



# **Control Panel**

## SEQUENCE OF OPERATION

### COMPACTLOGIX CONTROLLER

### XTO-POKER LAKE COMPRESSOR CONTROL SYSTEMS

**Customer :** Exterran

**Project :** Compressor Control Systems

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### Reference Documents

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| 1       | DRAWING  | 50-30-11414     | 0A      |
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| 3       | PROGRAM  | 50-34-11414     | B       |

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## 1. TYPE OF SYSTEM

The control system comprises an Allen-Bradley 1769-L36ERM CompactLogix PAC (Programmable Automation Controller) with an Allen-Bradley PanelView Plus 7 Performance Model 2711P-T15C22D9P 15-inch color touchscreen as HMI (Human-Machine Interface). The HMI monitors all process variables and control devices (Process Overview), provides configuration of all alarm and shutdown setpoints (Process Setpoints), displays all active alarms and shutdowns conditions (Active Alarm Display), and stores a history of the last 1000 alarm or shutdown conditions in chronological order (Alarm History).

Communications between the PLC, HMI, Red Lion RTU Gateway, CAT Controller and remote devices (DCS, MCC) are via managed Ethernet Switch with 8 fast-Ethernet (FE) RJ45 ports and two GE combo ports (SFP fiber optic connection capable).

The HMI has a status banner on every page which shows the operational status of the unit.

The system will be powered by user-supplied 120VAC, single phase, 60 Hz power source. Provision for one combined feed with two separate 20 amp AC/DC power supplies used for 1) System Power and 2) CAT controller power will provide the necessary 24Vdc power for the PLC, HMI and other devices.

The PAC will monitor analog instruments, switch inputs and shutdown the engine / compressor package. The controller will interface with a CAT 3600 Series ADEM 4 engine control panel. Engine data from CAT controller will be displayed on the PanelView Plus 7 thru RTU module communication link.

Provisions to start, stop and reset the compressor control system will be via the HMI interface soft touchbutton. Pressing RESET will clear any non-active alarms or shutdowns.

**Throughout this document, it is understood that when a digital output is acted upon to be energized or de-energized, it will remain in that state until described otherwise due to a process requirement, a Normal Stop, a Fault Shutdown, or an ESD condition**

## 2. CONTROL PANEL POWERUP

When the door mounted System Power On/Off switch is turned to the On position, the PLC, HMI and other internal devices will power up. The user should allow a few minutes for the equipment to power up before attempting to operate the unit.

## 3. SUCTION CONTROL VALVE PID

The Suction Control Valve PID loop has two modes of operation: Auto and Manual.

- **Manual Mode:** Under normal operating conditions, when the Suction Control Valve PID is placed in the Manual mode, the Control Valve 4-20 mA analog output will be ramped to the adjustable 'Valve Manual %' setpoint entered into the "Suction Control Valve – Control Loop" HMI page. This setting can also be changed on the "Suction Control Valve – Control Loop Tuning" HMI page, along with the Manual Rate Increase and Decrease setpoints. The PID will maintain the 'Desired Stand-by Pressure' setpoint while the engine is not running.
- **Auto PID Mode:** The Control Valve 4-20 mA analog output will be controlled by a PID loop calculation. The PID will maintain the 'Desired Stand-by Pressure' setpoint while the engine is

not running, and the 'Desired Running Pressure' setpoint once the engine is confirmed running. If the **Suction Pressure** is below the 'Desired Pressure' setpoint minus the deadband, the Control Valve 4-20 mA analog output will be **commanded to open**. If the **Suction Pressure** is above the 'Desired Pressure' setpoint plus the deadband, the Control Valve 4-20 mA analog output will be **commanded to close**. The PID Tuning parameters can be adjusted in the "Suction Control Valve – Control Loop Tuning" HMI screen. The PID output will range between the 'Min. Loaded Percent' and 'Max. Loaded Percent' setpoints.

In the event of an ESD condition, the Suction Control Valve 4-20 mA analog output will be commanded fully closed.

#### 4. CONTROL VALVE POSITIONER MONITORING

The PAC will monitor the Startup Bypass Valve 2<sup>nd</sup> to 1<sup>st</sup> Stg. and Startup Bypass 4<sup>th</sup> to 1<sup>st</sup> Stg. Valve positions **at all times**. Current valve position will be shown on the Process Overview Page of the HMI.

The controller will initiate a shutdown if the valve fails to reach the desired valve position after issuing an open or close command, or if the controller fails to sense the desired position after issuing an open or close command once the Valve Fail Delay (independent for each valve) expires.

#### 5. UTILITY/PROCESS COOLERS

The MCC VFD motor control is included in the PLC application to control and monitor each cooler motor. The Start/Stop commands will be initiated and running feedback will be monitored for the following devices:

- Utility Cooler Motor #1
- Utility Cooler Motor #2
- Process Cooler Motor #1
- Process Cooler Motor #2

The Utility & Process Coolers 753 VFD will be monitored and controlled thru the CompactLogix PLC by ethernet Network connection.

**Fail to start** alarm diagnostic will be enabled on the MCC motor control if the feedback is not received before the **Fail Delay** expires, the PAC will stop the start sequence if a **Fail to start** alarm occurs.

Once the equipment is confirmed running a **SEQUENCE SHUTDOWN FAULT** will occur if the feedback is lost while the unit is running.

#### 6. UNIT PURGE AND START

Note: The PLC Compressor package incorporate manual process control valves and has no provisions for performing automated process system equipment purging. The compressor package and all relevant piping and equipment must be purged of air prior to starting the compressor unit. This will include the manual override of the Bypass valve output control to properly open and close the valve during the purge operations. It is the responsibility of the operator to verify a complete compressor purge has been satisfied prior to attempting to start the package.

Every time the unit is in the 'Ready to Start' mode and the start pushbutton is Energized, an HMI popup pushbutton will appear asking the operator to confirm that the process system has been successfully purged. Pressing this HMI pushbutton ensures the PLC Compressor Control that it is safe to proceed with starting and running the compressor unit.



The Compressor System **REMOTE ESD** input needs to be Energized. At any time that this signal is lost, the controller will initiate the **SEQUENCE SHUTDOWN FAULT** and an ESD condition will occur.

## 7. COMPRESSOR PRELUBE CHECKS

The Compressor package includes a Hot Start system to provide Prelube capabilities. The Compressor Hot Start Enable output is always Energized when the compressor is not running, except during an ESD, High Oil Temperature or Low Oil Level shutdown conditions. The Compressor Hot Start system has local operator controls that affect its operation. For normal operating conditions, the Hotstart control needs to be put into the "AUTO" position.

The Compressor Oil Pressure will be compared to the Compressor Prelube Pressure Permissive setpoint. While the pressure remains less than the minimum oil pressure permissive, the Compressor Oil Pre-lube Permissive Delay begins timing, the HMI status banner will display:

*Compressor Prelube – Compressor Oil Pressure < Prelube Permissive SP  
Check Compressor Oil Pressure for Hot Start Operation*

The unit will remain in this state until the Compressor Oil Pressure Prelube Permissive is satisfied.

The Compressor Oil Temperature will be compared to the Compressor Prelube Temperature Permissive setpoint. While the temperature remains less than the permissive, the HMI status banner will display:

*Compressor Prelube – Compressor Oil Temp < Prelube Permissive SP  
Check Compressor Oil Temperature for Hot Start operation*

The unit will remain in this state until the Compressor Oil Temperature Prelube Permissive is satisfied.

When the Compressor Oil Pressure and Temperature Prelube Permissive levels are satisfied, then the Compressor Prelube Duration timer will begin counting down. The duration allows the compressor to be lubricated at the proper pressure and temperature for a preset time before CAT Engine is started. While the Compressor Prelube Timer is counting down, the HMI status banner will display:

*Compressor Prelube Duration Timing, ### seconds Remaining*

If the Compressor Oil Pressure, or the Compressor Oil Temperature falls below the permissive setpoints before the Prelube duration timer expires, the unit will SD on "Compressor Prelube Duration Failure". The Prelube permissive and duration timers will reset to zero until pressure and temperature return to normal operating conditions.

During the compressor prelube, the "Compressor prelube permissive fail timer" is monitored continually. If the Compressor Oil Pressure falls below the permissive SP, After the duration timer expires, the unit will generate SD on "Compressor Prelube Permissive Failure". When oil pressure goes below the compressor oil pressure min prelube permissive SP, Prelube duration will have to be satisfied again.

When hotstart has been running for the prelube time, even while the compressor not running the prelube should remain satisfied. The only thing that will make the prelube time restart is loss of oil pressure or hotstart stopping.

The compressor oil pressure and temperature will be continually monitored while the Hotstart unit is in operation to ensure the compressor Prelube is satisfied. When the Compressor Prelube Duration is completed, the sequence will advance to **START PERMISSIVE**.

## 8. START PERMISSIVE

The **Start Permissive** (From PCS) input must be Energized to continue with the sequence. If the permissive input is De-Energized, the HMI status banner will display:

*Compressor Run Permissive Check – Waiting for Permissive from PCS*

Once the permissive input is Energized, the sequence will advance to **READY TO START**. At any time that this signal is lost, and the Compressor System is running, the PAC will initiate the **NORMAL STOP SEQUENCE**.

## 9. READY TO START

NOTE: For a definition of Class A, B1, B2, C, P, S and ESD, please see the **Shutdown/Event Code List** section.

When Prelube and Run Permissives have been met, the HMI status banner will display:

*Unit Ready to Start – Press Local Start PB to Start Unit*

The PLC outputs will be controlled to the following states,

|                                                                        |                                                                                                                               |
|------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| Unit Running - Remote Indication                                       | Not Activated (Not running, Soft Tag)                                                                                         |
| Unit Alarm - Remote Indication                                         | Activated (Not activated on alarm, Soft Tag)                                                                                  |
| Unit Fault Shutdown - Remote Indication                                | Activated (Not Activated on shutdown, Soft Tag)                                                                               |
| Unit Running - Local Indication                                        | Not running (HMI Indication)                                                                                                  |
| Unit Alarm - Local Indication                                          | No alarms (HMI Indication)                                                                                                    |
| Unit Shutdown - Local Indication                                       | No shutdowns (HMI Indication)                                                                                                 |
| CAT Emergency - Stop Command                                           | Energized (no shutdowns, DO Signal)                                                                                           |
| Driven Equipment Ready - Caterpillar ECU to run                        | Energized (no shutdowns, DO Signal)                                                                                           |
| CAT Controller - Start Initiate/Stop                                   | De-Energized (Not running, DO Signal)                                                                                         |
| Compressor Hot Start/Pre-lube - Enable                                 | Energized (enabled to operate, DO Signal)                                                                                     |
| Engine/Coolant Hot – Start                                             | Energized (enabled to operate, DO Signal)                                                                                     |
| Utility Cooler Motor #1 & #2 – Start                                   | Not Activated (stop, Soft Tag)                                                                                                |
| Process Cooler Motor #1 & #2 Start                                     | Not Activated (stop, Soft Tag)                                                                                                |
| CAT ADEM 4 - Auto Speed Control                                        | Ramped to 4 mA (AO 4-20mA Signal)                                                                                             |
| Process Cooler Fan #1 - Speed Control                                  | Ramped to min Speed (Soft Tag)                                                                                                |
| Process Cooler Fan #2 - Speed Control                                  | Ramped to min Speed (Soft Tag)                                                                                                |
| Startup Bypass 2 <sup>nd</sup> to 1 <sup>st</sup> Stage – Open command | Energized (Fully Open, DO Signal)<br>If 4th Stage Discharge Pressure is less than "Unit Depressurization Permissive setpoint" |
| Startup Bypass 4 <sup>th</sup> to 1 <sup>st</sup> Stage – Open command | Energized (Fully Open, DO Signal)<br>If 4th Stage Discharge Pressure is less than "Unit Depressurization Permissive setpoint" |



|                                                                      |                                                                                                                                                                                                               |
|----------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Suction Control Valve PID - Control                                  | SP= Desired Stand-by Pressure (AO 4-20 mA Signal)<br>Suction pressure valve should be fully closed and 1st Stage Suction Pressure should be less than the Minimum Start Suction pressure permissive Setpoint. |
| SOV fuel gas SDV solenoid – Open Command                             | Energized (Fully Open, DO Signal)                                                                                                                                                                             |
| Compressor Hot Start Off Delay- Timer                                | Timer Disabled (Soft Tag)                                                                                                                                                                                     |
| Class B1 and B2 Lockout Delay - Timer                                | Timer Disabled (Soft Tag)                                                                                                                                                                                     |
| Minimum Warmup Duration Timers                                       | Timer Disabled (Soft Tag)                                                                                                                                                                                     |
| Maintenance Reminders – Timer                                        | Timer Disabled (Soft Tag)                                                                                                                                                                                     |
| 1 <sup>st</sup> to 4 <sup>th</sup> Stage Cooler Louver - Control PID | Disabled (AO 4-20 mA Signal)                                                                                                                                                                                  |
| Class C Alarms and Shutdowns                                         | Alarms Disabled (Soft Tag)                                                                                                                                                                                    |

A Unit Start is initiated by pressing the Local Start PB. As described in section 3, after pressing the Local Start PB an HMI popup prompt will appear asking the operator to confirm that the process system has been successfully purged.

|                                                                |        |
|----------------------------------------------------------------|--------|
| <i>Confirm the process system has been successfully Purged</i> |        |
| YES                                                            | CANCEL |

Choosing CANCEL will cancel the start request and remain in the Ready to Start condition. Choosing YES ensures the PLC that it is safe to proceed with starting and running the compressor unit.

Once the process system purge is confirmed, The Startup Bypass 2<sup>nd</sup> to 1<sup>st</sup> Stage (SOV-1111A) output will be energized to fully open the valve and the Startup Bypass 4<sup>th</sup> to 1<sup>st</sup> Stage (SOV-1111B) output will be energized to fully open the valve. The Valve Fail Delay timer will begin counting down.

The Controller will initiate a Shut Down if the valve does not match the Open/Close command.

Once the Bypass Valve Open Limit Switch feedback signals confirm the valves are fully open, the sequence will advance to **Starting Coolers**.

## 10. STARTING COOLERS

When start command output are Activated for the Utility/Process Cooler Motors #1, #2, #3 and #4, the **Run Failure Timer** diagnostic will begin counting down. The HMI status banner will display:

|                                                                                                      |
|------------------------------------------------------------------------------------------------------|
| <i>Utility Coolers - Starting Motor #1, #2, #3 and #4</i><br><i>Run Failure (### seconds Remain)</i> |
|------------------------------------------------------------------------------------------------------|

The Utility/Process Coolers Motors speed must be set to 6 Hz (min speed)

If the Utility/Process Cooler Motors are confirmed running the sequence will advance to **CAT Engine Start**.

The engine should only be started by the CompactLogix L36ERM controller. A shutdown on "UNEXPECTED START" will occur if the engine is started directly from the CAT ADEM 4 controller.

1st stage Suction Pressure must be above minimum suction pressure SP to run the CAT. If the 1st Stage suction pressure falls below the permissive setpoints before the "Minimum Section Pressure Permissive time" duration timer expires, the unit will generate SD "Minimum Section Pressure Not Met".

## 11. CAT ENGINE START

The Engine/Coolant Hot Start output will be de-Energized then the Start Initiate/Stop output is Energized and the Run Failure Delay will begin counting down. The HMI status banner will display:

*Unit Start Initiated – Starting CAT Engine  
Run Failure Delay Timer (### seconds Remain)*

The Start Initiate/Stop to CAT output is energized. If the CAT Engine is not considered running before the Run Failure Delay Timer expires, the unit will shut down under "**CAT Engine Run Failure**".

The Compressor Control System will monitor the Engine Speed from CAT controller by an analog input signal for a speed reference. The monitored RPM needs to be **greater** than the **Unit Running RPM Setpoint**. When the actual speed is greater than the unit running RPM setpoint, the PAC sequence will advance to **WARMUP**.

## 12. RUNNING SEQUENCE

### WARMUP

When the CAT Engine is considered running via Analog feedback input, HMI will indicate that the unit is running. The Warm-up Delay and Compressor Prelube Extended Delay timers will begin timing. The units Run Hours will begin to accumulate.

The Speed Control Mode can be set to **AUTO** or **MANUAL mode**. In either the Auto or Manual mode, the Auto Speed Control to CAT ADEM 4 4-20 mA analog output will be ramped to the adjustable 'Warmup RPM' setpoint. This setpoint can be adjusted on the "Desired Speed to Driver – Control loop" HMI page.

The status banner will display:

*Unit Started – CAT Engine Running  
Minimum Warmup Duration (### seconds Remain)*

When the **Compressor Hot Start Off Delay** timer expires, the Compressor Hot Start Enable output will be De-Energized to disable the compressor Hot Start system.

The status banner will display:

*Unit Started – CAT Engine Running  
Compressor Hot Start off Delay (### seconds Remain)*

The Suction Control Valve PID will start controlling the Suction Valve based on the **Desired Running Pressure Setpoint**. **Suction pressure controller SP must stay as entered by the operator.**



When the **Class B1 Lockout Timer** expires, all **Class B1 shutdowns and alarms** become activated.  
When the **Class B2 Lockout Timer** expires, all **Class B2 shutdowns and alarms** become activated.

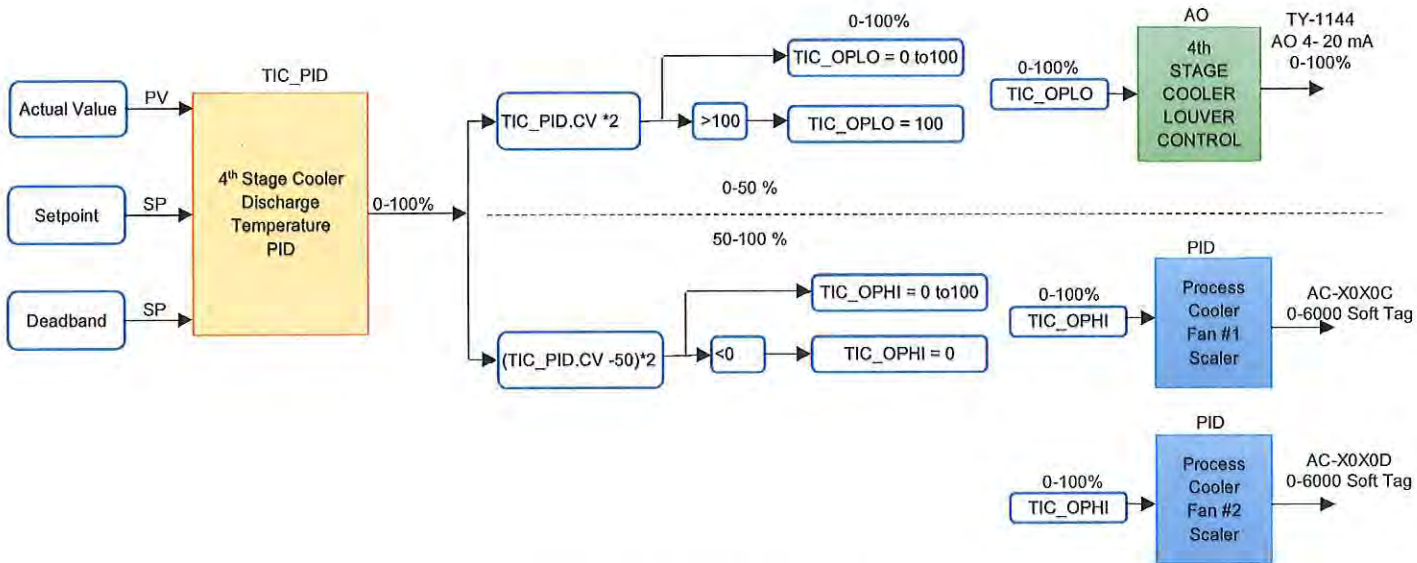
The Compressor Control System continuously monitors the Engine Speed from the CAT controller by the analog input while the engine is running, and will initiate a **"LOSS OF RPM SIGNAL/STALL"** shutdown, if engine speed is lower than the running RPM setpoint.

### 13. COOLER LOUVER AND FAN SPEED CONTROL

**Stage Cooler Louver Control PID (1<sup>st</sup> to 4<sup>th</sup>)** will be enabled and operate in Manual or Auto Control Mode and will be ramped to either the adjustable **Louver Manual Setpoint %** (Manual) or a desired **Discharge Temperature Setpoint** (Auto). Control PID direction will be established as below.-

- ∞ Cooler Discharge Temp < Temp SP –Louver PID to be commanded to close.
- ∞ Cooler Discharge Temp > Temp SP –Louver PID to be commanded to open.

The 4<sup>th</sup> Stage Cooler Louver and Process Cooler Fan #1 Speed Control / Process Cooler Fan #2 Speed Control will be controlled in Split-Range, as shown below:



Split-Range Control PID diagram.

The 4<sup>th</sup> Stage Cooler Discharge Temperature PID will be controlled by a PID loop calculation to maintain the **Discharge Temperature Setpoint**. Control PID direction will be establish as below.-

- ∞ Cooler Discharge Temp < Temp SP – Fan Speed to be commanded to decrease.
- ∞ Cooler Discharge Temp > Temp SP – Fan Speed to be commanded to increase.



The Process Cooler Fan #1 & # 2 Speed Scaler will be enabled and operate in Manual or Auto Control Mode ramped to the adjustable **Process Cooler Fan Manual SP Speed (Manual)** or a Split Range Scaler **Process Cooler Fan SP Speed (Auto)**. The Control PID output will be established as below:

- ∞ The scaler will monitor the 0 – 100% output of the 4<sup>th</sup> Stage Discharge Temperature PID. It will only scale its output, if the Temperature PID is in the range of the 'Input Minimum' and 'Input Maximum' settings. The output will be scaled linearly, according to the **Output Minimum** and **Output Maximum** settings.

Upon transfer from **MANUAL** or **AUTOMATIC** the output will ramp to the correct percentage.

Once the **Warm-Up Timer Delay** expires, the sequence will advance to **ENGINE LOAD PERMISSIVE (ENG OIL TEMPERATURE)**.

#### 14. COMPRESSOR LOAD PERMISSIVE (OIL TEMPERATURE)

Once the **Warm-Up Timer Delay** expires, the sequence will advance to **ENGINE LOAD PERMISSIVE (ENG OIL TEMPERATURE)**.

The Engine Load Permissive Fail timer will begin counting down and the Engine Coolant Temperature and Engine Oil Temperature (via Modbus communications) will be compared to their respective load permissive setpoints.

- While the Engine Coolant Temperature (via Modbus communications) remains less than the Engine Coolant Temperature Load Permissive, the HMI status banner will display

*Unit Running Unloaded – EJW Temp (####.## Deg F) < EJW Temp Load Perm SP  
(####.##DegF)  
Engine Load Permissive Fail Shutdown in:, #### Seconds*

- If the Engine Coolant Temperature remains less than the Engine Jacket Water Temperature Load Permissive Setpoint before the Engine Load Permissive Fail Timer expires, the unit will shut down for '**SD: Time Exceeded for Engine to Run Unloaded - Engine Jacket Water Temperature Load Permissive Failure**'.
- When the Engine Coolant Temperature exceeds the Engine Jacket Water Temperature Load Permissive before the Engine Load Permissive Fail Timer expires, The Engine Oil Temperature will be examined.
- While the Engine Oil Temperature (via Modbus) remains less than the Engine Oil Temperature Load Permissive, the HMI status banner will display

*Unit Running Unloaded – ENG Oil Temp (####.## Deg F) < ENG Oil Temp Load Perm SP  
(####.## DegF)  
Engine Load Permissive Fail Shutdown in:, #### Seconds*

- If the Engine Oil Temperature exceeds the Engine Oil Temperature Load Permissive Setpoint before the Engine Load Permissive Fail Timer expires, the unit will shut down for '**SD: Time Exceeded for Engine to Run Unloaded - Engine Oil Temperature Load Permissive Failure**'.
- If a communication failure occurs before the Engine Load Permissive are met, the HMI status banner will display

|                                                                                                                                                                         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><i>Unit Running Unloaded – ENG Load Permissive Temperatures Unknown, Awaiting Operator<br/>Action<br/>Engine Load Permissive Fail Shutdown in: ##### Seconds</i></p> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

- If the 'LOCAL RESET' pushbutton is pressed during the communication failure, the Engine Load Permissive Temperature requirements will be ignored and the sequence will advance to the Compressor Oil Temperature Load Permissive.
- If the Load Permissive Failure Timer expires while the engine load permissive temps are unknown or less than it's respective set point and the operator has NOT acknowledged via the 'LOCAL RESET' pushbutton, the unit will shut down for '**SD: Time Exceeded for Engine to Run Unloaded - Engine Parameters Unknown**'
- Engine Oil Temperature exceeds the Engine Oil Temperature Load Permissive before the timer expires or the operator has acknowledged a communication failure and decided to proceed with loading, the sequence will advance to **COMPRESSOR LOAD PERMISSIVE (OIL TEMPERATURE)**.
- Once the Engine Oil Temperature exceeds the Engine Oil Temperature Load Permissive before the timer expires or the operator has acknowledged a communication failure and decided to proceed with loading; the Compressor Post-Cooler Oil Temperature will be compared to the Compressor Oil Temperature Load Permissive setpoint and the Unit Load Permissive Fail Timer will continue counting down.

When the Minimum Warmup Duration Timer has expired and the Compressor Oil Temperature remains less than the Compressor Oil Temperature Load Permissive setpoint, the HMI status banner will display

|                                                                                                                               |
|-------------------------------------------------------------------------------------------------------------------------------|
| <p><i>Unit Started – Unit Running on Bypass<br/>Compressor Oil Temp (### Deg) &lt; Load Permissive Setpoint (### Deg)</i></p> |
|-------------------------------------------------------------------------------------------------------------------------------|

Once the Compressor Oil Temperature exceeds the Compressor Oil Temperature Load Permissive setpoint, the Compressor Control System will advance to **UNIT RUNNING – LOAD CONTROL**.

HMI status banner will display

|                                           |
|-------------------------------------------|
| <p><i>Unit Started – Unit Running</i></p> |
|-------------------------------------------|



## 15. UNIT RUNNING-LOAD CONTROL

The Speed Control Mode for CAT ADEM 4 can be set to either **AUTO** or **MANUAL** mode. In either Auto or Manual Mode, the Speed control analog output is ramped to the **Min. Load RPM Setpoint**. This setpoint can be adjusted on the “Desired Speed to Driver – Control loop” HMI page.

The ‘Failed to Load Delay’ timer will begin timing, and a **Press to Load** HMI Pushbutton will appear, allowing the operator to complete the load sequence once the remaining process valves are in their appropriate positions. The HMI will display:

|                                                                                                                                    |
|------------------------------------------------------------------------------------------------------------------------------------|
| Unit Running – Unit Unloaded<br>Press Load to Close Startup Bypass Valve and Load Unit, Fail to Load<br>Timer (### seconds Remain) |
|------------------------------------------------------------------------------------------------------------------------------------|

When the operator is ready to continue loading the compressor and the Minimum Load RPM Setpoint is satisfied. If “Press to Load” button is not initiated by operator before the ‘Failed to Load Delay’ timer time duration expires, the unit will generate SD “**Fail to Load**”

When the operator is ready to continue loading the compressor and the **Min. Load RPM Setpoint** is satisfied before the ‘Failed to Load Delay’ timer times out, the operator presses the Load touch button.

The Startup Bypass Valve Solenoid 2<sup>nd</sup> to 1<sup>st</sup> Stage will be De-Energized to close the Startup Bypass Valve.

While the Startup Bypass Valves are closing, the HMI status banner will display:

|                                                                   |
|-------------------------------------------------------------------|
| Unit Running – Loading Initiated<br>Closing Startup Bypass Valves |
|-------------------------------------------------------------------|

Once the position of the Startup Bypass 2<sup>nd</sup> to 1<sup>st</sup> Stage is confirmed closed via its limit switch position, the Startup Bypass 4<sup>th</sup> to 1<sup>st</sup> Stage output will be De-Energized to fully close the valve.

Once the Startup Bypass Valve 4<sup>th</sup> to 1<sup>st</sup> Stage is confirmed closed via its limit switch status, the Compressor Control System will consider the compressor fully loaded. The HMI status banner will display:

|                            |
|----------------------------|
| Unit Running – Unit Loaded |
|----------------------------|

The Class C Alarms and Shutdowns will be enabled, the Speed Control PID will be enabled and can be operated on **Manual/Auto Control Mode**. With Manual mode the Speed Control to CAT Engine analog output will ramp to the **Manual RPM Setpoint**. With Auto Mode the Speed Control to CAT Engine analog output will be controlled by a PID loop calculation to maintain the **Desired Suction Pressure Setpoint** or **Desired 4<sup>th</sup> Stage Discharge Pressure Setpoint**.

If the **Suction Pressure** is selected the PID setpoint will be calculated to maintain the **Suction Pressure**. Control PID direction will be establish as below:

- ∞ **Suction Pressure < Pressure SP – Engine Speed commanded to decrease.**
- ∞ **Suction Pressure > Pressure SP – Engine Speed commanded to increase.**

If **4<sup>th</sup> Stage Discharge Pressure** is selected the PID setpoint will be calculated to maintain the **Discharge Pressure**. Control PID direction will be establish as below:

- ∞ Discharge Pressure < Pressure SP– Engine Speed commanded to increase.
- ∞ Discharge Pressure > Pressure SP– Engine Speed commanded to decrease.

The PID output will range between the **Min. and Max. Loaded RPM Setpoints**.

The Compressor will remain running and loaded state until one of the following conditions apply:

- Normal Stop is initiated (Local or Remote) or the Start Permissive is lost,
- A Shutdown condition occurs (see list of shutdowns), or
- An ESD signal is generated (Local or Remote).

## 16. NORMAL STOP

A normal Stop is initiated by using the Local PB / Remote Stop signal input or if the Start Permissive signal is lost while the engine is considered running.

When a normal stop is initiated, The HMI status banner will display:

*Unit Stop Initiated – Unit Stop in progress*

The Class B1, B2 and C shutdowns are disarmed.

- If the Speed Control Mode is set to either **AUTO** or **MANUAL**, the Auto Speed Control to CAT ADEM 4 4-20 mA analog output is ramped to the adjustable COOLDOWN RPM setpoint. This setpoint can be adjusted on the “Desired Speed to Driver – Control loop” HMI page.

The Split-Range Control for the Process Cooler Fan #1 Speed and Process Cooler Fan #2 Speed Control 4-20 mA analog outputs will be ramped to 4 mA.

The Startup Bypass 4th to 1st Stage output will be energized to keep the valve fully open and Once the Startup Bypass Valve 4th to 1st Stage is confirmed open via its limit switch status, and After Cooldown timer is expired and If 4th Stage Discharge Pressure is less than “Unit De-pressurization Permissive setpoint” the Startup Bypass 2nd to 1st Stage output will be energized to keep the valve fully open (2nd to 1st Stage Cooler Louver Control 4-20 mA analog outputs will be commanded open).

The **Cooldown Delay Timer** will start once the above conditions are met. If unit has never loaded, do not require timed Cooldown. The HMI status banner will display:

*Unit Stop Initiated – Unit Stop in progress  
Cooldown (### seconds Remain)*

Once the **Cooldown Delay Timer** expires, the Compressor Control System will initiate the following conditions.

|                                         |                                                 |
|-----------------------------------------|-------------------------------------------------|
| Unit Running - Remote Indication        | Not Activated (Not running, Soft Tag)           |
| Unit Alarm - Remote Indication          | Activated (Not Activated on alarm, Soft Tag)    |
| Unit Fault Shutdown - Remote Indication | Activated (Not Activated on shutdown, Soft Tag) |
| Unit Running - Local Indication         | Not running (HMI Indication)                    |
| Unit Alarm - Local Indication           | No alarms(HMI Indication)                       |



|                                                                        |                                                                                                                                                                                                           |
|------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Unit Shutdown - Local Indication                                       | No shutdowns (HMI Indication)                                                                                                                                                                             |
| CAT Emergency - Stop Command                                           | Energized (no shutdowns, DO Signal)                                                                                                                                                                       |
| Driven Equipment Ready - Caterpillar ECU to run                        | Energized (no shutdowns, DO Signal)                                                                                                                                                                       |
| CAT Controller - Start Initiate/Stop                                   | De-Energized (Not running, DO Signal)                                                                                                                                                                     |
| Compressor Hot Start/Pre-lube - Enable                                 | Energized (enabled to operate, DO Signal)                                                                                                                                                                 |
| Engine/Coolant Hot – Start                                             | Energized (enabled to operate, DO Signal)                                                                                                                                                                 |
| Utility Cooler Motor #1 & #2 – Start                                   | De-Energized (stop, Soft Tag)                                                                                                                                                                             |
| Process Cooler Motor #1 & #2 Start                                     | De-Energized (stop, Soft Tag)                                                                                                                                                                             |
| CAT ADEM 4 - Auto Speed Control (Cool down Speed)                      | Ramped to 4 mA (AO 4-20mA Signal)                                                                                                                                                                         |
| Process Cooler Fan #1 - Speed Control                                  | Ramped to min Speed (Soft Tag)                                                                                                                                                                            |
| Process Cooler Fan #2 - Speed Control                                  | Ramped to min Speed (Soft Tag)                                                                                                                                                                            |
| Startup Bypass 2 <sup>nd</sup> to 1 <sup>st</sup> Stage – Open command | Energized (Fully Open, DO Signal)                                                                                                                                                                         |
| Startup Bypass 4 <sup>th</sup> to 1 <sup>st</sup> Stage – Open command | Energized (Fully Open, DO Signal)                                                                                                                                                                         |
| Suction Control Valve PID - Control                                    | SP= Desired Stand-by Pressure (AO 4-20mA Signal) Suction pressure valve should be fully closed and 1st Stage Suction Pressure should be less than the Minimum Start Suction pressure permissive Setpoint. |
| SOV fuel gas SDV solenoid – Open Command                               | Energized (no shutdowns, DO Signal) (Fully Open)                                                                                                                                                          |
| Compressor Hot Start Off Delay- Timer                                  | Timer Disabled (Soft Tag)                                                                                                                                                                                 |
| Class B1 and B2 Lockout Delay - Timer                                  | Timer Disabled (Soft Tag)                                                                                                                                                                                 |
| Minimum Warmup Duration Timers                                         | Timer Disabled (Soft Tag)                                                                                                                                                                                 |
| Maintenance Reminders – Timer                                          | Timer Disabled (Soft Tag)                                                                                                                                                                                 |
| 1 <sup>st</sup> to 4 <sup>th</sup> Stage Cooler Louver - Control PID   | Disabled (AO 4-20mA Signal)                                                                                                                                                                               |
| Class C Alarms and Shutdowns                                           | Alarms Disabled (Soft Tag)                                                                                                                                                                                |

The HMI status banner will display:

*Unit Ready to Start – Press Local Start PB to Start Unit*

## 17. FAULT SHUTDOWN (UNEXPECTED SHUTDOWN)

When a fault shutdown occurs, the Start Initiate/Stop to CAT, the Driven Equipment Ready, and the Cooler Motor Start #1 and #2 outputs will be immediately de-energized. The Process Cooler Motor #1 and #2 Start outputs will also immediately de-energize. This will signal the CAT panel to stop the engine and that the controller has detected a fault shutdown. No 'Cooldown Delay' will occur.

**NOTE: If the engine fails to stop within 30 seconds, the CAT Emergency Stop output will be de-energized to force a stop on the engine, otherwise it will remain energized.**

The Class B1, B2 and C shutdowns are disarmed.

The Startup Bypass 4<sup>th</sup> to 1<sup>st</sup> Stage output will be energized to keep the valve fully open.

The **De-Pressurization Delay Timer** will start to monitor the 4th Stage discharge pressure.

Once the Startup Bypass Valve 4th to 1st Stage is confirmed open via its limit switch status and 4th Stage discharge pressure should be less than "Unit De-pressurization Permissive setpoint". The Startup Bypass 2nd to 1st Stage output will be energized to keep the valve fully open.

Once the Depressurization time expired, if the 4th Stage discharge pressure greater than "Unit De-pressurization Permissive setpoint". The unit will SD on the "**Fail to Depressurized**" message.

- The Auto Speed Control to CAT ADEM 4 4-20 mA analog output is set at 4 mA.

The 1<sup>st</sup> Stage through 4<sup>th</sup> Stage Cooler Louver Control 4-20 mA analog outputs will be commanded closed.

The Split-Range Control for the Process Cooler Fan #1 Speed and Process Cooler Fan #2 Speed Control 4-20 mA analog outputs will be ramped to 4 mA.

The HMI status banner will display:

|                             |
|-----------------------------|
| <i>Unit Shutdown Exists</i> |
|-----------------------------|

The Compressor Control System will initiate the following conditions:

|                                                                        |                                                                                                      |
|------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| Unit Running - Remote Indication                                       | Not Activated (Not running, Soft Tag)                                                                |
| Unit Alarm - Remote Indication                                         | Activated (De-energized on alarm, Soft Tag)                                                          |
| Unit Fault Shutdown - Remote Indication                                | Not Activated (Soft Tag)                                                                             |
| Unit Running - Local Indication                                        | Not running (HMI Indication)                                                                         |
| Unit Alarm - Local Indication                                          | No alarms(HMI Indication)                                                                            |
| Unit Shutdown - Local Indication                                       | Shutdowns (HMI Indication)                                                                           |
| CAT Emergency - Stop Command                                           | Energized (no shutdowns, DO Signal)                                                                  |
| Driven Equipment Ready - Caterpillar ECU to run                        | De-Energized (DO Signal)                                                                             |
| CAT Controller - Start Initiate/Stop                                   | De-Energized (Not running, DO Signal)                                                                |
| Compressor Hot Start/Pre-lube - Enable                                 | Energized (enabled to operate, DO Signal)                                                            |
| Engine/Coolant Hot – Start                                             | Energized (enabled to operate, DO Signal)                                                            |
| Utility Cooler Motor #1 & #2 – Start                                   | De-Energized (stop, Soft Tag)                                                                        |
| Process Cooler Motor #1 & #2 Start                                     | De-Energized (stop, Soft Tag)                                                                        |
| CAT ADEM 4 - Auto Speed Control                                        | Ramped to 4 mA (AO 4-20mA Signal)                                                                    |
| Process Cooler Fan #1 - Speed Control                                  | Ramped to min Speed (Soft Tag)                                                                       |
| Process Cooler Fan #2 - Speed Control                                  | Ramped to min Speed (Soft Tag)                                                                       |
| Startup Bypass 2 <sup>nd</sup> to 1 <sup>st</sup> Stage – Open command | Energized (Fully Open, DO Signal)                                                                    |
| Startup Bypass 4 <sup>th</sup> to 1 <sup>st</sup> Stage – Open command | Energized (Fully Open, DO Signal)                                                                    |
| Suction Control Valve PID - Control                                    | Ramped to 4 mA (AO 4-20 mA Signal)<br>Suction pressure control valve fully Closed if it is shutdown. |
| SOV fuel gas SDV solenoid – Close Command (DO)                         | De-Energized (DO Signal)                                                                             |



|                                                                                   | De-Energized (Fully Closed, DO Signal) |
|-----------------------------------------------------------------------------------|----------------------------------------|
| Compressor Hot Start Off Delay- Timer                                             | Timer Disabled (Soft Tag)              |
| Class B1 and B2 Lockout Delay - Timer                                             | Timer Disabled (Soft Tag)              |
| Minimum Warmup Duration Timers                                                    | Timer Disabled (Soft Tag)              |
| Maintenance Reminders – Timer                                                     | Timer Disabled (Soft Tag)              |
| 1 <sup>st</sup> to 4 <sup>th</sup> Stage Cooler Louver - Control PID (AO 4-20 mA) | Disabled (AO 4-20 mA Signal)           |
| Class C Alarms and Shutdowns                                                      | Alarms Disabled (Soft Tag)             |

If the fault-shutdown was caused by a Low Compressor Oil Level, a Low Compressor Oil Pressure, or a High Compressor Oil Temperature the Compressor Hotstart/Pre-lube output will be de-energized.

If the fault-shutdown was caused by a Low Engine Oil Level or a Low Engine Jacket Water Level, the Engine/Coolant Hotstart output will be de-energized.

After the shutdown condition has been corrected and a unit reset is performed by pressing the Local Reset PB, the PLC will return to the "Compressor Prelube" state. The HMI status banner will display:

*Unit Ready to Start – Press Local Start PB to Start Unit*

## 18. ESD SHUTDOWN

In the case of an ESD shutdown, all the discrete outputs will become disabled and all analog output 4-20mA control signals will be driven to 4mA.

The HMI status banner will display:

*Unit ESD – Emergency Shutdown*

After the ESD shutdown has been cleared and a unit reset is performed by pressing the Local Reset PB, the PLC will return to the "Compressor Prelube" state. The HMI status banner will display:

*Unit Ready to Start – Press Local Start PB to Start Unit*

## 19. PLC OUTPUT FORCING (MANUAL OVERRIDE)

When no ESD shutdown conditions exist, and no Unit Start has been initiated, the user has the ability to Force the Compressor PLC outputs via the HMI from the Manual Override screen

## 20. TEST MODE

Test mode screen and links on the HMI will be visible to authorized login.

While the Unit is running, it may be placed in Test Mode by pressing the Start Individual Test Mode or Start Global Test Mode touchbuttons on the Test Mode screen. The Test Mode can be finalized by pressing the Stop Test touchbutton. If additional test time is required, press Reset touchbutton. All shutdowns must be cleared before the test timer expires or prior to finalizing the test mode otherwise a shutdown will occur.

Once either mode is selected individual or global, the Test Mode Timer will start counting down, a Test Mode Active indication will appear on the HMI screen header and a Test Mode Initiated message

will be entered into the Alarm list. All shutdowns identified as Class A, B1, B2, C, P or S may be tested without shutting down the unit. All shutdowns designated as Class ESD or A/S will not be locked out during Test Mode and may still trigger shutdowns.

## **21. GENERAL VALVE OPERATION**

All PLC controlled process valves are considered spring return type with one solenoid (open or close).

When the control sequence commands a particular valve to activate, the control output will be Energized and a valve open or close fail timer will begin counting down. If the correct limit switch status is not satisfied before the timer expires the unit will be shutdown under valve's open or close failure.

When the control sequence commands a particular valve to de-activate, the control output will be De-Energized and a valve open or close fail timer will begin counting down. If the correct limit switch status is not satisfied before the timer expires the unit will be shutdown under valve's open or close failure.

Applicable Valves:

- Startup Bypass 2<sup>nd</sup> to 1<sup>st</sup> Stage Valve (Fail Close, Energize to Open)
- Startup Bypass 4<sup>th</sup> to 1<sup>st</sup> Stage Valve (Fail Close, Energize to Open)
- External signal fuel gas SDV (Fail Close, Energize to Open)

## **22. GENERAL MOTOR CONTROL OPERATION**

For PLC-controlled VFD motor outputs with running feedback (PLC link communication), when the motor is commanded to Energize, its motor run failure timer will begin counting down. If its auxiliary feedback is not closed before the timer expires, the unit will shutdown under its motor run failure.

Applicable Motors:

- Utility Cooler Motor #1 & #2
- Process Cooler Motor #1 & #2

## **23. EXTERNAL PROCESS VARIABLES**

The following signals will be added on the Compressor Control System.-

- FIT-FuelGas – External mounted fuel gas meter (sick 500) mounted at the edge of skid by XTO. Analog Input signal (4-20 mA) scaled 0-1000 mscf/D will be displayed on the HMI.
- PIT-StartAir – Externally mounted pressure transmitter (4-20 mA) on the start air piping to each unit. Analog Input signal (4-20 mA) scaled 0-200 PSIG downstream of the PCV and tied to a PID loop with an output PY\_StartAir driving a DVC on the PCV maintaining 120 PSI.
- PY-Start Air – Analog output signal (4-20 mA) tied to the start air PIC driving PCV-Start air.



- SOV-Fuel Gas – Digital Output signal to the fuel gas SDV solenoid. This will be initiated on a unit ESD (local or Remote) or after the shutdown timer has expired, reset normally if unit is not in ESD.
- ZSO-Fuel Gas – Position limit open for fuel gas SDV.
- ZSC Fuel Gas – Position limit closed for fuel gas SDV.

## 24. ROD LOAD CALCULATIONS

Road Load Calculation screen and links on the HMI will be visible to authorized login.

Compressor Rod Load under the Ariel calculation method are performed by the Compressor PLC for each throw of the compressor. Rod Load calculations include Tension, Compression and Total.

### Double Acting Cylinders

$$RL_c = (A_{he} \times p_{di}) - (A_{ce} \times p_{si}) - (A_{rod} \times p_{atm})$$

$$RL_t = (A_{ce} \times p_{di}) - (A_{he} \times p_{si}) + (A_{rod} \times p_{atm})$$

Where,

$RL_c$  = internal compression gas rod load, lbf

$RL_t$  = internal tension gas rod load, lbf

$A_{he}$  = head end area,  $\left( \frac{\pi \times D_{cyl}^2}{4} \right)$ , in  $in^2$ , where  $D_{cyl}$  is the cylinder diameter, in inches

$A_{ce}$  = crank end area,  $(A_{he} - A_{rod})$ , in  $in^2$ .

$A_{rod}$  = rod area,  $\left( \frac{\pi \times D_{rod}^2}{4} \right)$ , in  $in^2$ , where  $D_{rod}$  is the rod diameter, in inches

Formula to calculate Pressure Loss Factor.

$$KP_s = (p_{si} + p_{atmo}) / (p_{sflg} + p_{atmo})$$

$$KP_d = (p_{di} + p_{atmo}) / (p_{dflg} + p_{atmo})$$

Formula to Calculate the Pressure Loss Factor in %.

$$PL_s = ABS ((1-KP_s)*100)$$

$$PL_d = ABS ((1-KP_d)*100)$$

LP = designation for low pressure cylinder or stage

HP = designation for high pressure cylinder or stage

$PL_s$  = suction pressure loss, in %

$PL_d$  = discharge pressure loss, in %

$p_{sflg}$  = flange suction pressure, in psia

$p_{dflg}$  = flange discharge pressure, in psia

$p_{si}$  = internal suction pressure, in psia

$p_{di}$  = internal discharge pressure, in psia

$p_{atm}$  = atmospheric pressure, in psi

$KP_s$  = suction pressure loss factor  
 $KP_d$  = discharge pressure loss factor  
 $p_{atmo}$  = Pressure Atmospheric

High alarm and shutdown functions are provided for rod load in compression, tension and total, which is compression and tension combined. Rod load setpoints are settable on the throw's rod load setpoints screen.

## 25. ALARM AND SHUTDOWN FUNCTIONS

The following table defines the signal function and abbreviation:

| Abbreviation | Signal Function                 |
|--------------|---------------------------------|
| AL           | Alarm                           |
| SD           | Shutdown                        |
| IND          | Indication (value display only) |
| CTL          | Control                         |

The following table defines the Shutdown/Alarm classes:

| Class | Description                                                                                                                                                                                                                                   |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ESD   | Emergency Shutdown, monitored at all times<br>Class ESD shutdowns are not affected by Test Mode (testing not permitted)                                                                                                                       |
| A     | Monitored at all times<br>Class A shutdowns are affected by Test Mode (testing permitted)                                                                                                                                                     |
| A/S   | Monitored at all times.<br>Class A/S shutdowns are not affected by test mode (testing not permitted)                                                                                                                                          |
| B1    | Not monitored during startup and become active after the Class B1 Lockout Delay has expired.<br>The Class B1 Lockout Delay starts counting down when the unit is running.<br>Class B1 shutdowns are affected by Test Mode (testing permitted) |
| B2    | Not monitored during startup and become active after the Class B2 Lockout Delay has expired.<br>The Class B2 Lockout Delay starts counting down when the unit is running.<br>Class B2 shutdowns are affected by Test Mode (testing permitted) |
| P     | Monitored once the unit is Running – Load Control Enabled.<br>Class P shutdowns are affected by Test Mode (testing permitted)                                                                                                                 |
| C     | Monitored when a certain process condition has been cleared for at least two seconds and the Class B1 Lockout Delay has expired.<br>Class C shutdowns are affected by Test Mode (testing permitted)                                           |
| S     | Monitored when a certain process condition is satisfied.<br>Class S shutdowns are affected by Test Mode (testing permitted)                                                                                                                   |
| DB    | Delay time to compensate switch bounce.                                                                                                                                                                                                       |

An up arrow (↑) signifies rising or increasing effect on signal

A down arrow (↓) signifies falling or decreasing effect on signal



| ID # | DESCRIPTION                                 | Device Tag     | Type     | Range (AI)<br>(TC)<br>Type (DI) | SD/AL/IND<br>CTL/MSG | Class | Factory Setpoint            |
|------|---------------------------------------------|----------------|----------|---------------------------------|----------------------|-------|-----------------------------|
| 1    | LOCAL EMERGENCY STOP SHUTDOWN               | ESD-LOCAL      | Discrete | NC                              | SD                   | ESD   | N/A                         |
| 2    | CAT PANEL SHUTDOWN                          | CAT_FAIL_CLASS | Discrete | NC                              | SD                   | A     | N/A                         |
| 3    | SPARE DI03 SHUTDOWN                         | CR             | Discrete | NC                              | SD                   | B1    | N/A                         |
| 4    | LUBE NO-FLOW LEFT BANK                      | FSL-1152       | Discrete | NC                              | SD                   | B1    | N/A                         |
| 5    | LUBE NO-FLOW RIGHT BANK                     | FSL-1151       | Discrete | NC                              | SD                   | B1    | N/A                         |
| 6    | LOW COMPRESSOR OIL LEVEL                    | LSLL-1150      | Discrete | NC                              | SD                   | A     | N/A                         |
| 7    | LOW ENGINE OIL LEVEL                        | LSLL-1160      | Discrete | NC                              | SD                   | A     | N/A                         |
| 8    | LOW ENGINE JACKET WATER LEVEL               | LSLL-1182      | Discrete | NC                              | SD                   | A     | N/A                         |
| 9    | LOW AUXILIARY WATER LEVEL                   | LSLL-1181      | Discrete | NC                              | SD                   | A     | N/A                         |
| 10   | HIGH 1ST STG SCRUB LIQ LVL                  | LSHH-1111      | Discrete | NC                              | SD                   | A     | N/A                         |
| 11   | HIGH 2ND STG SCRUB LIQ LVL                  | LSHH-1121      | Discrete | NC                              | SD                   | A     | N/A                         |
| 12   | HIGH 3RD STG SCRUB LIQ LVL                  | LSHH-1131      | Discrete | NC                              | SD                   | A     | N/A                         |
| 13   | HIGH 4TH STG SCRUB LIQ LVL                  | LSHH-1141      | Discrete | NC                              | SD                   | A     | N/A                         |
| 14   | HIGH FUEL GAS DIFF PRS                      | DPSHH-1171     | Discrete | NC                              | SD                   | B1    | N/A                         |
| 15   | UTILITY COOLER MOTOR #1 FEEDBACK LOST       | -              | Logic    | N/A                             | SD                   | S     | N/A                         |
| 16   | UTILITY COOLER MOTOR #2 FEEDBACK LOST       | -              | Logic    | N/A                             | SD                   | S     | N/A                         |
| 17   | PROC COOLER MOTOR #1 FEEDBACK LOST          | -              | Logic    | N/A                             | SD                   | S     | N/A                         |
| 18   | PROC COOLER MOTOR #2 FEEDBACK LOST          | -              | Logic    | N/A                             | SD                   | S     | N/A                         |
| 19   | STARTUP BYP 2ND TO 1ST STG FAILED TO OPEN   | ZSO-1111A      | Discrete | NO                              | SD                   | N/A   | N/A                         |
| 20   | STARTUP BYP 2ND TO 1ST STG FAILED TO CLOSED | ZSC-1111A      | Discrete | NO                              | SD                   | N/A   | N/A                         |
| 21   | STARTUP BYP 4TH TO 1ST STG FAILED TO OPEN   | ZSO-111B       | Discrete | NO                              | SD                   | N/A   | N/A                         |
| 22   | STARTUP BYP 4TH TO 1ST STG FAILED TO CLOSED | ZSC-111B       | Discrete | NO                              | SD                   | N/A   | N/A                         |
| 23   | HI ENGINE VIBRATION                         | VSHH-1101      | Discrete | NC                              | SD                   | A     | N/A                         |
| 24   | HI COMPRESSOR VIBRATION                     | VSHH-1100      | Discrete | NC                              | SD                   | A     | N/A                         |
| 25   | HI PROCESS COOLER #1 VIBRATION              | VSHH-1102A     | Discrete | NC                              | SD                   | A     | N/A                         |
| 26   | HI PROCESS COOLER #2 VIBRATION              | VSHH-1102B     | Discrete | NC                              | SD                   | A     | N/A                         |
| 27   | HI UTILITY COOLER #1 VIBRATION              | VSHH-1103A     | Discrete | NC                              | SD                   | A     | N/A                         |
| 28   | HI UTILITY COOLER #2 VIBRATION              | VSHH-1103B     | Discrete | NC                              | SD                   | A     | N/A                         |
| 29   | WAITING ON START PERMISSIVE SIGNAL          | -              | Discrete | NC                              | MSG                  | S     | N/A                         |
| 30   | REMOTE ESD                                  | -              | Discrete | NC                              | SD                   | ESD   | N/A                         |
| 31   | OPEN LIMIT F/B FOR FUEL GAS SDV             | ZSO-FUEL-GAS   | Discrete | NO                              | AL                   | S     | N/A                         |
| 32   | CLOSE LIMIT F/B FOR FUEL GAS SDV            | ZSC-FUEL-GAS   | Discrete | NO                              | AL                   | S     | N/A                         |
| 33   | LOST COMM #1 DCS                            | -              | Logic    | N/A                             | N/A                  | N/A   | N/A                         |
| 34   | LOST COMM #1 CAT                            | -              | Logic    | N/A                             | AL                   | A     | N/A                         |
| 35   | LOST COMM #2 MCC                            | -              | Logic    | N/A                             | AL                   | A     | N/A                         |
| 36   | ENGINE UNDERSPEED                           | SI-1101        | 4-20mA   | 0 – 9999<br>RPM                 | AL                   | B2    | 650 RPM ↓                   |
| 37   | ENGINE UNDERSPEED                           |                |          |                                 | SD                   | B2    | 600 RPM ↓                   |
| 38   | ENGINE OVERSPEED                            |                |          |                                 | AL                   | A     | 1085 RPM ↑                  |
| 39   | ENGINE OVERSPEED                            |                |          |                                 | SD                   | ESD   | 1150 RPM ↑                  |
| 40   | LOST ENGINE SPEED FROM CAT XMT              |                |          |                                 | SD                   | A     | Channel Fault               |
| 41   | LOST RPM SIGNAL/STALL                       | -              | Logic    | 0 – 9999<br>RPM                 | SD                   | ESD   | 250 RPM ↓                   |
| 42   | UNEXPECTED ENGINE START                     | -              | Logic    | 0 – 9999<br>RPM                 | SD                   | ESD   | 250 RPM ↑                   |
| 43   | ENGINE FAILURE TO START                     | -              | Logic    | 0 – 9999<br>RPM                 | SD                   | A     | 250 RPM ↑                   |
| 44   | COMP OIL PRE-LUBE PERM FAILURE              | -              | Logic    | 0-100 PSI                       | SD                   | S     | >30 PSI after 125 Sec       |
| 45   | ENGINE FAILURE TO STOP                      | -              | Logic    | 0 – 300 Sec                     | SD                   | ESD   | CAT > 250 RPM after 120 Sec |
| 46   | FAIL TO LOAD DLY TIMEOUT                    | -              | Logic    | 0 – 3600 Sec                    | SD                   | A     | 1800 Sec                    |
| 47   | STARTUP BYP VLV 2ND TO 1ST STG POS CONFLICT | -              | Logic    | 0 – 99 Sec                      | SD                   | A     | Valve Diagnostic (15 Sec)   |
| 48   | STARTUP BYP VLV 4TH TO 1ST STG POS CONFLICT | -              | Logic    | 0 – 99 Sec                      | SD                   | A     | Valve Diagnostic (15 Sec)   |
| 49   | UTILITY COOLER MOTOR #1 FAILED TO RUN       | AC-X0X0A       | Logic    | N/A                             | SD                   | S     | Motor Diagnostic (5 sec)    |
| 50   | UTILITY COOLER MOTOR #2 FAILED TO RUN       | AC-X0X0B       | Logic    | N/A                             | SD                   | S     | Motor Diagnostic (5 sec)    |
| 51   | PROC COOLER MOTOR #1 FAILED TO RUN          | AC-X0X0C       | Logic    | N/A                             | SD                   | S     | Motor Diagnostic (5 sec)    |
| 52   | PROC COOLER MOTOR #2 FAILED TO RUN          | AC-X0X0D       | Logic    | N/A                             | SD                   | S     | Motor Diagnostic (5 sec)    |
| 53   | HIHI 1ST STG SUCTION PRS                    | PT-1111        | 4-20mA   | 0-200 PSI                       | SD                   | A     | 66 PSI ↑                    |
| 54   | HI 1ST STG SUCTION PRS                      |                |          |                                 | ALM                  | A     | 64 PSI ↑                    |
| 55   | LO 1ST STG SUCTION PRS                      |                |          |                                 | ALM                  | C     | 18 PSI ↓                    |
| 56   | LOLO 1ST STG SUCTION PRS                    |                |          |                                 | SD                   | C     | 16 PSI ↓                    |
| 57   | LST 1ST STG SUCTION PRS XMT                 |                |          |                                 | SD                   | A+DB  | Channel Fault               |
| 58   | HIHI 1ST STG DISC PRS                       | PT-1113        | 4-20mA   | 0-300 PSI                       | SD                   | A     | 210 PSI ↑                   |
| 59   | HI 1ST STG DISC PRS                         |                |          |                                 | ALM                  | A     | 200 PSI ↑                   |
| 60   | LO 1ST STG DISC PRS                         |                |          |                                 | ALM                  | C     | 63 PSI ↓                    |



|     |                                            |               |        |                 |     |      |               |
|-----|--------------------------------------------|---------------|--------|-----------------|-----|------|---------------|
| 61  | LOLO 1ST STG DISC PRS                      |               |        |                 | SD  | C    | 66 PSI ↓      |
| 62  | LST 1ST STG DISC PRS XMT                   |               |        |                 | SD  | A+DB | Channel Fault |
| 63  | HIHI 2ND STG SUCTION PRS                   | PT-1121       | 4-20mA | 0-300 PSI       | SD  | A    | 205 PSI ↑     |
| 64  | HI 2ND STG SUCTION PRS                     |               |        |                 | ALM | A    | 195 PSI ↑     |
| 65  | LO 2ND STG SUCTION PRS                     |               |        |                 | ALM | C    | 63 PSI ↓      |
| 66  | LOLO 2ND STG SUCTION PRS                   |               |        |                 | SD  | C    | 60 PSI ↓      |
| 67  | LST 2ND STG SUCTION PRS XMT                |               |        |                 | SD  | A+DB | Channel Fault |
| 68  | HIHI 2ND STG DISC PRS                      | PT-1123       | 4-20mA | 0-600 PSI       | SD  | A    | 440 PSI ↑     |
| 69  | HI 2ND STG DISC PRS                        |               |        |                 | ALM | A    | 420 PSI ↑     |
| 70  | LO 2ND STG DISC PRS                        |               |        |                 | ALM | C    | 210 PSI ↓     |
| 71  | LOLO 2ND STG DISC PRS                      |               |        |                 | SD  | C    | 200 PSI ↓     |
| 72  | LST 2ND STG DISC PRS XMT                   |               |        |                 | SD  | A+DB | Channel Fault |
| 73  | HIHI 3RD STG SUCTION PRS                   | PT-1131       | 4-20mA | 0-600 PSI       | SD  | A    | 435 PSI ↑     |
| 74  | HI 3RD STG SUCTION PRS                     |               |        |                 | ALM | A    | 415 PSI ↑     |
| 75  | LO 3RD STG SUCTION PRS                     |               |        |                 | ALM | C    | 205 PSI ↓     |
| 76  | LOLO 3RD STG SUCTION PRS                   |               |        |                 | SD  | C    | 195 PSI ↓     |
| 77  | LST 3RD STG SUCTION PRS XMT                |               |        |                 | SD  | A+DB | Channel Fault |
| 78  | HIHI 3RD STG DISC PRS                      | PT-1133       | 4-20mA | 0-1000 PSI      | SD  | A    | 850 PSI ↑     |
| 79  | HI 3RD STG DISC PRS                        |               |        |                 | ALM | A    | 415 PSI ↑     |
| 80  | LO 3RD STG DISC PRS                        |               |        |                 | ALM | C    | 478 PSI ↓     |
| 81  | LOLO 3RD STG DISC PRS                      |               |        |                 | SD  | C    | 835 PSI ↓     |
| 82  | LST 3RD STG DISC PRS XMT                   |               |        |                 | SD  | A+DB | Channel Fault |
| 83  | HIHI 4TH STG SUCTION PRS                   | PT-1141       | 4-20mA | 0-1000 PSI      | SD  | A    | 845 PSI ↑     |
| 84  | HI 4TH STG SUCTION PRS                     |               |        |                 | ALM | A    | 830 PSI ↑     |
| 85  | LO 4TH STG SUCTION PRS                     |               |        |                 | ALM | C    | 473 PSI ↓     |
| 86  | LOLO 4TH STG SUCTION PRS                   |               |        |                 | SD  | C    | 447 PSI ↓     |
| 87  | LST 4TH STG SUCTION PRS XMT                |               |        |                 | SD  | A+DB | Channel Fault |
| 88  | HIHI 4TH STG DISC PRS                      | PT-1143       | 4-20mA | 0-2000 PSI      | SD  | A    | 1368 PSI ↑    |
| 89  | HI 4TH STG DISC PRS                        |               |        |                 | ALM | A    | 1332 PSI ↑    |
| 90  | LO 4TH STG DISC PRS                        |               |        |                 | ALM | C    | 969 PSI ↓     |
| 91  | LOLO 4TH STG DISC PRS                      |               |        |                 | SD  | C    | 918 PSI ↓     |
| 92  | LST 4TH STG DISC PRS XMT                   |               |        |                 | SD  | A+DB | Channel Fault |
| 93  | LO COMPRESSOR OIL PRS                      | PT-1150       | 4-20mA | 0-100 PSI       | ALM | B1   | 50 PSI ↓      |
| 94  | LOLO COMPRESSOR OIL PRS                    |               |        |                 | SD  | B1   | 45 PSI ↓      |
| 95  | LST COMP OIL PRS XMT                       |               |        |                 | SD  | A+DB | Channel Fault |
| 96  | COMPRESSOR OIL PERMISSIVE PRESSURE         |               |        |                 | CTL | A    | 30 PSI ↑      |
| 97  | LO FUEL GAS PRS                            |               |        |                 | ALM | B1   | 50 PSI ↓      |
| 98  | LOLO FUEL GAS PRS                          | PT-1171       | 4-20mA | 0-200 PSI       | SD  | B1   | 45 PSI ↓      |
| 99  | LST FUEL GAS PRS XMT                       |               |        |                 | SD  | A+DB | Channel Fault |
| 100 | HIHI ENG JCKT WTR LVL                      |               |        |                 | SD  | A    | 18 IN ↑       |
| 101 | HI ENG JCKT WTR LVL                        |               |        |                 | ALM | A    | 16 IN ↑       |
| 102 | LO ENG JCKT WTR LVL                        |               |        |                 | ALM | B2   | 9 IN ↓        |
| 103 | LOLO ENG JCKT WTR LVL                      | LT-1182       | 4-20mA | 0-20 IN         | SD  | B2   | 7 IN ↓        |
| 104 | LST ENG JCKT WTR LVL XMT                   |               |        |                 | SD  | A+DB | Channel Fault |
| 105 | HIHI AUX WTR LVL                           |               |        |                 | SD  | A    | 18 IN ↑       |
| 106 | HI AUX WTR LVL                             |               |        |                 | ALM | A    | 16 IN ↑       |
| 107 | LO AUX WTR LVL                             |               |        |                 | ALM | B2   | 9 IN ↓        |
| 108 | LOLO AUX WTR LVL                           | LT-1181       | 4-20mA | 0-20 IN         | SD  | B2   | 7 IN ↓        |
| 109 | LST AUX WTR LVL XMT                        |               |        |                 | SD  | A+DB | Channel Fault |
| 110 | HIHI                                       |               |        |                 | -   | -    | XXXX          |
| 111 | HI                                         |               |        |                 | -   | -    | XXXX          |
| 112 | LO                                         |               |        |                 | -   | -    | XXXX          |
| 113 | LOLO                                       | FIT-FUEL-GAS  | 4-20mA | 0-1000 (mscf/D) | -   | -    | XXXX          |
| 114 | LST EXTERNAL SIGNAL FUEL GAS METER XMT     |               |        |                 | AL  | A+DB | Channel Fault |
| 115 | HIHI                                       |               |        |                 | -   | -    | XXXX          |
| 116 | HI                                         |               |        |                 | -   | -    | XXXX          |
| 117 | LO                                         |               |        |                 | -   | -    | XXXX          |
| 118 | LOLO                                       | PIT-START-AIR | 4-20mA | 0-200 PSIG      | -   | -    | XXXX          |
| 119 | LST EXTERNAL SIGNAL START AIR PRESSURE XMT |               |        |                 | AL  | A+DB | Channel Fault |
| 120 | HIHI DISC CYL #1 TEMP                      |               |        |                 | SD  | A    | 286 Deg F ↑   |
| 121 | HI DISC CYL #1 TEMP                        |               |        |                 | ALM | A    | 273 Deg F ↑   |
| 122 | LST DISC CYL #1 TMP T/C                    |               |        |                 | SD  | A    | Channel Fault |
| 123 | HIHI DISC CYL #2 TEMP                      | TE-1140       | 4-20mA | -20 – 20 °F (K) | SD  | A    | 294 Deg F ↑   |
| 124 | HI DISC CYL #2 TEMP                        |               |        |                 | ALM | A    | 280 Deg F ↑   |
| 125 | LST DISC CYL #2 TMP T/C                    |               |        |                 | SD  | A    | Channel Fault |
| 126 | HIHI DISC CYL #3A TEMP                     |               |        |                 | SD  | A    | 296 Deg F ↑   |
| 127 | HI DISC CYL #3A TEMP                       | TE-1110C      | 4-20mA | -20 – 20 °F (K) | ALM | A    | 282 Deg F ↑   |



|     |                                  |          |        |                    |     |   |               |
|-----|----------------------------------|----------|--------|--------------------|-----|---|---------------|
| 128 | LST DISC CYL #3A TMP T/C         |          |        |                    | SD  | A | Channel Fault |
| 129 | HIHI DISC CYL #3B TEMP           | TE-1110D | 4-20mA | -20 – 20 °F<br>(K) | SD  | A | 296 Deg F ↑   |
| 130 | HI DISC CYL #3B TEMP             |          |        |                    | ALM | A | 282 Deg F ↑   |
| 131 | LST DISC CYL #3B TMP T/C         |          |        |                    | SD  | A | Channel Fault |
| 132 | HIHI DISC CYL #4 TEMP            | TE-1120B | 4-20mA | -20 – 20 °F<br>(K) | SD  | A | 314 Deg F ↑   |
| 133 | HI DISC CYL #4 TEMP              |          |        |                    | ALM | A | 299 Deg F ↑   |
| 134 | LST DISC CYL #4 TMP T/C          |          |        |                    | SD  | A | Channel Fault |
| 135 | HIHI DISC CYL #5A TEMP           | TE-1110A | 4-20mA | -20 – 20 °F<br>(K) | SD  | A | 296 Deg F ↑   |
| 136 | HI DISC CYL #5A TEMP             |          |        |                    | ALM | A | 282 Deg F ↑   |
| 137 | LST DISC CYL #5A TMP T/C         |          |        |                    | SD  | A | Channel Fault |
| 138 | HIHI DISC CYL #5B TEMP           | TE-1110B | 4-20mA | -20 – 20 °F<br>(K) | SD  | A | 296 Deg F ↑   |
| 139 | HI DISC CYL #5B TEMP             |          |        |                    | ALM | A | 282 Deg F ↑   |
| 140 | LST DISC CYL #5B TMP T/C         |          |        |                    | SD  | A | Channel Fault |
| 141 | HIHI DISC CYL #6 TEMP            | TE-1120A | 4-20mA | -20 – 20 °F<br>(K) | SD  | A | 314 Deg F ↑   |
| 142 | HI DISC CYL #6 TEMP              |          |        |                    | ALM | A | 299 Deg F ↑   |
| 143 | LST DISC CYL #6 TMP T/C          |          |        |                    | SD  | A | Channel Fault |
| 144 | HIHI COMP MAIN BEARING #1 TMP    | TE-1100A | 4-20mA | -20 – 20 °F<br>(K) | SD  | A | 230 Deg F ↑   |
| 145 | HI COMP MAIN BEARING #1 TMP      |          |        |                    | ALM | A | 220 Deg F ↑   |
| 146 | LST COMP MAIN BEARING #1 TMP T/C |          |        |                    | SD  | A | Channel Fault |
| 147 | HIHI COMP MAIN BEARING #2 TMP    | TE-1100B | 4-20mA | -20 – 20 °F<br>(K) | SD  | A | 230 Deg F ↑   |
| 148 | HI COMP MAIN BEARING #2 TMP      |          |        |                    | ALM | A | 220 Deg F ↑   |
| 149 | LST COMP MAIN BEARING #2 TMP T/C |          |        |                    | SD  | A | Channel Fault |
| 150 | HIHI COMP MAIN BEARING #3 TMP    | TE-1100C | 4-20mA | -20 – 20 °F<br>(K) | SD  | A | 230 Deg F ↑   |
| 151 | HI COMP MAIN BEARING #3 TMP      |          |        |                    | ALM | A | 220 Deg F ↑   |
| 152 | LST COMP MAIN BEARING #3 TMP T/C |          |        |                    | SD  | A | Channel Fault |
| 153 | HIHI COMP MAIN BEARING #4 TMP    | TE-1100D | 4-20mA | -20 – 20 °F<br>(K) | SD  | A | 230 Deg F ↑   |
| 154 | HI COMP MAIN BEARING #4 TMP      |          |        |                    | ALM | A | 220 Deg F ↑   |
| 155 | LST COMP MAIN BEARING #4 TMP T/C |          |        |                    | SD  | A | Channel Fault |
| 156 | HIHI COMP MAIN BEARING #5 TMP    | TE-1100E | 4-20mA | -20 – 20 °F<br>(K) | SD  | A | 230 Deg F ↑   |
| 157 | HI COMP MAIN BEARING #5 TMP      |          |        |                    | ALM | A | 220 Deg F ↑   |
| 158 | LST COMP MAIN BEARING #5 TMP T/C |          |        |                    | SD  | A | Channel Fault |
| 159 | HIHI COMP MAIN BEARING #6 TMP    | TE-1100F | 4-20mA | -20 – 20 °F<br>(K) | SD  | A | 230 Deg F ↑   |
| 160 | HI COMP MAIN BEARING #6 TMP      |          |        |                    | ALM | A | 220 Deg F ↑   |
| 161 | LST COMP MAIN BEARING #6 TMP T/C |          |        |                    | SD  | A | Channel Fault |
| 162 | HIHI 1ST STG SUCTION TMP         | TE-1111  | 4-20mA | -20 – 20 °F<br>(K) | SD  | A | 103 Deg F ↑   |
| 163 | HI 1ST STG SUCTION TMP           |          |        |                    | ALM | A | 98 Deg F ↑    |
| 164 | LST 1ST STG SUCT TMP T/C         |          |        |                    | SD  | A | Channel Fault |
| 165 | HIHI 2ND STG SUCTION TMP         | TE-1121  | 4-20mA | -20 – 20 °F<br>(K) | SD  | A | 142 Deg F ↑   |
| 166 | HI 2ND STG SUCTION TMP           |          |        |                    | ALM | A | 135 Deg F ↑   |
| 167 | LST 2ND STG SUCT TMP T/C         |          |        |                    | SD  | A | Channel Fault |
| 168 | HIHI 3RD STG SUCTION TMP         | TE-1131  | 4-20mA | -20 – 20 °F<br>(K) | SD  | A | 140 Deg F ↑   |
| 169 | HI 3RD STG SUCTION TMP           |          |        |                    | ALM | A | 135 Deg F ↑   |
| 170 | LST 3RD STG SUCT TMP T/C         |          |        |                    | SD  | A | Channel Fault |
| 171 | HIHI 4TH STG SUCTION TMP         | TE-1141  | 4-20mA | -20 – 20 °F<br>(K) | SD  | A | 139 Deg F ↑   |
| 172 | HI 4TH STG SUCTION TMP           |          |        |                    | ALM | A | 132 Deg F ↑   |
| 173 | LST 4TH STG SUCT TMP T/C         |          |        |                    | SD  | A | Channel Fault |
| 174 | HIHI 1ST STG CLR DISCH TMP       | TE-1114  | 4-20mA | -20 – 20 °F<br>(K) | SD  | A | 142 Deg F ↑   |
| 175 | HI 1ST STG CLR DISCH TMP         |          |        |                    | ALM | A | 135 Deg F ↑   |
| 176 | LST 1ST STG CLR DISCH TMP T/C    |          |        |                    | SD  | A | Channel Fault |
| 177 | HIHI 2ND STG CLR DISCH TMP       | TE-1124  | 4-20mA | -20 – 20 °F<br>(K) | SD  | A | 142 Deg F ↑   |
| 178 | HI 2ND STG CLR DISCH TMP         |          |        |                    | ALM | A | 135 Deg F ↑   |
| 179 | LST 2ND STG CLR DISCH TMP T/C    |          |        |                    | SD  | A | Channel Fault |
| 180 | HIHI 3RD STG CLR DISCH TMP       | TE-1134  | 4-20mA | -20 – 20 °F<br>(K) | SD  | A | 139 Deg F ↑   |
| 181 | HI 3RD STG CLR DISCH TMP         |          |        |                    | ALM | A | 132 Deg F ↑   |
| 182 | LST 3RD STG CLR DISCH TMP T/C    |          |        |                    | SD  | A | Channel Fault |
| 183 | HIHI 4TH STG CLR DISCH TMP       | TE-1144  | 4-20mA | -20 – 20 °F<br>(K) | SD  | A | 140 Deg F ↑   |
| 184 | HI 4TH STG CLR DISCH TMP         |          |        |                    | ALM | A | 130 Deg F ↑   |
| 185 | LST 4TH STG CLR DISCH TMP T/C    |          |        |                    | SD  | A | Channel Fault |
| 186 | HIHI COMP OIL TMP                | TE-1150  | 4-20mA | -20 – 20 °F<br>(K) | SD  | A | 190 Deg F ↑   |
| 187 | HI COMP OIL TMP                  |          |        |                    | ALM | A | 180 Deg F ↑   |
| 188 | LST COMP OIL TMP T/C             |          |        |                    | SD  | A | Channel Fault |
| 189 | COMP OIL TMP START PERMISSIVE    |          |        |                    | CTL | A | 55 Deg F ↑    |
| 190 | COMP OIL TMP LOAD PERMISSIVE     |          |        |                    | CTL | A | 150 Deg F ↑   |
| 191 | HIHI PRE-CAT TMP                 | TE-1191  | 4-20mA | -20 – 20 °F<br>(K) | SD  | A | 1280 Deg F ↑  |
| 192 | HI PRE-CAT TMP                   |          |        |                    | ALM | A | 1250 Deg F ↑  |
| 193 | LST PRE-CATALYST TMP T/C         |          |        |                    | SD  | A | Channel Fault |
| 194 | HIHI POST-CAT TMP                | TE-1192  | 4-20mA |                    | SD  | A | 1380 Deg F ↑  |



|     |                                               |   |            |                    |     |    |               |
|-----|-----------------------------------------------|---|------------|--------------------|-----|----|---------------|
| 195 | HI POST-CAT TMP                               |   |            | -20 – 20 °F<br>(K) | ALM | A  | 1350 Deg F ↑  |
| 196 | LST POST-CATALYST TMP T/C                     |   |            |                    | SD  | A  | Channel Fault |
| 197 | HI THROW 1 TENSION                            | - | Logic-CALC | 0 – 100000<br>Lbs  | ALM | B2 | 67500 Lbs     |
| 198 | HIHI THROW 1 TENSION                          | - | Logic-CALC | 0 – 100000<br>Lbs  | SD  | B2 | 71250 Lbs     |
| 199 | HI THROW 1 COMPRESSION                        | - | Logic-CALC | 0 – 100000<br>Lbs  | ALM | B2 | 72000 Lbs     |
| 200 | HIHI THROW 1 COMPRESSION                      | - | Logic-CALC | 0 – 100000<br>Lbs  | SD  | B2 | 76000 Lbs     |
| 201 | HI THROW 2 TENSION                            | - | Logic-CALC | 0 – 100000<br>Lbs  | ALM | B2 | 67500 Lbs     |
| 202 | HIHI THROW 2 TENSION                          | - | Logic-CALC | 0 – 100000<br>Lbs  | SD  | B2 | 71250 Lbs     |
| 203 | HI THROW 2 COMPRESSION                        | - | Logic-CALC | 0 – 100000<br>Lbs  | ALM | B2 | 72000 Lbs     |
| 204 | HIHI THROW 2 COMPRESSION                      | - | Logic-CALC | 0 – 100000<br>Lbs  | SD  | B2 | 76000 Lbs     |
| 205 | HI THROW 3 TENSION                            | - | Logic-CALC | 0 – 100000<br>Lbs  | ALM | B2 | 67500 Lbs     |
| 206 | HIHI THROW 3 TENSION                          | - | Logic-CALC | 0 – 100000<br>Lbs  | SD  | B2 | 71250 Lbs     |
| 207 | HI THROW 3 COMPRESSION                        | - | Logic-CALC | 0 – 100000<br>Lbs  | ALM | B2 | 72000 Lbs     |
| 208 | HIHI THROW 3 COMPRESSION                      | - | Logic-CALC | 0 – 100000<br>Lbs  | SD  | B2 | 76000 Lbs     |
| 209 | HI THROW 4 TENSION                            | - | Logic-CALC | 0 – 100000<br>Lbs  | ALM | B2 | 67500 Lbs     |
| 210 | HIHI THROW 4 TENSION                          | - | Logic-CALC | 0 – 100000<br>Lbs  | SD  | B2 | 71250 Lbs     |
| 211 | HI THROW 4 COMPRESSION                        | - | Logic-CALC | 0 – 100000<br>Lbs  | ALM | B2 | 72000 Lbs     |
| 212 | HIHI THROW 4 COMPRESSION                      | - | Logic-CALC | 0 – 100000<br>Lbs  | SD  | B2 | 76000 Lbs     |
| 213 | HI THROW 5 TENSION                            | - | Logic-CALC | 0 – 100000<br>Lbs  | ALM | B2 | 67500 Lbs     |
| 214 | HIHI THROW 5 TENSION                          | - | Logic-CALC | 0 – 100000<br>Lbs  | SD  | B2 | 71250 Lbs     |
| 215 | HI THROW 5 COMPRESSION                        | - | Logic-CALC | 0 – 100000<br>Lbs  | ALM | B2 | 72000 Lbs     |
| 216 | HIHI THROW 5 COMPRESSION                      | - | Logic-CALC | 0 – 100000<br>Lbs  | SD  | B2 | 76000 Lbs     |
| 217 | HI THROW 6 TENSION                            | - | Logic-CALC | 0 – 100000<br>Lbs  | ALM | B2 | 67500 Lbs     |
| 218 | HIHI THROW 6 TENSION                          | - | Logic-CALC | 0 – 100000<br>Lbs  | SD  | B2 | 71250 Lbs     |
| 219 | HI THROW 6 COMPRESSION                        | - | Logic-CALC | 0 – 100000<br>Lbs  | ALM | B2 | 72000 Lbs     |
| 220 | HIHI THROW 6 COMPRESSION                      | - | Logic-CALC | 0 – 100000<br>Lbs  | SD  | B2 | 76000 Lbs     |
| 221 | CHANGE ENGINE OIL                             | - | Logic-CALC | 0 – 10000<br>Hrs   | MSG | A  | 3500 Hrs      |
| 222 | SERVICE SPARK PLUGS                           | - | Logic-CALC | 0 – 10000<br>Hrs   | MSG | A  | 3500 Hrs      |
| 223 | ADJUST ENGINE VALVES                          | - | Logic-CALC | 0 – 10000<br>Hrs   | MSG | A  | 3500 Hrs      |
| 224 | TAKE OIL SAMPLE                               | - | Logic-CALC | 0 – 10000<br>Hrs   | MSG | A  | 720 Hrs       |
| 225 | SERVICE BATTERIES                             | - | Logic-CALC | 0 – 10000<br>Hrs   | MSG | A  | 3500 Hrs      |
| 226 | WAITING ON COMP OIL START TEMP PERM TO BE MET | - | Logic-CALC | -20 – 20 °F<br>(K) | MSG | A  | 55 °F         |



## 26. CONFIGURATION SETTINGS

The following configuration settings are adjustable from the HMI.

| Setting                                   | Description                                                                                                                      | Range         | Factory Setting |
|-------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|---------------|-----------------|
| Class B1 Shutdown -Lockout Timer          | The duration of the Class B1 shutdown lockout timer.                                                                             | 0 – 999 Sec   | 15              |
| Class B2 Shutdown Lockout Timer           | The duration of the Class B2 shutdown lockout timer.                                                                             | 0 – 999 Sec   | 60              |
| Class P Load Delay Timer                  | Class P Load Delay Timer                                                                                                         | 0 – 600 Sec   | 10              |
| Compressor Pre-lube Permissive Fail Timer | The duration of the compressor pre-lube permissive timer.                                                                        | 0 – 300 Sec   | 120             |
| Compressor Pre-lube Duration Timer        | The duration of the compressor pre-lube cycle timer.                                                                             | 120 – 900 Sec | 120             |
| Failure To Load Timer                     | The amount of time the controller will wait for the operator to acknowledge that the unit is ready to be loaded.                 | 0 – 3600 Sec  | 1800            |
| Utility Cooler Motor #1 Fail to Start     | The time after sending a start command to the Cooler Motor #1 within which a run feedback must be sensed or shutdown will occur. | 0 – 200 Sec   | 5               |
| Utility Cooler Motor #2 Fail to Start     | The time after sending a start command to the Cooler Motor #2 within which a run feedback must be sensed or shutdown will occur. | 0 – 200 Sec   | 5               |
| CAT ADEM 4 Run Fail Timer                 | The time after sending a start command to the CAT ADEM 4 within which it must be seen running or a failure will occur.           | 0 – 300 Sec   | 120             |
| Minimum Warmup Duration Timer             |                                                                                                                                  | 0 – 999 Sec   | 180             |

| Setting                                                                   | Description                                                                                                                   | Range         | Factory Setting |
|---------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|---------------|-----------------|
|                                                                           | The duration of the Warmup cycle following a normal stop command.                                                             |               |                 |
| Cooldown Delay Timer:                                                     | The duration of the Cooldown cycle following a normal stop command.                                                           | 0 – 999 Sec   | 180             |
| Startup Bypass 2 <sup>nd</sup> to 1 <sup>st</sup> Stage Valve Fail Delay: | The amount of time the controller will wait for the valve position to be confirmed, after an open or close command is issued. | 0 – 99 Sec    | 15              |
| Startup Bypass 4 <sup>th</sup> to 1 <sup>st</sup> Stage Valve Fail Delay: | The amount of time the controller will wait for the valve position to be confirmed, after an open or close command is issued. | 0 – 99 Sec    | 15              |
| Change Engine Oil                                                         | This is where the number of hours for a service reminder is set.                                                              | 0 – 10000 Hrs | 3500            |
| Startup Bypass Valve Open Limit Switch Failure Timer                      | The amount of time the controller will wait for the valve position to be confirmed, after an open or close command is issued  | 0 – 120 Sec   | 15              |
| Startup Bypass Valve Close Limit Switch Failure Timer                     | The amount of time the controller will wait for the valve position to be confirmed, after an open or close command is issued  | 0 – 120 Sec   | 15              |
| Startup Bypass Valve Close Limit Switch Failure Timer                     | Startup Bypass Valve Close Limit Switch Failure Timer                                                                         | 0 – 120 Sec   | 15              |
| Compressor Hot Start Off Delay timer                                      | Compressor Hot Start Off Delay timer                                                                                          | 0 – 999 Sec   | 10              |
| Minimum Suction Pressure to Start not Met Timer                           | Minimum Suction Pressure to Start not Met Timer                                                                               | 0 – 300 Sec   | 100             |
| Unit De-Pressurization Not Met Timer                                      | Unit De-Pressurization Not Met Timer                                                                                          | 0 – 300 Sec   | 100             |
| Unit De-Pressurization Permissive SP                                      | Unit De-Pressurization Permissive SP                                                                                          | 10 – 300 PSIG | 100             |
| Minimum Start Suction Pressure SP                                         | Minimum Start Suction Pressure SP                                                                                             | 5 – 30 PSIG   | 10              |
| Compressor Oil Pressure Prelube Permissive                                | Compressor Oil Pressure Prelube Permissive                                                                                    | 0 – 100 PSIG  | 30              |
| Compressor Oil Temperature Load Permissive                                | Compressor Oil Temperature Load Permissive                                                                                    | 0 – 250 Deg F | 110.0           |
| Compressor Oil Temperature Prelube Permissive SP                          | Compressor Oil Temperature Prelube Permissive SP                                                                              | 0 – 250 Deg F | 110.0           |
| Atmospheric Pressure                                                      | Atmospheric Pressure                                                                                                          | 0 – 15 PSI    | 12.861          |
| CAT Engine Run Failure Timer                                              | CAT Engine Run Failure Timer                                                                                                  | 0 – 600 Sec   | 120             |
| Test Mode Timer                                                           | Test Mode Timer                                                                                                               | 0 – 1200 Sec  | 300             |
| 1st Stage Suction Pressure Loss Factor                                    | 1st Stage Suction Pressure Loss Factor                                                                                        | 0 – 100 %     | 13.560          |
| 1st Stage Discharge Pressure Loss Factor                                  | 1st Stage Discharge Pressure Loss Factor                                                                                      | 0 – 100 %     | 10.720          |
| 2nd Stage Suction Pressure Loss Factor                                    | 2nd Stage Suction Pressure Loss Factor                                                                                        | 0 – 100 %     | 6.320           |
| 2nd Stage Discharge Pressure Loss Factor                                  | 2nd Stage Discharge Pressure Loss Factor                                                                                      | 0 – 100 %     | 6.060           |
| 3rd Stage Suction Pressure Loss Factor                                    | 3rd Stage Suction Pressure Loss Factor                                                                                        | 0 – 100 %     | 6.420           |
| 3rd Stage Discharge Pressure Loss Factor                                  | 3rd Stage Discharge Pressure Loss Factor                                                                                      | 0 – 100 %     | 5.470           |
| 4th Stage Suction Pressure Loss Factor                                    | 4th Stage Suction Pressure Loss Factor                                                                                        | 0 – 100 %     | 2.500           |
| 4th Stage Discharge Pressure Loss Factor                                  | 4th Stage Discharge Pressure Loss Factor                                                                                      | 0 – 100 %     | 5.020           |
| Utility Cooler Motor 1 Fail to Start                                      | Utility Cooler Motor 1 Fail to Start                                                                                          | 0 – 200 Sec   | 180             |
| Utility Cooler Motor 2 Fail to Start                                      | Utility Cooler Motor 1 Fail to Start                                                                                          | 0 – 200 Sec   | 180             |
| Process Cooler Motor 1 Fail to Start                                      | Process Cooler Motor 1 Fail to Start                                                                                          | 0 – 200 Sec   | 180             |
| Process Cooler Motor 2 Fail to Start                                      | Process Cooler Motor 2 Fail to Start                                                                                          | 0 – 200 Sec   | 180             |



| Setting                                                  | Description                                                      | Range              | Factory Setting |
|----------------------------------------------------------|------------------------------------------------------------------|--------------------|-----------------|
| High 1st Stage Scrubber Liquid Level                     | High 1st Stage Scrubber Liquid Level                             | 0 – 10             | 3               |
| High 2nd Stage Scrubber Liquid Level                     | High 2nd Stage Scrubber Liquid Level                             | 0 – 10             | 3               |
| High 3rd Stage Scrubber Liquid Level                     | High 3rd Stage Scrubber Liquid Level                             | 0 – 10             | 3               |
| High 4th Stage Scrubber Liquid Level                     | High 4th Stage Scrubber Liquid Level                             | 0 – 10             | 3               |
| Engine Oil Temperature Load Permissive Setpoint          | Engine Oil Temperature Load Permissive Setpoint                  | 100 – 200 Deg F    | 110             |
| Engine Jacket Water Temperature Load Permissive Setpoint | Engine Jacket Water Temperature Load Permissive Setpoint         | 100 – 200 Deg F    | 104             |
| Engine Load Permissive Fail Timer                        | Engine Load Permissive Fail Timer                                | 0 – 900 Secs       | 180.0           |
| Service Spark Plugs                                      | This is where the number of hours for a service reminder is set. | 0 – 10000 Hrs      | 3500            |
| Adjust Engine Valves                                     | This is where the number of hours for a service reminder is set. | 0 – 10000 Hrs      | 3500            |
| Take Oil Sample                                          | This is where the number of hours for a service reminder is set. | 0 – 10000 Hrs      | 720             |
| Service Batteries                                        | This is where the number of hours for a service reminder is set. | 0 – 10000 Hrs      | 3500            |
| Crank Disconnect/Run RPM:                                | This is the speed which the engine is considered running.        | 0 – 9999 RPM       | 250             |
| Engine Underspeed                                        | Shutdown:                                                        | 0 – 9999 RPM       | 600             |
| Engine Underspeed                                        | Alarm:                                                           | 0 – 9999 RPM       | 650             |
| Engine Overspeed                                         | Alarm:                                                           | 0 – 9999 RPM       | 1085            |
| Engine Overspeed                                         | Shutdown:                                                        | 0 – 9999 RPM       | 1150            |
| 1 <sup>st</sup> Stage Suction Pressure                   | Low Shutdown:                                                    | -32767 – 32767 PSI | 16              |
| 1 <sup>st</sup> Stage Suction Pressure                   | Low Alarm:                                                       | -32767 – 32767 PSI | 18              |
| 1 <sup>st</sup> Stage Suction Pressure                   | High Alarm:                                                      | -32767 – 32767 PSI | 64              |
| 1 <sup>st</sup> Stage Suction Pressure                   | High Shutdown:                                                   | -32767 – 32767 PSI | 66              |
| 1 <sup>st</sup> Stage Discharge Pressure                 | Low Shutdown                                                     | -32767 – 32767 PSI | 63              |
| 1 <sup>st</sup> Stage Discharge Pressure                 | Low Alarm                                                        | -32767 – 32767 PSI | 66              |
| 1 <sup>st</sup> Stage Discharge Pressure                 | High Alarm                                                       | -32767 – 32767 PSI | 200             |
| 1 <sup>st</sup> Stage Discharge Pressure                 | High Shutdown                                                    | -32767 – 32767 PSI | 210             |
| 2 <sup>nd</sup> Stage Suction Pressure                   | Low Shutdown:                                                    | -32767 – 32767 PSI | 60              |
| 2 <sup>nd</sup> Stage Suction Pressure                   | Low Alarm:                                                       | -32767 – 32767 PSI | 63              |
| 2 <sup>nd</sup> Stage Suction Pressure                   | High Alarm:                                                      | -32767 – 32767 PSI | 195             |
| 2 <sup>nd</sup> Stage Suction Pressure                   | High Shutdown:                                                   | -32767 – 32767 PSI | 205             |
| 2 <sup>nd</sup> Stage Discharge Pressure                 | Low Shutdown:                                                    | -32767 – 32767 PSI | 200             |
| 2 <sup>nd</sup> Stage Discharge Pressure                 | Low Alarm:                                                       | -32767 – 32767 PSI | 210             |

| Setting                                  | Description          | Range                 | Factory Setting |
|------------------------------------------|----------------------|-----------------------|-----------------|
| 2 <sup>nd</sup> Sage Discharge Pressure  | High Alarm:          | -32767 – 32767 PSI    | 420             |
| 2 <sup>nd</sup> Sage Discharge Pressure  | High Shutdown:       | -32767 – 32767 PSI    | 440             |
| 3 <sup>rd</sup> Stage Suction Pressure   | Low Shutdown:        | -32767 – 32767 PSI    | 195             |
| 3 <sup>rd</sup> Stage Suction Pressure   | Low Alarm:           | -32767 – 32767 PSI    | 205             |
| 3 <sup>rd</sup> Stage Suction Pressure   | High Alarm:          | -32767 – 32767 PSI    | 415             |
| 3 <sup>rd</sup> Stage Suction Pressure   | High Shutdown:       | -32767 – 32767 PSI    | 435             |
| 3 <sup>rd</sup> Stage Discharge Pressure | Low Shutdown:        | -32767 – 32767 PSI    | 452             |
| 3 <sup>rd</sup> Stage Discharge Pressure | Low Alarm:           | -32767 – 32767 PSI    | 478             |
| 3 <sup>rd</sup> Stage Discharge Pressure | High Alarm:          | -32767 – 32767 PSI    | 835             |
| 3 <sup>rd</sup> Stage Discharge Pressure | High Shutdown:       | -32767 – 32767 PSI    | 850             |
| 4 <sup>th</sup> Stage Suction Pressure   | Low Shutdown:        | -32767 – 32767 PSI    | 447             |
| 4 <sup>th</sup> Stage Suction Pressure   | Low Alarm:           | -32767 – 32767 PSI    | 473             |
| 4 <sup>th</sup> Stage Suction Pressure   | High Alarm:          | -32767 – 32767 PSI    | 830             |
| 4 <sup>th</sup> Stage Suction Pressure   | High Shutdown:       | -32767 – 32767 PSI    | 845             |
| 4 <sup>th</sup> Stage Discharge Pressure | Low Shutdown:        | -32767 – 32767 PSI    | 918             |
| 4 <sup>th</sup> Stage Discharge Pressure | Low Alarm:           | -32767 – 32767 PSI    | 969             |
| 4 <sup>th</sup> Stage Discharge Pressure | High Alarm:          | -32767 – 32767 PSI    | 1332            |
| 4 <sup>th</sup> Stage Discharge Pressure | High Shutdown:       | -32767 – 32767 PSI    | 1368            |
| Compressor Oil Pressure                  | Low Shutdown:        | -3276.7 – 3276.7 PSI  | 45.0            |
| Compressor Oil Pressure                  | Low Alarm:           | -3276.7 – 3276.7 PSI  | 50.0            |
| Compressor Oil Pressure                  | Permissive Pressure: | 0.0 – 999.9 PSI       | 30              |
| Fuel Gas Pressure                        | Low Shutdown:        | -32767 – 32767 PSI    | 45              |
| Fuel Gas Pressure                        | Low Alarm:           | -32767 – 32767 PSI    | 50              |
| Engine Jacket Water Level                | Low Shutdown:        | -327.67 – 327.67 INCH | 7               |
| Engine Jacket Water Level                | Low Alarm:           | -327.67 – 327.67 INCH | 9               |
| Engine Jacket Water Level                | High Alarm:          | -327.67 – 327.67 INCH | 16              |
| Engine Jacket Water Level                | High Shutdown:       | -327.67 – 327.67 INCH | 18              |
| Auxiliary Water Level                    | Low Shutdown:        | -327.67 – 327.67 INCH | 7               |
| Auxiliary Water Level                    | Low Alarm:           | -327.67 – 327.67 INCH | 9               |
| Auxiliary Water Level                    | High Alarm:          | -327.67 – 327.67 INCH | 16              |
| Auxiliary Water Level                    | High Shutdown:       | -327.67 – 327.67 INCH | 18              |



| Setting                                   | Description    | Range       | Factory Setting |
|-------------------------------------------|----------------|-------------|-----------------|
| Discharge Cyl #1 Temperature              | High Alarm:    | 0 – 2052 °F | 273             |
| Discharge Cyl #1 Temperature              | High Shutdown: | 0 – 2052 °F | 286             |
| Discharge Cyl #2 Temperature              | High Alarm:    | 0 – 2052 °F | 280             |
| Discharge Cyl #2 Temperature              | High Shutdown: | 0 – 2052 °F | 294             |
| Discharge Cyl #3A Temperature             | High Alarm:    | 0 – 2052 °F | 282             |
| Discharge Cyl #3A Temperature             | High Shutdown: | 0 – 2052 °F | 296             |
| Discharge Cyl #3B Temperature             | High Alarm:    | 0 – 2052 °F | 282             |
| Discharge Cyl #3B Temperature             | High Shutdown: | 0 – 2052 °F | 296             |
| Discharge Cyl #4 Temperature              | High Alarm:    | 0 – 2052 °F | 299             |
| Discharge Cyl #4 Temperature              | High Shutdown: | 0 – 2052 °F | 314             |
| Discharge Cyl #5A Temperature             | High Alarm:    | 0 – 2052 °F | 282             |
| Discharge Cyl #5A Temperature             | High Shutdown: | 0 – 2052 °F | 296             |
| Discharge Cyl #5B Temperature             | High Alarm:    | 0 – 2052 °F | 282             |
| Discharge Cyl #5B Temperature             | High Shutdown: | 0 – 2052 °F | 296             |
| Discharge Cyl #6 Temperature              | High Alarm:    | 0 – 2052 °F | 299             |
| Discharge Cyl #6 Temperature              | High Shutdown: | 0 – 2052 °F | 314             |
| Compressor Main Bearing #1 Temperature    | High Alarm:    | 0 – 2052 °F | 220             |
| Compressor Main Bearing #1 Temperature    | High Shutdown: | 0 – 2052 °F | 230             |
| Compressor Main Bearing #2 Temperature    | High Alarm:    | 0 – 2052 °F | 220             |
| Compressor Main Bearing #2 Temperature    | High Shutdown: | 0 – 2052 °F | 230             |
| Compressor Main Bearing #3 Temperature    | High Alarm:    | 0 – 2052 °F | 220             |
| Compressor Main Bearing #3 Temperature    | High Shutdown: | 0 – 2052 °F | 230             |
| Compressor Main Bearing #4 Temperature    | High Alarm:    | 0 – 2052 °F | 220             |
| Compressor Main Bearing #4 Temperature    | High Shutdown: | 0 – 2052 °F | 230             |
| Compressor Main Bearing #5 Temperature    | High Alarm:    | 0 – 2052 °F | 220             |
| Compressor Main Bearing #5 Temperature    | High Shutdown: | 0 – 2052 °F | 230             |
| Compressor Main Bearing #6 Temperature    | High Alarm:    | 0 – 2052 °F | 220             |
| Compressor Main Bearing #6 Temperature    | High Shutdown: | 0 – 2052 °F | 230             |
| 1 <sup>st</sup> Stage Suction Temperature | High Alarm:    | 0 – 2052 °F | 98              |
| 1 <sup>st</sup> Stage Suction Temperature | High Shutdown: | 0 – 2052 °F | 103             |
| 2 <sup>nd</sup> Stage Suction Temperature | High Alarm:    | 0 – 2052 °F | 135             |

| Setting                                            | Description                               | Range          | Factory Setting |
|----------------------------------------------------|-------------------------------------------|----------------|-----------------|
| 2 <sup>nd</sup> Stage Suction Temperature          | High Shutdown:                            | 0 – 2052 °F    | 142             |
| 3 <sup>rd</sup> Stage Suction Temperature          | High Alarm:                               | 0 – 2052 °F    | 135             |
| 3 <sup>rd</sup> Stage Suction Temperature          | High Shutdown:                            | 0 – 2052 °F    | 140             |
| 4 <sup>th</sup> Stage Suction Temperature          | High Alarm:                               | 0 – 2052 °F    | 132             |
| 4 <sup>th</sup> Stage Suction Temperature          | High Shutdown:                            | 0 – 2052 °F    | 139             |
| 1 <sup>st</sup> Stage Cooler Discharge Temperature | High Alarm:                               | 0 – 2052 °F    | 135             |
| 1 <sup>st</sup> Stage Cooler Discharge Temperature | High Shutdown:                            | 0 – 2052 °F    | 142             |
| 2 <sup>nd</sup> Stage Cooler Discharge Temperature | High Alarm:                               | 0 – 2052 °F    | 135             |
| 2 <sup>nd</sup> Stage Cooler Discharge Temperature | High Shutdown:                            | 0 – 2052 °F    | 142             |
| 3 <sup>rd</sup> Stage Cooler Discharge Temperature | High Alarm:                               | 0 – 2052 °F    | 132             |
| 3 <sup>rd</sup> Stage Cooler Discharge Temperature | High Shutdown:                            | 0 – 2052 °F    | 139             |
| 4 <sup>th</sup> Stage Cooler Discharge Temperature | High Alarm:                               | 0 – 2052 °F    | 130             |
| 4 <sup>th</sup> Stage Cooler Discharge Temperature | High Shutdown:                            | 0 – 2052 °F    | 140             |
| Compressor Oil Temperature                         | High Alarm:                               | 0 – 2052 °F    | 180             |
| Compressor Oil Temperature                         | High Shutdown:                            | 0 – 2052 °F    | 190             |
| Compressor Oil Temperature                         | Start Permissive:                         | 0 – 150 °F     | 55              |
| Compressor Oil Temperature                         | Load Permissive:                          | 0 – 150 °F     | 150             |
| Pre-Catalyst Temperature                           | High Alarm:                               | 0 – 2052 °F    | 1250            |
| Pre-Catalyst Temperature                           | Pre-Catalyst Temperature – High Shutdown: | 0 – 2052 °F    | 1280            |
| Post-Catalyst Temperature                          | High Alarm:                               | 0 – 2052 °F    | 1350            |
| Post-Catalyst Temperature                          | High Shutdown:                            | 0 – 2052 °F    | 1380            |
| Rod Load Cylinder #1                               | Tension High Alarm:                       | 0 – 100000 Lbs | 67500           |
| Rod Load Cylinder #1                               | Tension High Shutdown:                    | 0 – 100000 Lbs | 71250           |
| Rod Load Cylinder #1                               | Compression High Alarm:                   | 0 – 100000 Lbs | 72000           |
| Rod Load Cylinder #1                               | Compression High Shutdown:                | 0 – 100000 Lbs | 76000           |
| Rod Load Cylinder #2                               | Tension High Alarm:                       | 0 – 100000 Lbs | 67500           |
| Rod Load Cylinder #2                               | Tension High Shutdown:                    | 0 – 100000 Lbs | 71250           |
| Rod Load Cylinder #2                               | Compression High Alarm:                   | 0 – 100000 Lbs | 72000           |
| Rod Load Cylinder #2                               | Compression High Shutdown:                | 0 – 100000 Lbs | 76000           |
| Rod Load Cylinder #3                               | Tension High Alarm:                       | 0 – 100000 Lbs | 67500           |
| Rod Load Cylinder #3                               | Tension High Shutdown:                    | 0 – 100000 Lbs | 71250           |
| Rod Load Cylinder #3                               | Compression High Alarm:                   | 0 – 100000 Lbs | 72000           |
| Rod Load Cylinder #3                               | Compression High Shutdown:                | 0 – 100000 Lbs | 76000           |
| Rod Load Cylinder #4                               | Tension High Alarm:                       | 0 – 100000 Lbs | 67500           |



| Setting                            | Description                                                                                                                                                                                                                                                                                                                                                                                        | Range                           | Factory Setting     |
|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|---------------------|
| Rod Load Cylinder #4               | Tension High Shutdown:                                                                                                                                                                                                                                                                                                                                                                             | 0 – 100000 Lbs                  | 71250               |
| Rod Load Cylinder #4               | Compression High Alarm:                                                                                                                                                                                                                                                                                                                                                                            | 0 – 100000 Lbs                  | 72000               |
| Rod Load Cylinder #4               | Compression High Shutdown:                                                                                                                                                                                                                                                                                                                                                                         | 0 – 100000 Lbs                  | 76000               |
| Rod Load Cylinder #5               | Tension High Alarm:                                                                                                                                                                                                                                                                                                                                                                                | 0 – 100000 Lbs                  | 67500               |
| Rod Load Cylinder #5               | Tension High Shutdown:                                                                                                                                                                                                                                                                                                                                                                             | 0 – 100000 Lbs                  | 71250               |
| Rod Load Cylinder #5               | Compression High Alarm:                                                                                                                                                                                                                                                                                                                                                                            | 0 – 100000 Lbs                  | 72000               |
| Rod Load Cylinder #5               | Compression High Shutdown:                                                                                                                                                                                                                                                                                                                                                                         | 0 – 100000 Lbs                  | 76000               |
| Rod Load Cylinder #6               | Tension High Alarm:                                                                                                                                                                                                                                                                                                                                                                                | 0 – 100000 Lbs                  | 67500               |
| Rod Load Cylinder #6               | Tension High Shutdown:                                                                                                                                                                                                                                                                                                                                                                             | 0 – 100000 Lbs                  | 71250               |
| Rod Load Cylinder #6               | Compression High Alarm:                                                                                                                                                                                                                                                                                                                                                                            | 0 – 100000 Lbs                  | 72000               |
| Rod Load Cylinder #6               | Compression High Shutdown:                                                                                                                                                                                                                                                                                                                                                                         | 0 – 100000 Lbs                  | 76000               |
| TARGET RPM PROCESS VARIABLE SELECT | <i>Process Variable in which the PID will base its control.</i>                                                                                                                                                                                                                                                                                                                                    | Suction Pressure                | 4th Stage Discharge |
|                                    |                                                                                                                                                                                                                                                                                                                                                                                                    | OR                              |                     |
|                                    |                                                                                                                                                                                                                                                                                                                                                                                                    | 4 <sup>th</sup> Stage Discharge |                     |
| AUTO SETPOINT:                     | The setpoint that will be maintained if the PID loop mode is set to AUTO.                                                                                                                                                                                                                                                                                                                          | 0 – 2000 PSI                    | 1300                |
| DEADBAND:                          | The deadband around the setpoint. In Auto Mode, no change in TGT RPM OUT will occur if the Suction Pressure is inside this window.                                                                                                                                                                                                                                                                 | 0 – 2000 PSI                    | 5                   |
| MANUAL SETPOINT:                   | The Manual RPM setpoint that will be sent to the driver if the PID loop mode is set to manual. Change this setting after the loop has been placed into manual to keep the driver at the desired speed. When the mode is changed from Auto to Manual, or Remote to Manual, the TGT RPM OUT will be copied to the LOCAL RPM SP setting for bumpless transfer of control.                             | 0 – 10000 RPM                   | 700                 |
| PROPORTIONAL:                      | This is a multiplier for the error (pressure minus setpoint) and will determine how the error will directly affect the amount of change in output. Too low a number here will result in sluggish action of the PID loop. Too high a number here will result in overshoot and oscillation of the PID loop.                                                                                          | 0.00 – 100.00                   | 15                  |
| INTEGRAL:                          | This is a multiplier for the amount of time the error (pressure minus setpoint) has been above or below setpoint. The more time that passes before the loop does not reach its setpoint, will directly affect the amount of change in output. Too low a number here will take out the Integral part of control of the PID loop. Too high a number here will result in oscillation of the PID loop. | 0.00 – 100.00 %/s               | 10                  |
| DERIVATIVE:                        | This is a multiplier for how fast the error (pressure minus setpoint) is changing. The faster the pressure or setpoint changes will directly affect the amount of change in output. Too low a number here will take out the Derivative part of control of the PID loop. Too high a number here will result in oscillation of the PID loop.                                                         | 0.00 – 100.00 %xs               | 0                   |
| MANUAL, AUTO, REMOTE MODE:         | Set the PID loop in AUTO to automatically maintain a Suction Pressure or 2nd STAGE SUCTION PRESSURE. If the Suction pressure is below its setpoint the output will decreased. If the Suction Pressure is above its setpoint the output will be increased.                                                                                                                                          | Manual,                         | Manual              |
|                                    | If the 2nd STAGE SUCTION PRESSURE is below its setpoint the output will be increased. If the 2nd STAGE SUCTION PRESSURE is above its setpoint the output will be decreased.                                                                                                                                                                                                                        | Automatic, Remote               |                     |
|                                    | In MANUAL, the PID loop is turned off and the MANUAL RPM SP will be directly output to the driver.                                                                                                                                                                                                                                                                                                 |                                 |                     |
|                                    | In REMOTE, the PID loop is turned off and the Remote Speed sensed through the 'Remote Speed' 4-20 mA analog input is directly output to the driver.                                                                                                                                                                                                                                                |                                 |                     |
| MIN LOADED RPM:                    | The minimum desired driver running speed that the PID will be allowed to output while in Auto Mode.                                                                                                                                                                                                                                                                                                | 0 – 10000 RPM                   | 750                 |
| MAX LOADED RPM:                    |                                                                                                                                                                                                                                                                                                                                                                                                    | 0 – 10000 RPM                   | 1000                |

| Setting                                 | Description                                                                                                                                                                                                                                                                                                                                                                                          | Range               | Factory Setting |
|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|-----------------|
|                                         | The maximum desired driver running speed that the PID will be allowed to output while in Auto Mode.                                                                                                                                                                                                                                                                                                  |                     |                 |
| <b>SLEW RATE:</b>                       | Set the maximum change in output allowed while in automatic mode per scan.                                                                                                                                                                                                                                                                                                                           | 0.00 – 100.00 %/qs  | 25              |
| <b>MANUAL RATE OF DECREASE:</b>         | Amount of change per ramp time interval in manual mode                                                                                                                                                                                                                                                                                                                                               | 1 – 99 RPM/qs       | 1               |
| <b>MANUAL RATE OF INCREASE:</b>         | Amount of change per ramp time interval in manual mode                                                                                                                                                                                                                                                                                                                                               | 1 – 99 RPM/qs       | 1               |
| <b>RAMP TO RATED RPM RATE INC (qs):</b> | Special ramp time during warmup to rated transition                                                                                                                                                                                                                                                                                                                                                  | 1 – 99 RPM/qs       | 1               |
| <b>WARMUP RPM:</b>                      | The Warmup RPM setpoint that will be sent to the driver while the unit is in the Warmup state.                                                                                                                                                                                                                                                                                                       | 0 – 10000 RPM       | 750             |
| <b>COOLDOWN RPM:</b>                    | The Cooldown RPM setpoint that will be sent to the driver while the unit is in the Cooldown state.                                                                                                                                                                                                                                                                                                   | 0 – 10000 RPM       | 750             |
| <b>CONTROL MODE:</b>                    | In Auto PID:                                                                                                                                                                                                                                                                                                                                                                                         | Manual,             | Automatic       |
|                                         | If the <b>Suction Pressure</b> is below its setpoint the output will decreased. If the <b>Suction Pressure</b> is above its setpoint the output will be increased.                                                                                                                                                                                                                                   | OR                  |                 |
|                                         | In Manual PID:                                                                                                                                                                                                                                                                                                                                                                                       | Automatic           |                 |
|                                         | The PID loop is turned OFF and the MANUAL RPM SP will be directly output to the valve.                                                                                                                                                                                                                                                                                                               |                     |                 |
| <b>PID AUTO SETPOINT – STAND-BY:</b>    | The automatic pressure set point that will be maintained if the PID loop mode is set to auto.                                                                                                                                                                                                                                                                                                        | 0 – 9999 PSI        | 15              |
| <b>PID AUTO SETPOINT - RUNNING:</b>     | The automatic pressure set point that will be maintained if the PID loop mode is set to auto.                                                                                                                                                                                                                                                                                                        | 0 – 9999 PSI        | 30              |
| <b>PID DEADBAND:</b>                    | The pressure deadband around the set point. In Auto Mode, no change in % OUT will occur if the control pressure is inside this window.                                                                                                                                                                                                                                                               | 0 – 9999 PSI        | 5               |
| <b>PROPORTIONAL:</b>                    | This is a multiplier for the error (pressure minus set point) and will determine how the error will directly affect the amount of change in output. Too low a number here will result in sluggish action of the PID loop. Too high a number here will result in overshoot and oscillation of the PID loop.                                                                                           | 0.00 – 100.00       | 15              |
| <b>INTEGRAL:</b>                        | This is a multiplier for the amount of time the error (pressure minus set point) has been above or below set point. The more time that passes before the loop does not reach its setpoint, will directly affect the amount of change in output. Too low a number here will take out the Integral part of control of the PID loop. Too high a number here will result in oscillation of the PID loop. | 0.00 – 100.00 %/s   | 10              |
| <b>DERIVATIVE:</b>                      | This is a multiplier for how fast the error (pressure minus set point) is changing. The faster the pressure or set point changes will directly affect the amount of change in output. Too low a number here will take out the Derivative part of control of the PID loop. Too high a number here will result in oscillation of the PID loop.                                                         | 0.00 – 100.00 %xs   | 0               |
| <b>MANUAL SP:</b>                       | The manual valve set point that will be sent to the control valve if the PID loop mode is set to manual. Change this setting after the loop has been placed into manual to keep the valve at the desired position. When the mode is changed from Auto to Manual, the % OUT will be copied to the LOCAL % OUT SP setting for bumpless transfer of control.                                            | 0.00 – 100.00 %     | 0               |
| <b>MANUAL RATE OF INCREASE:</b>         | Amount of change per ramp time interval in manual mode                                                                                                                                                                                                                                                                                                                                               | 0.00 – 100.00 %/ qs | 1               |
| <b>MANUAL RATE OF DECREASE:</b>         | Amount of change per ramp time interval in manual mode                                                                                                                                                                                                                                                                                                                                               | 0.00 – 100.00 %/ qs | 1               |



| Setting                         | Description                                                                                                                                                                                                                                                                                                                                                                                             | Range               | Factory Setting |
|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|-----------------|
|                                 |                                                                                                                                                                                                                                                                                                                                                                                                         |                     |                 |
| <b>MIN LOADED PERCENT:</b>      | The minimum desired valve position that the PID will be allowed to output while in Auto Mode.                                                                                                                                                                                                                                                                                                           | 0.00 – 100.00 %     | 0               |
| <b>MAX LOADED PERCENT:</b>      | The maximum desired valve position that the PID output will be allowed to output while in Auto Mode.                                                                                                                                                                                                                                                                                                    | 0.00 – 100.00 %     | 100             |
| <b>SLEW RATE:</b>               | Set the maximum change in output allowed while in automatic mode per scan.                                                                                                                                                                                                                                                                                                                              | 1 – 99.99 %/qs      | 25              |
| <b>CONTROL MODE:</b>            | In Auto PID:                                                                                                                                                                                                                                                                                                                                                                                            | Manual,             | Automatic       |
|                                 | If the 1 <sup>st</sup> Stage Cooler Discharge Temperature is below its setpoint the output will decreased. If the 1 <sup>st</sup> Stage Cooler Discharge Temperature is above its setpoint the output will be increased.                                                                                                                                                                                | OR                  |                 |
|                                 | In Manual PID:                                                                                                                                                                                                                                                                                                                                                                                          | Automatic           |                 |
|                                 | The PID loop is turned OFF and the MANUAL RPM SP will be directly output to the louver.                                                                                                                                                                                                                                                                                                                 |                     |                 |
| <b>PID AUTO SETPOINT:</b>       | The automatic Temperature set point that will be maintained if the PID loop mode is set to auto.                                                                                                                                                                                                                                                                                                        | 0 – 9999 °F         | 20              |
| <b>PID DEADBAND:</b>            | The Temperature deadband around the set point. In Auto Mode, no change in % OUT will occur if the control Temperature is inside this window.                                                                                                                                                                                                                                                            | 0 – 9999 °F         | 5               |
| <b>PROPORTIONAL:</b>            | This is a multiplier for the error (Temperature minus set point) and will determine how the error will directly affect the amount of change in output. Too low a number here will result in sluggish action of the PID loop. Too high a number here will result in overshoot and oscillation of the PID loop.                                                                                           | 0.00 – 100.00       | 15              |
| <b>INTEGRAL:</b>                | This is a multiplier for the amount of time the error (Temperature minus set point) has been above or below set point. The more time that passes before the loop does not reach its setpoint, will directly affect the amount of change in output. Too low a number here will take out the Integral part of control of the PID loop. Too high a number here will result in oscillation of the PID loop. | 0.00 – 100.00 %/s   | 10              |
| <b>DERIVATIVE:</b>              | This is a multiplier for how fast the error (Temperature minus set point) is changing. The faster the Temperature or set point changes will directly affect the amount of change in output. Too low a number here will take out the Derivative part of control of the PID loop. Too high a number here will result in oscillation of the PID loop.                                                      | 0.00 – 100.00 %xs   | 0               |
| <b>MANUAL SP:</b>               | The manual louver set point that will be sent to the louver if the PID loop mode is set to manual. Change this setting after the loop has been placed into manual to keep the louver at the desired position. When the mode is changed from Auto to Manual, the % OUT will be copied to the LOCAL % OUT SP setting for bumpless transfer of control.                                                    | 0.00 – 100.00 %     | 0               |
| <b>MANUAL RATE OF INCREASE:</b> | Amount of change per ramp time interval in manual mode                                                                                                                                                                                                                                                                                                                                                  | 0.00 – 100.00 %/ qs | 1               |
| <b>MANUAL RATE OF DECREASE:</b> | Amount of change per ramp time interval in manual mode                                                                                                                                                                                                                                                                                                                                                  | 0.00 – 100.00 %/ qs | 1               |
| <b>MIN LOADED PERCENT:</b>      | The minimum desired louver position that the PID will be allowed to output while in Auto Mode.                                                                                                                                                                                                                                                                                                          | 0.00 – 100.00 %     | 0               |
| <b>MAX LOADED PERCENT:</b>      | The maximum desired louver position that the PID output will be allowed to output while in Auto Mode.                                                                                                                                                                                                                                                                                                   | 0.00 – 100.00 %     | 100             |
| <b>SLEW RATE:</b>               |                                                                                                                                                                                                                                                                                                                                                                                                         | 1 – 99.99 %/qs      | 25              |

| Setting                  | Description                                                                                                                                                                                                                                                                                                                                                                                             | Range               | Factory Setting |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|-----------------|
|                          | Set the maximum change in output allowed while in automatic mode per scan.                                                                                                                                                                                                                                                                                                                              |                     |                 |
| CONTROL MODE:            | In Auto PID:                                                                                                                                                                                                                                                                                                                                                                                            | Manual,             | Automatic       |
|                          | If the 2 <sup>nd</sup> Stage Cooler Discharge Temperature is below its setpoint the output will decreased. If the 2 <sup>nd</sup> Stage Cooler Discharge Temperature is above its setpoint the output will be increased.                                                                                                                                                                                | OR                  |                 |
|                          | In Manual PID:                                                                                                                                                                                                                                                                                                                                                                                          | Automatic           |                 |
|                          | The PID loop is turned OFF and the MANUAL RPM SP will be directly output to the louver.                                                                                                                                                                                                                                                                                                                 |                     |                 |
| PID AUTO SETPOINT:       | The automatic Temperature set point that will be maintained if the PID loop mode is set to auto.                                                                                                                                                                                                                                                                                                        | 0 – 9999 °F         | 20              |
| PID DEADBAND:            | The Temperature deadband around the set point. In Auto Mode, no change in % OUT will occur if the control Temperature is inside this window.                                                                                                                                                                                                                                                            | 0 – 9999 °F         | 5               |
| PROPORTIONAL:            | This is a multiplier for the error (Temperature minus set point) and will determine how the error will directly affect the amount of change in output. Too low a number here will result in sluggish action of the PID loop. Too high a number here will result in overshoot and oscillation of the PID loop.                                                                                           | 0.00 – 100.00       | 15              |
| INTEGRAL:                | This is a multiplier for the amount of time the error (Temperature minus set point) has been above or below set point. The more time that passes before the loop does not reach its setpoint, will directly affect the amount of change in output. Too low a number here will take out the Integral part of control of the PID loop. Too high a number here will result in oscillation of the PID loop. | 0.00 – 100.00 %/s   | 10              |
| DERIVATIVE:              | This is a multiplier for how fast the error (Temperature minus set point) is changing. The faster the Temperature or set point changes will directly affect the amount of change in output. Too low a number here will take out the Derivative part of control of the PID loop. Too high a number here will result in oscillation of the PID loop.                                                      | 0.00 – 100.00 %xs   | 0               |
| MANUAL SP:               | The manual louver set point that will be sent to the louver if the PID loop mode is set to manual. Change this setting after the loop has been placed into manual to keep the louver at the desired position. When the mode is changed from Auto to Manual, the % OUT will be copied to the LOCAL % OUT SP setting for bumpless transfer of control.                                                    | 0.00 – 100.00 %     | 0               |
| MANUAL RATE OF INCREASE: | Amount of change per ramp time interval in manual mode                                                                                                                                                                                                                                                                                                                                                  | 0.00 – 100.00 %/ qs | 1               |
| MANUAL RATE OF DECREASE: | Amount of change per ramp time interval in manual mode                                                                                                                                                                                                                                                                                                                                                  | 0.00 – 100.00 %/ qs | 1               |
| MIN LOADED PERCENT:      | The minimum desired louver position that the PID will be allowed to output while in Auto Mode.                                                                                                                                                                                                                                                                                                          | 0.00 – 100.00 %     | 0               |
| MAX LOADED PERCENT:      | The maximum desired louver position that the PID output will be allowed to output while in Auto Mode.                                                                                                                                                                                                                                                                                                   | 0.00 – 100.00 %     | 100             |
| SLEW RATE:               | Set the maximum change in output allowed while in automatic mode per scan.                                                                                                                                                                                                                                                                                                                              | 1 – 99.99 %/qs      | 25              |
| CONTROL MODE:            | In Auto PID:                                                                                                                                                                                                                                                                                                                                                                                            | Manual,             | Automatic       |
|                          | If the 3 <sup>rd</sup> Stage Cooler Discharge Temperature is below its setpoint the output will decreased. If the 3 <sup>rd</sup> Stage Cooler Discharge Temperature is above its setpoint the output will be increased.                                                                                                                                                                                | OR                  |                 |
|                          | In Manual PID:                                                                                                                                                                                                                                                                                                                                                                                          | Automatic           |                 |
|                          | The PID loop is turned OFF and the MANUAL RPM SP will be directly output to the louver.                                                                                                                                                                                                                                                                                                                 |                     |                 |
| PID AUTO SETPOINT:       |                                                                                                                                                                                                                                                                                                                                                                                                         | 0 – 9999 °F         | 20              |



| Setting                  | Description                                                                                                                                                                                                                                                                                                                                                                                             | Range               | Factory Setting |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|-----------------|
|                          | The automatic Temperature set point that will be maintained if the PID loop mode is set to auto.                                                                                                                                                                                                                                                                                                        |                     |                 |
| PID DEADBAND:            | The Temperature deadband around the set point. In Auto Mode, no change in % OUT will occur if the control Temperature is inside this window.                                                                                                                                                                                                                                                            | 0 – 9999 °F         | 5               |
| PROPORTIONAL:            | This is a multiplier for the error (Temperature minus set point) and will determine how the error will directly affect the amount of change in output. Too low a number here will result in sluggish action of the PID loop. Too high a number here will result in overshoot and oscillation of the PID loop.                                                                                           | 0.00 – 100.00       | 15              |
| INTEGRAL:                | This is a multiplier for the amount of time the error (Temperature minus set point) has been above or below set point. The more time that passes before the loop does not reach its setpoint, will directly affect the amount of change in output. Too low a number here will take out the Integral part of control of the PID loop. Too high a number here will result in oscillation of the PID loop. | 0.00 – 100.00 %/s   | 10              |
| DERIVATIVE:              | This is a multiplier for how fast the error (Temperature minus set point) is changing. The faster the Temperature or set point changes will directly affect the amount of change in output. Too low a number here will take out the Derivative part of control of the PID loop. Too high a number here will result in oscillation of the PID loop.                                                      | 0.00 – 100.00 %xs   | 0               |
| MANUAL SP:               | The manual louver set point that will be sent to the louver if the PID loop mode is set to manual. Change this setting after the loop has been placed into manual to keep the louver at the desired position. When the mode is changed from Auto to Manual, the % OUT will be copied to the LOCAL % OUT SP setting for bumpless transfer of control.                                                    | 0.00 – 100.00 %     | 0               |
| MANUAL RATE OF INCREASE: | Amount of change per ramp time interval in manual mode                                                                                                                                                                                                                                                                                                                                                  | 0.00 – 100.00 %/ qs | 1               |
| MANUAL RATE OF DECREASE: | Amount of change per ramp time interval in manual mode                                                                                                                                                                                                                                                                                                                                                  | 0.00 – 100.00 %/ qs | 1               |
| MIN LOADED PERCENT:      | The minimum desired louver position that the PID will be allowed to output while in Auto Mode.                                                                                                                                                                                                                                                                                                          | 0.00 – 100.00 %     | 0               |
| MAX LOADED PERCENT:      | The maximum desired louver position that the PID output will be allowed to output while in Auto Mode.                                                                                                                                                                                                                                                                                                   | 0.00 – 100.00 %     | 100             |
| SLEW RATE:               | Set the maximum change in output allowed while in automatic mode per scan.                                                                                                                                                                                                                                                                                                                              | 1 – 99.99 %/qs      | 25              |
| CONTROL MODE:            | In Auto PID:                                                                                                                                                                                                                                                                                                                                                                                            | Manual,             | Automatic       |
|                          | If the 4 <sup>th</sup> Stage Cooler Discharge Temperature is below its setpoint the output will decreased. If the 4 <sup>th</sup> Stage Cooler Discharge Temperature is above its setpoint the output will be increased.                                                                                                                                                                                | OR                  |                 |
|                          | In Manual PID:                                                                                                                                                                                                                                                                                                                                                                                          | Automatic           |                 |
|                          | The PID loop is turned OFF and the MANUAL RPM SP will be directly output to the louver.                                                                                                                                                                                                                                                                                                                 |                     |                 |
| PID AUTO SETPOINT:       | The automatic Temperature set point that will be maintained if the PID loop mode is set to auto.                                                                                                                                                                                                                                                                                                        | 0 – 9999 °F         | 20              |
| PID DEADBAND:            | The Temperature deadband around the set point. In Auto Mode, no change in % OUT will occur if the control Temperature is inside this window.                                                                                                                                                                                                                                                            | 0 – 9999 °F         | 5               |
| PROPORTIONAL:            | This is a multiplier for the error (Temperature minus set point) and will determine how the error will directly affect the amount of change in output. Too low a number here will result in sluggish action of the PID loop. Too high a number here will result in overshoot and oscillation of the PID loop.                                                                                           | 0.00 – 100.00       | 15              |

| Setting                           | Description                                                                                                                                                                                                                                                                                                                                                                                             | Range               | Factory Setting |
|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|-----------------|
| <b>INTEGRAL:</b>                  | This is a multiplier for the amount of time the error (Temperature minus set point) has been above or below set point. The more time that passes before the loop does not reach its setpoint, will directly affect the amount of change in output. Too low a number here will take out the Integral part of control of the PID loop. Too high a number here will result in oscillation of the PID loop. | 0.00 – 100.00 %/s   | 10              |
| <b>DERIVATIVE:</b>                | This is a multiplier for how fast the error (Temperature minus set point) is changing. The faster the Temperature or set point changes will directly affect the amount of change in output. Too low a number here will take out the Derivative part of control of the PID loop. Too high a number here will result in oscillation of the PID loop.                                                      | 0.00 – 100.00 %xs   | 0               |
| <b>MANUAL SP:</b>                 | The manual louver set point that will be sent to the louver if the PID loop mode is set to manual. Change this setting after the loop has been placed into manual to keep the louver at the desired position. When the mode is changed from Auto to Manual, the % OUT will be copied to the LOCAL % OUT SP setting for bumpless transfer of control.                                                    | 0.00 – 100.00 %     | 0               |
| <b>MANUAL RATE OF INCREASE:</b>   | Amount of change per ramp time interval in manual mode                                                                                                                                                                                                                                                                                                                                                  | 0.00 – 100.00 %/ qs | 1               |
| <b>MANUAL RATE OF DECREASE:</b>   | Amount of change per ramp time interval in manual mode                                                                                                                                                                                                                                                                                                                                                  | 0.00 – 100.00 %/ qs | 1               |
| <b>MIN LOADED PERCENT:</b>        | The minimum desired louver position that the PID will be allowed to output while in Auto Mode.                                                                                                                                                                                                                                                                                                          | 0.00 – 100.00 %     | 0               |
| <b>MAX LOADED PERCENT:</b>        | The maximum desired louver position that the PID output will be allowed to output while in Auto Mode.                                                                                                                                                                                                                                                                                                   | 0.00 – 100.00 %     | 100             |
| <b>SLEW RATE:</b>                 | Set the maximum change in output allowed while in automatic mode per scan.                                                                                                                                                                                                                                                                                                                              | 1 – 99.99 %/qs      | 25              |
| <b>PID SETPOINT:</b>              | The temperature setpoint that will be maintained by the PID control loop.                                                                                                                                                                                                                                                                                                                               | 0 – 9999 °F         | 100             |
| <b>PID DEADBAND:</b>              | The temperature deadband around the setpoint. No change in % OUT will occur if the suction temperature is inside this window.                                                                                                                                                                                                                                                                           | 0 – 9999 °F         | 5               |
| <b>PROPORTIONAL:</b>              | This is a multiplier for the error (temperature minus setpoint) and will determine how the error will directly affect the amount of change in output. Too low a number here will result in sluggish action of the PID loop. Too high a number here will result in overshoot and oscillation of the PID loop.                                                                                            | 0.00 – 100.00       | 15              |
| <b>INTEGRAL:</b>                  | This is a multiplier for the amount of time the error (temperature minus setpoint) has been above or below setpoint. The more time that passes before the loop does not reach its setpoint, will directly affect the amount of change in output. Too low a number here will take out the Integral part of control of the PID loop. Too high a number here will result in oscillation of the PID loop.   | 0.0 – 100.00<br>%/s | 10              |
| <b>DERIVATIVE:</b>                | This is a multiplier for how fast the error (temperature minus setpoint) is changing. The faster the temperature or setpoint changes will directly affect the amount of change in output. Too low a number here will take out the Derivative part of control of the PID loop. Too high a number here will result in oscillation of the PID loop.                                                        | 0.0 – 100.00<br>%xs | 0               |
| <b>MIN LOADED OUTPUT PERCENT:</b> | The minimum desired percent that the PID will be allowed to output while in Auto Mode.                                                                                                                                                                                                                                                                                                                  | 0.0 – 100.00<br>%   | 0               |
| <b>MAX LOADED OUTPUT PERCENT:</b> | The maximum desired percent that the PID will be allowed to output while in Auto Mode.                                                                                                                                                                                                                                                                                                                  | 0.0 – 100.00<br>%   | 100             |
| <b>SLEW RATE (qs):</b>            | Set the maximum change in output allowed while in automatic mode per scan.                                                                                                                                                                                                                                                                                                                              | 0.0 – 100.00<br>%   | 25              |
|                                   | In AUTO, the output will increase or decrease based on the 4 <sup>th</sup> Stage Cooler Discharge Temperature PID loop.                                                                                                                                                                                                                                                                                 | Manual,             | Automatic       |



| Setting                                        | Description                                                                                                                                                                                                                                        | Range              | Factory Setting |
|------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-----------------|
| <b>COOLER FAN SPEED CONTROL MODE:</b>          | In <b>MANUAL</b> , the low select is ignored and the 'Manual RPM SP' will be directly output to the engine.                                                                                                                                        | Automatic          |                 |
| <b>MANUAL RPM SP:</b>                          | The manual % set point that will be sent to the Cooler Fan Speed.                                                                                                                                                                                  | 0.00 – 100.00 %    | 0               |
|                                                | Change this setting after the loop has been placed into manual to keep the Cooler Fan Speed at the desired speed. When the mode is changed from Auto to Manual the % OUT will be copied to the MANUAL SP setting for bumpless transfer of control. |                    |                 |
| <b>Cooler Fan Speed Min Input:</b>             | The minimum percent input that the Temperature PID output will be compared to before it is scaled between.                                                                                                                                         | 0.00 – 100.00 %    | 0               |
| <b>Cooler Fan Speed Max Input:</b>             | The maximum percent input that the Temperature PID output will be compared to before it is scaled between.                                                                                                                                         | 0.00 – 100.00 %    | 50              |
| <b>Cooler Fan Speed Min Output %:</b>          | The minimum percent that is scaled to the output.                                                                                                                                                                                                  | 0.00 – 100.00 %    | 0               |
| <b>Cooler Fan Speed Max Output %:</b>          | The maximum percent that is scaled to the output.                                                                                                                                                                                                  | 0.00 – 100.00 %    | 100             |
| <b>RATE OF DECREASE:</b>                       | Amount of change per ramp time interval in manual mode                                                                                                                                                                                             | 0.00 – 100.00 %    | 1               |
| <b>RATE OF INCREASE:</b>                       | Amount of change per ramp time interval in manual mode                                                                                                                                                                                             | 0.00 – 100.00 %    | 1               |
| <b>COOLER FAN SPEED CONTROL MODE:</b>          | In <b>AUTO</b> , the output will increase or decrease based on the 4 <sup>th</sup> Stage Cooler Discharge Temperature PID loop.                                                                                                                    | Manual,            | Automatic       |
|                                                | In <b>MANUAL</b> , the low select is ignored and the 'Manual RPM SP' will be directly output to the engine.                                                                                                                                        | Automatic          |                 |
| <b>MANUAL RPM SP:</b>                          | The manual % set point that will be sent to the Cooler Fan Speed.                                                                                                                                                                                  | 0.00 – 100.00 %    | 0               |
|                                                | Change this setting after the loop has been placed into manual to keep the Cooler Fan Speed at the desired speed. When the mode is changed from Auto to Manual the % OUT will be copied to the MANUAL SP setting for bumpless transfer of control. |                    |                 |
| <b>Cooler Fan Speed Min Input:</b>             | The minimum percent input that the Temperature PID output will be compared to before it is scaled between.                                                                                                                                         | 0.00 – 100.00 %    | 50              |
| <b>Cooler Fan Speed Max Input:</b>             | The maximum percent input that the Temperature PID output will be compared to before it is scaled between.                                                                                                                                         | 0.00 – 100.00 %    | 100             |
| <b>Cooler Fan Speed Min Output %:</b>          | The minimum percent that is scaled to the output.                                                                                                                                                                                                  | 0.00 – 100.00 %    | 0               |
| <b>Cooler Fan Speed Max Output %:</b>          | The maximum percent that is scaled to the output.                                                                                                                                                                                                  | 0.00 – 100.00 %    | 100             |
| <b>RATE OF DECREASE:</b>                       | Amount of change per ramp time interval in manual mode                                                                                                                                                                                             | 0.00 – 100.00 %    | 1               |
| <b>RATE OF INCREASE:</b>                       | Amount of change per ramp time interval in manual mode                                                                                                                                                                                             | 0.00 – 100.00 %    | 1               |
| <b>1<sup>st</sup> Stage Suction Pressure</b>   | Min Range (4 mA)                                                                                                                                                                                                                                   | –32767 – 32767 PSI | 0               |
| <b>1<sup>st</sup> Stage Suction Pressure</b>   | Max Range (20 mA)                                                                                                                                                                                                                                  | –32767 – 32767 PSI | 200             |
| <b>1<sup>st</sup> Stage Discharge Pressure</b> | Min Range (4 mA)                                                                                                                                                                                                                                   | –32767 – 32767 PSI | 0               |

| Setting                                  | Description                                        | Range                 | Factory Setting |
|------------------------------------------|----------------------------------------------------|-----------------------|-----------------|
| 1 <sup>st</sup> Stage Discharge Pressure | Max Range (20 mA)                                  | -32767 – 32767 PSI    | 300             |
| 2 <sup>nd</sup> Stage Suction Pressure   | Min Range (4 mA)                                   | -32767 – 32767        | 0               |
| 2 <sup>nd</sup> Stage Suction Pressure   | Max Range (20 mA)                                  | -32767 – 32767        | 300             |
| 2 <sup>nd</sup> Stage Discharge Pressure | Min Range (4 mA)                                   | -32767 – 32767 PSI    | 0               |
| 2 <sup>nd</sup> Stage Discharge Pressure | Max Range (20 mA)                                  | -32767 – 32767 PSI    | 600             |
| 3 <sup>rd</sup> Stage Suction Pressure   | Min Range (4 mA)                                   | -32767 – 32767        | 0               |
| 3 <sup>rd</sup> Stage Suction Pressure   | Max Range (20 mA)                                  | -32767 – 32767        | 600             |
| 3 <sup>rd</sup> Stage Discharge Pressure | Min Range (4 mA)                                   | -32767 – 32767 PSI    | 0               |
| 3 <sup>rd</sup> Stage Discharge Pressure | Max Range (20 mA)                                  | -32767 – 32767 PSI    | 1000            |
| 4 <sup>th</sup> Stage Suction Pressure   | Min Range (4 mA)                                   | -32767 – 32767        | 0               |
| 4 <sup>th</sup> Stage Suction Pressure   | Max Range (20 mA)                                  | -32767 – 32767        | 1000            |
| 4 <sup>th</sup> Stage Discharge Pressure | Min Range (4 mA)                                   | -32767 – 32767 PSI    | 0               |
| 4 <sup>th</sup> Stage Discharge Pressure | Max Range (20 mA)                                  | -32767 – 32767 PSI    | 2000            |
| Compressor Oil Pressure                  | Min Range (4 mA)                                   | -3276.7 – 3276.7 PSI  | 0               |
| Compressor Oil Pressure                  | Max Range (20 mA)                                  | -3276.7 – 3276.7 PSI  | 100             |
| Fuel Gas Pressure                        | Min Range (4 mA)                                   | -32767 – 32767 PSI    | 0               |
| Fuel Gas Pressure                        | Max Range (20 mA)                                  | -32767 – 32767 PSI    | 200             |
| Engine Jacket Water Level                | Min Range (4 mA)                                   | -327.67 – 327.67 INCH | 0               |
| Engine Jacket Water Level                | Max Range (20 mA)                                  | -327.67 – 327.67 INCH | 20              |
| Auxiliary Water Level                    | Min Range (4 mA)                                   | -327.67 – 327.67 INCH | 0               |
| Auxiliary Water Level                    | Max Range (20 mA)                                  | -327.67 – 327.67 INCH | 20              |
| Valve                                    | Suction Control Valve Fail Position:               | Normally Open         | Normally Closed |
|                                          |                                                    | Normally Closed       |                 |
| Louver Calibration                       | 1 <sup>st</sup> Stage Cooler Louver Fail Position: | Normally Open         | Normally Closed |
|                                          |                                                    | Normally Closed       |                 |
| Louver Calibration                       | 2 <sup>nd</sup> Stage Cooler Louver Fail Position: | Normally Open         | Normally Closed |
|                                          |                                                    | Normally Closed       |                 |
| Louver Calibration                       | 3 <sup>rd</sup> Stage Cooler Louver Fail Position: | Normally Open         | Normally Closed |
|                                          |                                                    | Normally Closed       |                 |
| Louver Calibration                       | 4 <sup>th</sup> Stage Cooler Louver Fail Position: | Normally Open         | Normally Closed |
|                                          |                                                    | Normally Closed       |                 |
| Engine Speed                             | Min Range (4 mA)                                   | -32767 – 32767 RPM    | 700             |
| Engine Speed                             | Max Range (20 mA)                                  | -32767 – 32767 RPM    | 1000            |
| Discharge Cylinder #1 Temperature        | Offset                                             | -20 – 20 °F           | 0               |
|                                          | Type                                               | J or K                | K               |
| Discharge Cylinder #2 Temperature        | Offset                                             | -20 – 20 °F           | 0               |
|                                          | Type                                               | J or K                | K               |



| Setting                                            | Description                                                                                                                                                                                                                                                                              | Range           | Factory Setting |
|----------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------|
| Discharge Cylinder #3A Temperature                 | Offset                                                                                                                                                                                                                                                                                   | -20 – 20 °F     | 0               |
|                                                    | Type                                                                                                                                                                                                                                                                                     | J or K          | K               |
| Discharge Cylinder #3B Temperature                 | Offset                                                                                                                                                                                                                                                                                   | -20 – 20 °F     | 0               |
|                                                    | Type                                                                                                                                                                                                                                                                                     | J or K          | K               |
| Discharge Cylinder #4 Temperature                  | Offset                                                                                                                                                                                                                                                                                   | -20 – 20 °F     | 0               |
|                                                    | Type                                                                                                                                                                                                                                                                                     | J or K          | K               |
| Discharge Cylinder #5A Temperature                 | Offset                                                                                                                                                                                                                                                                                   | -20 – 20 °F     | 0               |
|                                                    | Type                                                                                                                                                                                                                                                                                     | J or K          | K               |
| Discharge Cylinder #5B Temperature                 | Offset                                                                                                                                                                                                                                                                                   | -20 – 20 °F     | 0               |
|                                                    | Type                                                                                                                                                                                                                                                                                     | J or K          | K               |
| Discharge Cylinder #6 Temperature                  | Offset                                                                                                                                                                                                                                                                                   | -20 – 20 °F     | 0               |
|                                                    | Type                                                                                                                                                                                                                                                                                     | J or K          | K               |
| CPC Cold Junction Temperature – Offset             | Calibration factor for the cold junction sensor on the Thermocouple Input module 1769-IT6. To set this, use a calibrated temperature sensor and measure the temperature of the terminal block. Compare against the CPC Cold Junction Reading, and use the offset to correct the reading. | -20.0 – 20.0 °F | 0.0             |
| CPC Cold Junction                                  | Cold Junction Temperature reading physically located above TC1 on the controller.                                                                                                                                                                                                        | -20.0 - 20.0 °F | 0.0             |
| Compressor Main Bearing #1 Temperature             | Offset                                                                                                                                                                                                                                                                                   | -20 – 20 °F     | 0               |
|                                                    | Type                                                                                                                                                                                                                                                                                     | J or K          | K               |
| Compressor Main Bearing #2 Temperature             | Offset                                                                                                                                                                                                                                                                                   | -20 – 20 °F     | 0               |
|                                                    | Type                                                                                                                                                                                                                                                                                     | J or K          | K               |
| Compressor Main Bearing #3 Temperature             | Offset                                                                                                                                                                                                                                                                                   | -20 – 20 °F     | 0               |
|                                                    | Type                                                                                                                                                                                                                                                                                     | J or K          | K               |
| Compressor Main Bearing #4 Temperature             | Offset                                                                                                                                                                                                                                                                                   | -20 – 20 °F     | 0               |
|                                                    | Type                                                                                                                                                                                                                                                                                     | J or K          | K               |
| Compressor Main Bearing #5 Temperature             | Offset                                                                                                                                                                                                                                                                                   | -20 – 20 °F     | 0               |
|                                                    | Type                                                                                                                                                                                                                                                                                     | J or K          | K               |
| Compressor Main Bearing #6 Temperature             | Offset                                                                                                                                                                                                                                                                                   | -20 – 20 °F     | 0               |
|                                                    | Type                                                                                                                                                                                                                                                                                     | J or K          | K               |
| 1 <sup>st</sup> Stage Suction Temperature          | Offset                                                                                                                                                                                                                                                                                   | -20 – 20 °F     | 0               |
|                                                    | Type                                                                                                                                                                                                                                                                                     | J or K          | K               |
| 2 <sup>nd</sup> Stage Suction Temperature          | Offset                                                                                                                                                                                                                                                                                   | -20 – 20 °F     | 0               |
|                                                    | Type                                                                                                                                                                                                                                                                                     | J or K          | K               |
| 3 <sup>rd</sup> Stage Suction Temperature          | Offset                                                                                                                                                                                                                                                                                   | -20 – 20 °F     | 0               |
|                                                    | Type                                                                                                                                                                                                                                                                                     | J or K          | K               |
| 4 <sup>th</sup> Stage Suction Temperature          | Offset                                                                                                                                                                                                                                                                                   | -20 – 20 °F     | 0               |
|                                                    | Type                                                                                                                                                                                                                                                                                     | J or K          | K               |
| 1 <sup>st</sup> Stage Cooler Discharge Temperature | Offset                                                                                                                                                                                                                                                                                   | -20 – 20 °F     | 0               |
|                                                    | Type                                                                                                                                                                                                                                                                                     | J or K          | K               |
| 2 <sup>nd</sup> Stage Cooler Discharge Temperature | Offset                                                                                                                                                                                                                                                                                   | -20 – 20 °F     | 0               |
|                                                    | Type                                                                                                                                                                                                                                                                                     | J or K          | K               |
| 3 <sup>rd</sup> Stage Cooler Discharge Temperature | Offset                                                                                                                                                                                                                                                                                   | -20 – 20 °F     | 0               |
|                                                    | Type                                                                                                                                                                                                                                                                                     | J or K          | K               |