonderware; AB TOP Server for Ethernet	2
01-0080D	Wonderware; InTouch Runtime 60k Tags	2

5.2. CTG Control Room SCADA Nodes

The following section is a bill of materials for the CTG Control Room SCADA Nodes.

Part Number	Manufacturer/Description	Qty.
Optiplex	Dell; Optiplex GX260 MiniTower, 2.8GHz Intel Pentium 4 Processor, 128MB RAM, 3.5” 1.44MB Floppy Drive, 20 GB Hard Drive, 18” Flat Screen Monitor, 10/100/1000 NIC, 32MB Video RAM, Windows 2000 Professional, 8/4/32X CD-RW, V.92 Data/Fax Modems	2
ML395C	Okidata; Dot Matrix Printer	1
2500N	HP; Color Laserjet Printer	1
9324-RLD700NXENE	Allen-Bradley; RSLogix5000 Professional	1
1756-CP3	Allen-Bradley; Programmer Cable	1
41233150	Wonderware; AB TOP Server for Ethernet	2
01-0075D	Wonderware; InTouch Development 60k Tags	1
01-0080D	Wonderware; InTouch Runtime 60k Tags	1
	Symantec; PC Anywhere	1

6. Field Inputs and Outputs

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Signed:	**Date:**
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6.1. I/O Types

This section specifies all of the input and output types used with the Allen-Bradley PLC's.

6.1.1. Discrete Inputs

Field signals are 24VDC or 120VAC. For the 24VDC signals, power is supplied by the 24VDC power supply in the enclosure. For the 120VAC signals, power is supplied by a motor starter external to the enclosure and the signal is wired to an interposing relay to allow all the Discrete Input modules to be 24VDC.

6.1.2. Discrete Outputs

All the Discrete Outputs are dry contact relays. Field signals are 24VDC or 120VAC. For the 24VDC signals, power is supplied by the 24VDC power supply in the enclosure. For the 120VAC signals, power is supplied by a motor starter external to the enclosure.

6.1.3. Analog Inputs

Two-wire transmitters (4-20mA) are loop powered from the 24VDC power supply in the enclosure and are wired single-ended to the module (noted as "AI-2W" on the I/O List). Four-wire transmitters (4-20mA) are powered from the enclosure and wired differentially to the module (noted as "AI-4W" on the I/O List).

6.1.4. Analog Outputs

All field signals are 4-20 mA powered from the module.

6.1.5. Communicated I/O

Communicated I/O signals are interfaced via four (4) protocols: Ethernet IP, Data Highway Plus, ControlNet, and Modbus RTU. The communication bridges are located in each ControlLogix I/O chassis located in the BOP100 and BOP200 control panels.

6.2. I/O List

The following is a list of all of the field I/O that will be interfaced with the Allen-Bradley PLC's.

6.3. System Architecture

The TVC System Architecture Drawing, XXXX-700, details the four different network protocols (Ethernet/IP, Modbus RTU, Redundant ControlNet, and Data Highway Plus) used to tie the control panels and operator interfaces computers (SCADA) systems together.

Starting from the Main Control Room, there are five computers, two printers, two Moxa Ethernet to Fiber Optic switches, and one remote I/O panel, CP-52-1 supplied by TVC. Two of the computers are Wonderware SCADA nodes, supplied by TVC, two Alstom Wonderware SCADA nodes, and one OSI PI Historian Server. Each computer is connected to a switch at least once to interface to the control panels and each other via Category 5 Ethernet cable to the switches, which is part of a redundant Fiber Optic ring. Off each TVC SCADA through the printer port there is a printer, Okidata Dot Matrix used for alarm printing, and HP Color Laser used for printing graphic screens and reports. The CP-52-1 remote I/O panel is connected to the BOP system via the Redundant ControlNet network.

In the CTG Control Room, there are four computers, two printers, ten control panels, and one Fiber Optic Patch Panel. Two of the computers are Wonderware SCADA nodes, supplied by TVC, and there are two Alstom Wonderware SCADA nodes. Each computer is connected to a switch at least once to interface to the control panels and each other via Category 5 Ethernet cable to the switches. Off each TVC SCADA, through the printer port, there is a printer, Okidata Dot Matrix used for alarm printing and HP Color Laser used for printing graphic screens and reports. Two of the ten control panels in the CTG Control Room are BOP100 CP-101 and BOP200 CP-200, which are supplied by TVC. In each of the TVC supplied control panels there are two hot standby ControlLogix PLC's, two ten-slot I/O chassis's, and two Moxa Ethernet to Fiber Optic switches. Each ten-slot chassis has at least one Redundant ControlNet Bridge module, an Ethernet/IP communication module, and one unique communication module, which are Data Highway Plus and Modbus RTU. Each I/O chassis communicates to the hot standby ControlLogix PLC's and Remote I/O panels via Redundant ControlNet network. Each chassis also communicates to the Operator Interfaces and Alstom control panels through the switches via Ethernet/IP. One of the I/O chassis's in each of the TVC supplied control panels communicates to each of the vendor supplied control panels on the plant floor via Data Highway Plus, while the other I/O chassis communicates to the CEMS controller via Modbus RTU. The Fiber Optic pairs from each of the Moxa switches are terminated in the Fiber Optic patch panel.

In the Plant, there are six control panels, three remote I/O panels, and one CEMS monitoring unit. One of the three remote I/O panels, FCP-64, is supplied by TVC and the other two remote I/O panels, BOPMCC100 and 200, are supplied by others. The three remote I/O panels communicate to the BOP system via Redundant ControlNet. The CEMS monitoring unit, which monitors the turbine exhaust temperatures,

communicates to the BOP system via Modbus RTU. The six control panels supplied by others communicate to the BOP system via Data Highway Plus.

This is the entire Functional Specification as provided by TVC Systems.

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TOTAL ENERGY PLANT
Portsmouth, New Hampshire

COGENERATION UPGRADE PROJECT

SEQUENCE OF OPERATIONS
REV. 0 – WORKING COPY

TVC WORK ORDER NO. 0XXX

CUSTOMER REVIEW			
Printed Name	**Signature**	**Title**	**Date**

xx August, 2004

RALPH SPINELLI
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TOTAL ENERGY PLANT
PORTSMOUTH, NEW HAMPSHIRE
COGENERATION UPGRADE PROJECT
SEQUENCE OF OPERATIONS

Document Revision History

Revision	Description	Date
A	Initial Issue for Customer Approval	XXAUG04
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TOTAL ENERGY PLANT
PORTSMOUTH, NEW HAMPSHIRE
COGENERATION UPGRADE PROJECT
SEQUENCE OF OPERATIONS

Table of Contents

TOTAL ENERGY PLANT
PORTSMOUTH, NEW HAMPSHIRE
COGENERATION UPGRADE PROJECT
SEQUENCE OF OPERATIONS

1. Introduction

This document specifies all control functions that are supported by the Allen-Bradley ControlLogix Programmable Logic Controller (PLC's) and the Wonderware version XXXX Supervisory Control and Data Acquisition (SCADA) software for the Balance of Plant portion of the Total Energy Plant Cogeneration Upgrade Project located in Portsmouth, New Hampshire. Alterations to this document will not be made without the consent of THE CUSTOMER and TVC Systems.

2. Applicable Documents

The following documents are recognized as acceptable sources of information to be used in the development of the Control System:

A. TVC generated Sequence of Operations (this document)
B. TVC generated Functional Specification
C. TVC generated Project Drawings
D. All drawings and specifications developed by XXX Engineering and XXX Engineers, LLC, as listed in Section 6: Appendix.

3. Overview

The following pages detail all of the software sequencing that occurs under normal and abnormal conditions for every portion of the process. "Normal Operation" details software interlocks/functions and the operating procedure. "Abnormal Conditions" details alarm states with descriptions and the resulting control action. "Operator Selections" details all inputs that an operator can make from the graphic screens. If a variable is described as "operator entered" or "selectable", it is changeable from the graphic screens.

All devices controlled by the PLC will have auto/manual selections, and the ability to manually command the device from the graphic screens.

Settings and tagnames that are not known are shown as "Tag?", "xxx", or "TBD" (to be determined). Please fill in the appropriate information.

Throughout this document, the abbreviation "PLC" will be used to describe the Allen-Bradley ControlLogix Programmable Logic Controllers. The abbreviation "HMI" will be used to describe the Wonderware SCADA software on the Dell Desktop PCs.

The operator interface section provides details about the graphic screens, data monitoring, and alarms. Please reference the above listed "Applicable Documents" for additional information about devices and their tagnames.

Customer review blocks are provided at the beginning of each of the sections for the remainder of this document. Please sign, date, and check the appropriate box. Space is available for comments if they are required.

4. Sequence of Operations

CUSTOMER REVIEW	
Signed:	**Date:**
❑ **Approved** ❑ **Approved as Noted** ❑ **Revise and Resubmit** **(please check one)**	**Comments:**

4.1. Energy Center Overview

The purpose of the Balance of Plant (BOP) and supervisory control and data acquisition (SCADA) systems is to support the addition of two (2) Alstom combustion turbine generators and the associated heat recovery steam generators. The control system consists of five main process systems:

- Combustion turbine generator systems
- Heat recovery steam generator systems
- Fuel systems (Natural gas and fuel oil)
- Cooling systems (Water and glycol)
- Emission monitoring and control (Urea and ammonia reagents)

The SCADA system provides operating control and interface with each of these systems, and collects data for reporting and analysis.

4.2. Combustion Turbine Generator Systems

The following equipment associated with the CTG systems are addressed in this section:

- Alstom combustion turbine generators (qty=2)
- Drain tanks (qty=6)
- Waste water pumps (qty=4)
- Camfil-Farr inlet air filters (qty=2)

4.2.1. Combustion Turbine Generator Startup/Shutdown Sequences

The following sequence is for Combustion Turbine Generator Unit 100, CTG-100, and is typical for CTG-200.

a. Normal Operation

The CTG-100 startup sequence is initiated by the operator from the graphic screens. The following table details the operator events and the resulting control actions performed by the BOP control system.

Item	Condition or Event	Resulting Control Action
1	Operator selects the "CTG-100 Start" screen from the main screen directory	The CTG-100 start screen is displayed, with the following message: "Do you wish to begin the CTG start sequence?" Selections: "Yes" / "Cancel"
2	Operator selects "Yes"	Message: "Generator is configured to synchronize to Breaker E (or F). Do you wish to continue?" Selections: "Yes" / "No"
3	Operator selects "Cancel" (item 1)	The main screen directory is displayed.
4	Operator selects "Yes" (item 2)	Message: "Please select the fuel." Selections: "CTG-100 Gas" / "CTG-100 Oil"
5	Operator selects one of the choices	The system performs a critical interlock check and displays the status of each interlock, as follows: • High Steam Pressure Trip (CPAHH130 via control relay HRSG100-RHHSP) • High Turbine Exhaust Pressure Trip (CPSH160 via control relay HRSG100-RHTEP) • Low Water Level Cutoff – Probe (CLSLLT5 via control relay HRSG100-RRWCL) • Low Water Level Cutoff – Float (CLSLL130 via control relay HRSG100 - RRWLS) • Low Feed Water Pressure (CPSLL101 via control relay HRSG100-RLFP) • Damper DGL-50 Closed (CZS-50C)

Item	Condition or Event	Resulting Control Action
6	Critical interlock check fails	Message: "Critical Interlock check failed – CTG start sequence terminated." The operator will see which interlock(s) failed.
7	Critical interlock check passes (item 5)	The system performs a warning interlock check and displays the status of each interlock, as follows: • Demineralized water low pressure (CPSL-153) • Drain tank high level (CLIT-103, 123, or 124 > TBD "H2O) • Fuel oil low pressure (CPIT-1405 < TBD PSIG)
8	Warning interlock check fails	The operator will see which interlock(s) failed. Selections: "Proceed With Startup" / "Abort Startup"
9	Warning interlock check passes (item 7)	Message: "Interlock check passed – CTG start sequence initiated." System energizes outputs for CTG start (CTG100-BOP-RSIG57), fuel selected (CTG100-BOP-GISIG410 or CTG100-BOP-GISIG112), and starts purge seal air fan (SAF-100).
10	Operator selects "Proceed With Startup" (item 8)	Message: "CTG start sequence initiated." System energizes outputs for CTG start (CTG100-BOP-RSIG57), fuel selected (CTG100-BOP-GISIG410 or CTG100-BOP-GISIG112), and starts purge seal air fan (SAF-100).
11	Operator selects "Abort Startup" (item 8)	The main screen directory is displayed.
12	CTG speed > 3000 RPM, Breeching damper > 20% open and CTG purge sequence started (Spin)	Message: "CTG supplemental purge sequence started. Time remaining: xx min." System opens purge air damper, starts purge air fan (PAF-100), and starts purge timer (typ. 5 min.).
13	Purge timer elapses	Message: "Purge Complete – Ignition Pending." System informs CTG that the purge is complete (Tag?) and stops the purge air fan and closes the purge air damper.

Item	Condition or Event	Resulting Control Action
14	Purge fails (damper or fan fails, see section 4.3.3.)	Message: "Supplemental Purge Fan/Damper Failed – Turbine Purge Continuing." System extends the purge timer (typ. 20 min.) to require the CTG to purge longer. Time remaining is displayed. After 20 minutes, system informs CTG that the purge is complete (Tag?) and stops the purge air fan and closes the purge air damper (Tag?).
15	CTG is at stable idle (Tag?).	Message: "Do you want to auto synchronize?" Selections: "Yes" / "No"
16	Operator selects "Yes"	System sends the auto synchronize confirmation (Tag?).
17	Operator selects "No"	The operator is required to manually synchronize the breaker from the Generator control panel (GCP).
18	Breaker "E" or "F" closes	The CTG overview screen is displayed. System energizes output for droop mode (Tag?), and sets demand signal (CTG100-GCP80) of 0.5 MW (default start settings). The startup sequence is complete.

At this point, the operator is viewing the CTG overview screen, and has the following selections:

- Demand signal (0.5 to 15.0 MW)
- CTG operation mode (droop or isocronous, demand signal applies in both modes)
- Normal shutdown
- Emergency shutdown
- Trip to idle

The shutdown and trip modes are explained further as follows:

Normal shutdown

- If the operator selects the "Normal Shutdown" button, a pop-up screen is displayed which states "Confirmation Required", "Shutdown" / "Cancel".
- When the operator confirms the shutdown, the demand signal is ramped down at TBD MW/min to 0.5 MW, and then the CTG stop output (CTG100-BOP-GISIG58) is energized.

- When the CTG is fully stopped, the seal air fan (SAF-100) is stopped.

Emergency shutdown

- If the operator selects the "Emergency Shutdown" button, a pop-up screen is displayed which states "Confirmation Required", "Shutdown" / "Cancel".
- When the operator confirms the shutdown, the demand signal is immediately set to 0.5 MW, and the CTG stop output (CTG100-BOP-GISIG58) is energized.
- When the CTG is fully stopped, the seal air fan (SAF-100) is stopped.

Trip to Idle

- If the operator selects the "Trip to Idle" button, a pop-up screen is displayed which states "Confirmation Required", "Trip" / "Cancel".
- When the operator confirms the trip, the CTG trip to idle output (CTG100-BOP-GISIG790) is energized.
- The CTG control system brings it to an idle state, the breaker opens, and it remains available for synchronizing.

b. Abnormal Conditions

- "High Steam Pressure Trip": Occurs if the high steam pressure switch (CPAHH130 via control relay HRSG100-RHHSP) is de-energized. CTG-100 will be prevented from starting (interlock failure) or will undergo an emergency shutdown.
- "High Turbine Exhaust Pressure Trip": Occurs if the high turbine exhaust pressure trip switch (CPSH160 via control relay HRSG100-RHTEP) is de-energized. CTG-100 will be prevented from starting (interlock failure) or will undergo an emergency shutdown.
- "Low Water Cutoff - Probe": Occurs if the low water cutoff - probe switch (CLSLLT5 via control relay HRSG100-RRWCL) is de-energized. CTG-100 will be prevented from starting (interlock failure) or will undergo an emergency shutdown.
- "Low Water Cutoff - Float": Occurs if the low water cutoff - float switch (CLSLL130 via control relay HRSG100-RRWLS) is de-energized. CTG-100 will be prevented from starting (interlock failure) or will undergo an emergency shutdown.
- "Low Feed Water Pressure": Occurs if the low feed water pressure switch (CPSLL101 via control relay HRSG100-RLFP) is de-energized. CTG-100 will be prevented from starting (interlock failure) or will undergo an emergency shutdown.

- "Drain Tank DT-100 High Level": Occurs if the drain tank level (CLIT- 123 > TBD "H2O). Typical for DT-101, 102.
- "Fuel Oil Supply High Pressure": Occurs if the fuel oil pressure (CPIT-1405) is > TBD PSIG.
- "Demineralized Water Low Pressure": Occurs if the low demineralized water pressure switch (CPSL-153) is activated.
- "HRSG-100 Steam Delivery High Temperature Trip": Occurs if the HRSG-100 steam delivery temperature (CTIT-121) is > 775 Deg F. CTG-100 will undergo an emergency shutdown.
- HRSG-100 Steam Delivery High Temperature": Occurs if the HRSG-100 steam delivery temperature (CTIT-121) is > 760 Deg F.

c. Operator Selections

- Startup screen selections (identified above)
- CTG operation mode (droop or isocronous)
- Demand signal (xx.x MW)
- Normal shutdown
- Emergency shutdown
- Trip to idle
- HRSG-100 steam delivery high temperature trip setpoint (xxx.x Deg F.)

4.2.2. Drain Tank Monitoring and Control

The following sequence is for Drain Tanks DT-100, 102 and Waste Water Pump WWP-102 and is typical for the other tanks and pumps. Tank and pump lineup is as follows:

- DT-100, 102 are supported by WWP-102
- DT-101 is supported by WWP-101
- Typical for CTG-200 equipment

a. Normal Operation

DT-100 and 102 levels are continuously monitored. The waste water pump is used to drain the tanks, as follows:

- If DT-100 or 102 level is high (see below), WWP-102 is started.
- WWP-102 runs continuously for 2 minutes (selectable) after the high level alarm is cleared, and then stops.

b. Abnormal Conditions

- "Drain Tank DT-100 High Level": Occurs if the drain tank level (CLIT-123 > TBD "H2O).

c. Operator Selections

- DT-100, 102 high level setpoints (xx "H2O)
- WWP-102 auto/manual and start/stop
- Pump runtime (xx min)

4.2.3. Inlet Air Filter Monitoring and Control

The following sequence is for the Camfil-Farr Inlet Air Filter AFS-100, and is typical for AFS-200.

a. Normal Operation

The filter differential pressure and upstream/downstream cooling coil temperatures are continuously monitored. The differential pressure determines when the filter should be cleaned, as follows:

- If the differential pressure is high (see below), a pop-up screen is displayed which states "Air Filters Require Cleaning", "Start" / "Postpone for TBD Hours".
- When the delay timer elapses, the pop-up screen is displayed again, and the choices are offered again.
- If "start" is selected, the cleaning cycle start output (Tag?) is energized, and the inhibit output (Tag?) is de-energized.
- The inhibit output is energized whenever a start is not being requested.

b. Abnormal Conditions

- "Inlet Air Filter High-High DP – Turbine Will Trip at 8 "H2O": Occurs if the inlet air filter differential pressure (DPT-100) is > 6 "H2O.
- "Inlet Air Filter High Differential Pressure": Occurs if the inlet air filter high differential pressure switch (CDPS-101) is activated. Control action is noted above.

c. Operator Selections

- Inlet air filter cleaning postponement delay (xx hours)

4.3. Heat Recovery Steam Generator Systems

The following equipment associated with the HRSG systems are addressed in this section:

- HRSG feedwater valves (qty=2)
- Coen duct burners (qty=2)
- Breaching seal air fans (qty=2)
- Purge seal air fans (qty=2)
- Purge air fans (qty=2)
- Purge air dampers (qty=2)
- Mud drum heater valves (qty=2)

4.3.1. HRSG Feedwater Control

The following sequence is for HRSG-100 Feedwater Flow Control, and is typical for HRSG-200. The flow control is always active unless put in manual by the operator.

a. Normal Operation

The feedwater flow control uses a three element scheme, in which the feedwater flow is proportional to the steam flow, biased with the output of a drum level controller. The drum level controller is as follows:

Parameter	Description	Range
Forward Acting PID Loop	HRSG-100 Drum Level Controller	-----
Process Variable	CLIT-130; HRSG-100 Drum Level	-10 to 10 “H2O
Setpoint	Operator entered	-10 to 10 “H2O
Output	Input to summation function	0 to 100 %
Summation Function	[Drum level controller output] + [HRSG-100 Steam Flow (CFIT-101)], output used as setpoint for feedwater flow controller	0 to 120,000 lb/hr

The feedwater flow controller is as follows:

Parameter	Description	Range
Forward Acting PID Loop	HRSG-100 Feedwater Flow Controller	-----
Process Variable	CFIT-102; Feedwater Flow	0 to 750 “H2O
Setpoint	Summation output noted above	0 to 750 “H2O
Output	CFCV-101; Feedwater Flow Control Valve	0 to 100 %

b. Abnormal Conditions

- “Economizer High Outlet Temperature”: Occurs if the economizer outlet temperature (CTT-110) is > 500 Deg F.

c. Operator Selections

- PID Loop parameters (auto/manual, setpoint, output, tuning)

4.3.2. Duct Burner Monitoring and Control

The following sequence is for Coen Duct Burner DB-100, and is typical for DB-200.

a. Normal Operation

Each duct burner is manually started from the Coen burner management system panel. All safety controls and interlocks are self-contained within the Coen system.

Under normal operating conditions, the duct burner gas flow control valve, CFY-305, will modulate to maintain gas flow to the duct burner. Temperatures, flows, and pressure related to the duct burner will be monitored. The control loop is as follows:

Parameter	Description	Range
Forward Acting PID Loop	Duct Burner Gas Flow Controller	-----
Process Variable	CFIT-0304; Duct Burner Gas Flow	TBD "H2O
Setpoint	Operator entered	TBD "H2O
Output	CFY-305; Duct Burner Gas Flow Control Valve	0 to 100 %

The setpoint for the above loop is typically TBD "H2O.

The following conditions will override the above control loop:

- The Drum Pressure (CPT-130) is high (see below). The gas valve will ramp closed at a rate of 100 %/min (selectable). While the gas valve is ramping, a flashing "Override" message will be displayed.
- The Duct Burner recycle switch (CPSH-130) is activated. The valve will close immediately with no ramping.

b. Abnormal Conditions

- "High Drum Pressure": Occurs if the duct burner drum pressure (CPT-130) is > 700 PSIG (selectable). Control action is noted above.
- "Duct Burner Recycle": Occurs if the duct burner recycle switch (CPSH-130) is activated. Control action is noted above.
- "Duct Burner High-High Gas Pressure": Occurs if the duct burner gas pressure (CPIT-0300) is > TBD PSIG while the duct burner is in service. The duct burner will be tripped off.
- "Duct Burner High Gas Pressure": Occurs if the duct burner gas pressure (CPIT-0300) is > TBD PSIG while the duct burner is in service.
- "Duct Burner Low Gas Pressure": Occurs if the duct burner gas pressure (CPIT-0300) is < TBD PSIG while the duct burner is in service.
- "Duct Burner Low-Low Gas Pressure": Occurs if the duct burner gas pressure (CPIT-0300) is < TBD PSIG while the duct burner is in service. The duct burner will be tripped off.

c. Operator Selections

- PID Loop parameters (auto/manual, setpoint, output, tuning)
- Duct Burner Drum Pressure override ramp rate setpoint (xx %/min)
- Duct Burner Drum Pressure override setpoint (xxx PSIG)

4.3.3. Purge Air Fan Control

The purge air fans are constant speed fans. The following sequence is for Purge Air Fan PAF-100 and Purge Air Damper CFZ-100, and is typical for PAF-200 and CFZ-200.

a. Normal Operation

PAF-100 and its associated damper, shall operate to purge the CTG-100 exhaust duct of unused fuel prior to ignition.

PAF-100 operates during the purge cycle of the CTG start sequence. Please see section 4.2.1 for details.

b. Abnormal Conditions

- "Purge Air Fan PAF-100 Failure": Occurs if the purge air fan pressure switch (CPSL-150) is not received within TBD seconds after the start command has been given, or if it fails while running. A failure reset is required to make the fan available. Control action is stated in section 4.2.1.
- "Purge Air Damper CFZ-100 Failure": Occurs if the damper's closed limit switch (CZAC-100) is not made within TBD seconds after a close command is given or if the damper's open limit switch (CZAO-100) is not made within TBD seconds after an open command is given. Control action is stated in section 4.2.1.

c. Operator Selections

- Purge air fan PAF-100 auto/manual, start/stop, and failure reset
- Purge air damper CFZ-100 auto/manual and open/close

4.3.4. Purge Seal Air Fan Control

The purge seal air fans are constant speed fans. The following sequence is for purge seal air fan SAF-100, and is typical for SAF-200.

a. Normal Operation

SAF-100 shall run to provide a positive air pressure to seal exhaust gases in the exhaust stream. It shall operate whenever a CTG start is requested (interlocks have passed), until the CTG is fully stopped. Please see section 4.2.1 for details.

b. Abnormal Conditions

- "Purge Seal Air Fan SAF-100 Failure": Occurs if the purge seal air fan run status (SAF100-ZA-101) is not received within TBD seconds after the start command has been given, or if it fails while running. A failure reset is required to make the fan available.

c. Operator Selections

- Purge seal air fan SAF-100 auto/manual, start/stop, and failure reset

4.3.5. Breaching Seal Air Fan Control

The breaching seal air fans are constant speed fans. The following sequence is for breaching seal air fan SAF-50, and is typical for SAF-10.

a. Normal Operation

SAF-50 shall run to provide a positive air pressure to seal exhaust gases in the exhaust stream. It shall operate whenever in auto control.

b. Abnormal Conditions

- "Breaching Seal Air Fan SAF-50 Failure": Occurs if the breaching seal air fan run status (CZA-180) is not received within TBD seconds after the start command has been given, or if it fails while running. A failure reset is required to make the fan available.

c. Operator Selections

- Breaching seal air fan SAF-50 auto/manual, start/stop, and failure reset

4.3.6. Mud Drum Heaters Control

The following sequence is for HRSG-100 Mud Drum Heater, and is typical for HRSG200. The following control scheme is always active unless put in manual by the operator.

a. Normal Operation

Under normal operating conditions the Mud Drum Heater Valve CPCV-130 modulates to maintain the steam drum pressure. The control loop is as follows:

Parameter	Description	Range
Forward Acting PID Loop	Mud Drum Heater Steam Pressure Controller	-----
Process Variable	CPT-130; Steam Drum Pressure	0 to 1000 PSIG
Setpoint	Operator entered	0 to 1000 PSIG
Output	CPCV-130; Mud Drum Heater Control Valve	0 to 100 %

The setpoint for the above loop is typically 650 PSIG.

b. Abnormal Conditions

None.

c. Operator Selections

- PID Loop parameters (auto/manual, setpoint, output, tuning)

4.4. Fuel Systems

The following equipment associated with fuel systems are addressed in this section:

- Toromont fuel gas compressors (qty=2)
- Fuel oil pumps (qty=2)

4.4.1. Fuel Gas Compressor and Glycol Cooling Pump Control

The following sequence is for Fuel Gas Compressor FGC-100 and Glycol Cooling Pump GCP-50, and is typical for FGC-200 and GCP-51.

a. Normal Operation

Starting and stopping of fuel gas compressors is done manually from the graphic screen. The operator typically starts a fuel gas compressor prior to starting a CTG on gas.

Each glycol cooling pump is sized to support both fuel gas compressors. The lead pump is selected by the operator. Under normal operating conditions the lead pump is running. The pump alternation scheme is as follows:

- Every seven days the system will display a message requesting the operator to alternate which pump is lead.
- Lead pump selection is done via screen pushbuttons.

If the operator requests a start of a fuel gas compressor, a glycol cooling pump must be proven operating prior to issuing the compressor start command.

The conditions to open/close the fuel gas accumulator valve, CSV-0800, are as follows:

- The operator manually opens the valve
- If there is a Fuel Gas Compressor FGC-100 Emergency Trip (see below), the valve closes.

b. Abnormal Conditions

- "Fuel Gas Compressor FGC-100 Failure": Occurs if not confirmed running (CZA-0804) within TBD seconds after the start command has been given, or if it fails while running. A failure reset is required to make the compressor available. The CTG with the least load (via communication from Alstom) will be switched to oil.
- "Fuel Gas Compressor FGC-100 Low (or High) Outlet Pressure": Occurs if the fuel gas compressor discharge pressure (CPIT-0802) is < 300 PSIG or > TBD PSIG respectively.
- "Fuel Gas Accumulator FGA-100 Low (or High) Pressure": Occurs if the fuel gas accumulator pressure (CPIT-0800) is < 300 PSIG or > TBD PSIG respectively.
- "Fuel Gas Accumulator FGA-100 Low (or High) Header Pressure": Occurs if the fuel gas accumulator header pressure (CPIT-0805) is < 300 PSIG or > TBD PSIG respectively.
- "Fuel Gas Compressor FGC-100 Emergency Trip": Occurs if two out of four fuel gas compressor or accumulator pressure signals are < 200 PSIG. The fuel gas compressors will trip, the fuel gas accumulator valve will close, and all running CTGs will switch to oil.
- "Glycol Cooling Pump GCP-50 Failure": Occurs if not confirmed running (GCP50-ZA-1105) within 3 seconds after a start command has been given, or if it fails while running. A failure reset is required to make the pump available. The next available pump in auto will start.

- "Glycol Cooling Pump Common Low Header Differential Pressure": Occurs if the differential pressure across the common header (CPIT-1100) is < TBD PSID. Five seconds after the activation of this alarm, the next available pump in auto will start.
- "Glycol Cooling Pump GCP-50 High Suction Differential Pressure": Occurs if the glycol cooling pump suction differential pressure (CPDIT-1105) is > TBD PSID.
- "Glycol Cooling Pump GCP-50 High-High Suction Differential Pressure": Occurs if the glycol cooling pump suction differential pressure (CPDIT-1105) is > TBD PSID.

c. Operator Selections

- Fuel gas compressor FGC-100 start/stop and failure reset
- Fuel gas accumulator valve FGA-100 auto/manual and open/close
- Glycol cooling pump GCP-50 auto/manual, start/stop, and failure reset
- Glycol cooling pump lead/lag selection

4.4.2. Fuel Oil Pumps Control

The fuel oil pumps are constant speed pumps, and the operator designates the operating sequence. The following sequence is for Fuel Oil Pump FOP-3C, and is typical for FOP-3A and 3B.

a. Normal Operation

Under normal operating conditions the lead fuel oil pump is running. The pump alternation scheme is as follows:

- Every seven days the system will display a message requesting the operator to alternate which pump is lead.
- Lead pump selection is done via screen pushbuttons.

The fuel oil return pressure control valve will modulate to maintain the CTG fuel oil supply pressure (CPIT-1405). The control loop is as follows:

Parameter	Description	Range
Reverse Acting PID Loop	CTG Fuel Oil Supply Pressure Controller	-----
Process Variable	CPIT-1405; CTG Fuel Oil Supply Pressure	0 to 60 PSIG
Setpoint	Operator entered	0 to 60 PSIG
Output	CPCV-1410; Fuel Oil Return Pressure Control Valve	0 to 100 %

The setpoint for the above loop is typically 30 PSIG.

The following are the conditions for starting a second pump in auto:

- The fuel oil return pressure control valve is > TBD % for TBD sec.
- A CTG is commanded to start on oil.

The third pump will not be automatically started, since two pumps will handle two CTGs.

The following are the conditions for stopping the second pump in auto:

- The fuel oil return pressure control valve is < TBD % for TBD sec.
- All CTGs are confirmed stopped.

b. Abnormal Conditions

- "Fuel Oil Pump FOP-3C Failure": Occurs if the fuel oil pump has not been confirmed running (FOP3C-ZA-1407) within 3 seconds after a start command has been given, or if it fails while running. A failure reset is required to make the pump available. The next available pump in auto will start.
- "Fuel Oil High Differential Pressure": Occurs if the fuel oil differential pressure (CPDIT-1406) downstream of the oil pumps is > TBD PSID.
- "Fuel Oil High-High Differential Pressure": Occurs if the fuel oil differential pressure (CPDIT-1406) downstream of the oil pumps is > TBD PSID.
- "Fuel Oil Header High Pressure": Occurs if the CTG fuel oil supply pressure (CPIT-1405) is > TBD PSID.
- "Fuel Oil Header Low Pressure": Occurs if the CTG fuel oil supply pressure (CPIT-1405) is < TBD PSID.
- "Fuel Oil Pump FOP-3C Room 1 Emergency Shutoff Detected": Occurs if the fuel oil pump room 1 emergency shutoff valve (CHS-1413) is closed. Upon activation of this alarm, fuel oil pumps, FOP-3A or B, will be started.

- "Fuel Oil Pump FOP-3A/B Room 2 Emergency Shutoff Detected": Occurs if the fuel oil pump room 2 emergency shutoff valve (CHS-1414) is closed. Upon activation of this alarm, fuel oil pump, FOP-3C, will be started.

c. Operator Selections

- PID Loop parameters (auto/manual, setpoint, output, tuning)
- Fuel oil pump FOP-3C auto/manual, start/stop, and failure reset
- Fuel oil pump operating sequence (first, second, third)
- Second pump auto start/stop valve positions (xx %) and time delays (xx sec)

4.5. Cooling Systems

The following equipment associated with cooling systems are addressed in this section:

- Cooling water pumps (qty=2)
- Desuperheater systems (qty=2)

4.5.1. Cooling Water Pumps Control

The cooling water pumps are constant speed pumps. The following sequence is for Cooling Water Pump CWP-50, and is typical for CWP-51.

a. Normal Operation

Each cooling water pump is sized to handle the load of both CTGs, therefore, only one pump will run in auto at any time. The lead pump is operated as follows:

- If any heat exchanger outlet temperature (CTIT-1017, 1018, 1027, or 1028) is > 105 Deg F, the lead pump starts.
- If all four (4) heat exchanger outlet temperatures are < 103 Deg F for TBD min and the pump has been running for 2 hours, the pump stops.

The lead pump is selected by the operator. The pump alternation scheme is as follows:

- Every seven days the system will display a message requesting the operator to alternate which pump is lead.
- Lead pump selection is done via screen pushbuttons.

b. Abnormal Conditions

- "Cooling Water Pump CWP-50 Failure": Occurs if the pump has not been confirmed running (CWP50-ZA-1008) within 3 seconds after a start command has been given, or if it fails while running. A failure reset is required to make the pump available. The next available pump in auto will start.
- "Cooling Water Pump CWP-50 Suction Diffuser High Differential Pressure": Occurs if the suction diffuser differential pressure (CPDIT-1008) of the cooling water pump is > TBD PSID.

c. Operator Selections

- Cooling water pump CWP-50 auto/manual, start/stop, and failure reset
- Cooling water pump lead/lag selection

4.5.2. Desuperheater Cooling Water Flow Control

The following sequence is for Desuperheater Cooling Water Block Valve CSV-152 and the Outlet Temperature Control Valve CTCV-150, and is typical for CSV-252 and CTCV-250.

a. Normal Operation

The demineralized cooling water flow to the desuperheater is controlled by a 2-position block valve (CSV-152) and a modulating valve (CTCV-150) in series. The block valve is commanded open whenever it's in auto and the modulating valve is commanded above 0%. The modulating valve is controlled to maintain outlet temperature of the desuperheater. The control loop is as follows:

Parameter	Description	Range
Reverse Acting PID Loop	Desuperheater Outlet Steam Temperature Controller	-----
Process Variable	CTIT-120; Desuperheater Outlet Steam Temperature	30 to 1000 Deg F.
Setpoint	Operator entered	30 to 1000 Deg F.
Output	CTCV-150; Desuperheater Outlet Temperature Control Valve	0 to 100 %

The setpoint for the above loop is typically 750 Deg F.

b. Abnormal Conditions

- "Demineralized Low Water Pressure": Occurs if the demineralized water low pressure switch (CPSL-153) is activated.
- "Superheater #1 High Steam Outlet Temperature": Occurs if the superheater #1 steam outlet temperature (CTT-123) is > 765 Deg F.
- "Desuperheater High HPS Temperature": Occurs if the desuperheater high pressure steam temperature (CTIT-120) is > 775 Deg F.
- "HPS High Temperature #1": Occurs if the high pressure steam temperature #1 (CTIT-121) is > 775 Deg F.

c. Operator Selections

- PID Loop parameters (auto/manual, setpoint, output, tuning)

4.6. Emissions Reduction Systems

The following equipment associated with emissions reduction systems are addressed in this section:

- Urea forwarding pumps (qty=2)
- Fueltech emissions reductions skids (qty=2)
- CEMS exhaust monitoring system

4.6.1. Urea Forwarding Pumps Control

The urea forwarding pumps are constant speed pumps. The following sequence is for Urea Forwarding Pump UFP-50, and is typical for UFP-51.

a. Normal Operation

Under normal operating conditions the lead urea forwarding pump is running. The pump alternation scheme is as follows:

- Every seven days the system will display a message requesting the operator to alternate which pump is lead.
- Lead pump selection is done via screen pushbuttons.

b. Abnormal Conditions

- "Urea Forwarding Pump UFP-50 Failure": Occurs if the pump has not been confirmed running (UFP50-ZA-1209) within 3 seconds after a start command

has been given, or if it fails while running. A failure reset is required to make the pump available. The next available pump in auto will start.

- "Urea Forwarding Pump Common Header Low Differential Pressure": Occurs if the differential pressure across the common header (CPIT-1222) is > TBD PSID. Five seconds after the activation of this alarm, the next available pump in auto will start.
- "Urea Forwarding Pump UFP-50 High Suction Differential Pressure": Occurs if the suction differential pressure (CPDIT-1220) of the urea forwarding pump is > TBD PSID.
- "Urea Forwarding Pump UFP-50 High-High Suction Differential Pressure": Occurs if the suction differential pressure (CPDIT-1220) of the urea forwarding pump is > TBD PSID.

c. Operator Selections

- Urea forwarding pump UFP-50 auto/manual, start/stop, and failure reset
- Urea forwarding pump lead/lag selection

4.6.2. Emissions Reduction Skid Operations

The following sequence is for Emissions Reduction Skid ERS-100, and is typical for ERS-200.

a. Normal Operation

The Emissions reduction skid has associated blower/heater pairs A and B. The operator selects from the HMI screen which pair will run when ERS-100 is enabled. ERS-100 is operated as follows:

- If CTG-100 is requested to start, ERS-100 is started.
- If CTG-100 is confirmed stopped, ERS-100 is stopped.

The ERS-100 system controls chemical injection based on CTG operating parameters communicated from the BOP control system.

b. Abnormal Conditions

- "Emissions Reductions Skid ERS-100 Blower/Heater Pair A (or B) Failure": Occurs if the blower/heater has not been confirmed running (ERS100-CR438) within TBD seconds after a start command has been given, or if the blower/heater fails while running. A failure reset is required to make the blower/heater available.

c. Operator Selections

- Emissions reductions skid ERS-100 blower/heater pairs A&B auto/manual, start/stop, and failure reset
- Emissions reductions skid ERS-100 blower/heater pair selection

4.6.3. CEMS Monitoring

a. Normal Operation

Under normal operating conditions the CEMS system will be activated when the CTG is running so that it can monitor exhaust temperatures.

b. Abnormal Conditions

None.

c. Operator Selections

None.

4.7. PLC Initialization Sequence

The following sequence is for the Balance of Plant control panel, BOP-100, and is typical for BOP-200.

During the BOP-100 PLC initialization, all the outputs will be in the off state while the hot standby PLC's are synchronizing. During the sychronization, the first BOP-100 PLC to come online will be primary (Prim) and the second BOP-100 PLC will be secondary (Sync). After the hot standby PLC's are synchronized the following pieces of equipment will begin to operate:

- The lead fuel oil pump
- Breaching seal air fan (SAF-50)
- The lead glycol cooling pump
- The lead cooling water pump
- The lead urea forwarding pump

During operation while the primary PLC is controlling it will update the secondary PLC. If for any reason the primary PLC (Prim) should fail the secondary PLC (Sync) will become primary and instantaneously assume the control of the failed PLC from its last state of operation.

The BOP-100 PLC control panel is powered via uninterrupted power supply (UPS) to allow the operator some time to put the plant equipment into a safe state before the BOP-100 PLC control panel loses power.

5. Operator Interface

CUSTOMER REVIEW	
Signed:	**Date:**
❑ **Approved** ❑ **Approved as Noted** ❑ **Revise and Resubmit** **(please check one)**	**Comments:**

5.1. Graphic Screens

The following is a brief description of the graphic screens that will be provided:

5.1.1. Overview Displays

The overview displays will show the overall plant status of all major equipment and systems. The operator will be able to select individual pieces of equipment, and can view a detail screen of that item. The following screens will be provided:

- Main Screen Directory
- Plant Overview

5.1.2. Equipment Detail

Detail screens will be provided for the following equipment and systems:

- CTG Detail Screen (qty=2)
- Unit 100 CTG Start-up
- Unit 200 CTG Start-up
- HRSG Detail Screen (qty=2)
- Duct Burner Detail Screen (qty=2)
- Emission Reduction System (qty=2)
- Fuel Oil System Detail Screen
- Gas Compressor Detail Screen (qty=2)
- Cooling Water System
- Steam System

- Individual valve screens
- Individual pump screens
- Main Setpoints / Run hours
- System Status

5.1.3. PID Faceplate Screens

Screens will be provided as needed to display a PID faceplate for every loop in the system. The operator will have password access to auto/manual, setpoint, output, and tuning parameters.

5.1.4. Setpoint Screens

In addition to PID parameters, there are several other variables that need operator interaction, such as time delays, selectors, etc. They will all be provided on a main setpoint screen and individual detail screens as required.

5.1.5. Trending Screens

Real-time and historical trend displays will be configured for all analog input points for the system.

5.2. Monitoring

5.2.1. Analog Monitoring

All analog inputs and outputs to and from the PLC systems will be scaled in engineering units and displayed on the graphics. High-High, High, Low and Low-Low alarms for the analog inputs will be provided where required. Historical collection for the analog inputs will also be provided where required.

All modulating control valves will include the % open under the valve symbol on the graphics.

5.2.2. Digital Monitoring

All digital inputs and outputs to and from the PLC systems will be displayed on the graphics (red for on/running/open and green for off/stopped/closed). Digital alarms will be provided where required.

5.3. Alarms

The SCADA package has extensive alarm functionality built-in to the software. Analog and digital inputs will have alarm parameters configured as specified. An alarm summary page will be configured which shows all alarms in order of the time that they came in. All configured screens will have an alarm status bar at the bottom, which shows the latest system alarm as a minimum. Alarms are only active when the associated equipment is online.

5.4. Reports

The report requirements are as follows:

- TBD

The reports will be able to be printed automatically (by schedule) or on demand.

6. Appendix

The drawings and specifications referenced in the preparation of this document are as follows (to be provided by Total Energy Plant, LLC):

Drawing/ Spec. No.	Rev.	Date	Engineer	Description

This is the entire Sequence of Operations as provided by TVC Systems.