ADAC

Advanced Deaerator Control

Operation Manual

750-236
07/07

⚠ WARNING

DO NOT OPERATE, SERVICE, OR REPAIR THIS EQUIPMENT UNLESS YOU FULLY UNDERSTAND ALL APPLICABLE SECTIONS OF THIS MANUAL.

DO NOT ALLOW OTHERS TO OPERATE, SERVICE, OR REPAIR THIS EQUIPMENT UNLESS THEY FULLY UNDERSTAND ALL APPLICABLE SECTIONS OF THIS MANUAL. FAILURE TO FOLLOW ALL APPLICABLE WARNINGS AND INSTRUCTIONS MAY RESULT IN SEVERE PERSONAL INJURY OR DEATH.

TO: Owners, Operators and/or Maintenance Personnel

This operating manual presents information that will help to properly operate and care for the equipment. Study its contents carefully. The unit will provide good service and continued operation if proper operating and maintenance instructions are followed. No attempt should be made to operate the unit until the principles of operation and all of the components are thoroughly understood. Failure to follow all applicable instructions and warnings may result in severe personal injury or death.

It is the responsibility of the owner to provide safety training not only to his or her personnel, but to any contractor's personnel who are servicing, repairing or operating the equipment.

Cleaver-Brooks equipment is designed and engineered to give long life and excellent service on the job. The electrical and mechanical devices supplied as part of the unit were chosen because of their known ability to perform; however, proper operating techniques and maintenance procedures must be followed at all times. Although these components afford a high degree of protection and safety, operation of equipment is not to be considered free from all dangers and hazards inherent in operating and maintaining this equipment.

Any "automatic" features included in the design do not relieve the attendant of any responsibility. Such features merely take over certain repetitive chores, allowing more time for the proper upkeep of equipment.

It is solely the operator's responsibility to properly operate and maintain the equipment. No amount of written instructions can replace intelligent thinking and reasoning and this manual is not intended to relieve the operating personnel of the responsibility for proper operation. On the other hand, a thorough understanding of this manual is required before attempting to operate, maintain, service, or repair this equipment.

Operating controls will normally function for long periods of time and we have found that some operators become lax in their daily or monthly testing, assuming that normal operation will continue indefinitely. Malfunctions of controls lead to uneconomical operation and damage to the equipment. In most cases, these malfunctions can be traced directly to carelessness and deficiencies in testing and maintenance.

The operation of this equipment by the owner and the operating personnel must comply with all requirements or regulations of their insurance company and/or other authority having jurisdiction. In the event of any conflict or inconsistency between such requirements and the warnings or instructions contained herein, please contact Cleaver-Brooks before proceeding.

SAFETY PRECAUTIONS AND ABBREVIATIONS

Safety Precautions

It is essential to read and understand all safety precautions before attempting to operate the equipment. Failure to follow these precautions may result in damage to equipment, serious personal injury, or death. A complete understanding of this manual is required before attempting to start up, operate or maintain the equipment. The equipment should be operated only by personnel who have a working knowledge and understanding of the equipment.

The following symbols are used throughout this manual:

⚠ WARNING

This symbol indicates a potentially hazardous situation which, if not avoided, could result in serious personal injury or death.

⚠ CAUTION

This symbol indicates a potentially hazardous situation which, if not avoided, could result in damage to the equipment.

Note: This symbol indicates information that is vital to the operation of this equipment.

Abbreviations

Following is an explanation of the abbreviations, acronyms, and symbols used in this manual.

AC	Alternating Current
AR	Automatic Reset
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
BHP	Boiler Horsepower
BTU	British Thermal Unit
°C	Degrees Celsius
CFH	Cubic Feet per Hour
Cu Ft	Cubic Feet
DC	Direct Current
°F	Degrees Fahrenheit
FM	Factory Mutual
FS	Flame Safeguard
ft	Feet
GPM	Gallons per Minute
Hd	Head
HT	Height
HTB	High Turndown Burner
HZ	Hertz
In H_2O	Inches of Water
IRI	Industrial Risk Insurance
Lb	Pound
LWCO	Low-Water Cut-Off
M	Million
MFD	Micro-Farad
MR	Manual Reset
NEC	National Electric Code
No.	Number
pH	Degree of acidity or alkalinity of a solution
P/N	Part Number
PPM	Parts Per Million
PR	Program Relay
psi	Pounds Per Square Inch
SAE	Society of Automotive Engineers
scfh	Standard Cubic Feet per Hour
T	Temperature
TC	Temperature Control
TI	Temperature Gauge
UL	Underwriter's Laboratories
V	Volt
WC	Water Column

CONTENTS

Chapter 1 - General

Chapter 2 - System Components

Chapter 3 - Commissioning

Chapter 4 - Operation

Chapter 5 - Input/Output Lists

Chapter 6 - Parts

Appendix - Supporting Documents/Reference Drawings

Chapter 1
General

1.1-Introduction

The Cleaver-Brooks ADAC is an exclusive Deaerator and/or Surge Tank Management and Control System specifically designed to integrate the functions of a Programmable Controller with other operating and ancillary controls. The Programmable Controller (PLC) is a modular design providing flexibility for expansion with easily serviceable components. The ADAC system incorporates a user-friendly, graphical touch screen Human Machine Interface that displays tank parameters, fault annunciation and alarm history, as well as providing access to system configuration and control functions. The system provides a complete tank level, tank pressure, and pump control solution.

In addition to installation on new Deaerators and Surge tanks, the ADAC can be added as a retrofit to existing tanks. Call your local authorized Cleaver-Brooks representative for details.

1.2-Single Tank System Description

A single tank system can control up to 6 pumps, all of which can be run by contactors, combination starters, soft starters, or Variable Speed Drives. All pumps on a tank must utilize the same type of starter/drive.

Pumps on a common header can be alternated on a customer defined schedule and be set up in a customer defined lead lag format.

When lead lag operation is in use, a pressure transmitter mounted in the common header sends a signal to the PLC. The customer sets the pressure point via the touch screen. If the first pump cannot achieve that set point, the PLC will start a second pump and so on. If the pressure rises above the set point, the PLC will shed the last pump and so on.

Pumps on a "one pump per boiler" installation can be controlled by a contact closure on the boiler, or in a VSD system, by individual pressure sensors.

Standard system is capable of using discrete level alarm switches (such as the McDonnell Millar 63 or 64) for fixed level alarms, or a level transmitter which can be configured from the touch screen.

OPC compliant Ethernet IP communications are included as standard. This feature can be used to connect the ADAC system to a boiler Master Panel or customer BAS.

A. Standard Equipment

PLC based control system for a single tank includes processor, PLC Power supply, I/O cards, 6" color touch screen, and NEMA 4 control panel. Programming and I/O are provided for the following:

- 1-6 pumps using contactors, soft starters or combination starters; inputs and outputs which include Hand-Off-Auto

Selector Switches, a pump motor running input, a pump motor overload or fault input, and pump run output.

- Low Water pump cut off
- Audible Alarm output
- Stack Light outputs and light (Green for all systems normal, Yellow for non-critical alarms such as High Water, Red for critical alarm such as Pump Failure)
- Recirc Bypass output
- Chemical Feed Relay output
- Boiler 1-6 feed water required inputs for one pump per boiler configuration
- Analog Tank Pressure Input
- Analog Tank Temperature Input
- Analog Tank Level Input
- Analog Discharge Header Pressure Input

B. Options

Programming and I/O cards for the following are optional (each option requires the preceding ones):

Option 1

- Feedwater Make up Valve Analog Output
- PRV Analog Output

Option 2

- 1-6 Pump Proving Flow Switch Inputs

Option 3

- Single tank system emergency Make up Valve

Option 4

- 1-3 VSD driven pumps I/O
- 1 customer configured analog input (future)

Option 5

- 4-6 VSD driven pumps I/O

Option 6

- 1-6 VSD driven pump analog inputs

Note: Each ADAC programming option requires the corresponding hardware (drives, valves, transmitters, switches, etc.)

1.3-Two Tank System Description

Two Tank systems can control up to 6 boiler feed pumps and 3 transfer pumps, all of which can be run by contactors, combination starters, soft starters, or Variable Speed Drives. Method selected must be the same for all pumps on a tank, but tank 1 method can be different from tank 2. For example, Tank 1 may use variable speed drives, but tank 2 may use contactors.

Pumps on a common header can be alternated on a customer defined schedule and be set up in a customer defined lead lag format.

When lead lag operation is in use, a pressure transmitter mounted in the common header sends a signal to the PLC. The customer sets the pressure point via the touch screen. If the first pump cannot achieve that set point, the PLC will start a second pump and so on. If the pressure rises above the set point, the PLC will shed the last pump and so on.

Pumps on a "one pump per boiler" installation can be controlled by the boiler, or in a VSD system, by individual pressure sensors. Pumps on the second tank will always be configured on a common header.

Standard system is capable of using discrete level alarm switches (such as the McDonnell Millar 63 or 64) for fixed level alarms, or a level transmitter which can be configured from the touch screen.

Level control can be an independent mechanical system, or by using the above mentioned transmitter, control an electrical or I/P make-up valve.

Tank Pressure is monitored by a transmitter in steam space. PRV can be an independent mechanical system or an electrical or I/P pressure reducing valve. The second tank will be treated as an atmospheric pressure tank and will not have a tank pressure sensor.

A. Standard Equipment

10 inch color touch screen is standard.

A three module stack light is standard with a light for each mode. Green for normal, Yellow for non critical alarms Red for critical alarms. An audible alarm is standard, either a bell, horn or electronic sounder

PLC based control system for a two tank starts with and includes processor, PLC Power supply, I/O cards, 10" color touch screen, and Nema 4 control panel to provide the following functions

Level control can be an independent mechanical system, or by using the above mentioned transmitter, control an electrical or I/P make-up valve.

Tank Pressure is monitored by a transmitter in steam space. PRV can be an independent mechanical system or an electrical or I/P pressure reducing valve.

Communication options include OPC compliant Ethernet IP to Boiler master panel or customer BAS.

PLC based control system for a two tank starts with and includes processor, PLC Power supply, I/O cards, 10" color touch screen, and NEMA 4 control panel. Programming and I/O provided for the following:

- 1-6 pumps on the first tank, 1-3 pumps on the second tank using contactors, soft starters or combination starters; inputs and outputs which include Hand-Off-Auto Selector Switches, a pump motor running input, a pump motor overload or fault input, and pump run output.
- Low Water pump cut off on both tanks
- Audible Alarm output
- Stack Light outputs and light (Green for all systems normal, Yellow for non-critical alarm such as High Water, Red for critical alarms such as Pump Failure)
- Recirc Bypass output on Tank One Only
- Chemical Feed Relay output on both tanks
- Boiler 1-6 feed water required inputs
- Analog Tank Pressure Input on Tank One only
- Analog Tank Temperature Input and transmitter on both tanks
- Analog Tank Level Input on both tanks
- Analog Discharge Header Pressure Input on both tanks using common headers
- 1-6 Pump Proving Flow Switch Inputs

Select one of the following devices.

Differential Pressure switch mounted and plumbed across the pump. Price per Pump

Pressure Switch mounted and plumbed on discharge side of pump. Price per Pump

Current sensing switch mounted to monitor 1 phase of the pump. Price per Pump

B. Options

Programming and I/O cards for the following are optional (each option requires the preceding ones):

Option 1

- Feedwater Make up Valve Analog Output for both tanks

Option 2

- PRV Analog Output
- Emergency Make up Valve Analog Output for tank 1.

Option 3

- Second tank system emergency Make up Valve

Option 4

- 1-3 VSD driven pumps I/O on tank one
- 1 VSD driven pump I/O on tank 2

Option 5

- 4-6 VSD driven pumps I/O on tank one
- 2-3 VSD driven pumps I/O on tank two
- 1-6 BF pump 1 pump per boiler VSD driven pump analog inputs

Note: Each ADAC programming option requires the corresponding hardware (drives, valves, transmitters, switches, etc.)

1.4-Specifications

Power	
Power Supply Voltage	120 VAC (102 VAC - 132 VAC)
Power Supply Frequency	50 or 60 Hz
Maximum Total Connected Load	500 VA
Fusing	
Controller Power Supply	3.15A
Analog Power Supply	2A
Touch Screen HMI	2A
Environmental	
Ambient Operating Temperature Limits	32° to 130°F.
Humidity	85% RH continuous, non-condensing
Vibration	Continuous to 0.5 G

Chapter 2
System Components

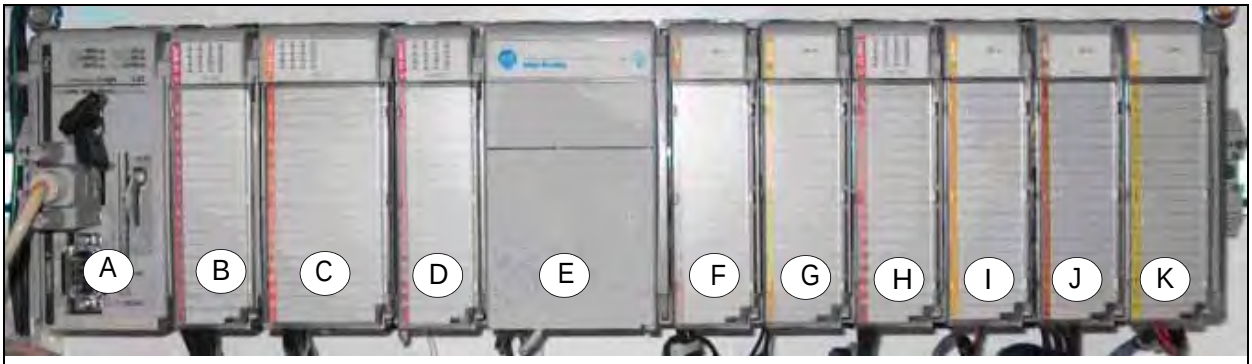
2.1-Components

The ADAC control system consists primarily of a Programmable Controller (PLC), touch screen Human Machine Interface (HMI), 24VDC power supplies, stack light, and various relays. Optional components could include an EtherNet hub and remote access paging modem.

The ADAC controller is factory pre-programmed to work with most Cleaver-Brooks deaerator and surge tank systems, yet allows easy configuration for specific options. The controller program logic is password secured, ensuring tamper-proof operation. The touch screen HMI provides user-friendly access to pump and level control functions, diagnostics and alarm histories, and any connected operating parameters.

A. Controller

The controller, or PLC, is a compact, modular microprocessor-based device that easily mounts on a DIN rail in the ADAC control panel.



A. Programmable Controller
B. Discrete (Digital) Input Module
C. Discrete Output Module
D. Discrete Input Module
E. Power Supply
F. Analog Input Module
G. Analog Output Module
H. Discrete Input Module
I. Analog Output Module
J. Analog Input Module
K. Analog Output Module

Figure 2-1 Typical controller-I/O configuration

The PLC holds the program logic and configuration data for the ADAC controls. The program logic is password-secured at the factory. The included power supply powers all of the rack modules as well as the integrated communications bus.

The remaining control components vary according to the type of system and the options chosen. The Base controller-I/O configuration consists of 16 discrete (digital) inputs, 4 or 8 analog inputs, and 2 or 8 analog outputs. A right end cap terminator is required in order to complete the controller modular communications bus.

Optional modules can be added to the PLC to provide additional functionality (see below).

Single Tank PLC Layout (also see Chapter 5, **Input/Output Lists**)

Base System

1. Processor (Slot 0)
2. Discrete Input Module (16 inputs) (Slot 1)
3. Discrete Output Module (16 outputs) (Slot 2)
4. Discrete Input Module (16 inputs) (Slot 3)
5. Power Supply
6. Analog Input Module (4 Ch.)(Slot 4)

Optional Cards

7. Analog Output Module (2 Ch.)(Slot 5)
8. Discrete Input Module (16 inputs) (Slot 6)
9. Analog Output Module (2 Ch.)(Slot 7)
10. Analog Input Module (4 Ch.)(Slot 8)
11. Analog Output Module (2 Ch.)(Slot 9)

Second Rack

12. Rack Expansion Kit
13. Power Supply
14. Analog Output Module (2 Ch.)(Slot 10)
15. Analog Input Module (4 Ch.)(Slot 11)
16. Analog Output Module (2 Ch.)(Slot 12)
17. Analog Input Module (4 Ch.)(Slot 13)

Two Tank PLC Layout (also see Chapter 5, **Input/Output Lists**)

Base System

1. Processor (Slot 0)
2. Discrete Input Module (16 inputs) (Slot 1)
3. Discrete Output Module (16 outputs) (Slot 2)
4. Discrete Input Module (16 inputs) (Slot 3)
5. Power Supply
6. Discrete Input Module (16 inputs) (Slot 4)
7. Analog Input Module (4 Ch.)(Slot 5)
8. Analog Input Module (4 Ch.)(Slot 6)

Optional Cards

9. Analog Output Module (2 Ch.)(Slot 7)
10. Analog Output Module (2 Ch.)(Slot 8)
11. Analog Output Module (2 Ch.)(Slot 9)

Second Rack

12. Rack Expansion Kit
13. Power Supply
14. Analog Input Module (4 Ch.)(Slot 10)
15. Analog Output Module (8 Ch.)(Slot 11)
16. Analog Input Module (4 Ch.)(Slot 12)
17. Analog Input Module (8 Ch.)(Slot 13)

Figure 2-2

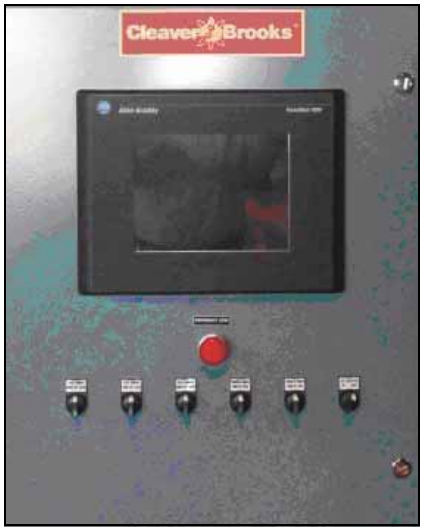


Figure 2-3

B. Operator Interface

Single tank systems use a 6” touch screen HMI (Fig. 2-2), which provides user-friendly access to boiler control information and functions in a backlit color display. The HMI not only displays numerous ADAC parameters at a glance, but in addition provides easy menu navigation for configuring control functions and troubleshooting alarms. A 10” touch screen (Fig. 2-3) is standard for two tank systems.

The HMI communicates with the PLC using an RS-232 serial connection.

C. Ethernet Communications

An Ethernet/IP port connects the ADAC controller to an Ethernet network. The ADAC utilizes OPC compliant Ethernet/IP for several communication functions:

- Connecting the ADAC system to an existing infrastructure, e.g. plant Local Area Network (LAN)
- Integration with a Building/Plant Automation System (BAS)
- E-mail control system alarms to plant or service personnel
- Remote monitoring of the system via customer Wide Area Network (WAN) or via Internet

Ethernet/IP is also used for certain control functions. The CB Hawk ICS Boiler Room Network connects individual boiler controllers and the ADAC with the Cleaver-Brooks Hawk ICS Master Boiler Room Controller. The Boiler Room Network provides a single BAS interface for multiple boiler and ADAC systems. Additional boiler room control functions can also be incorporated into the Master controller.

D. Sensor Inputs

- Steam Pressure Transmitter for DA tanks only (Fig. 2-4); mounted in steam space. This transmitter provides a sensor input to the ADAC controller. It transmits a 4-20mA process variable signal to the controller for the purpose of displaying pressure inside the tank or to provide a process value for optional PRV control.

- Hot Water Temperature Transmitter (Fig. 2-5); one per tank. This transmitter provides a sensor input to the ADAC controller. The 4-20mA signal is used to display water temperature in the tank.

Figure 2-5

Figure 2-4

2.2-Optional Accessories

A. Sensors

- Water Level, 4-20mA signal, one per tank (Fig. 2-6).
- Header Pressure Transmitter, 4-20 mA signal (used for pump lead/lag and alternation), one per tank for common headers, one per pump for one-pump-per-boiler VSD systems (Fig. 2-7).

Figure 2-6

Figure 2-7

Figure 2-8 Variable Speed Drives

Figure 2-9 Recirculation Valve

Note: For magnetic sensor level charts and installation diagram, see **Appendix** pp. A-2—A-4.

B. Variable Speed Drives for Pumps

An optional Variable Speed Drive (VSD) controls the speed of the pump motor for enhanced pressure/flow control and reduced electrical energy consumption.

Drives are NEMA 1 and are supplied with line reactors.

C. Expanded Diagnostics

An optional 16-point discrete input module can be used to provide additional pump monitoring.

D. Recirculation Valve Control

This option allows the ADAC system to close off the recirculation piping, sending all of the pump flow out to the boiler. When the system detects sufficient flow to protect the pump, the valve closes. When demand drops, the valve opens, allowing flow back to the tank and protecting the pump.

E. Magnetic Level Transmitter

The level transmitter is made up of four components:

- Stainless steel chamber with 2 process connections
- Level indicator consisting of magnetically interlocked flags in a plastic housing strapped to the chamber.
- Transmitter junction box containing the circuit board and sensor tube.
- Magnetic float (shipped loose).

Sensor resolution is 3/8”.

Figure 2-10 Level Transmitter and Float

NOTE: The float must be installed before the transmitter or level indicator will work. The float is laser etched with the word “TOP” and an arrow indicating the direction the float must be inserted into the chamber.

As with any level control device, regular maintenance to blow down and inspect the inner chamber should be performed to ensure proper operation.

F. Differential Pressure Level Transmitter

Commissioning

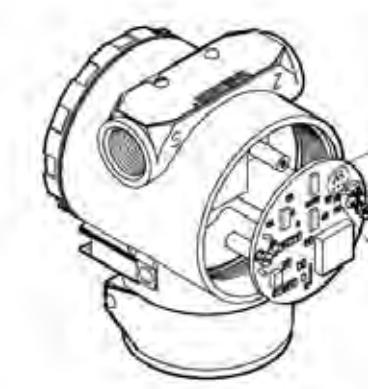
This procedure applies only to differential pressure transmitters used for level measurement on pressurized closed pressure vessels (boiler drum or deaerator).

Note: For differential pressure transmitter installation diagram see **Appendix** p. A-5.

1. Make sure that power to the transmitter is “OFF”.
2. With stop valves on the pressure vessel side closed, fill the impulse line going to the low-pressure side of transmitter with distilled water.
3. Open low and high pressure valves on the vessel side to fill impulse lines with water.
4. Slowly open the high pressure valve on the transmitter side (part of 3-valve manifold) to fill the transmitter pressure-detector section with water.
5. Slowly open the low pressure valve on the transmitter side (part of 3-valve manifold) to fill the transmitter pressure-detector section with water.
6. Check that there are no leaks in the impulse piping, 3-valve manifold, transmitter or other components.
7. To vent air from the impulse lines and transmitter, slowly open vent plug on the transmitter (one side at the time) until only liquid is coming from the plug orifice. Tighten vent plugs.
8. Turn on power to the transmitter.
9. Confirm transmitter operation.

To Re-span Rosemount 3051 Transmitter

1. On the top of the transmitter head locate Zero (Z) and Span (S) buttons.
2. Fill reference leg (low pressure side) with water.
3. On the three valve bypass manifold open high pressure side valve, close low pressure side valve and open bypass valve.
4. Loosen bleed nut on the high pressure side and wait until only water is coming out (no air). Repeat for the low pressure side.
5. Close bypass valve and open low pressure side valve.
6. Fill deaerator with water to the button of the gauge glass and press Zero button. Hold Zero button for at least 2 seconds.
7. Fill deaerator with water to the top of the gauge glass and press Span button. Hold Span button for at least 2 seconds.
8. Measure the length of the gauge glass.
9. On the PanelView screen for transmitter calibration. Zero = 0. Span = Length of the gauge glass.



Chapter 3
Commissioning

3.1-HMI Push Button Color Key

The HMI push buttons are color-coded as follows:

BLUE: Navigates to the indicated Operator screen. Examples: <Screen Sel Menu>, <DA Tank Overview>, <Feed Pump Control>, etc.

GRAY: Navigates to the indicated Configuration screen. Examples: <Analog In #1>, <Chem Feed Config>, <Feed Pump Config>, etc.

These screens are password protected and should only be accessed by qualified personnel.

When a gray Configuration button is pressed, a password keypad will be displayed. Enter password and press the Enter key to access the desired screen.

Note: When transitioning from one Configuration screen to another Configuration screen in succession, the password does not need to be re-entered. If a transition is made from a Configuration screen to an Operator screen, the password will again be required before re-entering Configuration mode.

If an incorrect password is entered, the screen will indicate “ERROR: Access Denied...” Touch the screen to continue using the HMI.

GREEN: Start/activate devices.

RED: Stop/deactivate devices, and enter values for alarm messages that utilize the red stack light.

YELLOW: Enter values for alarm messages that utilize the yellow stack light.

3.2-Entering values on the HMI screens

Screens containing user-modifiable values will show a <Change> pushbutton. To change a value, press <Change>; the numeric keypad will appear. Enter the desired value and press Enter.

The keypad will close and the chosen value will be displayed on the <Change> button. Next, press the pushbutton for the value to be changed (<Span>, for example). The new value will be displayed on the selected button.

If the entered value is not within the acceptable range for the chosen parameter, an “Out of Range’ message will appear above the <Change> button. To continue, press <Change> again and repeat the above steps.

If an out-of-range value is entered, the <Change> button will reset to zero if a new value is not entered within 60 seconds.

Note: Screen layout may differ between 6” and 10” screens.

3.3-Screen Selection Menu

On system power-up, the Screen Selection Menu is displayed. This screen provides pushbutton access to the various Operator, Configuration, and Alarm screens.

Note: It may be convenient to remove the alarm relay until system configuration is complete. The alarm circuit is designed to energize the relay while the system is functioning normally. In the event of an alarm condition the relay will de-energize, causing the alarm to sound.

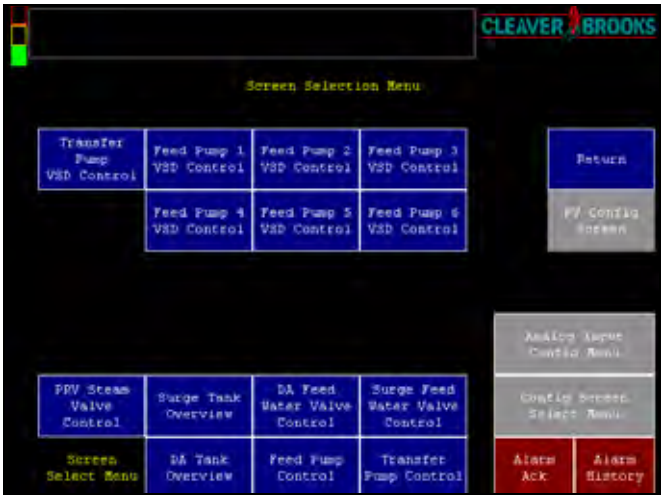


Figure 3-1 Screen Selection Menu

Note: Prior to commissioning the controls, ensure transmitters have been correctly installed. See previous chapter, **System Components.** See also **Appendix** p. A-4 (magnetic transmitter) or A-5 (differential pressure transmitter).

3.4-Configuring I/O Modules

Config Screen Select Menu

DA Tank Option Select

The Inputs/Outputs must be configured first. From the Screen Select Menu press <Config Screen Select Menu>. Password for this level is 3232.

Next select <DA Tank Option Select>.

Next select <I/O Configuration Not Complete>. Password for this level is 5463.

Next select <Configure I/O Modules>.

This will trigger the processor to poll and display all of the attached modules. Ensure that the number of modules shown on the screen matches the actual modules in the control cabinet. If the modules present do not all appear on the display, power down the panel and check that the white locking lever on top of each module is locked into position. Then power up and try the configuration sequence again. When finished, press <DA Tank Option Select>.

Figure 3-2 I/O Module Configuration

3.5-DA Tank Options

Press <Select Tank Type> to choose either Duo Tank or Two Tank installation.

Select Tank Type
Duo or Two Tanks:
DUO TANK SELECTED

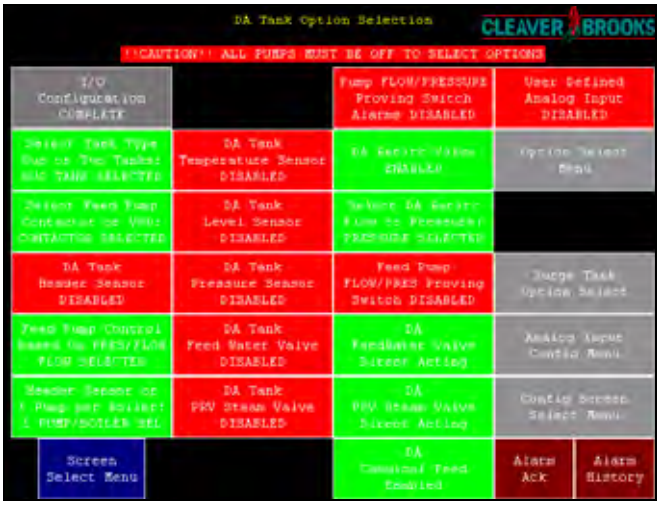


Figure 3-3 DA Tank Option Selection

Use the remaining buttons on this screen to turn on all options present on this tank. Selections will turn green when enabled.

Additional buttons on the Option Select screen perform the following functions:

- Enable/disable the Pump Flow/Pressure Switch alarms (if applicable)
- Toggle the analog output signal to the DA feedwater valve:

  Direct Acting: 4mA = valve closed; 20mA = valve fully opened
  Reverse Acting: 4mA = valve fully opened; 20mA = valve closed
- Toggle the analog output signal to the PRV valve:

  Direct Acting: 4mA = valve closed; 20mA = valve fully opened
  Reverse Acting: 4mA = valve fully opened; 20mA = valve closed

3.6-Surge Tank Options

Select <Surge Tank Option Select>.

Surge Tank
Option Select

Figure 3-4 Surge Tank Option Selection

Use this screen to turn on all options present for this tank. Selections will turn green when enabled.

Other pushbuttons on this screen perform the following functions:

- Enable/disable the Pump Flow/Pressure Switch alarms (if applicable)
- Toggle the analog output signal to the surge feedwater valve:

  Direct Acting: 4mA = valve closed; 20mA = valve fully opened
  Reverse Acting: 4mA = valve fully opened; 20mA = valve closed

3.7-Analog Input Configuration

After configuring the I/O Modules, DA Tank options, and Surge Tank options, press <Analog Input Config Menu>. From this screen the span, process set points, and alarm set points for all analog I/O devices are set.

Figure 3-5 Analog Input Configuration

To configure Analog Input 1, press <DA Header Pressure>. The following screen will appear:

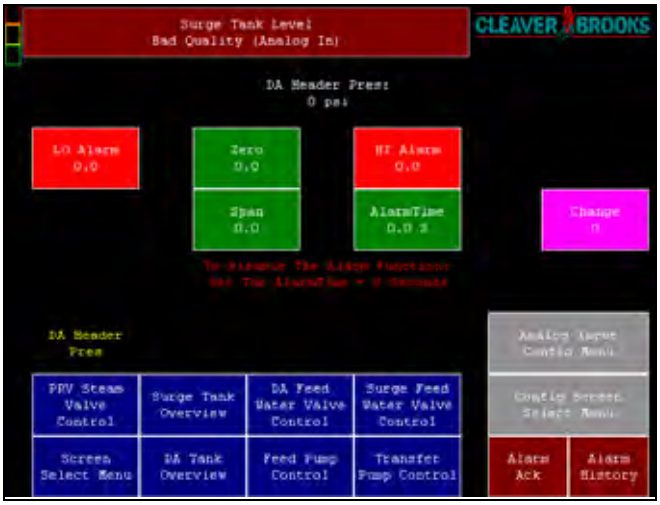


Figure 3-6 DA Header Pressure Configuration

Use this screen to enter the desired values for Zero, Span, HI Alarm, LO Alarm, and Alarm Time.

To enter or change a value, press the <Change> button. When the numeric keypad appears, enter desired value and press enter key. ↵ Then press the button for the parameter that you wish to change (Zero, Span, HI Alarm, LO Alarm, or Alarm Time).

The LO Alarm value must be between the Zero value and the HI Alarm value. The HI Alarm value must be between the LO Alarm value and the Span value.

To enable alarms, enter an Alarm Time value between 0.1 seconds and 32400.0 seconds (9 hours). To disable alarms, set the Alarm Time to 0 (zero) seconds.

After configuring Analog Input 1 (DA Header Pressure) press <Analog Input Config Menu> and repeat the above steps for the remaining inputs:

- Analog In #2 DA Tank Temp
- Analog In #3 DA Tank Levl
- Analog In #4 DA Tank Pres
- Analog In #5 Sg Hdr Pres
- Analog In #6 Sg Tank Temp
- Analog In #7 Sg Tank Levl

3.8-Feed Pump Configuration

After configuring the Analog Inputs, press <Config Screen Select Menu>. On the Configuration Screen Selection Menu press <Feed Pump Config>. The following screen will appear:

Figure 3-7 Feed Pump Configuration

First use the <Change> button to select the number of feed pumps (allowable value is 1-6).

Next set the following values:

- **If this system uses Variable Speed Drives for the feed pumps:**

1. Enter the START LAG %. Allowable values are 0 (zero) % to STOP LAG %.
2. Enter the STOP LAG %. Allowable values are START LAG % to 100 %.
3. Enter the START Del time. Allowable values are 0 to 300 seconds.

4. Enter the STOP Del time. Allowable values are 0 to 999 seconds.

- **If this system uses Motor Starters/Contactors (standard) for the feed pumps:**

1. Enter the START LAG PSI. Allowable values are either:

   Boiler Feedwater Header Pressure Zero to STOP LAG PSI if boiler feedwater header pressure alarms are disabled (AlarmTime = 0).

   or

   Boiler Feedwater Header Pressure LO Alarm value to STOP LAG PSI if boiler feedwater header pressure alarms are enabled (AlarmTime K 0).

2. Enter the STOP LAG PSI. Allowable values are either:

   START LAG PSI to Boiler Feedwater Header Pressure Span if boiler feedwater header pressure alarms are disabled (AlarmTime = 0).

   or

   START LAG PSI/Boiler Feedwater Header Pressure LO Alarm value to Boiler Feedwater Header Pressure HI Alarm value if the boiler feedwater header pressure alarms are enabled (AlarmTime K 0).

3. Enter the START Del time. Allowable values are 0 to 20 seconds.
4. Enter the STOP Del time. Allowable values are 0 to 999 seconds.
5. Enter the Alternate Feed Pump time increment. Allowable values are 0 hours (alternate disabled) to 9999 hours.

The Lead/Lag function can be started or stopped using the <START (STOP) LEAD-LAG> pushbutton.

The Alternate function can be started or stopped using the <START (STOP) ALTERNATE> pushbutton.

3.9-Transfer Pump Configuration

Next, from the Configuration Screen Selection Menu, press <Transfer Pump Config>.

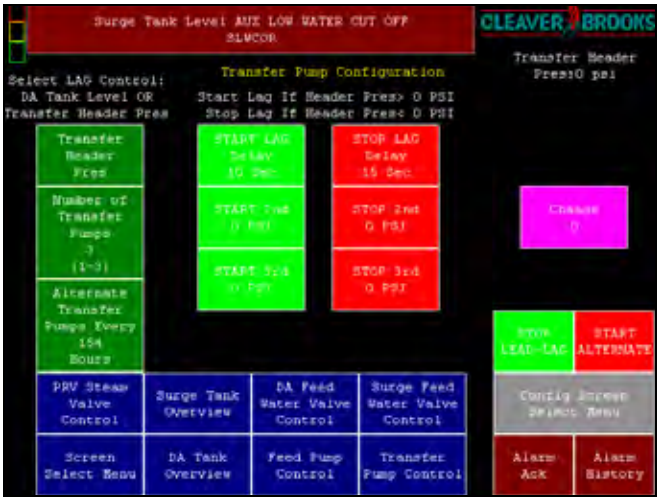


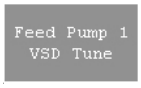
Figure 3-8 Transfer Pump Configuration

Enter the number of transfer pumps in the system (allowable value is 1-3).

Remaining entries are similar to Feed Pump Configuration above.

3.10-Feed Pump VSD Tuning/Control

PID tuning and Manual/Auto control for the feed pump VSDs are accessed through these screens. Press <Feed Pump VSD Tune> from the Configuration Screen Selection Menu.



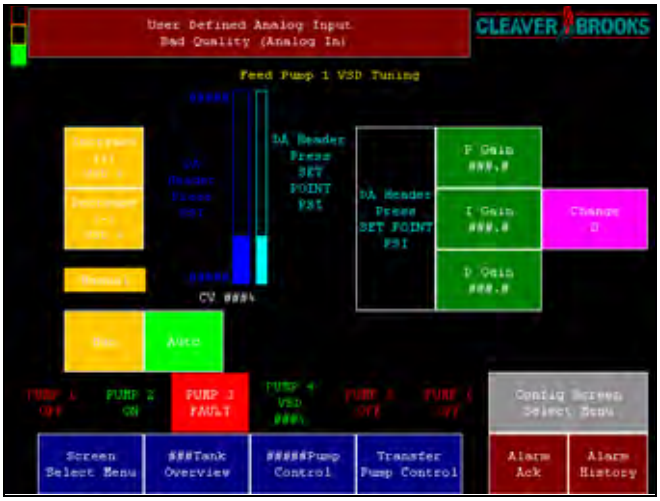


Figure 3-9 Feed Pump VSD Tuning

First set the DA header pressure set point. Allowable values are either:

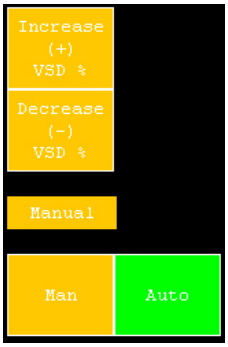
Boiler Feedwater Header Pressure Zero to Boiler Feedwater Header Pressure Span if Boiler Feedwater Header Pressure Alarms are disabled (Alarm Time = 0).

or

Boiler Feedwater Header Pressure LO Alarm value to Boiler Feedwater Header Pressure HI Alarm value if Boiler Feedwater Header Pressure Alarms are enabled (Alarm Time K 0).

Next enter the PID gain values. These values will vary based on the application. Allowable values are 0.0 to 999.0 (D gain is typically set to 0).

The <Man> and <Auto> pushbuttons are used to toggle VSD control between Manual and Automatic mode. In Manual mode the <Increase (Decrease) VSD %> buttons are used to manually control VSD output. In Automatic mode, the PLC controls VSD output based on the set point and PID settings.



The Feed Pump VSD Control Screen is similar to the Feed Pump VSD Tuning Screen. The Control screen allows Manual/Auto switching and manual increment/decrement of control output, but does not have access to PID tuning.

3.11-DA Feedwater Valve Tuning/Control

Return to the Configuration Screen Selection Menu and press <DA Feed Water Valve Tune>.

DA Feed Water Valve Tune

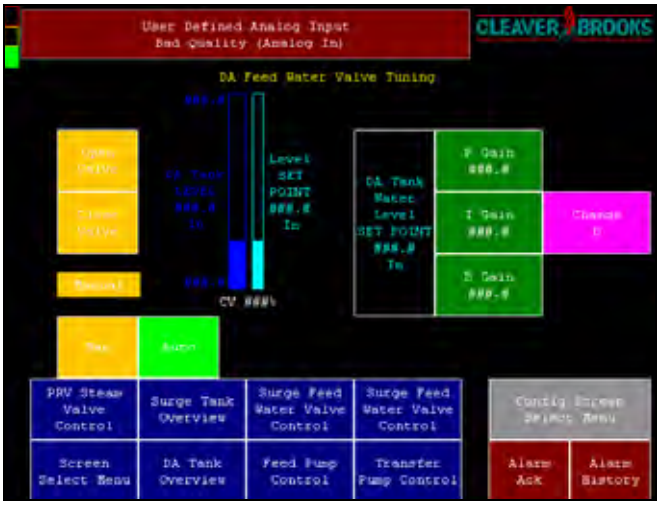


Figure 3-10 DA Feedwater Valve Tuning

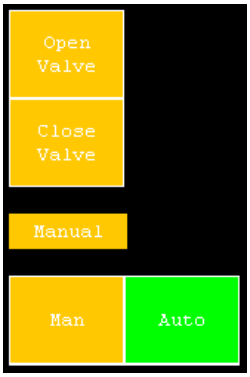
PID tuning and Manual/Auto control for the DA feedwater valve are accessed through these screens.

First set the DA tank water level set point (inches). Allowable values are:

DA Tank Level Zero to DA Tank Level Span if DA Tank Level Alarms are disabled (Alarm Time = 0).

or

DA Tank Level LO Alarm value to DA Tank Level HI Alarm value if DA Tank Level Alarms are enabled (Alarm Time K 0).



Next enter the PID gain values. These values will vary based on the application. Allowable values are 0.0 to 999.0 (D gain is typically set to 0).

The <Man> and <Auto> pushbuttons are used to toggle feed water valve control between Manual and Automatic mode. In Manual mode the <Open (Close) Valve> buttons are used to manually open and close the feedwater valve. In Automatic mode, the PLC controls the valve based on the set point and PID settings.

The DA Feedwater Valve Control Screen is similar to the DA Feedwater Valve Tuning Screen. The Control screen allows Manual/Auto switching and manual increment/decrement of control output, but does not have access to PID tuning.

3.12-Surge Feed Water Valve Tuning/Control

If the system is equipped with a surge tank, a <Surge Feed Water Valve Tune> button will appear on the Configuration Screen Select screen. Use this button to access the Surge Feed Water Valve tuning and control screens.

Surge Feed Water Valve tuning parameters are configured in a similar manner as those for the DA Feed Water Valve.

3.13-DA Tank PRV Steam Valve Tuning/Control

If the system is equipped with a DA tank PRV Steam Valve, a <PRV Steam Valve Tune> pushbutton will apear on the Configuration Screen Select screen.

PRV Steam Valve Tune

First set the DA Tank Pressure set point. Allowable values are either:

DA Tank Pressure Zero to DA Tank Pressure Span if the DA Tank Pressure alarms are disabled (Alarm Time = 0).

or

DA Tank Pressure LO Alarm value to DA Tank Pressure HI Alarm value if DA Tank Pressure alarms are enabled (Alarm Time K0).

Next enter the PID Gain values. These values will vary based on the application. Allowable values are 0.0 to 999.0 (D gain is typically set to 0).

The <Man> and <Auto> pushbuttons are used to toggle PRV Steam Valve control between Manual and Automatic mode. In Manual mode the <Open (Close) Valve> buttons are used to manually open and close the PRV valve. In Automatic mode, the PLC controls the valve based on the set point and PID settings.

The PRV Steam Valve Control screen is similar to the Tuning screen. The Control screen allows Manual/Auto switching and manual increment/decrement of control output, but does not have access to PID tuning.

3.14-Chemical Feed Configuration

If the system is equipped with a DA (Surge) chemical feed system, the appropriate pushbutton will appear on the Configuration Screen Select screen.

DA Chemical Feed Config

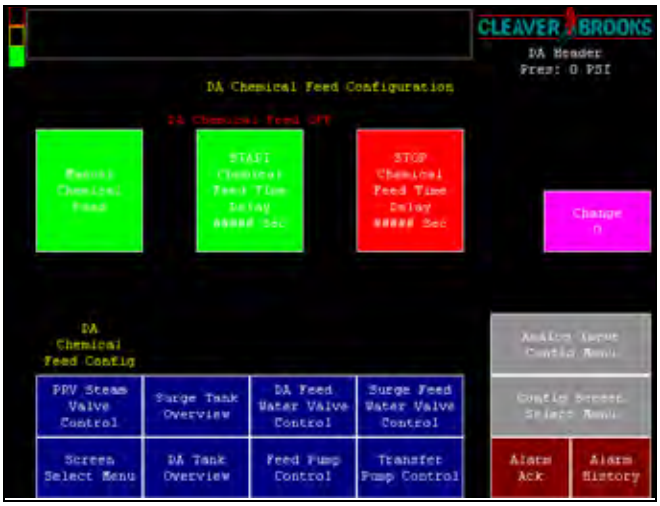


Figure 3-11 DA Chemical Feed Configuration

To configure the feed system, enter values for START Chemical Feed Time Delay and STOP Chemical Feed Time Delay. Allowable range is 0 to 32400 seconds (9 hours).

The start and stop delays function as follows:

When any DA feed pump is ON and in AUTO mode (PLC control) and the START Chemical Feed Time Delay has elapsed, the chemical feed contact will CLOSE.

When all of the DA feed pumps are OFF (or if no pumps are in AUTO) and the STOP Chemical Feed Time Delay has elapsed, the chemical feed contact will OPEN.

Manual Chemical Feed

Manual chemical feed does not utilize the START/STOP delays. While the <Manual Chemical Feed> button is held, the chemical feed contact will be CLOSED.

When the <Manual Chemical Feed> button is released, the chemical feed contact will OPEN unless there is a DA feed pump ON and in AUTO. In this case, the chemical feed contact will not OPEN until all of the DA feed pumps are OFF and the STOP Chemical Feed Time Delay has elapsed.

After configuring DA Chemical Feed, repeat steps for Surge Chemical Feed (if applicable).

3.15-Ethernet Configuration

Ethernet Config

To establish Ethernet communications, certain information needs to be entered on the Ethernet Configuration screen, accessible by pressing <Ethernet Config> on the Configuration Screen Select menu.

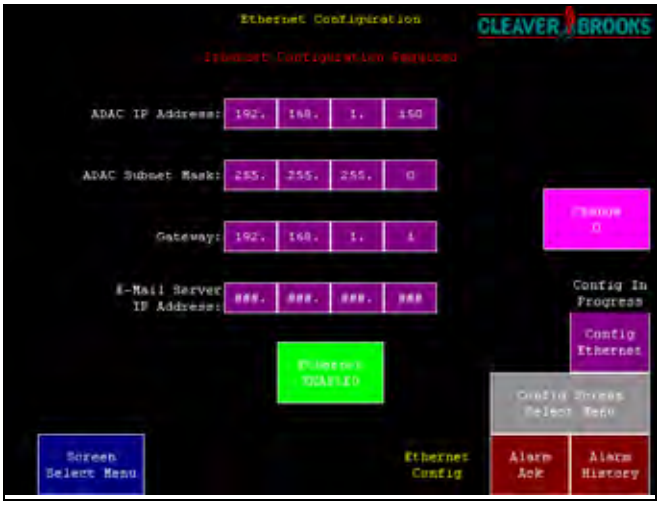


Figure 3-12 Ethernet Configuration

The following items can be configured from this screen:

- ADAC IP Address - This address and the Subnet Mask are required to allow access to a local area network. These addresses need to be obtained from your local information management department. Use the <Change> button to modify the values.
- ADAC Subnet Mask - See ADAC IP Address.
- Gateway - Used to communicate with other networks. This address needs to be obtained from your local information management department. Use the <Change> button to modify the values.
- E-Mail Server IP Address - Set to your company's E-mail server address.

This default Ethernet addressing is as follows:

Table 3-1 Cleaver-Brooks Default Ethernet Addresses

	ADAC IP Address	ADAC Subnet Mask	Gateway
ADAC DA Single Tank PLC	192.168.1.150	255.255.255.0	192.168.1.1
ADAC Surge Single Tank	192.168.1.151	255.255.255.0	192.168.1.1
ADAC Dual Tank PLC	192.168.1.150	255.255.255.0	192.168.1.1

When changes are made on this screen, after the changes have been entered, the <Config Ethernet> button must be pressed. This will automatically update the Ethernet settings. If the configuration has not been completed, a message will appear on several screens to remind the operator that configuration is required.

3.16-Display Configuration

Most of the Panel View parameters are preset and should not be changed. PV configuration does, however, allow setting of the date and time. Press <PV Config Screen> from the Screen Selection Menu to access. You will be prompted for a password (3232).

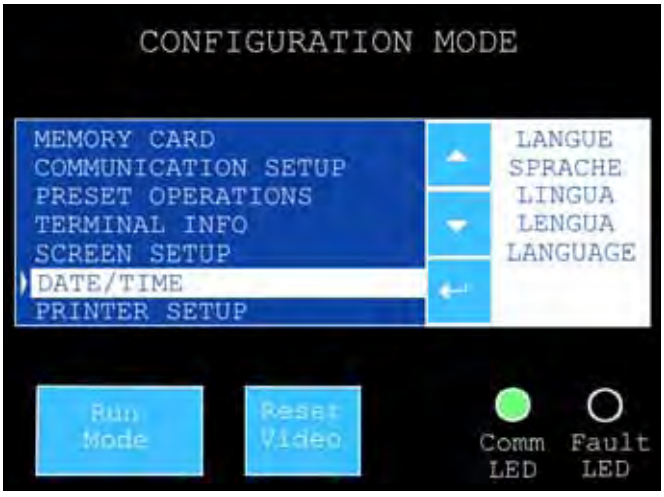


Figure 3-13. Configuration Screen

To change the date and time, arrow down to the Date/Time menu and press return.

Figure 3-14. Date / Time Screen

Select the value to change. Enter the desired value in the numeric keypad and press return. When finished press the <EXIT> button.

The ADAC can also print its alarm history to a serial printer. The printer is connected to the RS232 port on the display. To enable printing, press the Port Mode button.

The printer will print alarms as they occur.

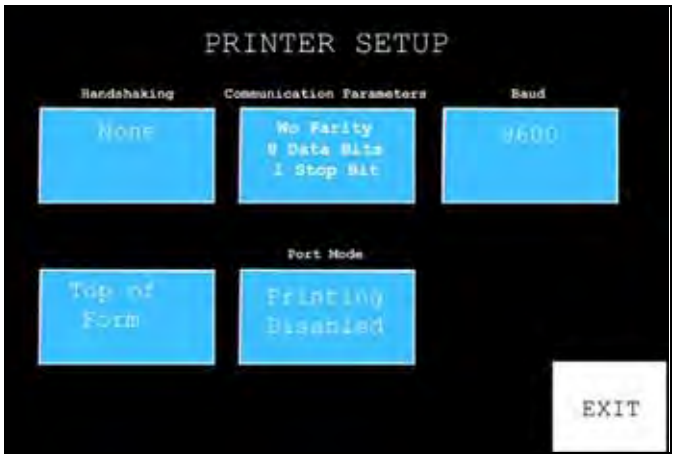


Figure 3-15. Printer Setup Screen

The display has a screen saver feature that can be enabled. Arrow to the <Screen Setup> and press return.

Toggle the <Screen Saver> button to activate. From this screen the brightness can be adjusted using the <Intensity> button.

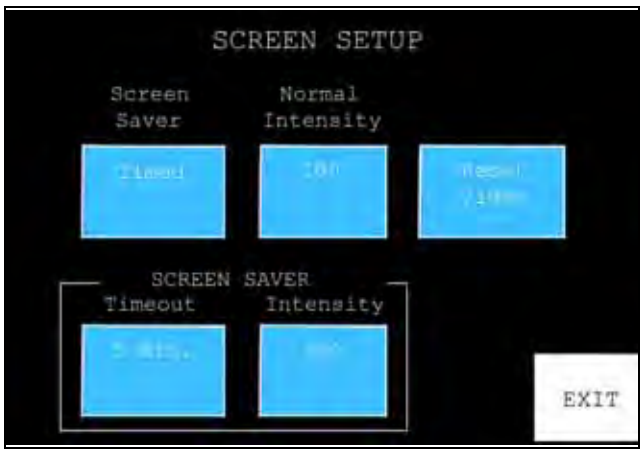


Figure 3-16. Screen Setup

The Panel View software can be loaded or saved utilizing a PCMCIA memory card. The card inserts into the back of the display. Arrow to the <Memory Card> button and press return.

Figure 3-17. Panel View Memory Card

Figure 3-18. Memory Card Screen

If the memory card contains the proper applications for the display they will be listed on this screen. To load the program into memory select the file and press <Restore from Card>. Conversely, to save the application to the memory card, press the <Save to Card> button before removing the card.

When finished with the memory card, before removing, press the <Disconnect Card> button.

Notice

The additional functions of the Display Configuration screen should only be changed by qualified personnel. Improper modification can render the display inactive.

Chapter 4
Operation

4.1-System Control/Operation

A. Screen Select

On system powerup, the Screen Selection Menu will be displayed. This screen allows access to all of the primary control, monitoring, and configuration sections of the ADAC system.

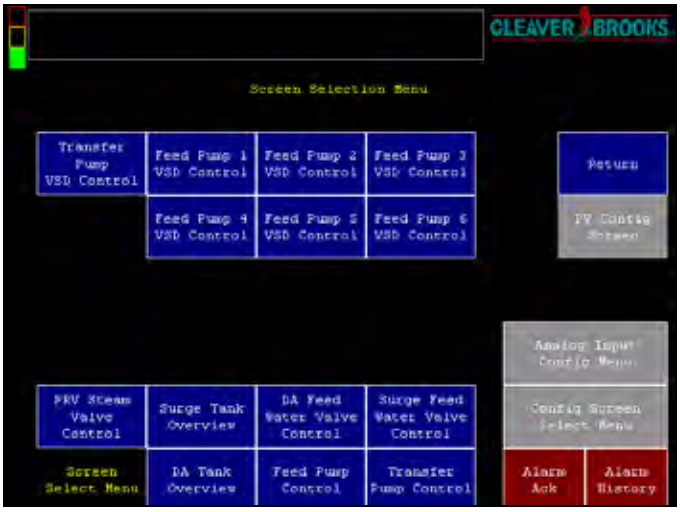


Figure 4-1 Screen Select Screen

For a graphic display of the DA system, press <DA Tank Overview>.

B. DA Tank Overview

DA Tank Overview

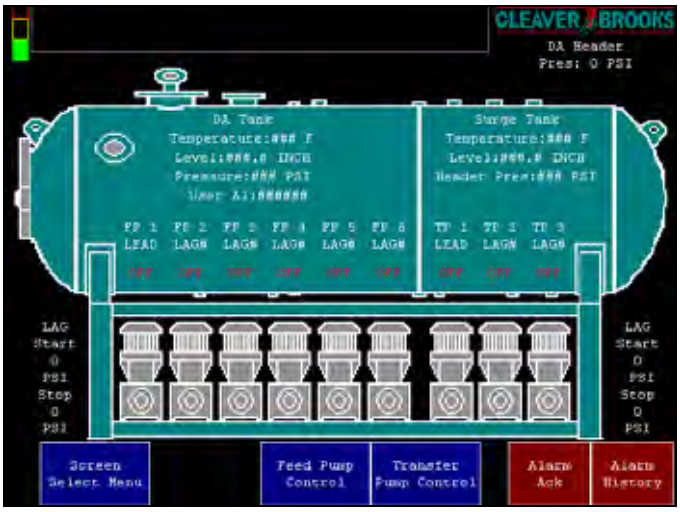


Figure 4-2 DA Tank Overview Screen

This screen allows the operator to monitor device status and certain data critical to system operation.

On-screen indication is provided for the following:

- DA Recirc Valve status – OPEN/CLOSED
- DA Header Pressure
- DA Tank Temperature
- DA Tank Level
- DA Tank Pressure
- Lead-Lag status (Lead, Lag1, Lag2, etc.) for each of the Feed Pumps
- OFF/ON/FLT status for each of the Feed Pumps
- Start LAG and Stop LAG data

C. Surge Tank Overview

A two-tank system will feature separate overview screens for the DA and Surge tanks. A <Surge Tank Overview> button will appear on the Screen Selection Menu.

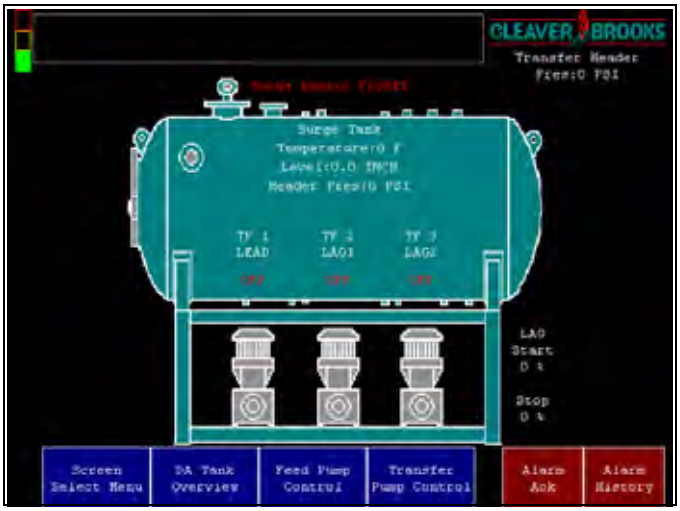


Figure 4-3 Surge Tank Overview Screen

The Surge Tank Overview Screen indicates the following:

- Surge Header Pressure
- Surge Tank Temperature
- Surge Tank Level
- Lead-Lag Status (Lead, Lag1, Lag2) for each of the transfer pumps
- ON/OFF/FLT status for each of the transfer pumps
- Start Lag and Stop Lag data

D. Feed Pump Control

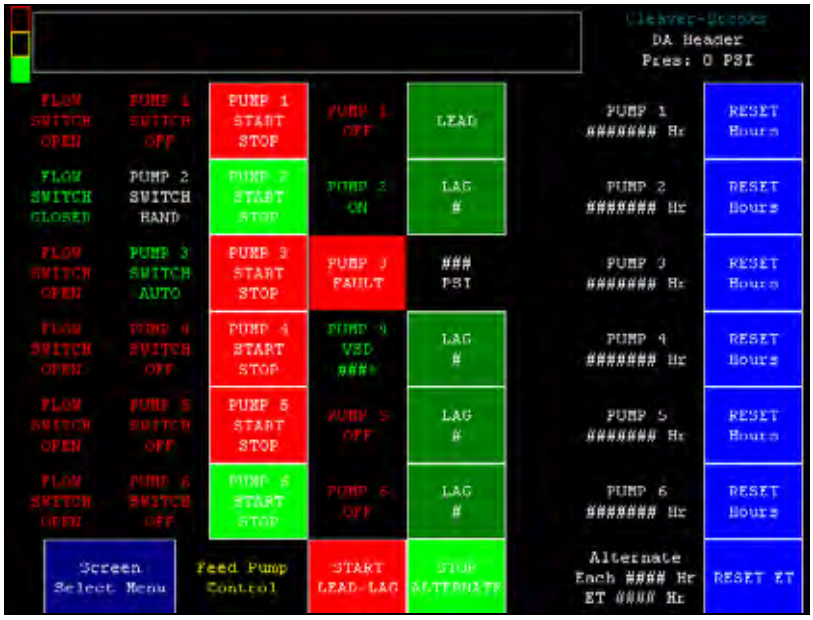


Figure 4-4 Feed Pump Control Screen

The Feed Pump Control Screen provides an indication of the following items:

- DA Header Pressure
- Status of the optional Flow Switches – OPEN/CLOSED
- Selector Switch Position HAND/OFF/AUTO
- OFF/ON/FAULT status for each of the Feed Pumps
- Lead-Lag status (Lead, Lag1, Lag2, etc.) for each of the Feed Pumps
- Elapsed Run Time for each Feed Pump
- Feed Pump Alternate Time increment
- Lead Pump Elapsed Time (when the Alternate function is active)

The Feed Pump Control Screen provides the following Control Functions:

- Individual Feed Pump START/STOP Push Buttons

  When the Selector Switch is in AUTO(PLC) and the L-LAG is OFF, the START/STOP Push Button can be used to START/STOP the corresponding Feed Pump.

  If the L-LAG is ON, the START/STOP Push Buttons are not active.

- Individual Feed Pump LEAD/LAG assignment Push Buttons

  These Push Buttons are used to assign the LEAD Pump and the LAG Pump Sequence. Each Feed Pump must have its own unique value or an “INVALID L-LAG CFG” indicator will appear on the screen. Once a valid Lead-Lag Configuration has been selected, after a short time delay, a “SAVING L-LAG CFG” indicator will appear on the screen.

- START L-LAG Push Button. This button will START and STOP the Lead-Lag sequencing.

  To START the L-LAG (Lead-Lag) function: At least two Feed Pumps need to be Configured (present in the system) and have the Selector Switch in the AUTO position.

  When the Lead-Lag sequence is started, if a pump(s) has been started with the Individual Feed Pump START/STOP Push Button, if that pump is not the LEAD Pump, it will be shut off. The LEAD Pump will be Started.

  If one or more of the LAG Pumps is required, they will be Started.

  When the L-LAG function is turned off (L-LAG STOP Push Button), the Feed Pumps will be OFF.

- The <START ALTRN> Push Button. If an Alternate Feed Pump Time value has been entered (on the Feed Pump Config screen), The Feed Pump Alternate sequence can be Started and Stopped using the <START ALTRN> Push Button.
- The <RESET Hours> and the <RESET ET> Push Buttons can be used to reset the corresponding elapsed time values to 0 (zero).

E. Transfer Pump Control

Information and controls on this screen are similar to Feed Pump Control above.

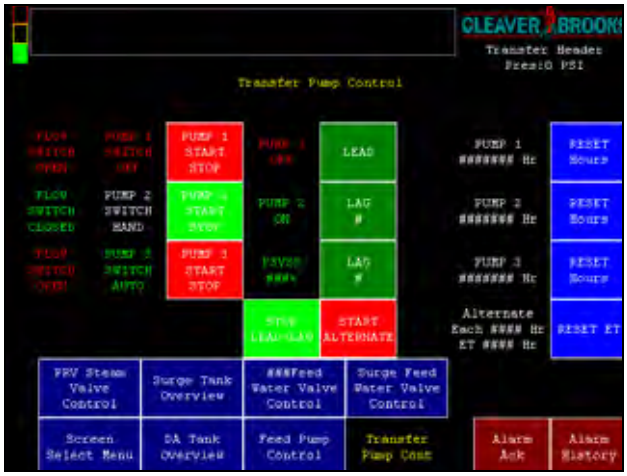


Figure 4-5 Transfer Pump Control Screen

4.2-Alarms

A. Alarm Banner

Any active alarms will appear on the Alarm Banner screen. Active alarms must be acknowledged using the <Ack> button on this screen, or by using the <Alarm Ack> button which appears in the lower right corner of most other HMI screens.

Figure 4-6 Alarm Banner Screen

Following are examples of some ADAC system alarms:

Alarm Message	**Stack Light**	**Alarm Bell Relay** status
Deaerator Level LOW DLWR	Yellow	De-energized (Alarm bell on)
Deaerator Level HIGH DHWR	Yellow	De-energized (Alarm bell on)
Deaerator Level LOW WATER CUT OFF DLWCOR	Red	De-energized (Alarm bell on)
Feed Pump 1 FAULT	Red	De-energized (Alarm bell on)
Feed Pump 1 OVERLOAD/VSD ALARM	Red	De-energized (Alarm bell on)
Boiler Feedwater Header Pressure Bad Quality (Analog In 1)	Red	De-energized (Alarm bell on)

When an alarm occurs, the alarm relay will de-energize, sounding the alarm bell/horn. Acknowledging the alarm will silence the bell/horn.

The GREEN stack light indicates normal operation; no alarms are detected and at least one pump is set to AUTO (PLC).

The YELLOW stack light indicates a warning condition.

The RED stack light indicates equipment failure or a condition preventing pump operation.

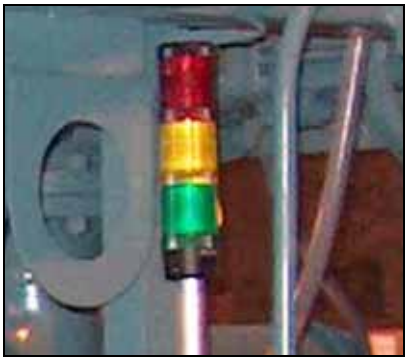


Figure 4-7 Stack Light

B. Alarm History

Recently occurring alarms can be viewed on the Alarm History screen. The screen stores the last 100 alarms, and gives alarm date and time, acknowledge date and time, and alarm description for each.

This screen also shows the current PLC and Panel View program version numbers for this ADAC system.

Figure 4-8 Alarm History Screen

Chapter 5
Input/Output Lists

5.1-SINGLE TANK PLC I/O LAYOUT

BANK 1 = Slots 0-9
BANK 2 = Slots 10-13

SLOT 1 - DISCRETE INPUTS

IN 0	PUMP 1 ON / VSD RUN CONTACT
IN 1	PUMP 1 O/L / VSD ALARM
IN 2	PUMP 1 IN AUTO
IN 3	PUMP 2 ON / VSD RUN CONTACT
IN 4	PUMP 2 O/L / VSD ALARM
IN 5	PUMP 2 IN AUTO
IN 6	PUMP 3 ON / VSD RUN CONTACT
IN 7	PUMP 3 O/L / VSD ALARM
IN 8	PUMP 3 IN AUTO
IN 9	PUMP 4 ON / VSD RUN CONTACT
IN 10	PUMP 4 O/L / VSD ALARM
IN 11	PUMP 4 IN AUTO
IN 12	PUMP 5 ON / VSD RUN CONTACT
IN 13	PUMP 5 O/L / VSD ALARM
IN 14	PUMP 5 IN AUTO
IN 15	LOW-LOW WATER LEVEL (LWCO) SW

SLOT 2 - DISCRETE OUTPUTS

OUT 0	PUMP 1 START (PR1) / VSD RUN
OUT 1	PUMP 2 START (PR2) / VSD RUN
OUT 2	PUMP 3 START (PR3) / VSD RUN
OUT 3	PUMP 4 START (PR4) / VSD RUN
OUT 4	PUMP 5 START (PR5) / VSD RUN
OUT 5	PUMP 6 START (PR6) / VSD RUN
OUT 6	
OUT 7	
OUT 8	
OUT 9	NO ALARMS (AR)
OUT 10	RED STACK LIGHT (RSL)
OUT 11	YELLOW STACK LIGHT (YSL)
OUT 12	GREEN STACK LIGHT (GSL)
OUT 13	CHEMICAL FEED RELAY (CRF)
OUT 14	
OUT 15	RECIRC VALVE

SLOT 3 - DISCRETE INPUTS

IN 0	PUMP 6 ON / VSD RUN CONTACT
IN 1	PUMP 6 O/L / VSD ALARM
IN 2	PUMP 6 IN AUTO
IN 3	BOILER 1 ON - WATER REQUIRED
IN 4	BOILER 2 ON - WATER REQUIRED
IN 5	BOILER 3 ON - WATER REQUIRED
IN 6	BOILER 4 ON - WATER REQUIRED
IN 7	BOILER 5 ON - WATER REQUIRED
IN 8	BOILER 6 ON - WATER REQUIRED
IN 9	
IN 10	
IN 11	
IN 12	
IN 13	
IN 14	TANK HIGH WATER LEVEL SW
IN 15	TANK LOW WATER LEVEL SW

SLOT 4 - ANALOG INPUTS

B A N K 1 P/S	IN 0	BOILER 1 FW PRES or BOILER FW HEADER PRESS or BOILER FW HEADER FLOW or SURGE TANK (TRANSFER) HEADER PRESSURE
	IN 1	TANK TEMPERATURE
	IN 2	TANK LEVEL
	IN 3	TANK PRESSURE

SLOT 5 - ANALOG OUTPUTS

OUT 0	TANK FEED WATER VALVE
OUT 1	PRV Valve

SLOT 6 - DISCRETE INPUTS

IN 0	
IN 1	
IN 2	
IN 3	
IN 4	
IN 5	
IN 6	
IN 7	PUMP 1 FLOW/PRESS. SWITCH
IN 8	PUMP 2 FLOW/PRESS. SWITCH
IN 9	PUMP 3 FLOW/PRESS. SWITCH
IN 10	PUMP 4 FLOW/PRESS. SWITCH
IN 11	PUMP 5 FLOW/PRESS. SWITCH
IN 12	PUMP 6 FLOW/PRESS. SWITCH
IN 13	
IN 14	
IN 15	

SLOT 7 - ANALOG OUTPUTS

OUT 0	SECOND FEED WATER VALVE
OUT 1	PUMP 1 VSD SPEED CONTROL

SLOT 8 - ANALOG INPUTS

IN 0	PUMP 1 VSD SPEED FEEDBACK
IN 1	PUMP 2 VSD SPEED FEEDBACK
IN 2	PUMP 3 VSD SPEED FEEDBACK
IN 3	USER DEFINED INPUT

SLOT 9 - ANALOG OUTPUTS

OUT 0	PUMP 2 VSD SPEED CONTROL
OUT 1	PUMP 3 VSD SPEED CONTROL

BANK 2 P/S

SLOT 10 - ANALOG OUTPUTS

OUT 0	PUMP 4 VSD SPEED CONTROL
OUT 1	PUMP 5 VSD SPEED CONTROL

SLOT 11 - ANALOG INPUTS

IN 0	PUMP 4 VSD SPEED FEEDBACK
IN 1	PUMP 5 VSD SPEED FEEDBACK
IN 2	PUMP 6 VSD SPEED FEEDBACK
IN 3	BOILER 2 FEEDWATER PRESSURE

SLOT 12 - ANALOG OUTPUTS

OUT 0	PUMP 6 VSD SPEED CONTROL
OUT 1	

SLOT 13 - ANALOG INPUTS

IN 0	BOILER 3 FEEDWATER PRESSURE
IN 1	BOILER 4 FEEDWATER PRESSURE
IN 2	BOILER 5 FEEDWATER PRESSURE
IN 3	BOILER 6 FEEDWATER PRESSURE

NOTE: If VSDs are used, the VSD Speed is controlled by the Analog Output modules in Slots 7, 9, 10, and 12. VSD Drive Status will use inputs in Slots 1 and 3 in place of the VSD Run Contact inputs.

Slot 2 Pump Start outputs control contactors for standard systems or run commands for VSD systems.

Chemical feed dry contacts are provided by an interposing relay.

5.2-TWO TANK PLC I/O LAYOUT

BANK 1 = Slots 0-9
BANK 2 = Slots 10-13

SLOT 1 - DISCRETE INPUTS

IN 0	BF PUMP 1 ON / VSD RUN CONTACT
IN 1	BOILER FEED PUMP 1 O/L / VSD ALARM
IN 2	BF PUMP 1 IN AUTO
IN 3	BF PUMP 2 ON / VSD RUN CONTACT
IN 4	BF PUMP 2 O/L / VSD ALARM
IN 5	BF PUMP 2 IN AUTO
IN 6	BF PUMP 3 ON / VSD RUN CONTACT
IN 7	BF PUMP 3 O/L / VSD ALARM
IN 8	BF PUMP 3 IN AUTO
IN 9	BF PUMP 4 ON / VSD RUN CONTACT
IN 10	BF PUMP 4 O/L / VSD ALARM
IN 11	BOILER FEED PUMP 4 IN AUTO
IN 12	BF PUMP 5 ON / VSD RUN CONTACT
IN 13	BOILER FEED PUMP 5 O/L / VSD ALARM
IN 14	BOILER FEED PUMP 5 IN AUTO
IN 15	DA TANK LOW-LOW WATER LEVEL (LWCO) SW

SLOT 2 - DISCRETE OUTPUTS

OUT 0	BF PUMP 1 START (PR1) / VSD RUN
OUT 1	BF PUMP 2 START (PR2) / VSD RUN
OUT 2	BF PUMP 3 START (PR3) / VSD RUN
OUT 3	BF PUMP 4 START (PR4) / VSD RUN
OUT 4	BF PUMP 5 START (PR5) / VSD RUN
OUT 5	BF PUMP 6 START (PR6) / VSD RUN
OUT 6	TR PUMP 1 START (TPR1) / VSD RUN
OUT 7	TR PUMP 2 START (TPR2) / VSD RUN
OUT 8	TR PUMP 3 START (TPR3) / VSD RUN
OUT 9	NO ALARMS (AR)
OUT 10	RED STACK LIGHT (RSL)
OUT 11	YELLOW STACK LIGHT (YSL)
OUT 12	GREEN STACK LIGHT (GSL)
OUT 13	DA CHEMICAL FEED RELAY (CRF)
OUT 14	SURGE CHEMICAL FEED RELAY
OUT 15	DA RECIRC VALVE

SLOT 3 - DISCRETE INPUTS

IN 0	BF PUMP 6 ON / VSD RUN CONTACT
IN 1	BOILER FEED PUMP 6 O/L / VSD ALARM
IN 2	BOILER FEED PUMP 6 IN AUTO
IN 3	BOILER 1 ON - WATER REQUIRED
IN 4	BOILER 2 ON - WATER REQUIRED
IN 5	BOILER 3 ON - WATER REQUIRED
IN 6	BOILER 4 ON - WATER REQUIRED
IN 7	BOILER 5 ON - WATER REQUIRED
IN 8	BOILER 6 ON - WATER REQUIRED
IN 9	TRANSFER PUMP 1 ON / VSD RUN CONTACT
IN 10	TRANSFER PUMP 1 O/L / VSD ALARM
IN 11	TRANSFER PUMP 1 IN AUTO
IN 12	TRANSFER PUMP 2 ON / VSD RUN CONTACT
IN 13	TRANSFER PUMP 2 O/L / VSD ALARM
IN 14	TRANSFER PUMP 2 IN AUTO
IN 15	DA TANK LOW WATER LEVEL SW

SLOT 4 - DISCRETE INPUTS

IN 0	DA TANK HIGH WATER LEVEL SW
IN 1	TR PUMP 3ON / VSD RUN CONTACT
IN 2	TR PUMP 3 O/L / VSD ALARM
IN 3	TR PUMP 3 IN AUTO
IN 4	SURGE TANK LOW-LOW WATER LEVEL (LWCO) SW
IN 5	SURGE TANK LOW WATER LEVEL SW
IN 6	SURGE TANK HIGH WATER LEVEL SW
IN 7	BF PUMP 1 FLOW/PRESSURE SWITCH
IN 8	BF PUMP 2 FLOW/PRESSURE SWITCH
IN 9	BF PUMP 3 FLOW/PRESSURE SWITCH
IN 10	BF PUMP 4 FLOW/PRESSURE SWITCH
IN 11	BF PUMP 5 FLOW/PRESSURE SWITCH
IN 12	BF PUMP 6 FLOW/PRESSURE SWITCH
IN 13	TR PUMP 1 FLOW/PRESSURE SWITCH
IN 14	TR PUMP 2 FLOW/PRESSURE SWITCH
IN 15	DA TANK HIGH WATER LEVEL SW

SLOT 5 - ANALOG INPUTS

IN 0	BOILER 1 FEEDWATER PRESSURE or BOILER FEEDWATER HEADER PRESSURE or BOILER FEEDWATER HEADER FLOW
IN 1	DA TANK TEMPERATURE
IN 2	DA TANK LEVEL
IN 3	DA TANK PRESSURE

SLOT 6 - ANALOG INPUTS

IN 0	SURGE TANK DISCHARGE (TRANSFER) HEADER PRESSURE
IN 1	SURGE TANK TEMPERATURE
IN 2	SURGE TANK LEVEL
IN 3	USER DEFINED INPUT

SLOT 7 - ANALOG OUTPUTS

OUT 0	DA TANK FEED WATER VALVE
OUT 1	SURGE TANK FEED WATER VALVE

SLOT 8 - ANALOG OUTPUTS

OUT 0	PRV Valve
OUT 1	EMRG/SECOND DA FEED WATER VALVE

SLOT 9 - ANALOG OUTPUTS

OUT 0	SECOND SURGE TANK FEED WATER VALVE
OUT 1	BOILER FEED PUMP 1 VSD SPEED CONTROL

SLOT 10 - ANALOG INPUTS

BANK 2 P/S

IN 0	BF PUMP 1 VSD SPEED FEEDBACK
IN 1	BF PUMP 2 VSD SPEED FEEDBACK
IN 2	BF PUMP 3 VSD SPEED FEEDBACK
IN 3	TR PUMP 1 VSD SPEED FEEDBACK

SLOT 11 - ANALOG OUTPUTS

OUT 0	BOILER FEED PUMP 2 VSD SPEED CONTROL
OUT 1	BOILER FEED PUMP 3 VSD SPEED CONTROL
OUT 2	BOILER FEED PUMP 4 VSD SPEED CONTROL
OUT 3	BOILER FEED PUMP 5 VSD SPEED CONTROL
OUT 4	BOILER FEED PUMP 6 VSD SPEED CONTROL
OUT 5	TRANSFER PUMP 1 VSD SPEED CONTROL
OUT 6	TRANSFER PUMP 2 VSD SPEED CONTROL
OUT 7	TRANSFER PUMP 3 VSD SPEED CONTROL

SLOT 12 - ANALOG INPUTS

IN 0	BF PUMP 4 VSD SPEED FEEDBACK
IN 1	BF PUMP 5 VSD SPEED FEEDBACK
IN 2	BF PUMP 6 VSD SPEED FEEDBACK
IN 3	TR PUMP 2 VSD SPEED FEEDBACK

SLOT 13 - ANALOG INPUTS

IN 0	TRANSFER PUMP 3 VSD SPEED FEEDBACK
IN 1	BOILER 2 FEEDWATER PRESSURE
IN 2	BOILER 3 FEEDWATER PRESSURE
IN 3	BOILER 4 FEEDWATER PRESSURE
IN 4	BOILER 5 FEEDWATER PRESSURE
IN 5	BOILER 6 FEEDWATER PRESSURE
IN 6	(SPARE)
IN 7	(SPARE)

NOTE: If VSDs are used, VSD speed is controlled by the Analog Output modules in Slots 9 and 11. VSD Drive Status will use inputs in Slots 1, 3, and 4 in place of the VSD Run Contact inputs.

Slot 2 Pump Start outputs control contactors for standard systems or run commands for VSD systems.

Chemical feed dry contacts are provided by an interposing relay.

Chapter 6
Parts

Standard System

Component	CB Part Number
CompactLogix L32E Processor	833-3052
Power Supply	833-2834
Discrete Input Module	833-2842
Discrete Output Module (Isolated)	833-3210
Analog Input Module (4 Channel)	833-2835
Analog Input Module (8 Channel)	833-3106
Analog Output Module (2 Channel)	833-2844
Analog Output Module (8 Channel)	833-3107
Right Termination End Cap	833-2838
HMI Display (6” Color Serial; standard on One Tank system)	833-2858
HMI Display (10” Color Serial; standard on Two Tank system)	833-2856
Stack Light (Red Module)	881-0361
Stack Light (Green Module)	881-0362
Stack Light (Yellow Module)	881-0363
Stack Light Base	881-0364

Optional Components:

Component	CB Part Number
HMI Display 10” Color Serial for Single Tank system	833-2856
HMI Display 6” Color Ethernet	880-1273
HMI Display 10” Color Ethernet	880-1274
Remote access paging modem	833-2873
Current Overload	sized for pump
Combination Starter	sized for pump
Soft Starter	sized for pump
Variable Speed Drive - PowerFlex 70, 400, or 700	sized for pump
Electric actuators for pump water recirculation	sized for system

Appendix

Supporting Documents/Reference Drawings

NOTE: The following information is provided for reference purposes only. For detailed, up-to-date information on specific installations, contact Cleaver-Brooks.

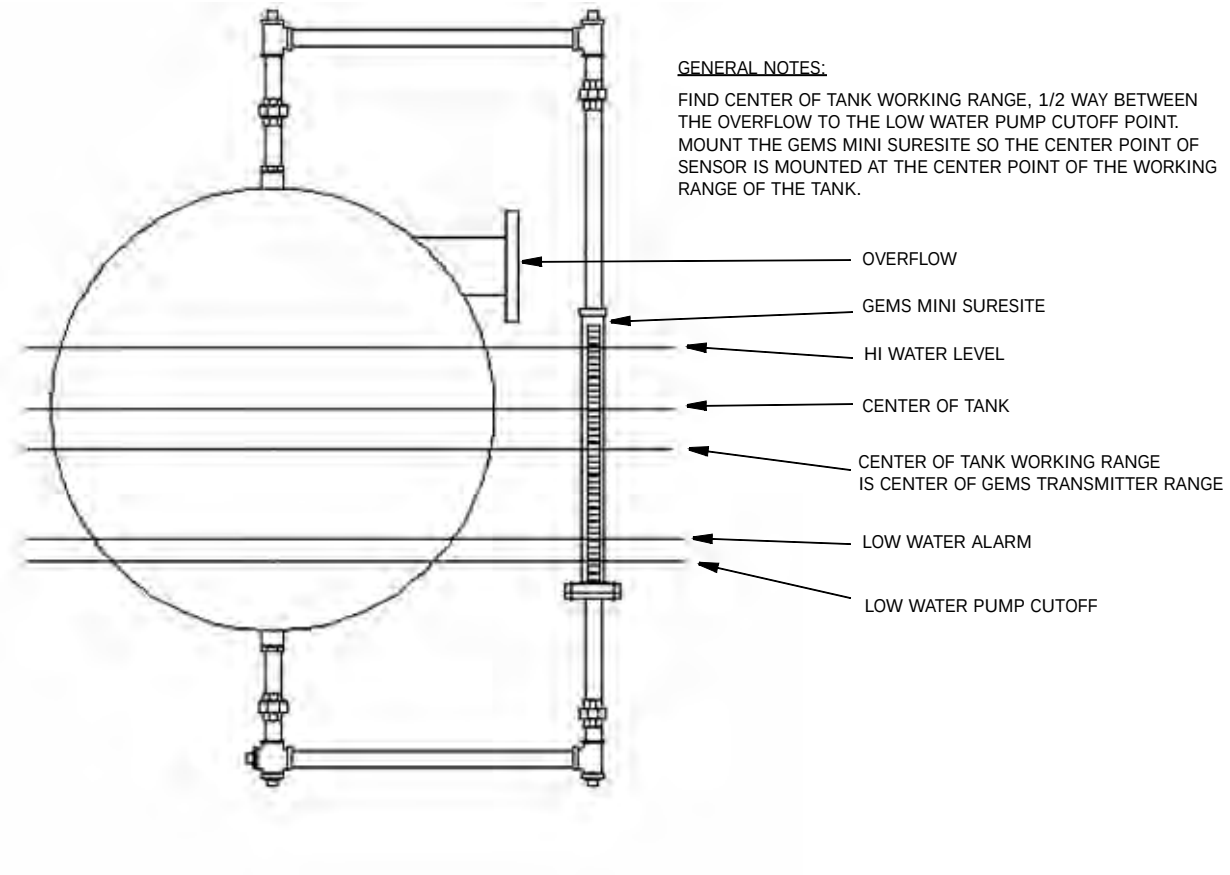
Magnetic Level Control Sizing Chart (1 of 2)

MODEL	High Water Alarm Location from bottom of tank	Low Water Alarm Location from bottom of tank	Low Water Cut-Off Location from bottom of tank	Normal Water Level from bottom of tank	Overflow Location from Bottom of tank	Distance Between High Water Alarm and Low Water Cut-off	Distance Between Overflow and Low Water Cut-off	Suggested Gem Length	CB Part Number For Gauge	CB Part Number for xmtr
SPRAYMASTER 36"	26.50	9.50	7.50	21.00	28.00	19.00	20.50	29.00	881-365	817-4086
SPRAYMASTER 48"	21.00	9.00	7.00	15.00	24.00	14.00	17.00	29.00	881-365	817-4086
SPRAYMASTER 54"	28.00	14.00	12.00	19.00	31.00	16.00	19.00	29.00	881-365	817-4086
SPRAYMASTER 60"	34.00	15.00	13.00	25.00	37.00	21.00	24.00	29.00	881-365	817-4086
SPRAYMASTER 66"	34.50	16.50	14.50	25.50	39.50	20.00	25.00	29.00	881-365	817-4086
SPRAYMASTER 72"	41.00	18.00	16.00	32.00	44.00	25.00	28.00	29.00	881-365	817-4086
SPRAYMASTER 84"	53.00	21.00	19.00	44.00	56.50	34.00	37.50	48.00	881-366	817-4087
SPRAYMASTER 96"	70.00	24.00	22.00	61.00	74.50	48.00	52.50	59.00	881-376	817-4088
SPRAYMASTER 108"	77.00	27.00	25.00	68.00	81.50	52.00	56.50	59.00	881-376	817-4088
SURGE 36"	27.00	9.00	7.00	18.00	30.00	20.00	23.00	29.00	881-365	817-4086
SURGE 48"	36.00	12.00	10.00	24.00	39.00	26.00	29.00	29.00	881-365	817-4086
SURGE 54"	40.50	13.50	11.50	27.00	46.00	29.00	34.50	48.00	881-366	817-4087
SURGE 60"	45.00	15.00	13.00	30.00	50.50	32.00	37.50	48.00	881-366	817-4087
SURGE 66"	49.50	16.50	14.50	33.00	55.00	35.00	40.50	48.00	881-366	817-4087
SURGE 72"	54.00	18.00	16.00	36.00	61.50	38.00	45.50	48.00	881-366	817-4087
SURGE 84"	63.00	21.00	19.00	42.00	73.00	44.00	54.00	59.00	881-376	817-4088
BOILERMATE 24"	18.00	6.00	4.00	12.00	20.00	14.00	16.00	19.00	Call	Call
BOILERMATE 36"	30.00	12.00	10.00	24.00	32.00	20.00	22.00	29.00	881-365	817-4086
BOILERMATE 48"	42.00	18.00	16.00	34.00	44.00	26.00	28.00	29.00	881-365	817-4086
BOILERMATE 54"	39.00	26.00	28.00	31.00	50.00	11.00	22.00	29.00	881-365	817-4086
BOILERMATE 60"	54.00	15.00	13.00	45.00	56.00	41.00	43.00	48.00	881-366	817-4087
Signature DA 260 gallon 48"	19.19	9.00	6.00	16.06	25.56	13.19	19.56	29.00	881-365	817-4086
Signature DA 415 gallon 48"	19.25	8.88	6.00	14.38	25.88	13.25	19.88	29.00	881-365	817-4086
Signature DA 610 gallon 54"	24.06	11.19	6.00	18.00	31.44	18.06	25.44	29.00	881-365	817-4086
Signature DA 840 gallon 60"	28.75	13.31	6.00	21.44	37.44	22.75	31.44	48.00	881-366	817-4087
Signature DA 1105 gallon	33.38	13.38	6.00	24.81	43.88	27.38	37.88	48.00	881-366	817-4087
Signature DA 1400 gallon	37.75	17.31	6.00	28.00	49.81	31.75	43.81	48.00	881-366	817-4087
Signature DA 2485 gallon	45.81	20.88	6.00	33.81	60.25	39.81	54.25	59.00	881-376	817-4088

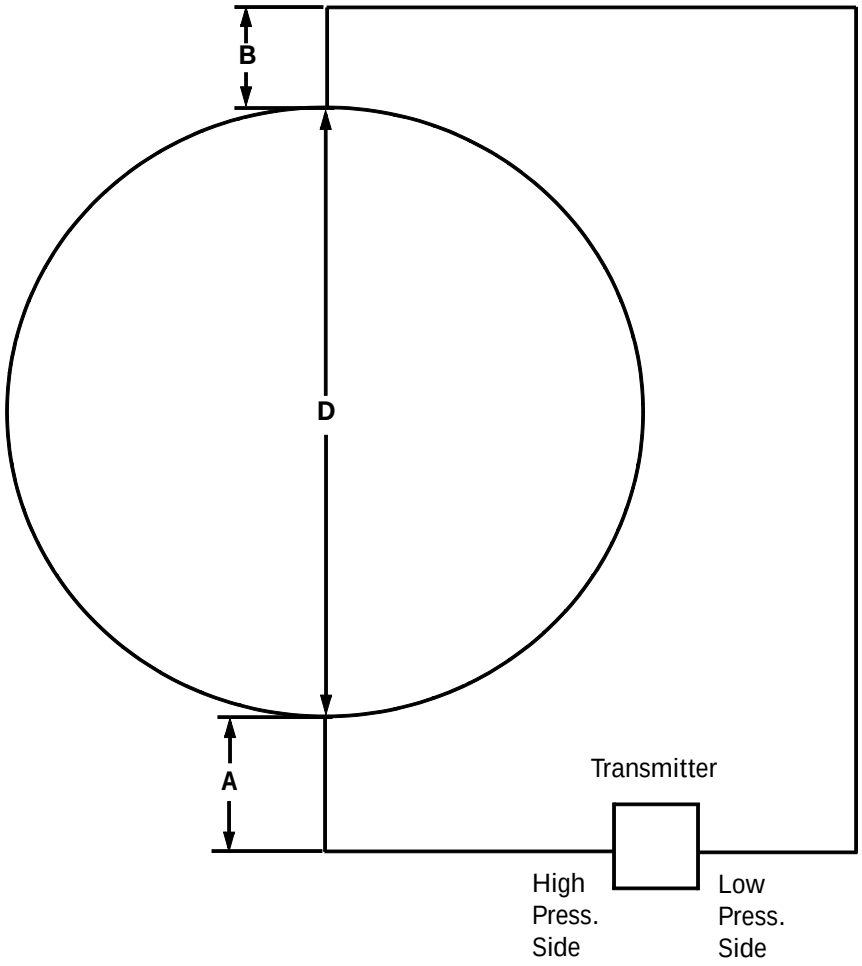
Magnetic Level Control Sizing Chart (2 of 2)

MODEL	Center of working range to bottom of tank	Center of Gems Working Range	Control Lwco setpoint	Control LWA Setpoint	Control HWA	Control Normal Water Level Setpoint
SPRAYMASTER 36"	17.75	14.50	4.25	6.25	23.25	17.75
SPRAYMASTER 48"	15.50	14.50	6.00	8.00	20.00	14.00
SPRAYMASTER 54"	21.50	14.50	5.00	7.00	21.00	12.00
SPRAYMASTER 60"	25.00	14.50	2.50	4.50	23.50	14.50
SPRAYMASTER 66"	27.00	14.50	2.00	4.00	22.00	13.00
SPRAYMASTER 72"	30.00	14.50	0.50	2.50	25.50	16.50
SPRAYMASTER 84"	37.75	24.00	5.25	7.25	39.25	30.25
SPRAYMASTER 96"	48.25	29.50	3.25	5.25	51.25	42.25
SPRAYMASTER 108"	53.25	29.50	1.25	3.25	53.25	44.25
SURGE 36"	18.50	14.50	3.00	5.00	23.00	14.00
SURGE 48"	24.50	14.50	0.00	2.00	26.00	14.00
SURGE 54"	28.75	24.00	6.75	8.75	35.75	22.25
SURGE 60"	31.75	24.00	5.25	7.25	37.25	22.25
SURGE 66"	34.75	24.00	3.75	5.75	38.75	22.25
SURGE 72"	38.75	24.00	1.25	3.25	39.25	21.25
SURGE 84"	46.00	29.50	2.50	4.50	46.50	25.50
BOILERMATE 24"	12.00	9.50	1.50	3.50	15.50	9.50
BOILERMATE 36"	21.00	14.50	3.50	5.50	23.50	17.50
BOILERMATE 48"	30.00	14.50	0.50	2.50	26.50	18.50
BOILERMATE 54"	39.00	14.50	3.50	1.50	14.50	6.50
BOILERMATE 60"	34.50	24.00	2.50	4.50	43.50	34.50
Signature DA 260 gallon 48"	15.78	14.50	4.72	7.72	17.91	14.78
Signature DA 415 gallon 48"	15.94	14.50	4.56	7.44	17.81	12.94
Signature DA 610 gallon 54"	18.72	14.50	1.78	6.97	19.84	13.78
Signature DA 840 gallon 60"	21.72	24.00	8.28	15.59	31.03	23.72
Signature DA 1105 gallon 66"	24.94	24.00	5.06	12.44	32.44	23.88
Signature DA 1400 gallon 72"	27.91	24.00	2.09	13.41	33.84	24.09
Signature DA 2485 gallon 84"	33.13	29.50	2.38	17.25	42.19	30.19

Magnetic Level Control Installation Diagram



DA Level Differential Pressure Transmitter Calibration

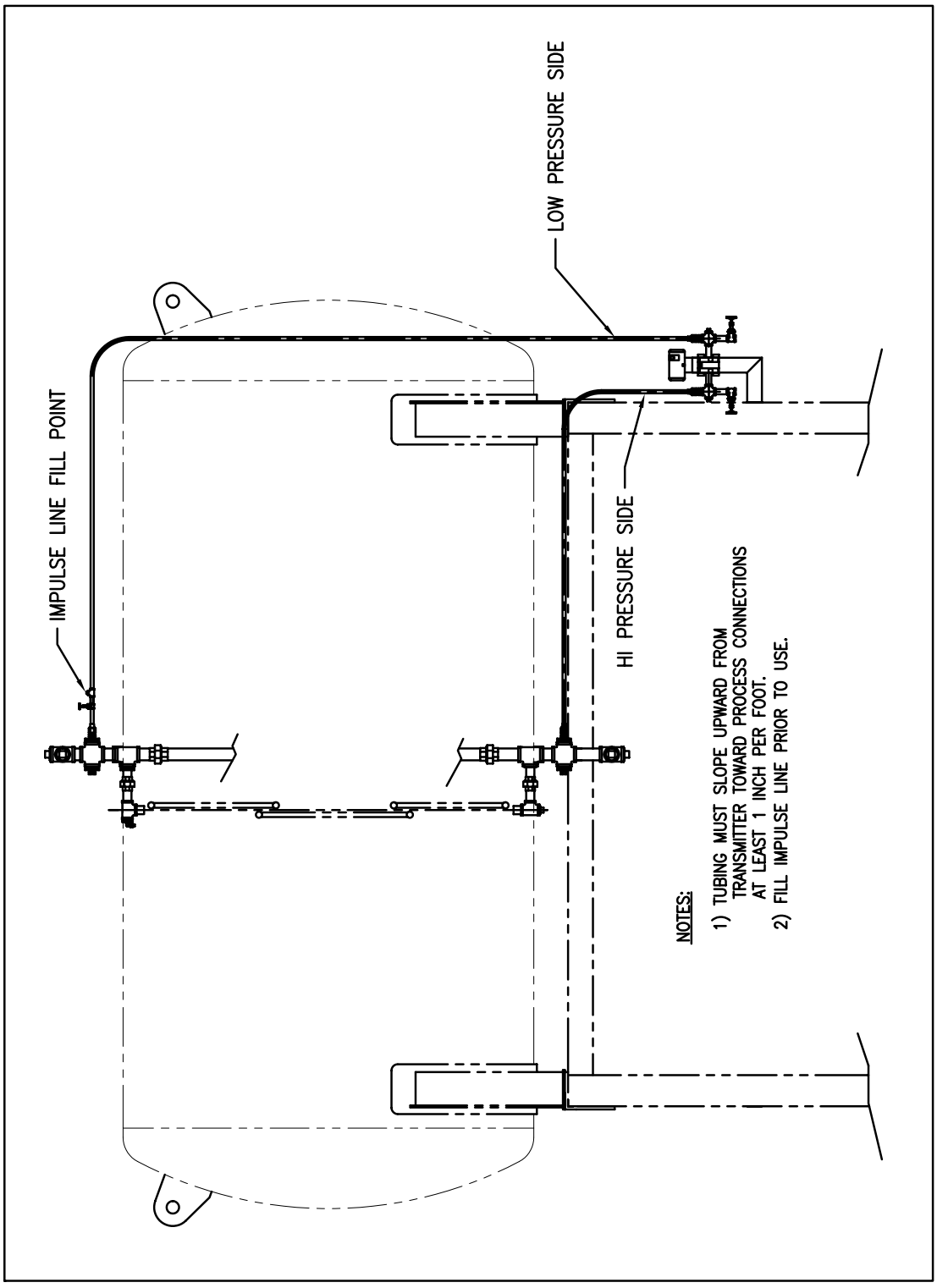


Tank Diameter D Inches	24	36	48	54	60	66	72	84	96	108
Dimension B Inches	4	4	4	4	4	4	4	4	4	4
Transmitter Zero (4mA)	-28	-40	-52	-58	-64	-70	-76	-88	-100	-112
Transmitter Span (20mA)	-4	-4	-4	-4	-4	-4	-4	-4	-4	-4

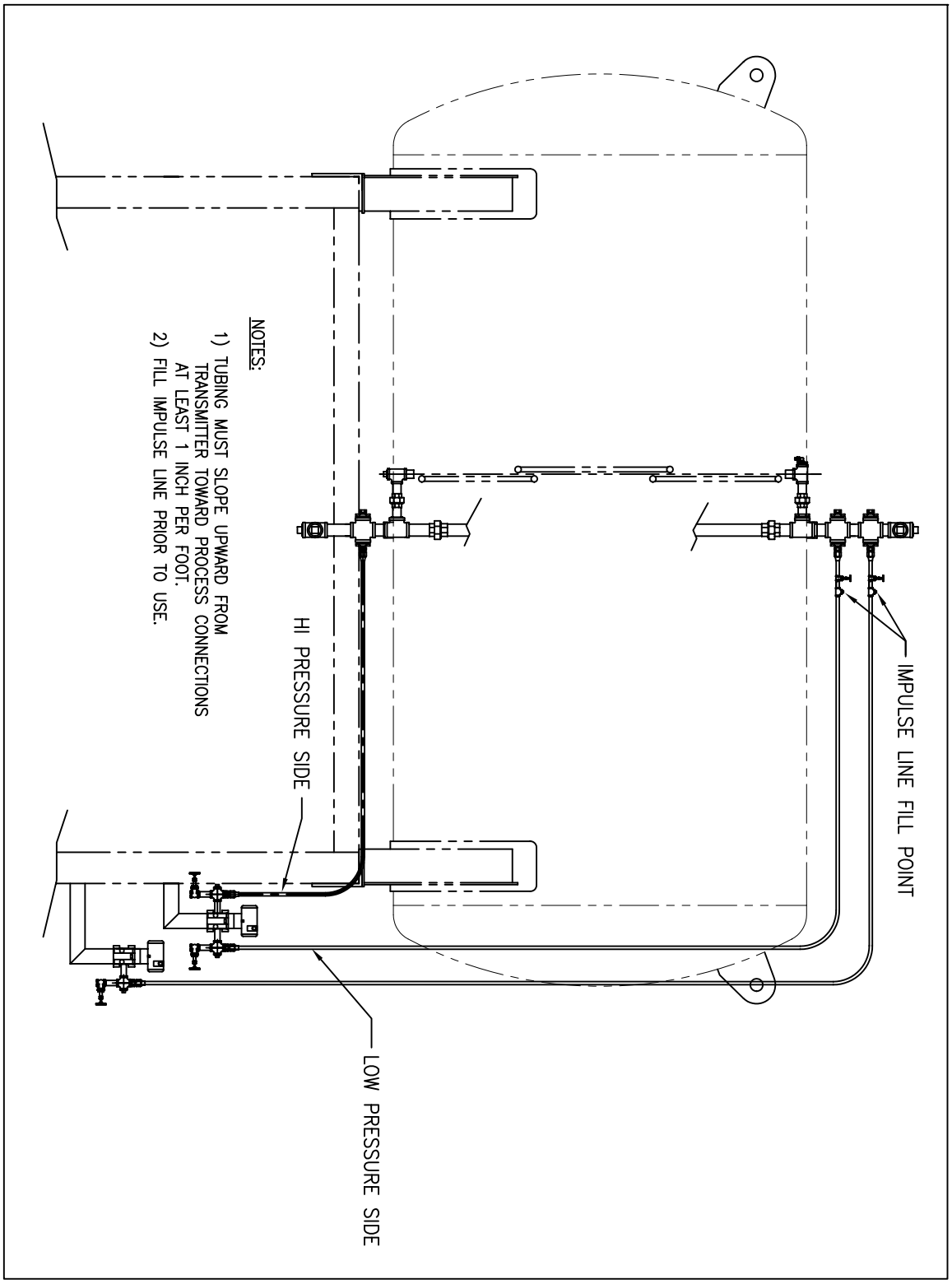
Equations Used: dP(zero) = -(D+B)
dP(span) = -B

Note: Dimension B is an estimate.

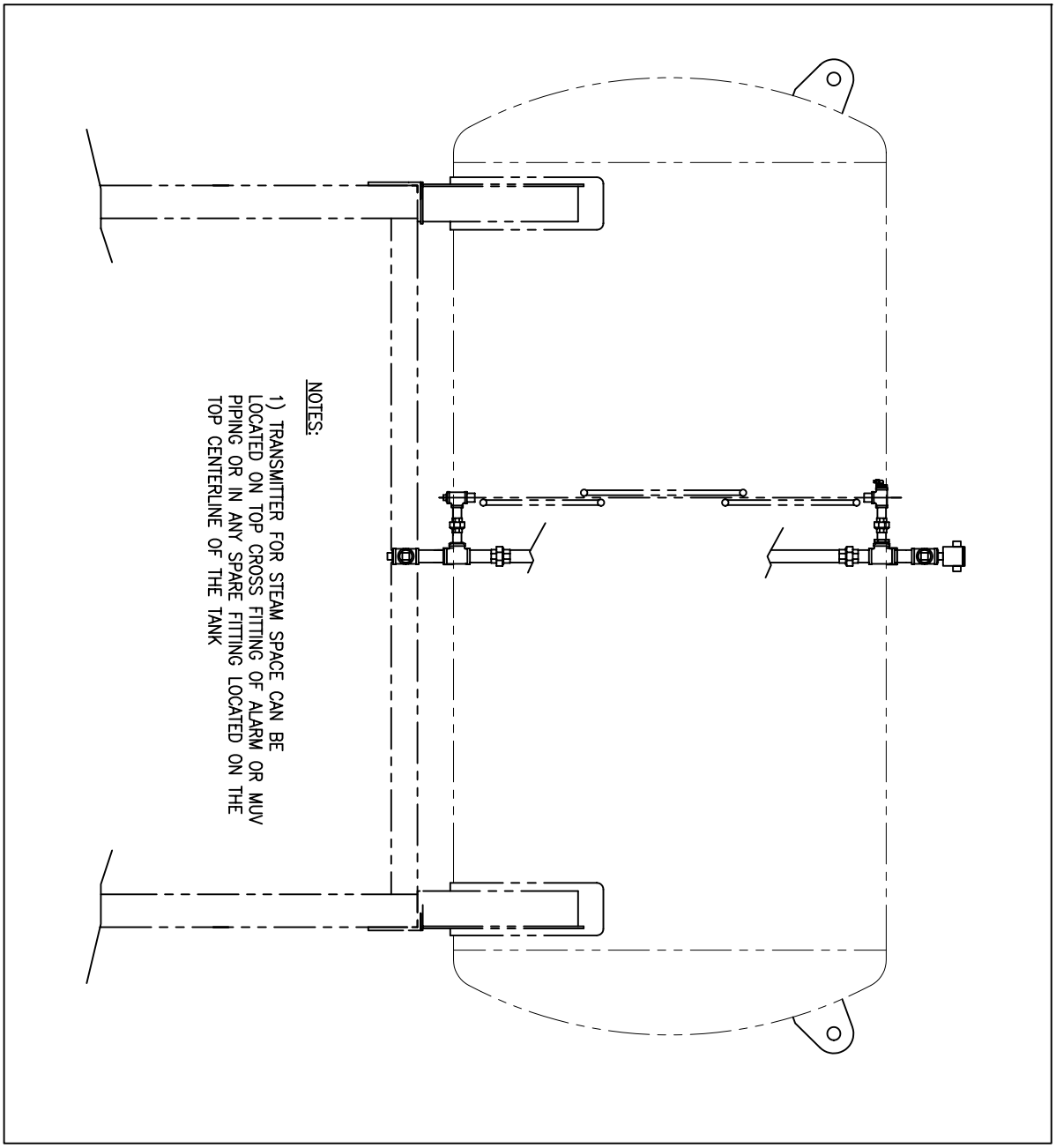
Differential Pressure Level Control



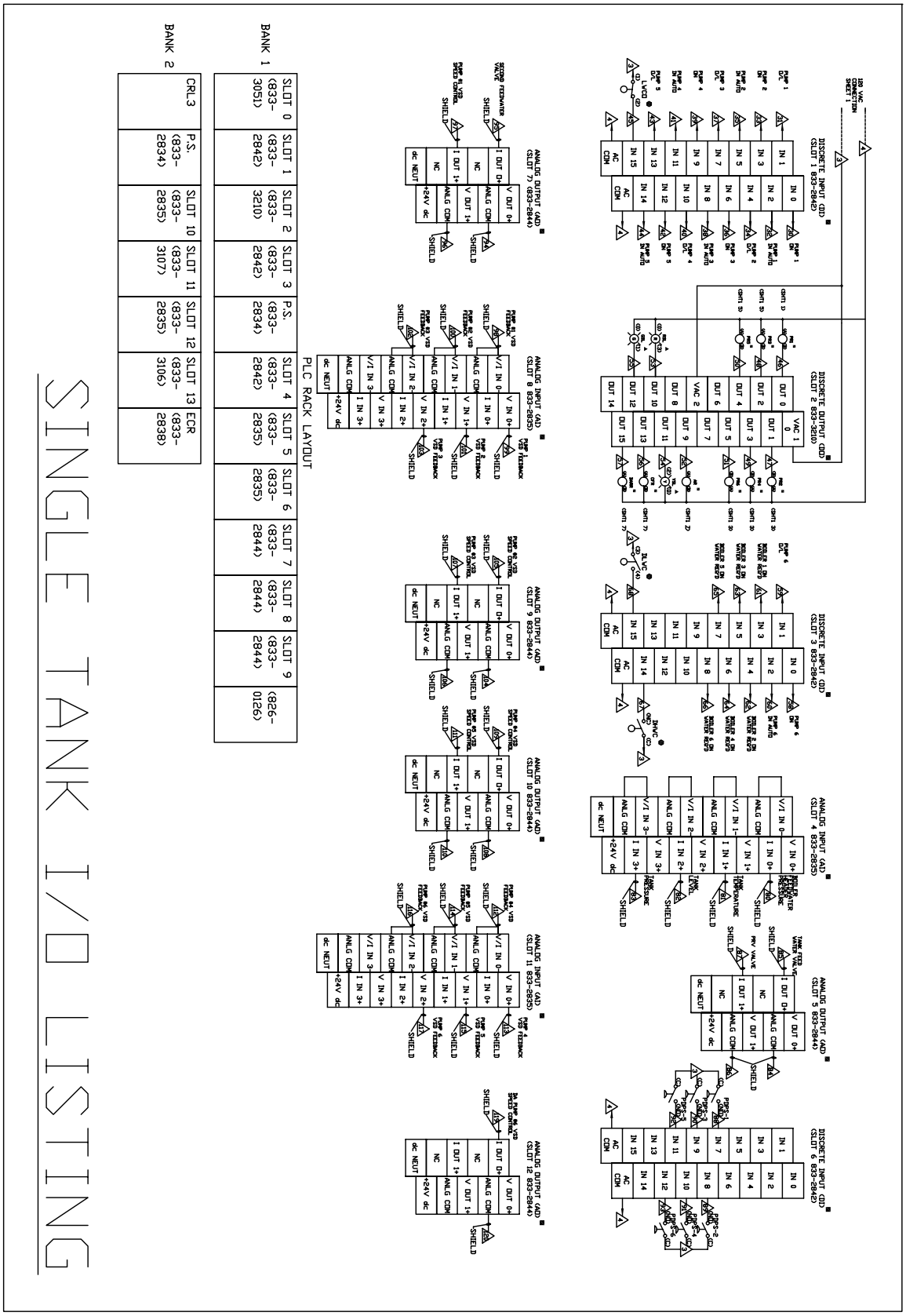
Differential Pressure Level Control and DA Tank Pressure Control (1 of 2)



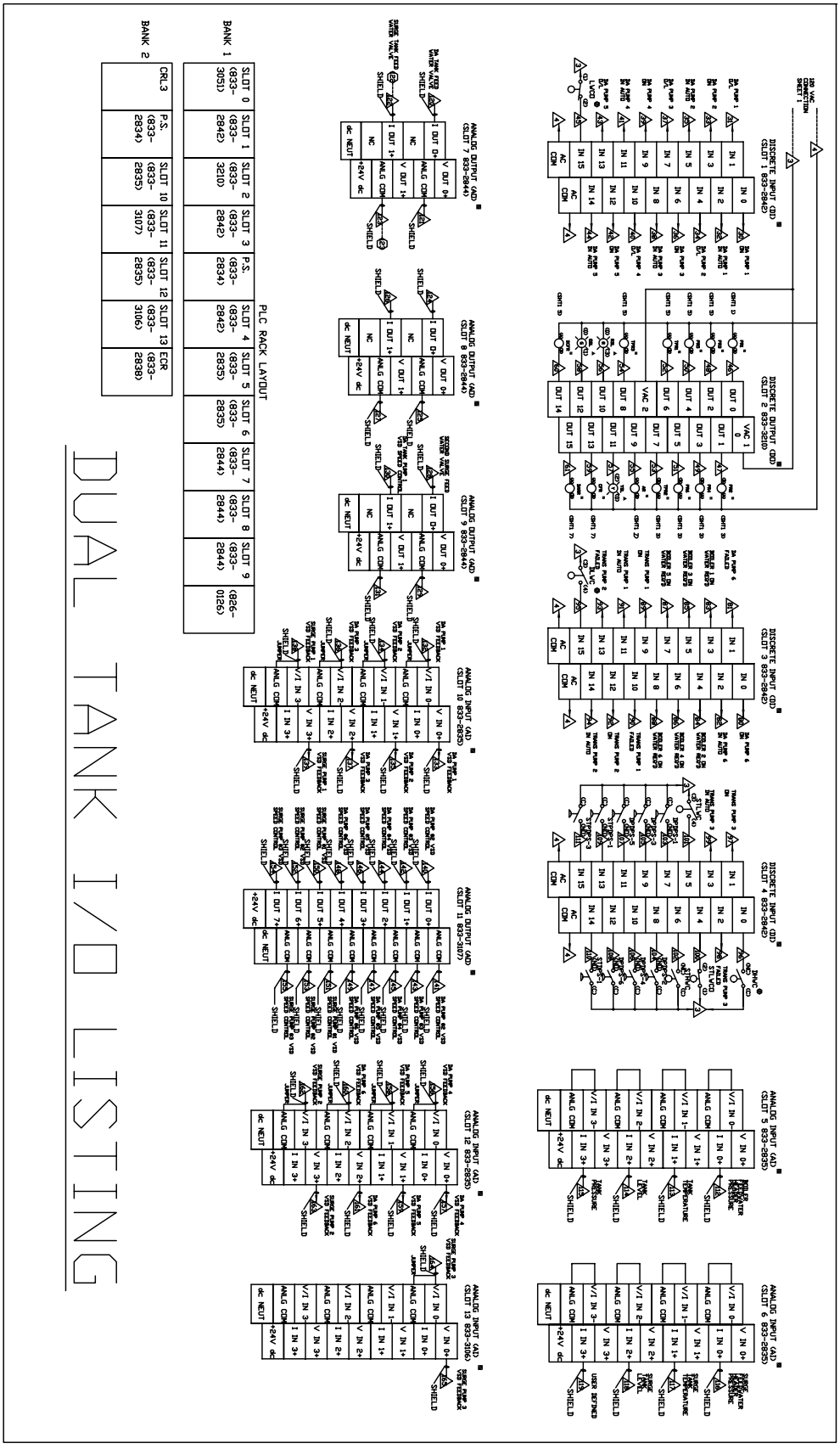
Differential Pressure Level Control and DA Tank Pressure Control (2 of 2)



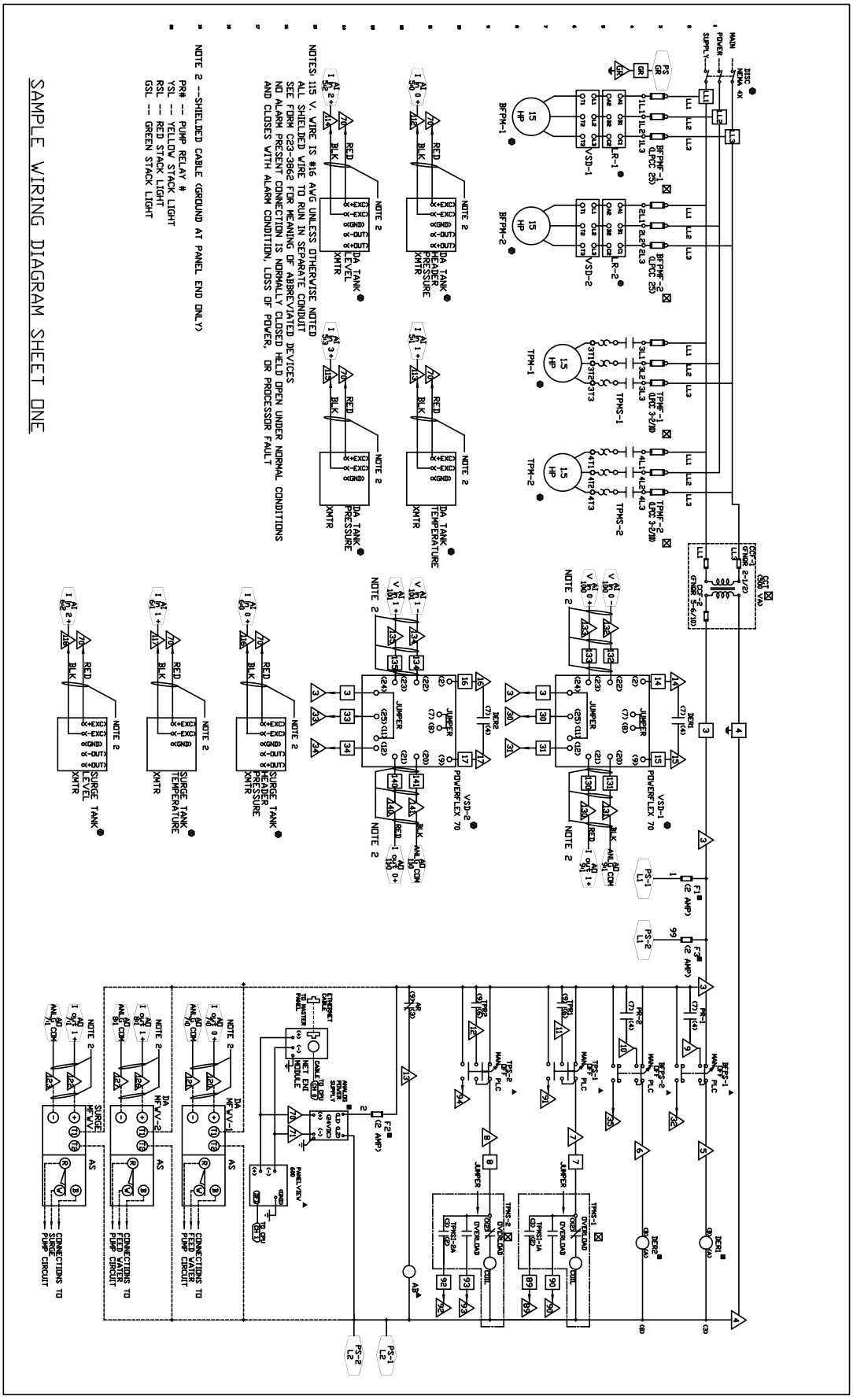
Single Tank I/O Card Layout



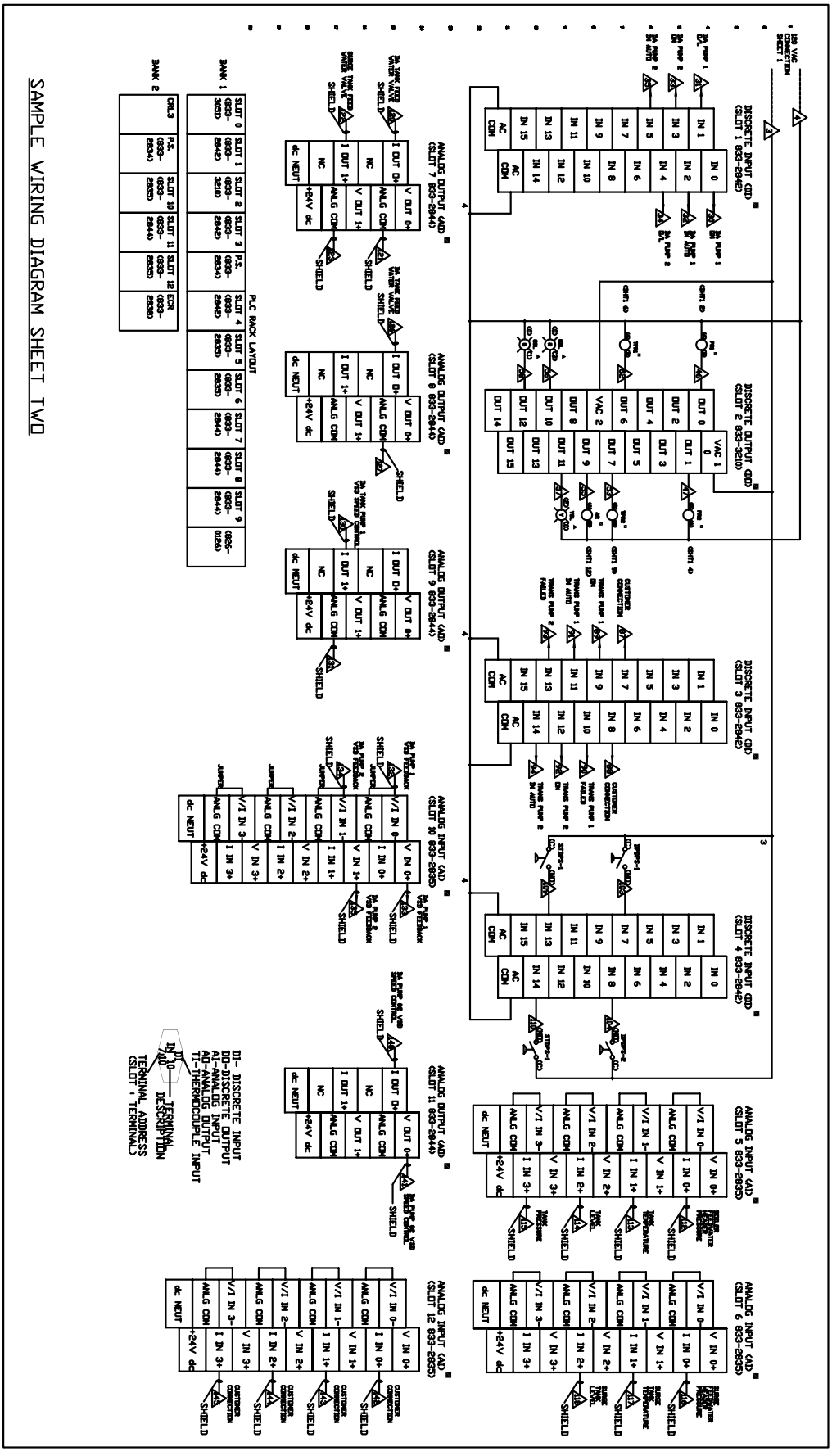
Dual Tank I/O Card Layout



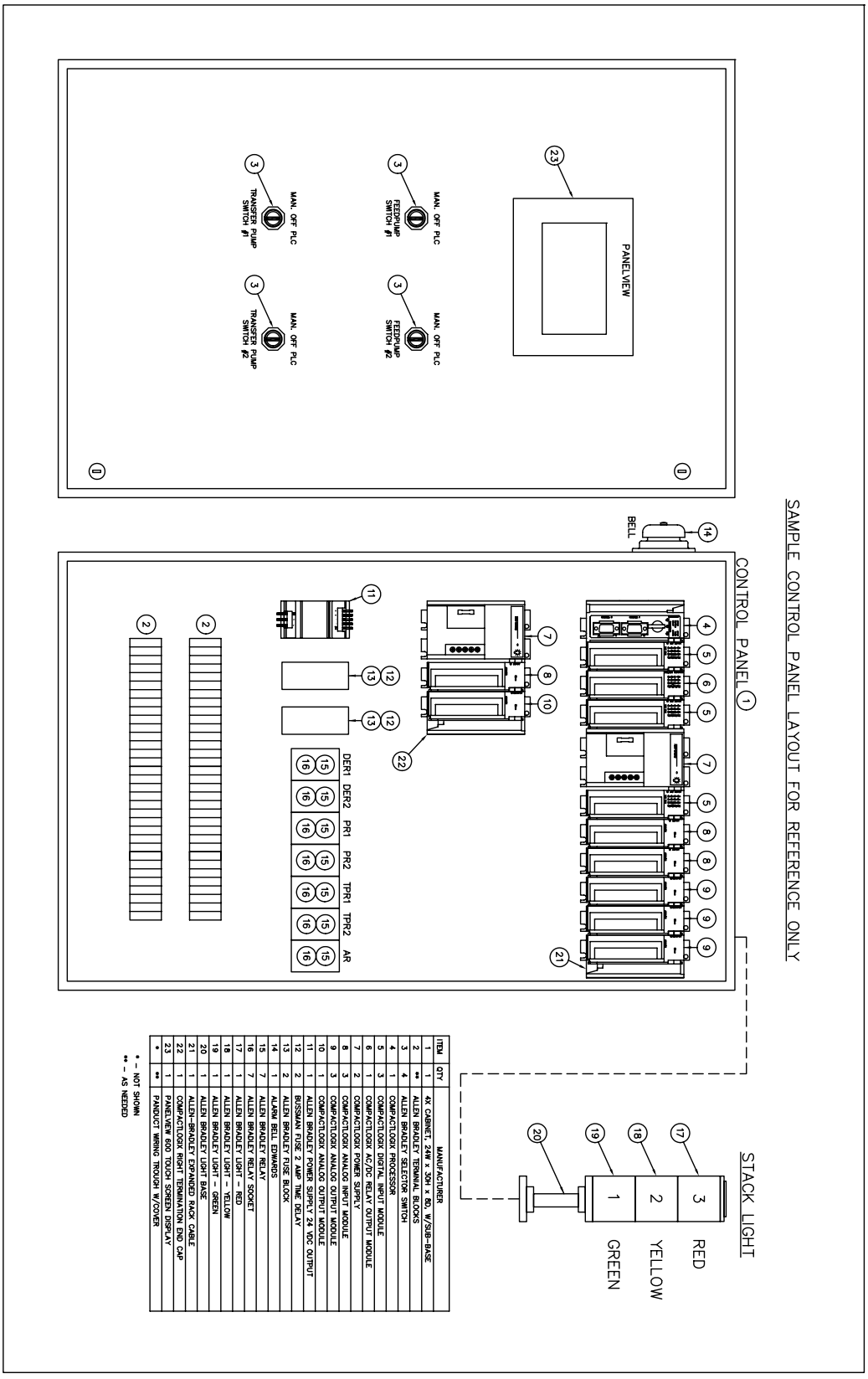
Wiring Diagram (1 of 2)



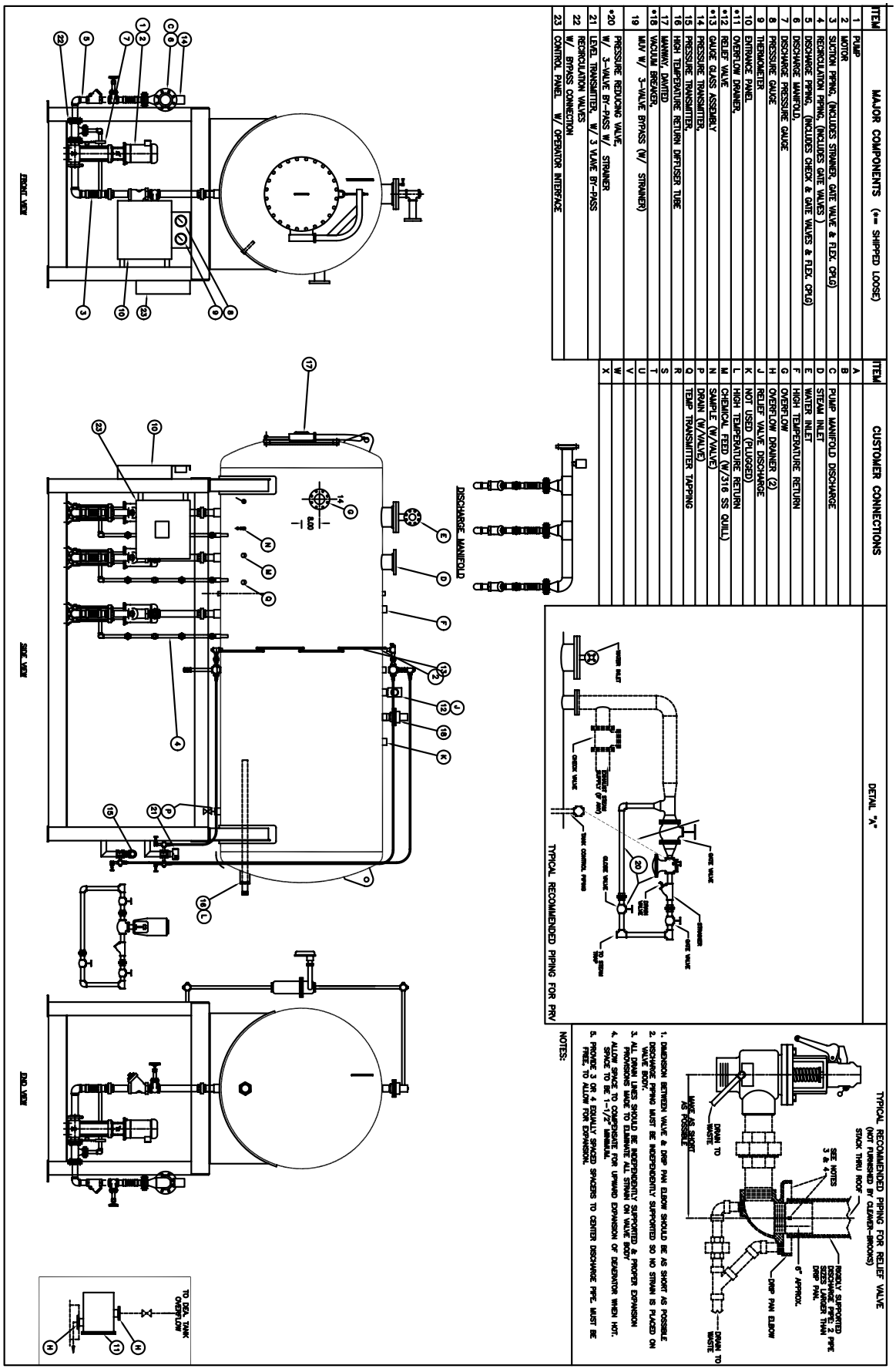
Wiring Diagram (2 of 2)



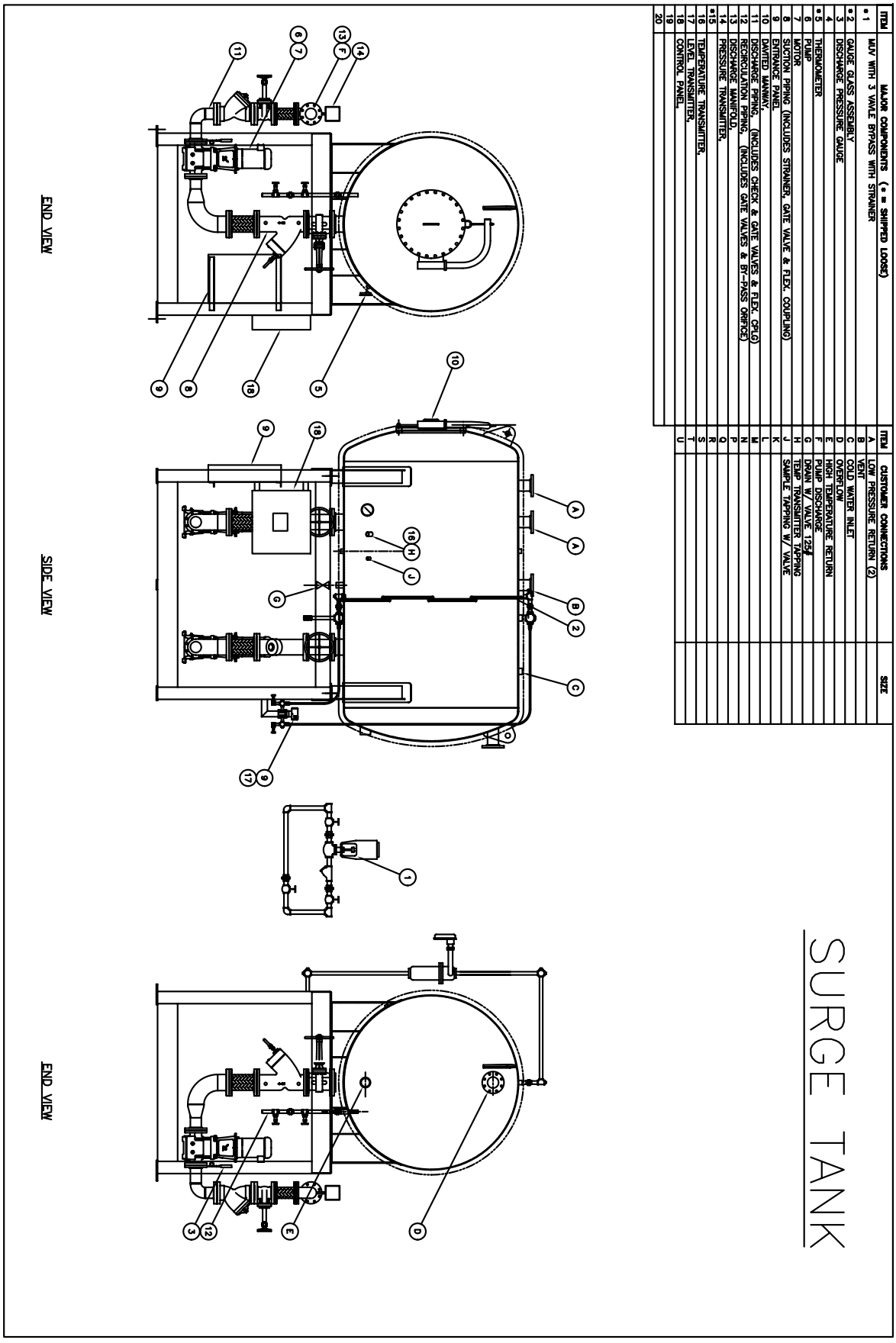
Control Panel Layout



DA Tank


MAJOR COMPONENTS (** SHIPPED LOOSE)
1 PUMP
2 MOTOR
3 SUCTION PIPING, (INCLUDES STRAINER, GATE VALVE & FLEX. CPLG)
4 RECIRCULATION PIPING, (INCLUDES GATE VALVES)
5 DISCHARGE PIPING, (INCLUDES CHECK & GATE VALVES & FLEX. CPLG)
6 DISCHARGE MANIFOLD,
7 DISCHARGE PRESSURE GAUGE
8 PRESSURE GAUGE
9 THERMOMETER
10 ENTRANCE PANEL
**11 OVERFLOW DRAINER,
**12 RELIEF VALVE
**13 GAUGE GLASS ASSEMBLY
14 PRESSURE TRANSMITTER,
15 PRESSURE TRANSMITTER,
16 HIGH TEMPERATURE RETURN DIFFUSER TUBE
17 MANWAY, DIMPLED
**18 VACUUM BREAKER,
19 MIV W/ 3-VALVE BYPASS (W/ STRAINER)
**20 PRESSURE REDUCING VALVE,
W/ 3-VALVE BY-PASS W/ STRAINER
21 LEVEL TRANSMITTER, W/ 3 VALVE BY-PASS
22 RECIRCULATION VALVES
W/ BYPASS CONNECTION
23 CONTROL PANEL W/ OPERATOR INTERFACE
CUSTOMER CONNECTIONS
A
B
C PUMP MANIFOLD DISCHARGE
D STEAM INLET
E WATER INLET
F HIGH TEMPERATURE RETURN
G OVERFLOW
H OVERFLOW DRAINER (2)
J RELIEF VALVE DISCHARGE
K NOT USED (PLUGGED)
L HIGH TEMPERATURE RETURN
M CHEMICAL FEED (W/316 SS QUILL)
N SAMPLE (W/VALVE)
P DRAIN (W/VALVE)
Q TEMP TRANSMITTER TAPPING
R
S
T
U
V
W
X
FRONT VIEW
SIDE VIEW
END VIEW
DISCHARGE MANIFOLD
DETAIL "A"
TYPICAL RECOMMENDED PIPING FOR PRV
TYPICAL RECOMMENDED PIPING FOR RELIEF VALVE
(NOT FURNISHED BY CLEAVER-BROOKS)
STACK THRU ROOF
SEE NOTES 3 & 4
RIGIDLY SUPPORTED DISCHARGE PIPE, 2 PIPE DIAM. LARGER THAN DRIP PAN.
6" APPROX.
DRIP PAN ELBOW
DRAIN TO WASTE
MAKE AS SHORT AS POSSIBLE
NOTES:
1. DIMENSION BETWEEN VALVE & DRIP PAN ELBOW SHOULD BE AS SHORT AS POSSIBLE
2. DISCHARGE PIPING MUST BE INDEPENDENTLY SUPPORTED SO NO STRAIN IS PLACED ON VALVE BODY.
3. ALL DRAIN LINES SHOULD BE INDEPENDENTLY SUPPORTED & PROPER EXPANSION PROVISIONS MADE TO ELIMINATE ALL STRAIN ON VALVE BODY
4. ALLOW SPACE TO COMPENSATE FOR UPWARD EXPANSION OF DEAERATOR WHEN HOT. SPACE TO BE 1-1/2" MINIMUM.
5. PROVIDE 3 OR 4 EQUALLY SPACED SPACERS TO CENTER DISCHARGE PIPE. MUST BE FREE TO ALLOW FOR EXPANSION.
TO DEA. TANK OVERFLOW

Surge Tank



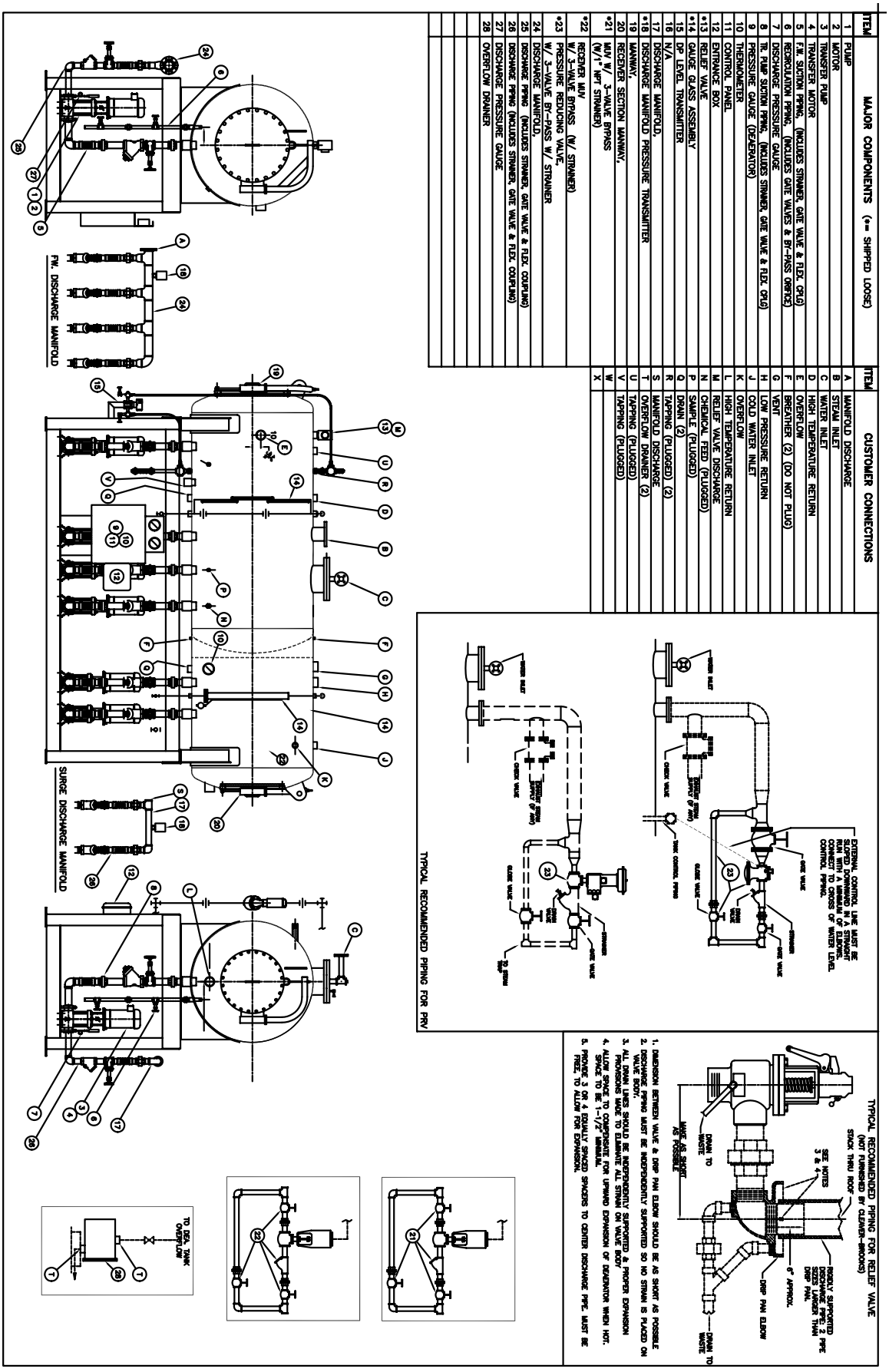
ITEM	MAJOR COMPONENTS (• = SHIPPED LOOSE)
• 1	MUV WITH 3 VALVE BYPASS WITH STRAINER
• 2	GAUGE GLASS ASSEMBLY,
3	DISCHARGE PRESSURE GAUGE
4	THERMOMETER
• 5	PUMP
6	MOTOR
7	SUCTION PIPING (INCLUDES STRAINER, GATE VALVE & FLEX. COUPLING)
8	ENTRANCE PANEL,
9	DAYTED MANWAY,
10	DISCHARGE PIPING, (INCLUDES CHECK & GATE VALVES & FLEX. CPLG)
11	RECIRCULATION PIPING, (INCLUDES GATE VALVES & BY-PASS ORIFICE)
12	DISCHARGE MANIFOLD,
13	PRESSURE TRANSMITTER,
• 14	TEMPERATURE TRANSMITTER,
15	LEVEL TRANSMITTER,
16	CONTROL PANEL,
19	
20	

ITEM	CUSTOMER CONNECTIONS	SIZE
A	LOW PRESSURE RETURN (2)	
B	VENT	
C	COLD WATER INLET	
D	OVERFLOW	
E	HIGH TEMPERATURE RETURN	
F	PUMP DISCHARGE	
G	DRAIN W/ VALVE 125#	
H	TEMP TRANSMITTER TAPPING	
J	SAMPLE TAPPING W/ VALVE	
K		
L		
M		
N		
P		
R		
S		
T		
U		

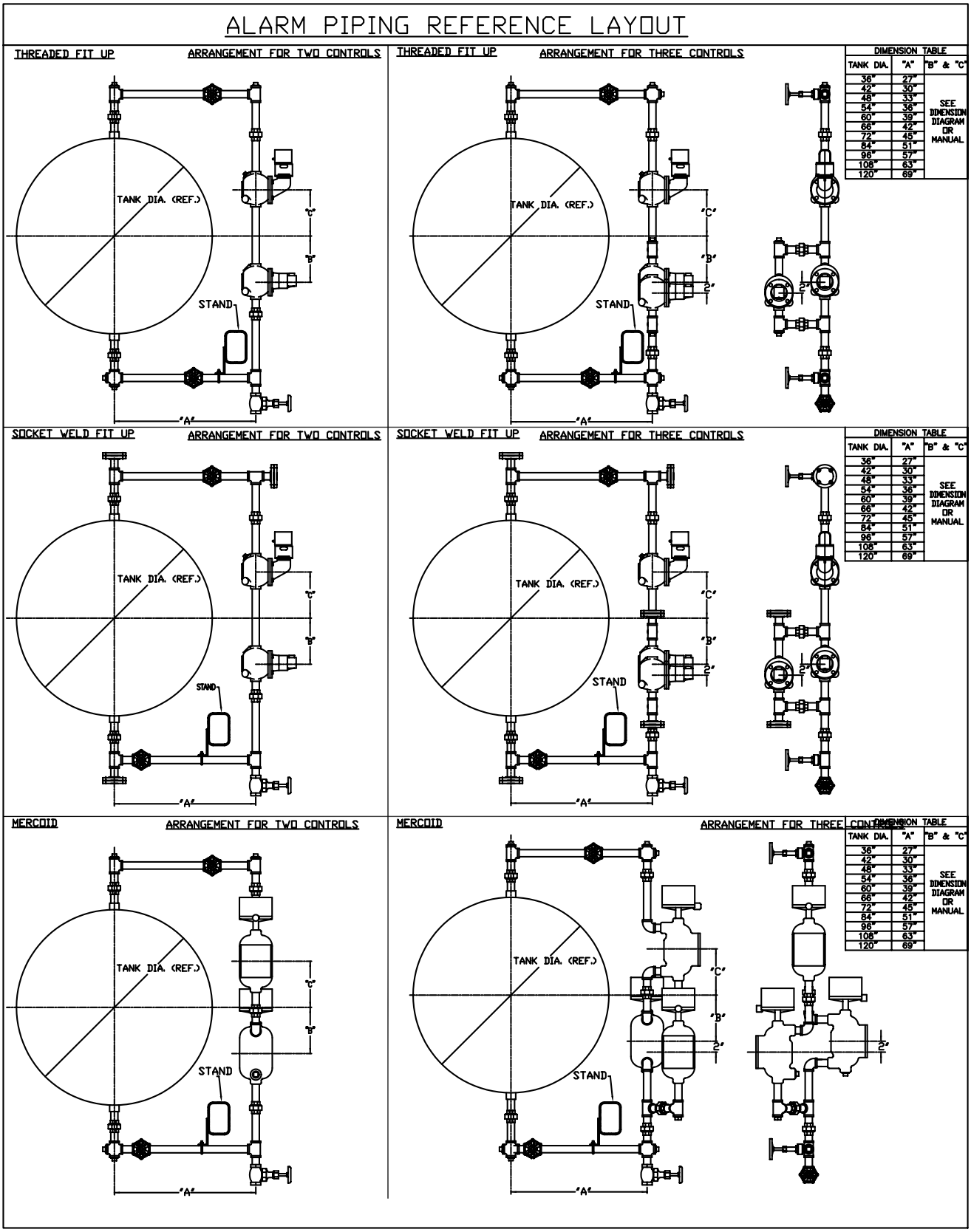
Duo-Tank

ITEM	MAJOR COMPONENTS (* = SHIPPED LOOSE)
1	PUMP
2	MOTOR
3	TRANSFER PUMP
4	TRANSFER MOTOR
5	F.W. SUCTION PIPING, (INCLUDES STRAINER, GATE VALVE & FLEX. CPLG)
6	RECIRCULATION PIPING, (INCLUDES GATE VALVES & BY-PASS ORIFICE)
7	DISCHARGE PRESSURE GAUGE
8	TK. PUMP SUCTION PIPING, (INCLUDES STRAINER, GATE VALVE & FLEX. CPLG)
9	PRESSURE GAUGE (DEAERATOR)
10	THERMOMETER
11	CONTROL PANEL
12	ENTRANCE BOX
*13	RELIEF VALVE
*14	GAUGE GLASS ASSEMBLY
15	DP LEVEL TRANSMITTER
16	N/A
17	DISCHARGE MANIFOLD:
*18	DISCHARGE MANIFOLD PRESSURE TRANSMITTER
19	MANWAY,
20	RECEIVER SECTION MANWAY,
*21	MUV W/ 3-VALVE BYPASS (W/1" NPT STRAINER)
*22	RECEIVER MUV W/ 3-VALVE BYPASS (W/ STRAINER)
*23	PRESSURE REDUCING VALVE, W/ 3-VALVE BY-PASS W/ STRAINER
24	DISCHARGE MANIFOLD,
25	DISCHARGE PIPING (INCLUDES STRAINER, GATE VALVE & FLEX. COUPLING)
26	DISCHARGE PIPING (INCLUDES STRAINER, GATE VALVE & FLEX. COUPLING)
27	DISCHARGE PRESSURE GAUGE
28	OVERFLOW DRAINER

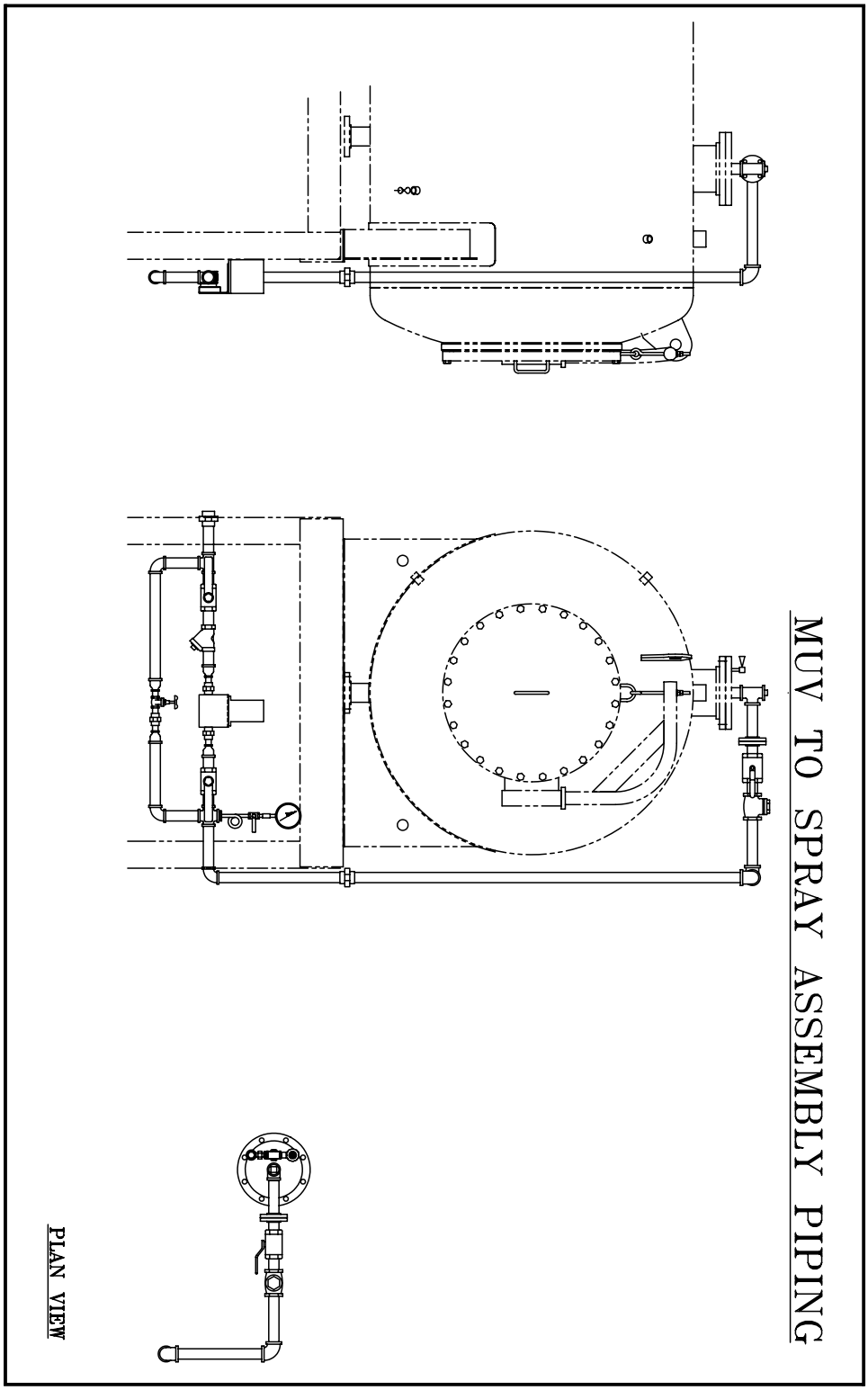
ITEM	CUSTOMER CONNECTIONS
A	MANIFOLD DISCHARGE
B	STEAM INLET
C	WATER INLET
D	HIGH TEMPERATURE RETURN
E	OVERFLOW
F	BREATHER (2) (DO NOT PLUG)
G	VENT
H	LOW PRESSURE RETURN
J	COLD WATER INLET
K	OVERFLOW
L	HIGH TEMPERATURE RETURN
M	RELIEF VALVE DISCHARGE
N	CHEMICAL FEED (PLUGGED)
P	SAMPLE (PLUGGED)
Q	DRAIN (2)
R	TAPPING (PLUGGED) (2)
S	MANIFOLD DISCHARGE
T	OVERFLOW DRAINER (2)
U	TAPPING (PLUGGED)
V	TAPPING (PLUGGED)
W	
X	



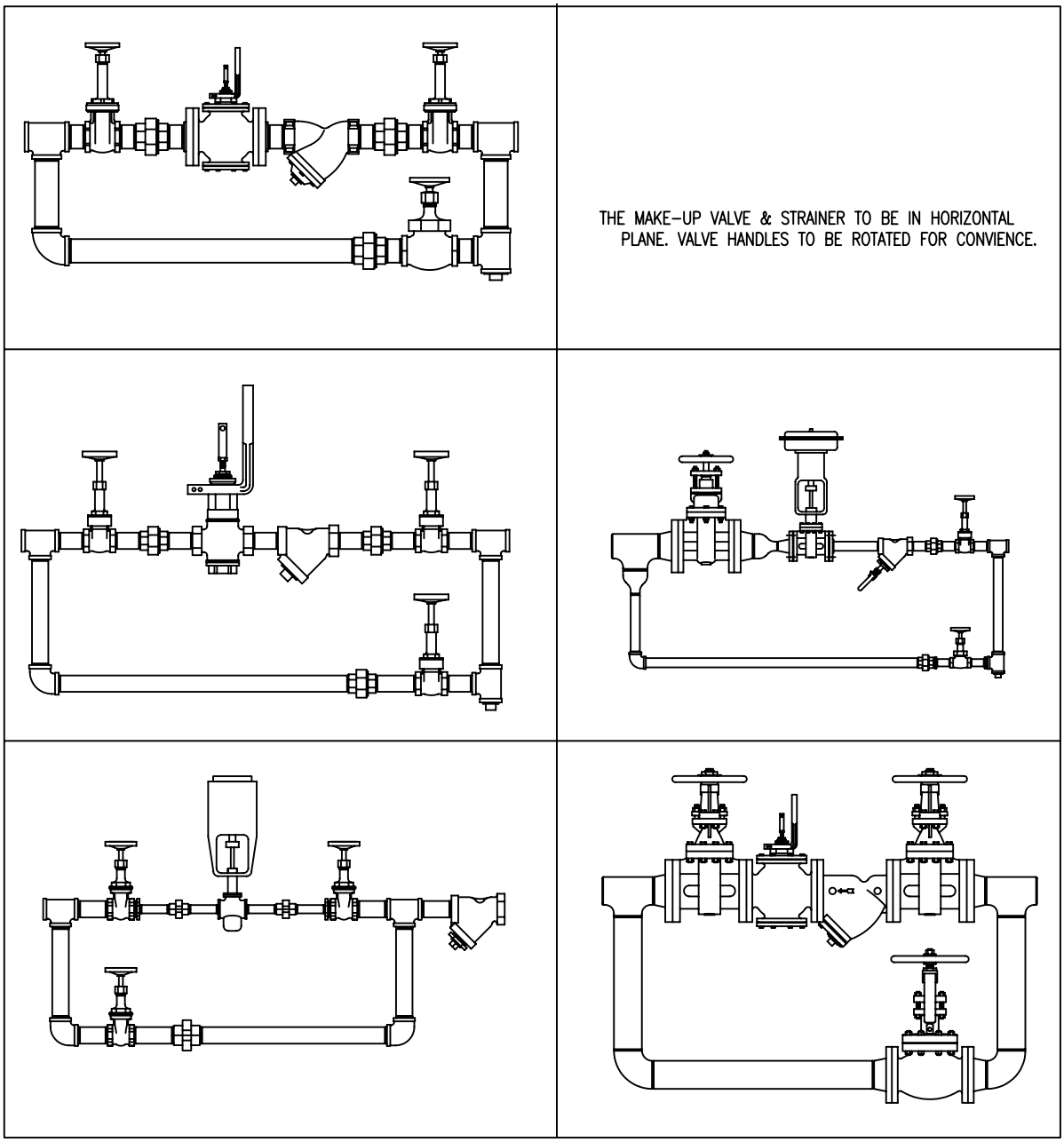
Alarm Piping



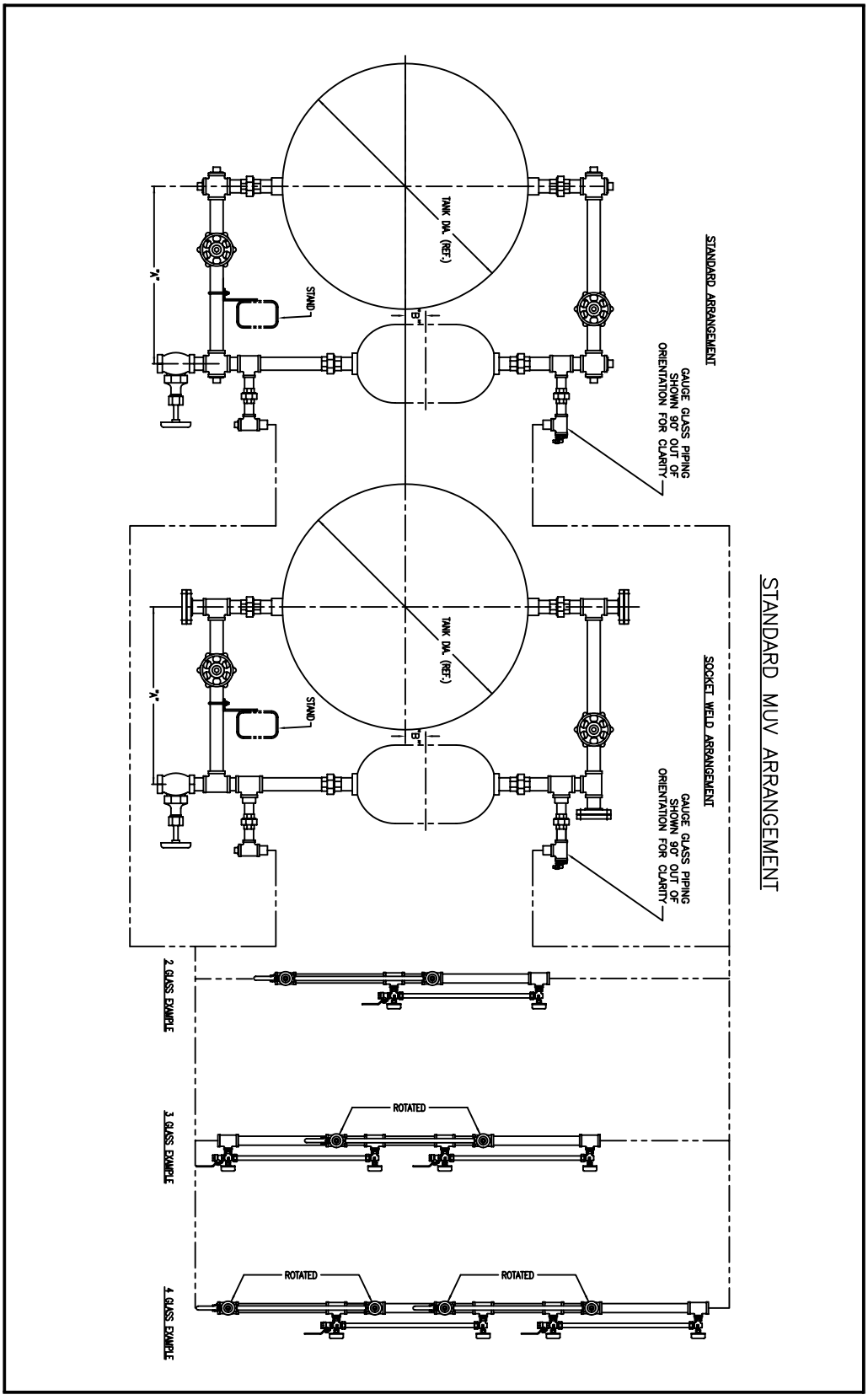
Make-Up Valve (1 of 3)



Make-Up Valve (2 of 3)



Make-Up Valve (3 of 3)

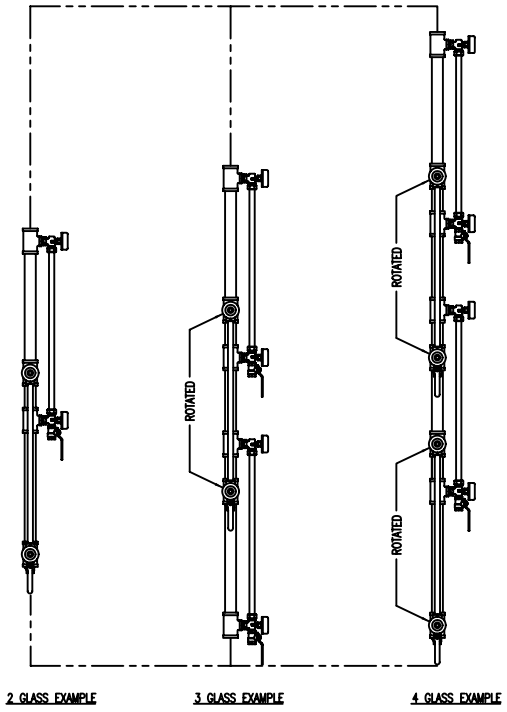


Gauge Glass

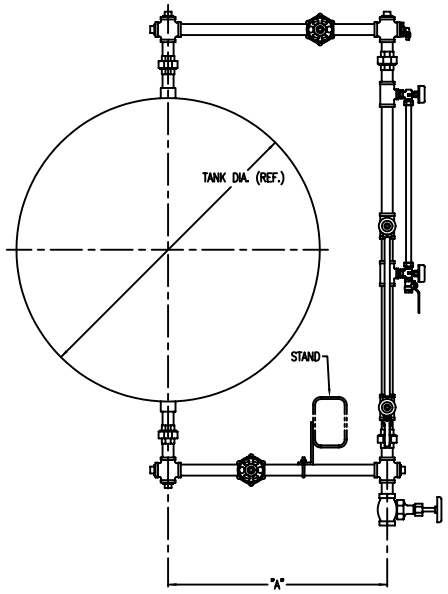
DIMENSION TABLE		
TANK DIA.	"A"	"B"
24"	21"	SEE DIMENSION DIAGRAM OR MANUAL
36"	27"	
42"	30"	
48"	33"	
54"	36"	
60"	39"	
66"	42"	
72"	45"	
84"	51"	
96"	57"	
108"	63"	
120"	69"	

GENERAL NOTES:

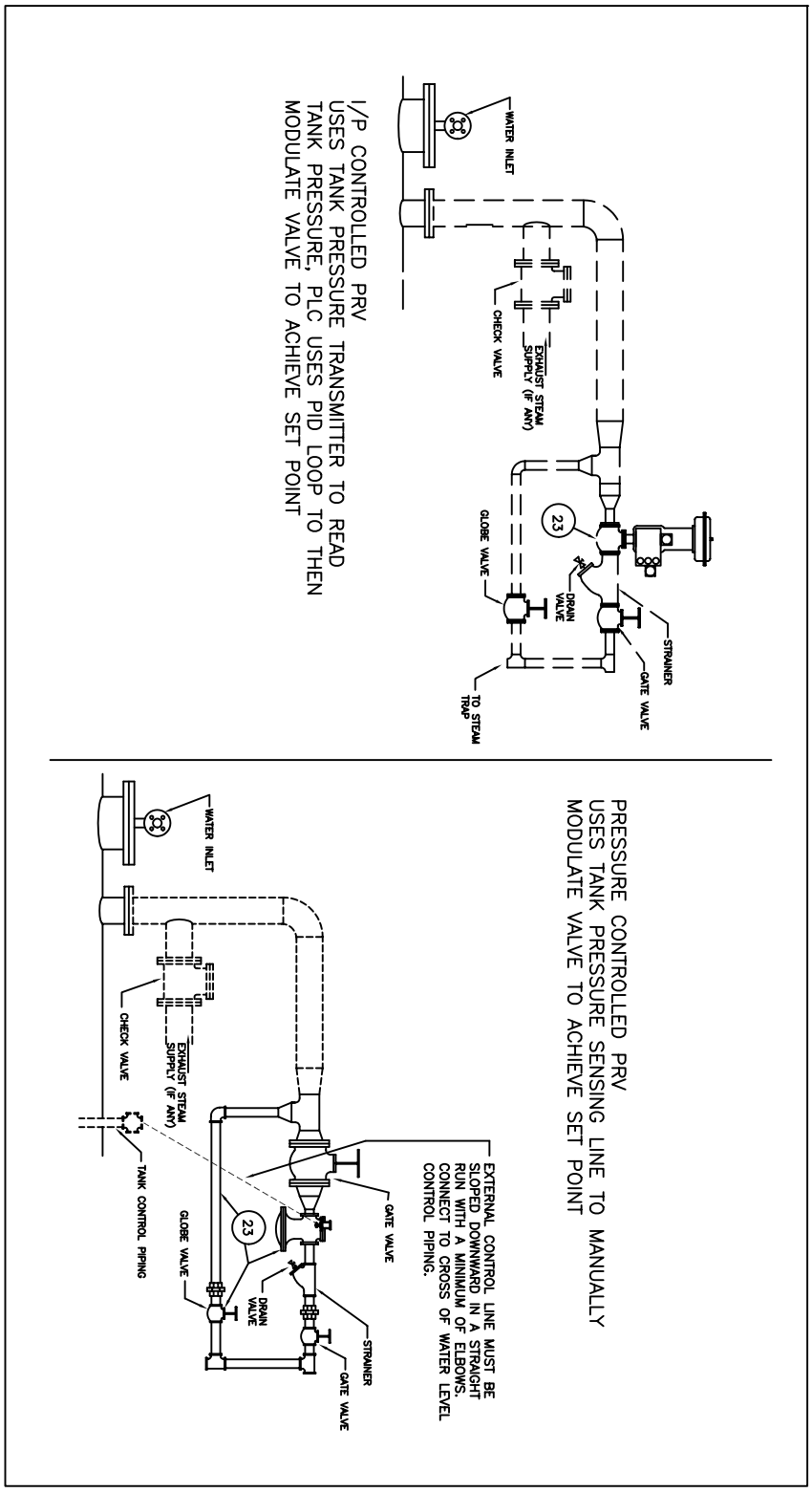
1. WHEN 3 OR MORE GAUGE GLASSES ARE REQUIRED, ONE OR MORE OF THE TEE SETS MUST BE ROTATED 90° FROM THE OTHER(S).
   3 OR 4 GLASSES = 1 ROTATED
   5 OR 6 GLASSES = 2 ROTATED
   7 GLASSES = 3 ROTATED



SPECIAL ARRANGEMENT
(i.e. WHEN USING LEVEL TRANSMITTER OR MUV CONTROLLER BY OTHERS, ETC)



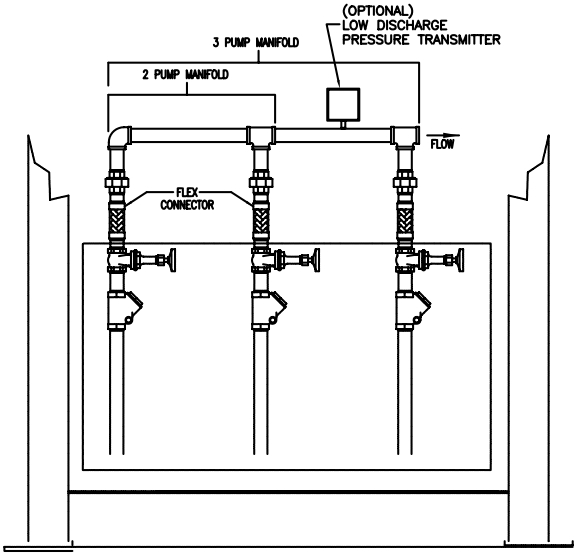
Pressure Reducing Valve



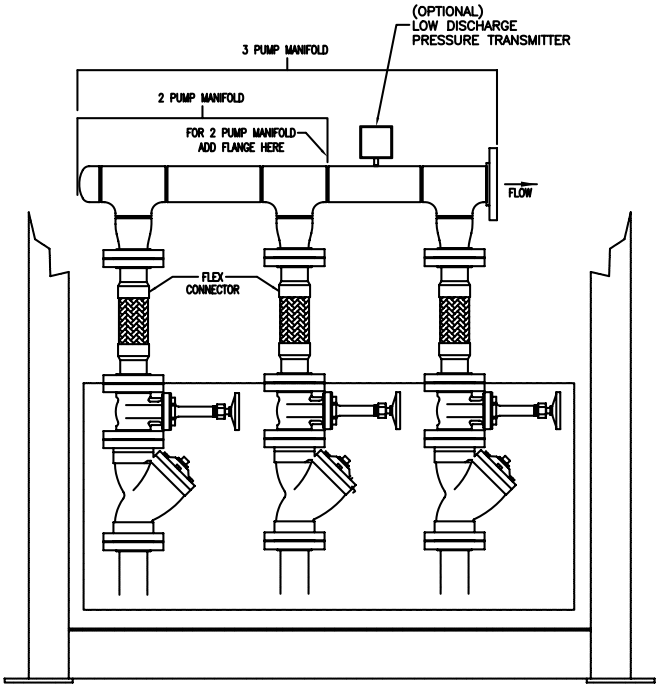
Discharge Manifold

REFERENCE FOR DISCHARGE MANIFOLD PIPING

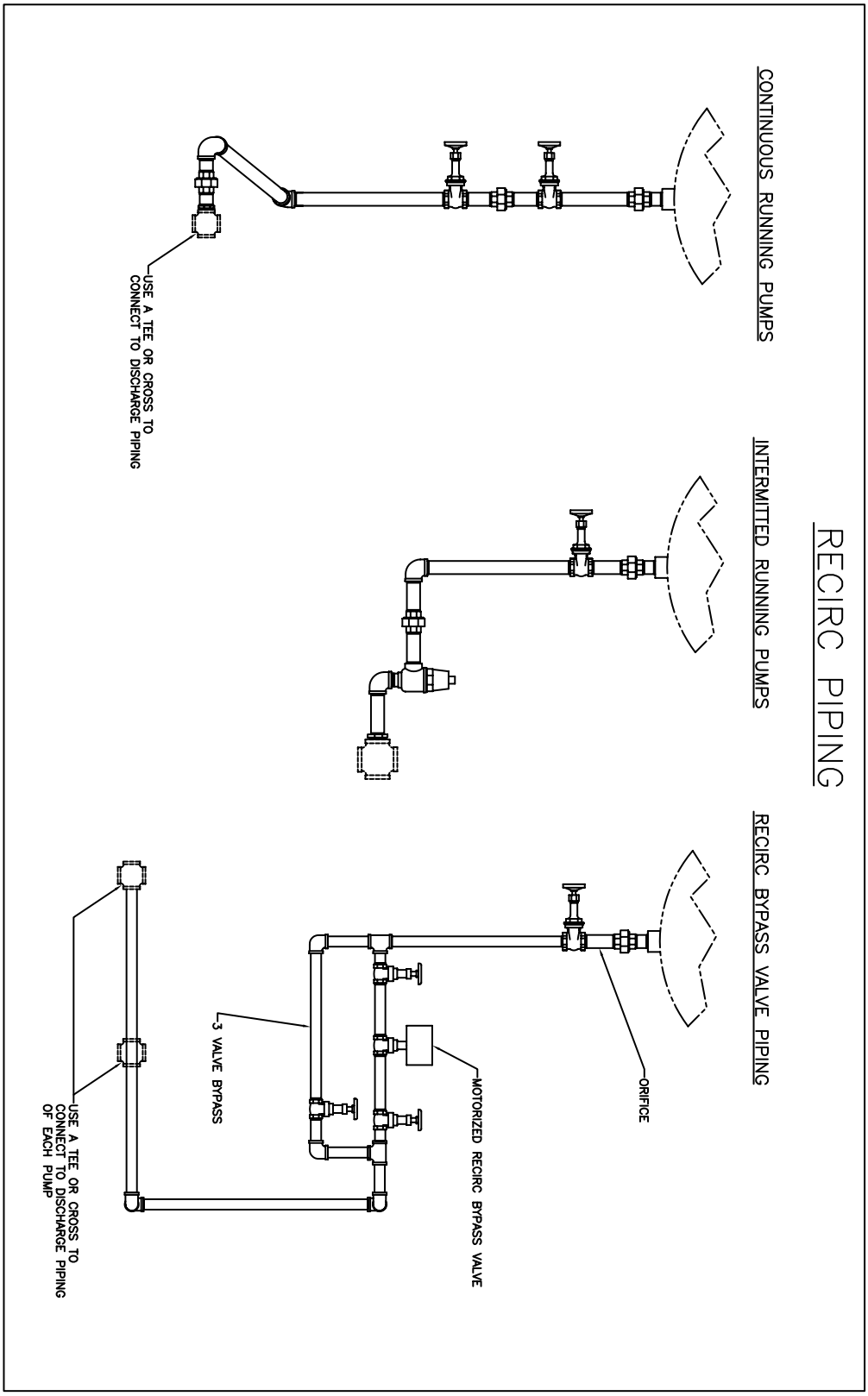
THREADED PIPING
1.) PIPE THREAD SEALENT
A. CLEAN BOTH MALE AND FEMALE THREADS FREE OF OIL GRIME AND THREADED CHIPS.
B. APPLY PIPE JOINT COMPOUND STARTING APPROX. 1/8" FROM END OF PIPE AND BRUSH WELL INTO THREADS FOR APPROX. 3/4 OF THREAD LENGTH. DO NOT USE ON FEMALE THREADS.
NOTE: USE PIPE JOINT COMPOUND HERCULES, REAL-TUFF TEFLON PASTE PART NUMBER 872-542.
2.) SUPPORTS TO BE ADDED AS NECESSARY TO PREVENT PIPING STRAIN ON PUMP.



WELDED PIPING
1.) SUPPORTS TO BE ADDED AS NECESSARY TO PREVENT PIPING STRAIN



Recirculation Piping



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