Exhibit D

Operation and Maintenance Manual for a JOHN ZINK® BIOGAS FLARE SYSTEM with ENCLOSED ZTOF® BIOGAS FLARE

JOHN ZINK HAMWORTHY COMBUSTION

John Zink Company, LLC
11920 East Apache Street
Tulsa, Oklahoma 74116-1300

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OPERATION AND MAINTENANCE MANUAL

FOR A JOHN ZINK®

BIOGAS FLARE SYSTEM

WITH

ENCLOSED ZTOF® BIOGAS FLARE

NOTICE

Read this manual before using this product. Failure to follow instructions and safety precautions in this manual can result in serious injury, death, or equipment damage.

KEEP THIS MANUAL IN A SAFE PLACE FOR FUTURE REFERENCE.

This is the safety alert symbol intended to signal potential personal injury hazards. Obey all safety messages associated with this symbol to avoid possible injury or death.

Prepared for
Purchasing Company: Miron Construction Co. Inc.
Purchase Order: 150115-000041
Site Location: South Sioux, NE
Date Published: June 2016

Prepared by
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Sales Order: 9169848

For assistance, please contact John Zink Company as follows:

Service (918) 234-2751	Emergency (918) 234-1800
Spare Parts (918) 234-2751	Facsimile (918) 234-2700

Request field service and spare part assistance during regular office hours, from 8:00 a.m. to 4:30 p.m. (CST).

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II. GENERAL NOTICES

NOTICE

Read All Instructions before Using the Equipment

This instruction manual was prepared to serve as a general guide for installing, operating, and maintaining industrial process or combustion equipment furnished by this company.

It is intended for use by qualified personnel with knowledge of operating industrial equipment. It is not intended to cover all possible variations in equipment or address every specific operating problem which may arise.

Each person is responsible for adhering to all warnings or cautions provided in this manual. In addition to any general safety measures provided in this manual, each person must comply with all current national, state, local, and company safety regulations at all times.

Safety symbols appearing within comply with ISO 3864.

⚠ DANGER Indicates a hazard with a high level of risk which, if not avoided will result in death or serious injury.

⚠ WARNING Indicates a hazard with a medium level of risk which, if not avoided may result in death or serious injury.

⚠ CAUTION Indicates a hazard with a low level of risk which, if not avoided will result in minor or moderate injury.

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III. INTRODUCTION

This manual provides an overview of a John Zink® Biogas Flare System. The system consists of an Enclosed ZTOF® Flare, Flare Control Panel, and a ZMS Moisture Separator. Pertinent information required to operate and maintain safely the John Zink supplied equipment is located within these instructions.

A John Zink Biogas Flare System offers automated operation and is designed to destroy safely, with automatic temperature control, typical organic compounds generated by solid waste and other biogas processes. The system is controlled with a processor, or programmable logic controller (PLC), which receives and transmits signals with respect to operating conditions. If an unacceptable operating condition occurs, the control system discontinues flow of biogas or adjusts the operating parameters to correct the problem. Control of the Enclosed ZTOF Flare includes an initial purge cycle, automatic ignition sequence, and fail-safe controls. A self-checking flame scanner monitors pilot flame or main flame and integrated safety shutdown features prevent equipment damage.

Please become familiar with this manual. Contact John Zink Company with any questions or to request additional assistance.

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IV. SAFETY SUMMARY

The following general safety precautions apply to operating and maintaining a John Zink® Biogas Flare System. Instructions contained in this manual are in addition to, and do not replace, the existing operating procedures and policies of the operating company and owner with regard to standard safety precautions for flare operation and maintenance.

DANGER

ARC FLASH AND/OR SHOCK HAZARD

High voltages capable of causing injury or death are associated with this equipment. Use extreme caution when servicing electrical enclosures or any other electrical components. Disconnect the electrical source of any circuit on which service is being performed and lock open the corresponding disconnect switch. Ensure electrical enclosures and components are grounded properly before applying power.

NOTICE

If electrical conduit is installed for electrical wiring, any necessary conduit seal fitting must be poured before operating equipment in normal service. This is a customer or site responsibility and not performed at the factory.

DANGER

TOXIC FUMES AND VAPORS

Industrial process and combustion equipment may contain or produce toxic gases. Always consider appropriate safety precautions whenever personnel may be exposed to process gases. In particular, exposure may occur during close inspection of a flare tip or pilot and during removal or maintenance of equipment attached to gas supply pipe.

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DANGER

CERAMIC FIBER AND DUST

Failure to use proper respiratory equipment may result in exposure to hazardous materials. As supplied, product contains no crystalline silica; however, when exposed to temperatures above 1800 °F (982°C) during operation, cristobalite, a form of crystalline silica, may form.

Prolonged exposure to dust may cause silicosis, a progressive pneumoconiosis, or other respiratory diseases. Dust from product at any stage of use or during demolition after service may, especially during extended exposure, lead to lung disease unless respiratory protection is employed. Wear proper (NIOSH approved) respirators during removal of insulation after service. While a respiratory hazard and/or nuisance dust may exist from the product itself, other foreign substances may warrant additional precautions during removal and disposal.

Contact between insulation ceramic fibers and skin may result in transitory skin rash. Susceptibility varies with individuals, with some individuals showing no susceptibility. In addition to the use of proper respiratory equipment, please refer to Section XVII, "Safety Data Sheets" for detailed product information.

WARNING

PERSONAL PROTECTION EQUIPMENT

Some or all of the following safety equipment will be necessary when installing, operating, or maintaining this equipment:

- Safety Glasses
- Hard Hat
- Ear Plugs/Protection
- Gloves
- Steel Toed Shoes
- Fire Retardant/Resistant Clothing
- Respirator (NIOSH approved or better)
- Electrical (NFPA 70e)
- Face Shield

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⚠ CAUTION

Elevated surface temperatures may exist during certain operating conditions. Exercise caution while near equipment to prevent burns.

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V. RECEIPT AND INSTALLATION

Receipt

Upon delivery to the site and prior to installation, carefully examine equipment for damage. Any damage sustained during shipment will be reimbursed through the freight company and their insurance agent. To assure prompt and accurate processing of any claims, the following is recommended:

1. Inspect each item as it is unloaded or uncrated. Note any damage or shortages on shipping documentation before signing for delivery acceptance.
2. If cargo cannot be inspected upon arrival, sign delivery acceptance documents with the following qualification:

   "accepted subject to future inspection"

3. Inspect cargo as soon as possible, and no later than 10 days after delivery.
4. If damage or shortages are apparent, notify the freight company immediately and supply an itemized damage or shortage list. In addition, notify John Zink Company to initiate prompt replacement or repair procedures.

Installation

Reference Drawings

The following list of drawings are necessary for equipment installation and are located in Section XIII, "Reference Drawings". To identify specific components or for additional information, also refer to component specification sheets located in Section XIV, "Specification Sheets".

D-F-9169848-150	Process and Instrument Diagram
D-F-9169848-301	Enclosed Biogas Flare
ST-11912	KE-1/ST Pilot
D-F-9169848-303	ZMS Moisture Separator
D-F-9169848-400, Sheet 1	Panel Rack Assembly
D-F-9169848-401	Wiring Diagram
D-F-9169848-402	Wiring Diagram
D-F-9169848-403	Wiring Diagram
D-F-9169848-404	Wiring Diagram
D-F-9169848-405	Wiring Diagram
D-F-9169848-406	Wiring Diagram
D-F-9169848-407	Wiring Diagram

General

1. Installation, connection, and assembly of the stack, any remaining piping, electrical conduit, wiring, supports, field or finish painting, heat tracing, external insulation, and lightning protection are not the responsibility of John Zink Company.

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2. Ensure foundations are level and designed for site soil conditions considering loads the equipment will produce. Required anchor bolt and support locations appear on the reference drawings.
3. Ensure equipment is grounded adequately for site soil conditions and as directed by local electric codes.
4. Review reference drawings for electrical and process piping connections to the system.
5. Power wires, thermocouple wires, signal wires, and flame scanner wires each are to be installed in separate conduit. Wire separation is necessary to avoid electrical interference problems which may affect equipment performance.
6. Ignition rod insulators in the pilot are fragile. Verify insulators are not damaged and the rod, insulator bracket, and insulators are secure.
7. Verify thermocouple assemblies are not damaged.
8. Clean inside all system piping and remove sand, rocks, weld slag, or any other debris immediately prior to assembly or installation. Use high pressure air to clear piping after assembly and installation.
9. If high winds are probable, positioning a windscreen approximately 6 feet in front of each damper is recommended.

NOTICE

Ethylene Propylene Diene Monomer (EPDM) gasket material is not recommended for biogas applications.

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2. Install conduit and connect signal wire between the following components and the flare control panel, PNL-101:

   flow meter, FE-107 (allow sufficient flexible conduit for removal)
   pressure transmitter, PIT-110
   pressure control valve, PCV-110

Miscellaneous

1. Confirm final alignment of any rotating equipment after installation at the site, but before operation begins. Alignment again is recommended during commissioning and initial operation. Rotating equipment may include, but is not limited to, any gas blower, air blower, condensate pump, drain pump, recirculation pump, or air cooler.
2. Confirm all filter elements, mesh screens, and mist elimination elements are installed properly, if required.
3. Verify all pipe fittings and flanges (with gaskets, if required) are secure and all threaded nuts, bolts, and fittings are tightened properly.
4. If applicable, do not seal electrical conduit connections until the system installation is verified and initial operation is complete.
5. Verify all electrical conduit fittings (with seals, if required) are secure.
6. Verify all external electrical control and power wire is sized correctly and the system contains adequate overload protection.
7. Verify all electrical wiring connections are secure and all threaded terminals are tightened properly.

NOTICE

An enclosure heater is installed in the Flare Control Panel, PNL-101, to prevent internal corrosion. Individual electric motors may contain integral heaters also to prevent internal corrosion. Ensure all heaters are connected to a reliable power supply and operated continuously, especially during outside storage or when operation is discontinued for an extended duration. Consult wiring diagrams in Section XIII, “Reference Drawings” for additional details.

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VI. DESIGN BASIS

Gas Stream

[redacted]

[redacted]

* lower heating value basis

DANGER

Flame flashback may occur if the gas stream contains an amount of oxygen within the explosive limit.

NOTICE

Methane concentrations less than 30% may require the addition of enrichment fuel for stable combustion.

Process Design

Smokeless Capacity:	100%
Destruction Efficiency:	98% (minimum)
[redacted]	[redacted])
Ambient Pressure:	14.1 psia

Mechanical Design

Wind Speed Classification:	110 mph
Seismic Classification:	Class E
Ambient Temperature:	32 to 120 °F
Electrical Area Classification:	non-hazardous
Site Elevation:	1,100' above sea level

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NOTICE

Heat trace and insulation are recommended as freeze protection for any susceptible components.

Utility Requirements

Pilot Gas:	[redacted]
[redacted]	
Electrical:	120 V, single phase, 60 Hz for control components

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VII. OPERATING PHILOSOPHY

The following information briefly describes the operating logic and sequence for an Enclosed ZTOF® Flare.

⚠WARNING

Do not circumvent the purge cycle, any flame management sequence, or any other safety sequence.

Logic

A combustion safety system, which includes a flame safeguard package, monitors specific parameters and discontinues operation if an unsafe condition occurs. An ultraviolet, self-checking flame scanner detects both pilot flame and main flame. The flame scanner is unable to distinguish between flame sources. Typical fault conditions include:

Flare High Temperature Shutdown

Flare High Temperature Shutdown occurs the moment a temperature above the high temperature switch setpoint value is detected within the flare enclosure by a dedicated high temperature thermocouple. The "Flare Fault" light illuminates immediately and system operation discontinues.

Flare Low Temperature Shutdown

Flare Low Temperature Shutdown occurs when a temperature below the low temperature switch setpoint value is detected within the flare enclosure by the selected temperature control thermocouple and exists for ten minutes consecutively. The "Flare Fault" light illuminates and system operation discontinues.

Pilot Flame Failure and Shutdown

Pilot Flame Failure occurs, during the ignition sequence, when the flame scanner is unable to detect the presence of flame inside the flare enclosure. When Pilot Flame Failure occurs, system operation is interrupted momentarily. Then the entire purge cycle and ignition sequence are repeated automatically. A Shutdown occurs only after three consecutive Failures, or unsuccessful attempts. After the final Pilot Flame Failure occurs, the "Flare Fault" light illuminates and system operation discontinues.

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Main Flame Failure and Shutdown

Main Flame Failure occurs, after the ignition sequence is complete, when the flame scanner is unable to detect the presence of flame inside the flare enclosure. When Main Flame Failure occurs, system operation is interrupted momentarily. Then the entire purge cycle and ignition sequence are repeated automatically. A Shutdown occurs only after three consecutive Failures, or unsuccessful attempts. After the final Main Flame Failure occurs, the "Flare Fault" light illuminates and system operation discontinues.

Automatic Block Valve Fault

An automatic block valve fault conditions occurs when dedicated limit switches are unable to confirm proper valve position. Both closed and open limit switches are monitored and a corresponding fault occurs if improper valve position is detected for 45 seconds consecutively. The "Flare Fault" light illuminates and system operation discontinues.

Other safety features include:

Purge Failure
Separator High Level

Upon determining the source of any alarm or fault condition and completing the necessary corrective action, a system reset is required to begin operation again.

Gas Distribution

System design allows operation of the Enclosed ZTOF Flare and interaction with a gas facility. The objective of the entire system is to supply a sufficient amount of landfill gas to the facility, while diverting any excess gas to the enclosed flare. The distribution of landfill gas between the flare and facility is accomplished with a modulating pressure control valve. The pressure control valve receives a signal from a pressure transmitter and modulates to maintain a constant pressure.

For interaction with the gas facility, two remote signals are necessary. One signal originates at the facility, indicating the facility is available to receive landfill gas, and one signal originates at the flare, indicating no fault conditions exists so landfill gas can be provided. Operation only is permitted when both signals agree.

Three operating scenarios exist:

1. only the enclosed flare is operating (flare only)
2. only the gas facility is operating (facility only)
3. both the enclosed flare and gas facility are operating (both)

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For "flare only" operation, the pressure control valve does not modulate and instead is maintained fully open. If any fault condition occurs operation of the flare discontinues.

For "facility only" operation the pressure control valve does not modulate and instead is maintained fully closed. If any fault condition occurs the remote signal indicates a fault condition.

For the "both" operating scenario, outlet pressure is maintained by varying automatically the position of the pressure control valve. If a fault condition associated only with the flare occurs, only flare operation discontinues.

Sequence

A typical operating sequence consists of:

Flare Control Selection

Select either local or remote control to initiate flare operation. Local control requires operator interaction at the control panel to start and stop operation. Remote control allows starting and stopping operation through a remote contact, without operator interaction at the control panel.

Continuous Pilot Selection

Select “Auto” for continuous pilot operation or select “Off” to resume intermittent pilot operation.

Initial Conditions

System operation is permitted only after confirming two safety conditions exist. The closed limit switch for the automatic block valve must be satisfied, proving a closed valve position. Additionally, the flame scanner must not detect the presence of flame inside the flare enclosure.

Purge Cycle

Prior to beginning the ignition sequence, the combustion chamber and flare enclosure must be purged with ambient air to ensure no potentially explosive gas mixture exists inside. To create a safe condition for pilot ignition, the purge air blower operates and automatic air damper louvers are maintained fully open for five minutes prior to each ignition attempt. When purge air blower operation begins, the "Flare Operating" light flashes.

Ignition Sequence

The ignition sequence begins immediately after the purge cycle is complete. The pilot gas solenoid opens automatically, supplying gas to the pilot, and the ignition transformer energizes.

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The ignition transformer continues for ten seconds and then the flame scanner verifies flame is present.

Gas Supply

Once the flame scanner detects pilot flame, the automatic block valve opens, supplying gas to the flare. After opening the automatic block valve, the pilot gas solenoid closes, and the "Flare Operating" light illuminates. While the flame scanner verifies the presence of flame, system operation continues.

Automatic Air Damper Temperature Control

The operating temperature, or temperature maintained inside the flare enclosure, is controlled by varying the ambient air available through air damper louvers. The elevation of the temperature control thermocouple is selected depending on gas flow rate and methane concentration. The operating temperature is maintained by adjusting automatically the louver position. Closing louvers reduces the amount of air available and increases the operating temperature, while opening louvers increases the amount of air available and decreases the operating temperature. Louvers are maintained open initially, before beginning automatic temperature control modulation, which introduces air inside the flare enclosure while the enclosure is cold and lacking draft, to minimize smoke during initial operation.

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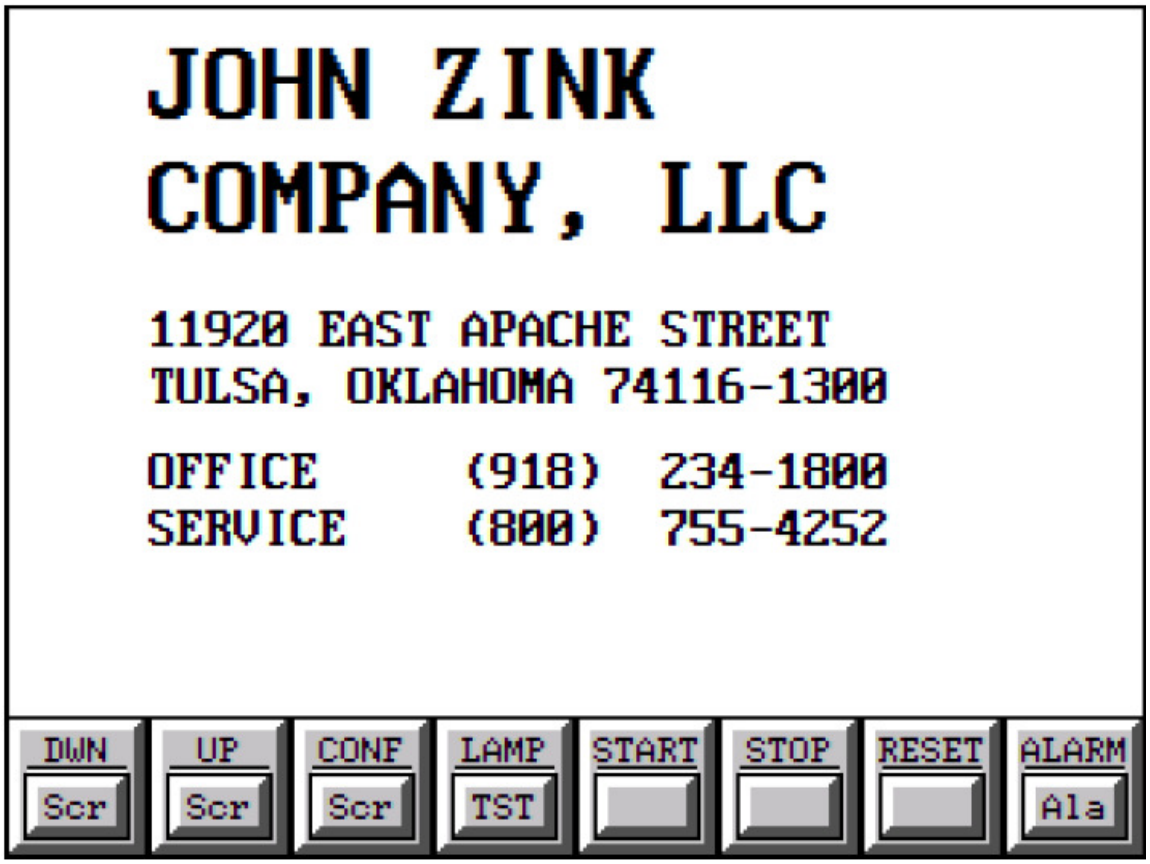
Operator Interface Panel

The Flare Control Panel contains an Operator Interface Panel (OIP), or touch screen, which replaces the usual selector switches, indicating lights, and pushbuttons provided to control, operate, and monitor the system equipment.

Contact Screen



The "Contact" screen displays contact information for John Zink Company and each available screen contains separate buttons for transferring to the various screens or for controlling system operation. Press either button located at the bottom left corner of any screen to activate the next ("Up") or previous ("Down") screen. Press the corresponding buttons located at the bottom right corner of any screen to begin flare operation automatically ("Start"), discontinue flare operation ("Stop"), reset a fault condition ("Reset"), or access detailed alarm information ("Alarm"). Press the "Lamp" button to confirm all panel indicating lights are functional and press the "Conf" button to access parameters from a separate "Configuration" screen.

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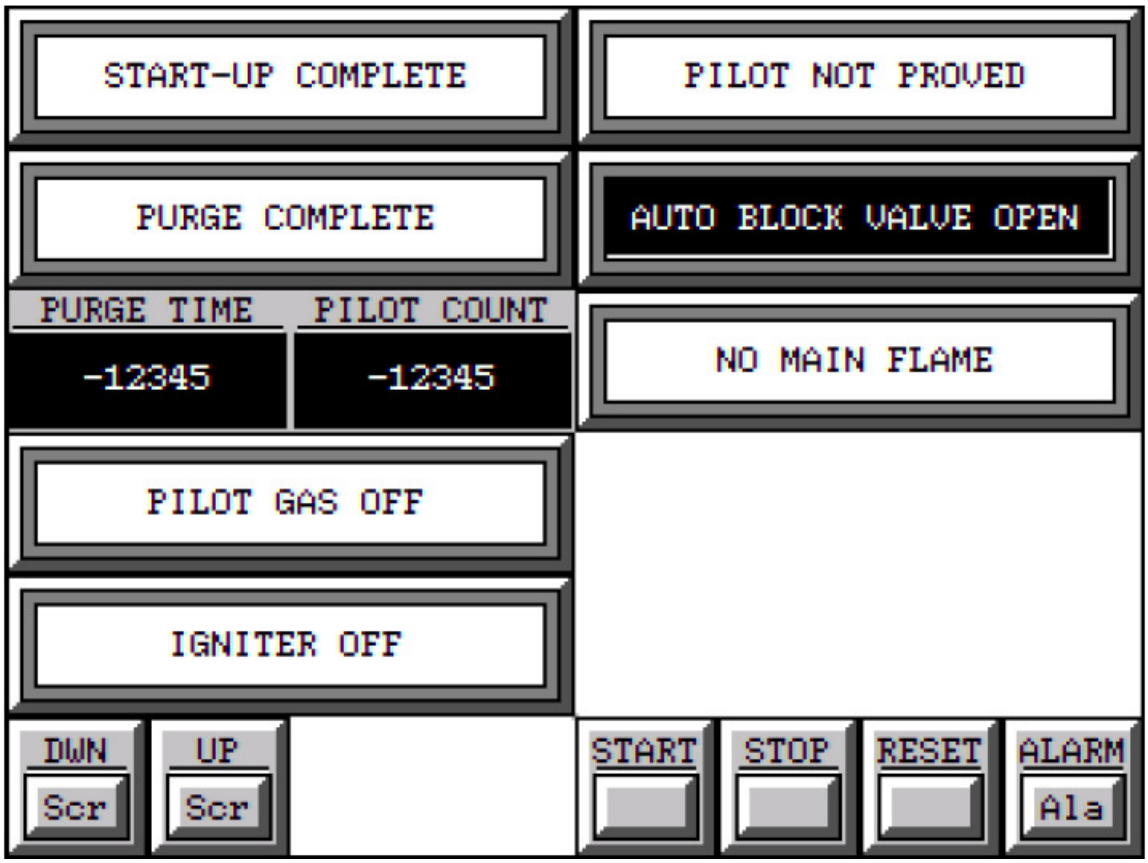
Flare Status Screen



Access the "Flare Status" screen to continuously monitor progression through the flare operating sequence and the current flare operating status.

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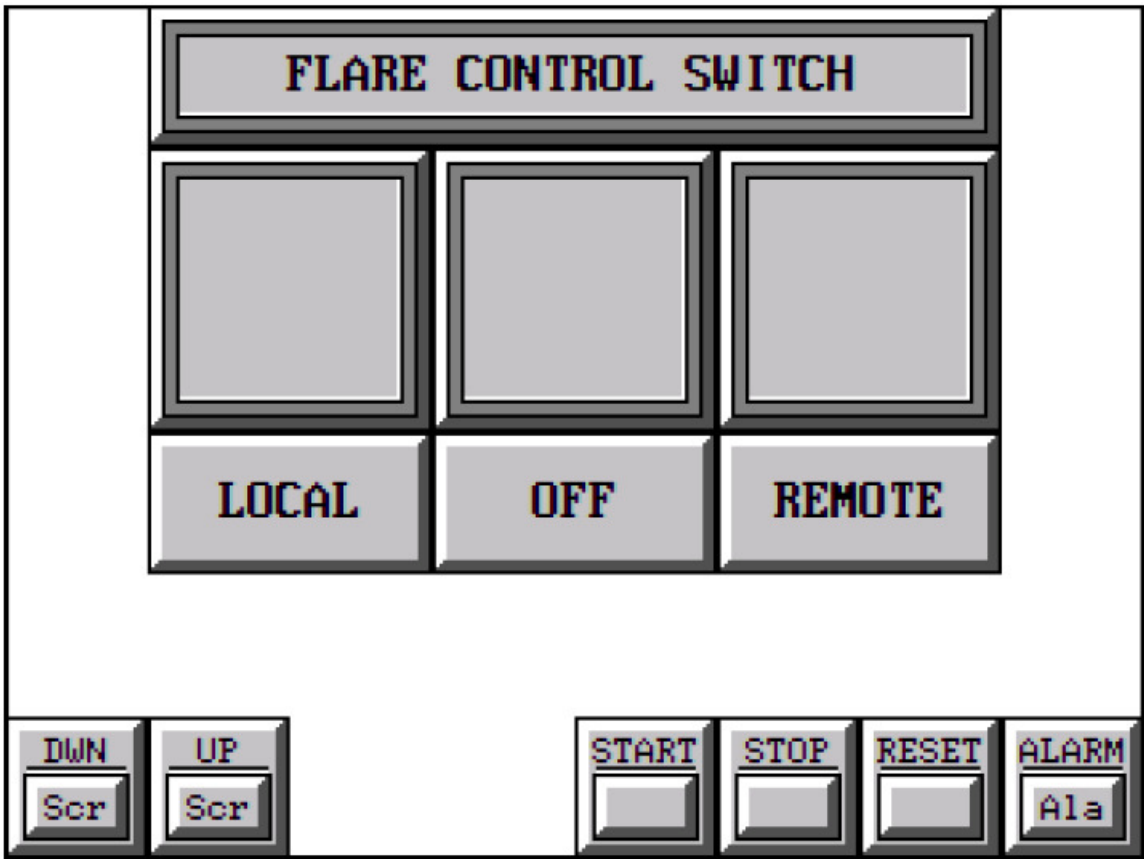
Flare Control Screen



Access the "Flare Control" screen to select either "Local" or "Remote" operation. Operation of the flare only is discontinued by pressing the "Off" button.

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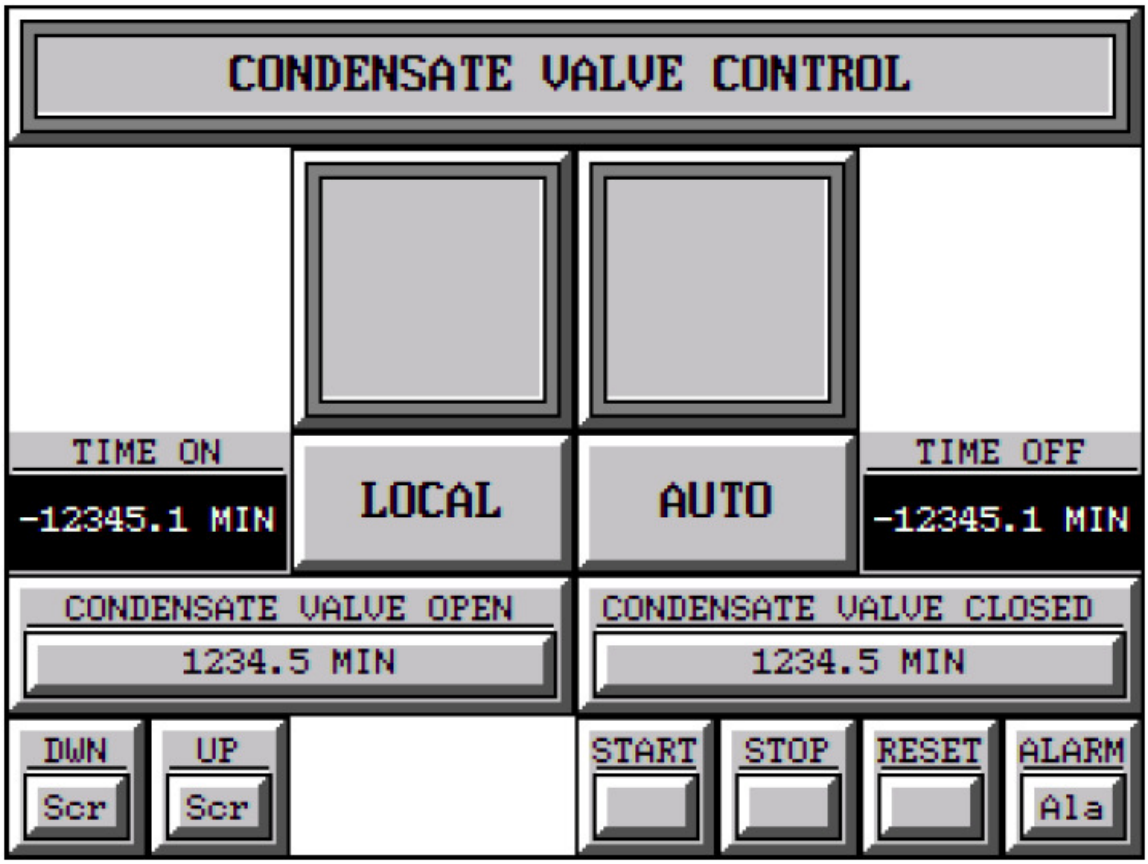
Condensate Valve Selection Screen



Access the "Condensate Valve" screen to select either "Auto" or "Local" operation. Select "Auto" to open and close the valve based on the liquid level sensed by the level switches in the ZMS Moisture Separator. Select "Local" to drive the valve open and closed based on cycle time. Establish the valve cycle interval by entering values for the open and close sequence.

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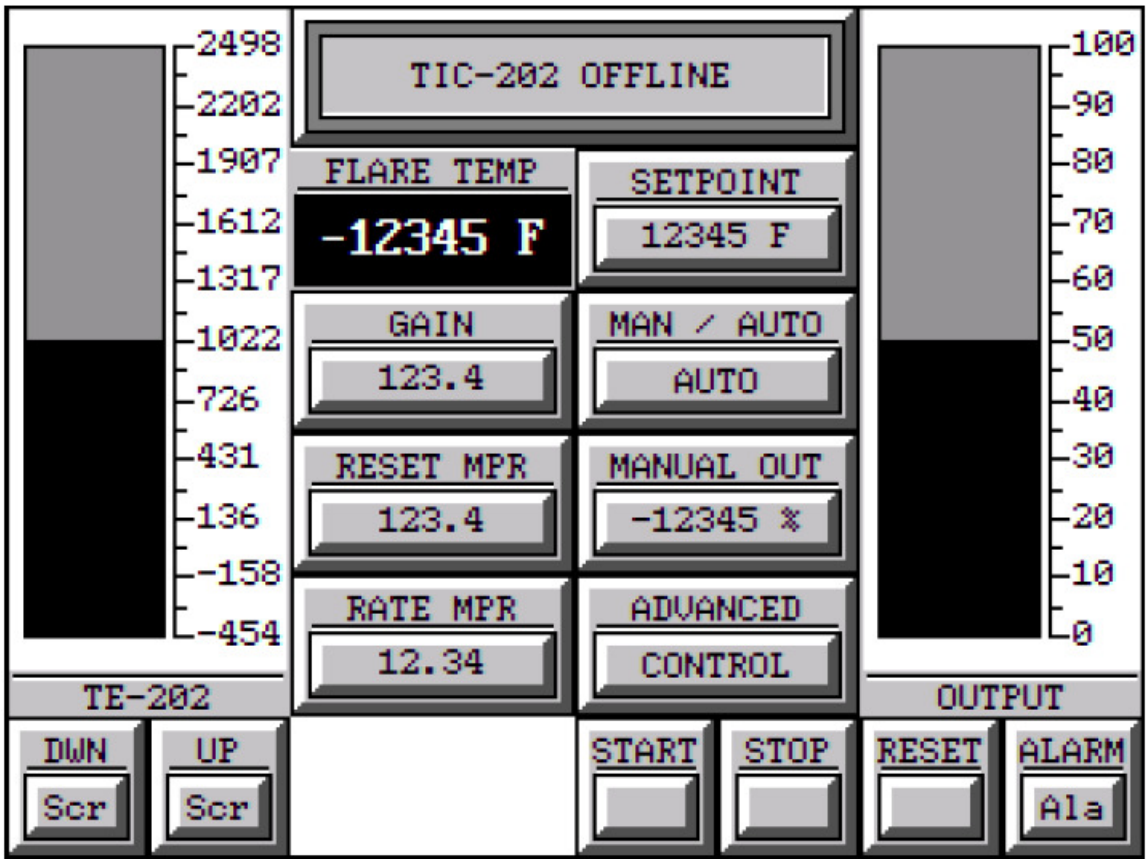
Air Damper Temperature Control Screen



Access the "TIC-202" screen to adjust or monitor the temperature control module. Actual flare temperature detected by the selected control thermocouple (the operating temperature) is labeled "Flare Temp". The operating temperature setpoint is labeled "Setpoint". Press the "Setpoint" value to adjust the operating temperature setpoint. Tuning parameters corresponding to modulation of air damper louvers are labeled "Gain", "Reset", and "Rate". Press each of these three values to adjust the corresponding parameter. The signal value controlling louver position is labeled "Output". Louvers are fully open with a 0% value and fully closed with a 100% value. Press the "Man/Auto" button to adjust louver position manually instead of automatically. After selecting manual, press the "Manual Out" value, enter an output percentage, and louver position adjusts accordingly. For automatic operation only, press the "Advanced Control" button to access more parameters, which allow entering values to restrict the minimum and maximum louver position or maintaining a fixed louver position until exceeding a certain temperature limit.

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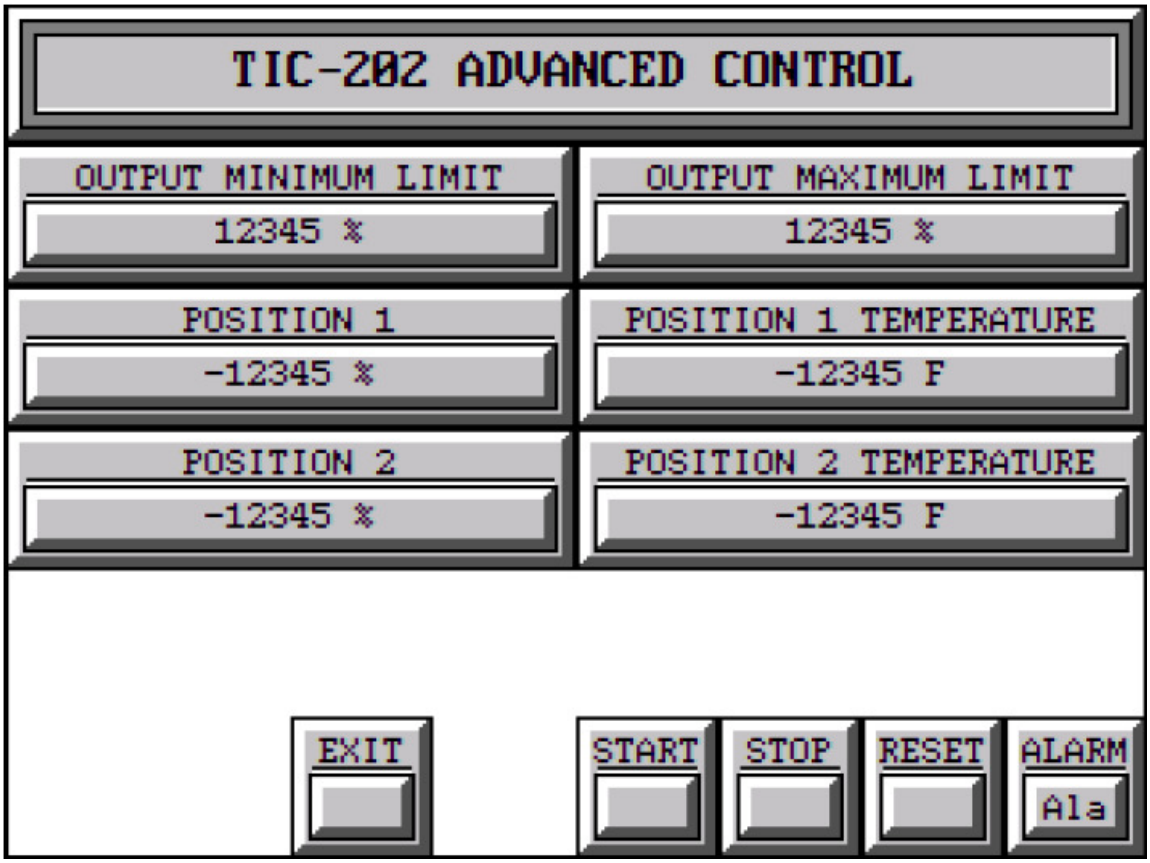

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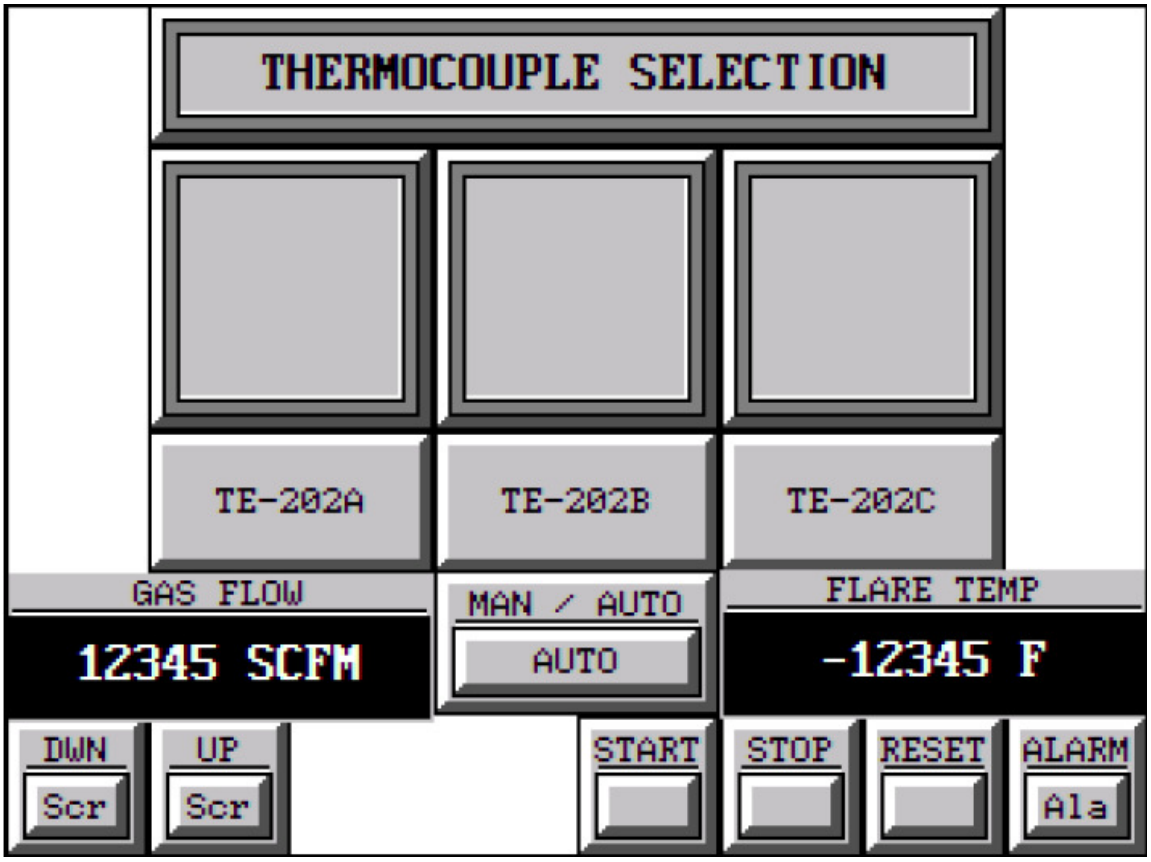
Thermocouple Selection Screen



Access the "Thermocouple Selection" screen to monitor or select flare temperature control thermocouples. Values appear for actual temperature detected by the selected temperature control thermocouple (the operating temperature) and total gas flow rate to the flare. Either automatic or manual thermocouple selection is available. Automatic thermocouple selection continuously determines proper elevation of the temperature control thermocouple for maintaining the operating temperature considering total gas flow rate and any subsequent variation in total gas flow rate. Press the "Man/Auto" button to select a temperature control thermocouple manually. After selecting manual operation, select proper elevation of the temperature control thermocouple for maintaining the operating temperature by considering total gas flow rate and pressing the button next to the corresponding thermocouple. Each significant variation in total gas flow rate again will require manual selection of the proper temperature control thermocouple.

NOTICE

Equipment damage may occur if the elevation of the temperature control thermocouple is selected incorrectly.

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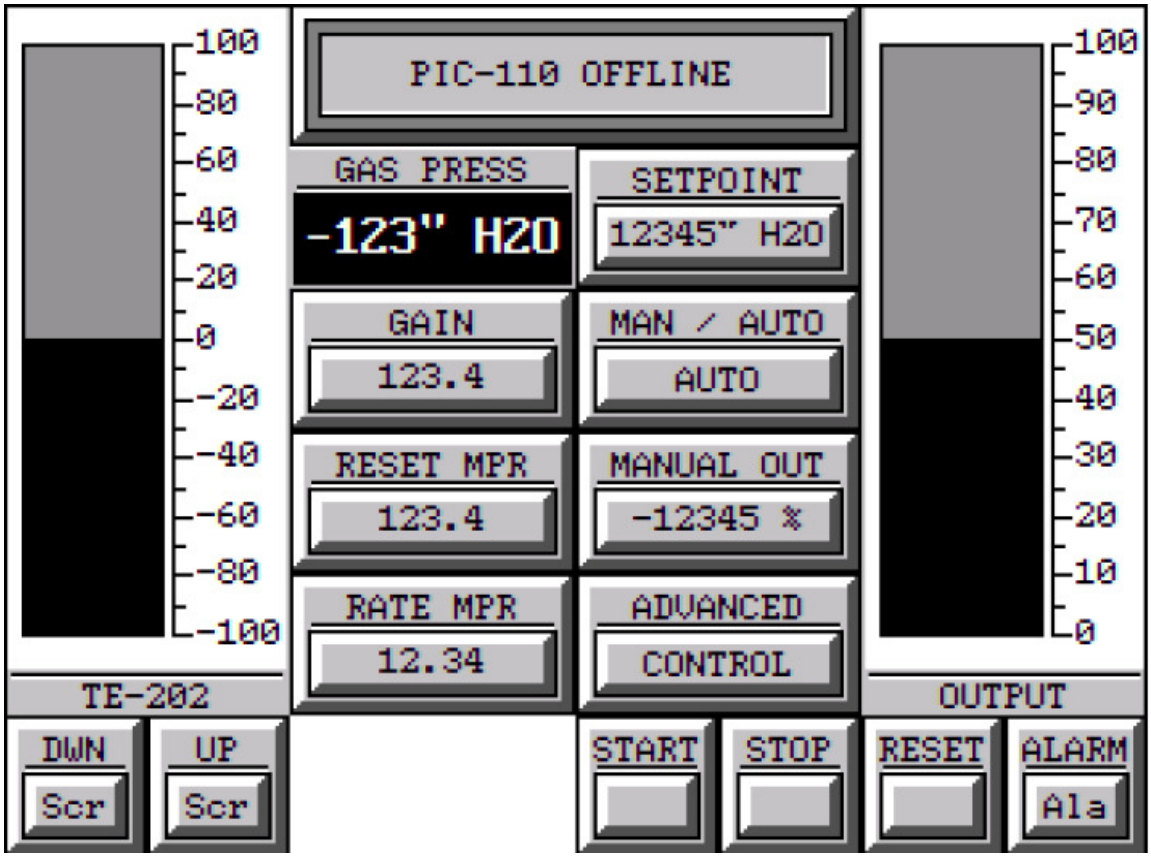
Gas Facility Pressure Control Screen



Access the "PIC-110" screen to adjust or monitor the gas facility pressure control module. Actual pressure detected by the facility pressure transmitter is labeled "Gas Press". The operating pressure setpoint is labeled "Setpoint". Press the "Setpoint" value to adjust the operating pressure setpoint. Tuning parameters corresponding to modulation of the pressure control valve are labeled "Gain", "Reset", and "Rate". Press each of these three values to adjust the corresponding parameter. The signal value controlling the pressure control valve is labeled "Output". The pressure control valve fully closes with a 0% value and fully opens with a 100% value. Press the "Man/Auto" button to adjust valve position manually instead of automatically. After selecting manual, press the "Manual Out" value, enter an output percentage, and valve position adjusts accordingly. For automatic operation only, press the "Advanced Control" button to access more parameters, which allow entering values to restrict the minimum and maximum valve position.

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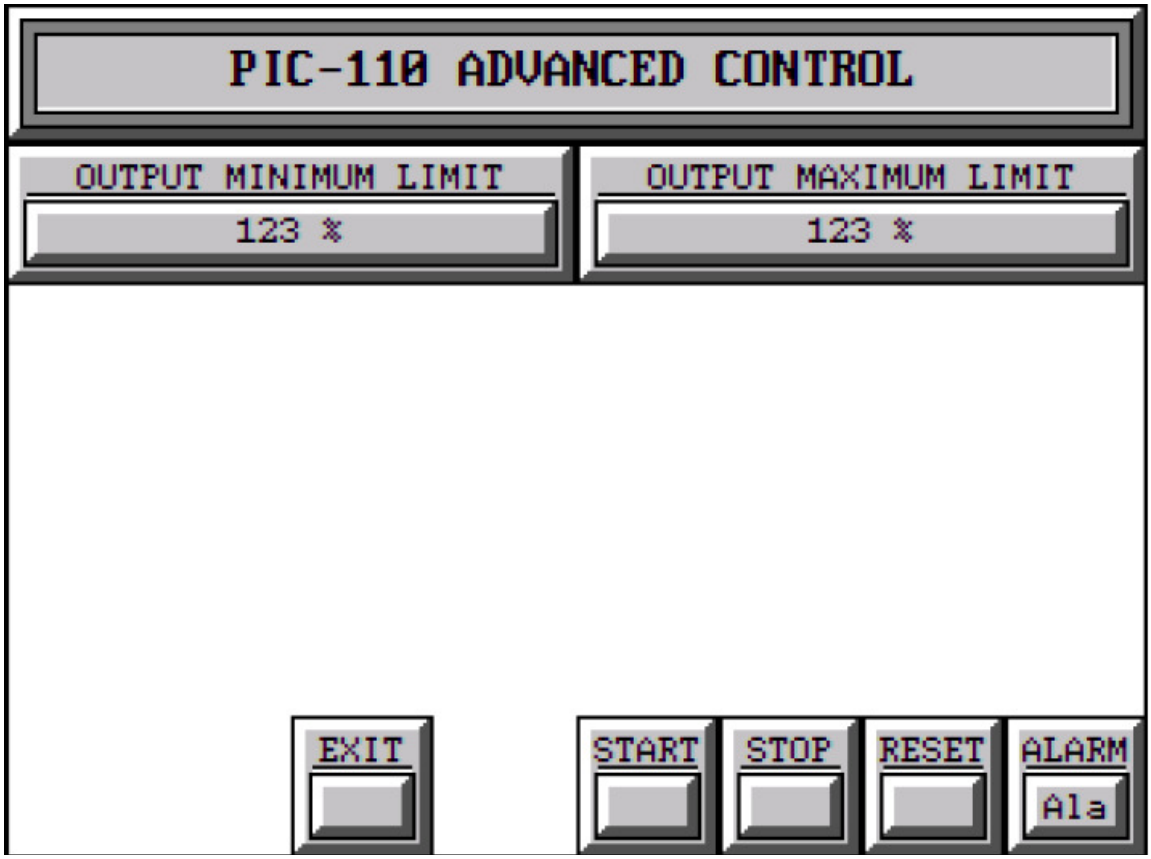

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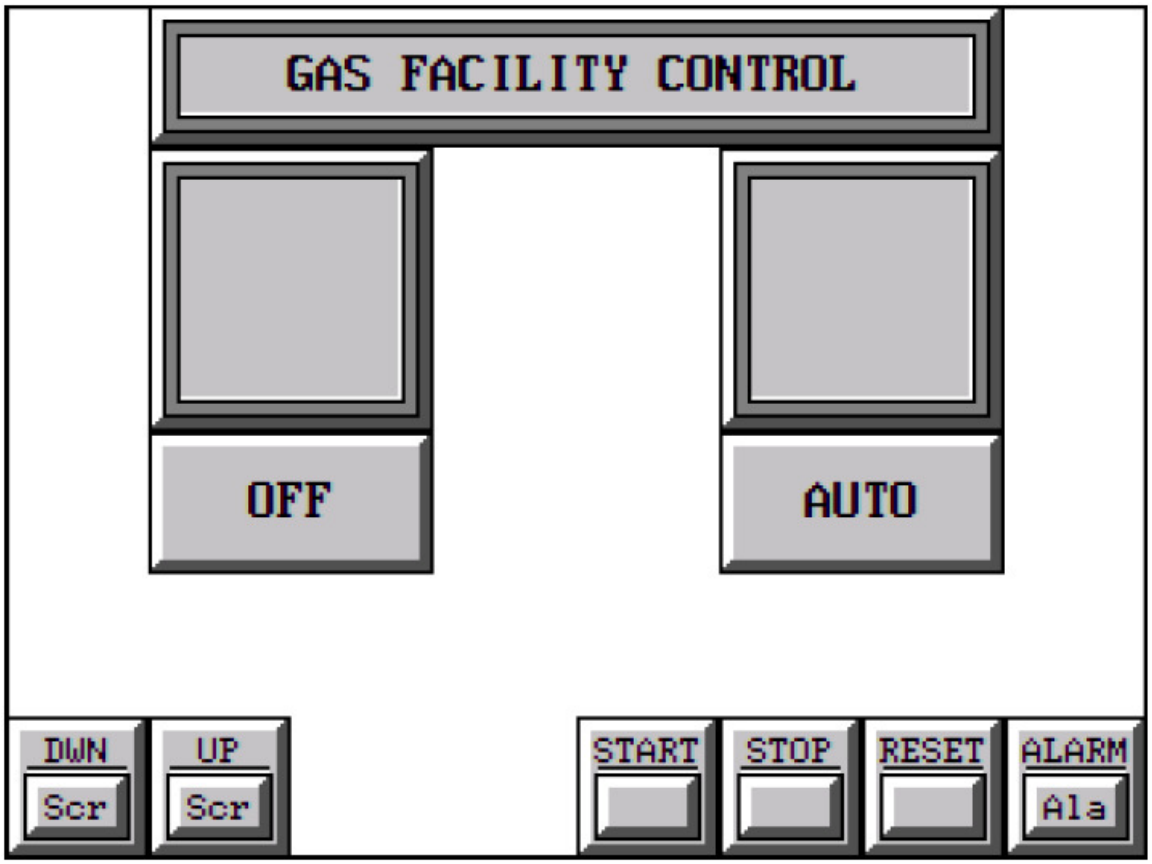
Facility Control Screen



Access the "Facility Control" screen to select either "Off" or "Auto" for interaction with the gas facility. Remote signals allow starting and stopping operation in "Auto", while operation is discontinued in "Off".

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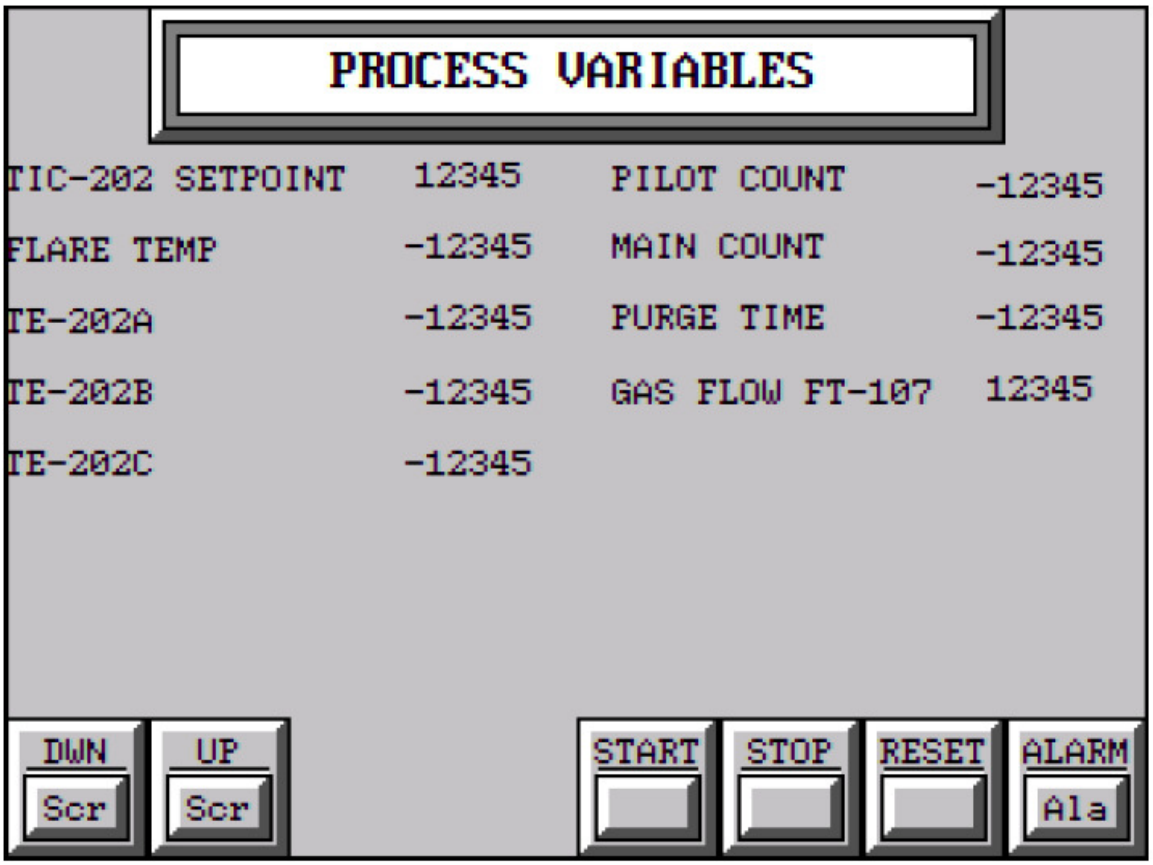
Process Variables Screen



Access the "Process Variables" screen to monitor various system parameters. Values appear for actual temperature detected by each control thermocouple and gas flow rate, along with summarizing other operating information.

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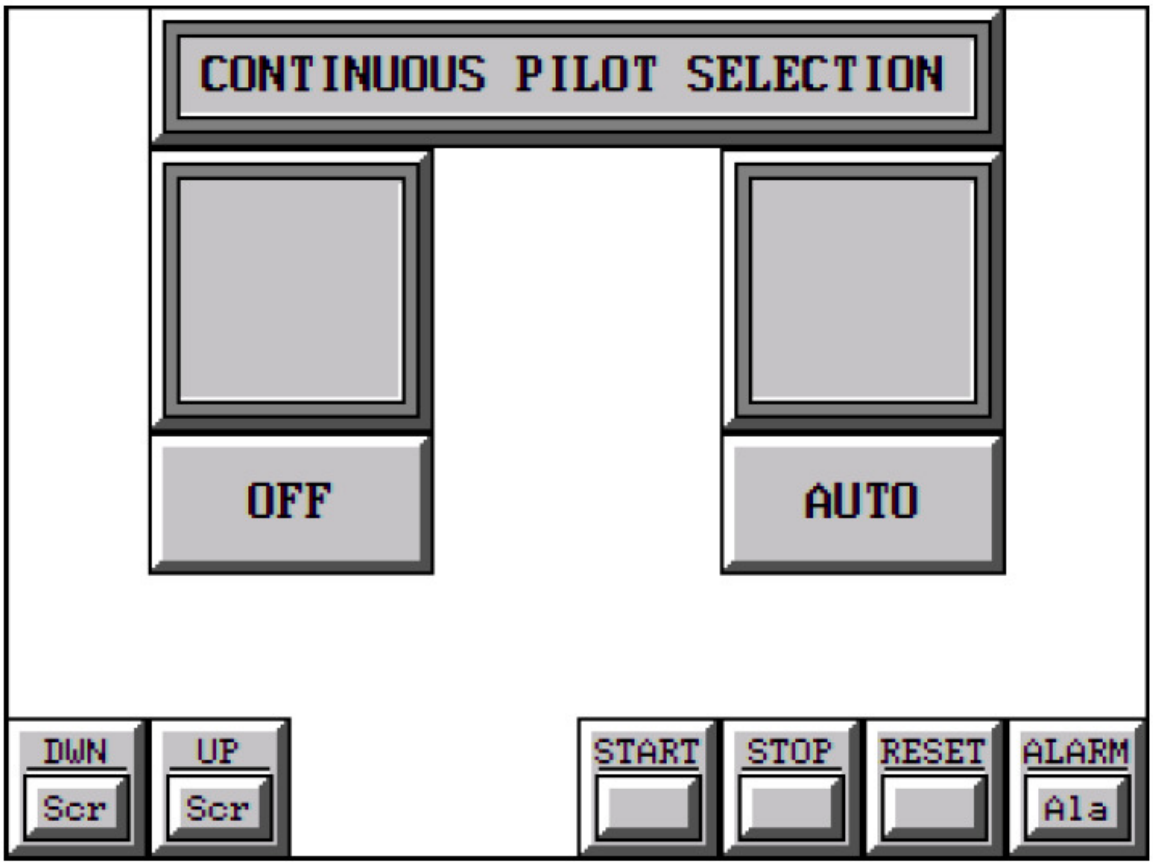
Pilot Selection Screen



Access the "Continuous Pilot" screen to start and stop continuous pilot operation. Select "Auto" for continuous pilot operation. By default the pilot operates intermittently when continuous pilot operation is discontinued by pressing the "Off" button. Intermittent operation conserves gas by eventually discontinuing pilot operation, while continuous operation only is disrupted if a fault condition occurs.

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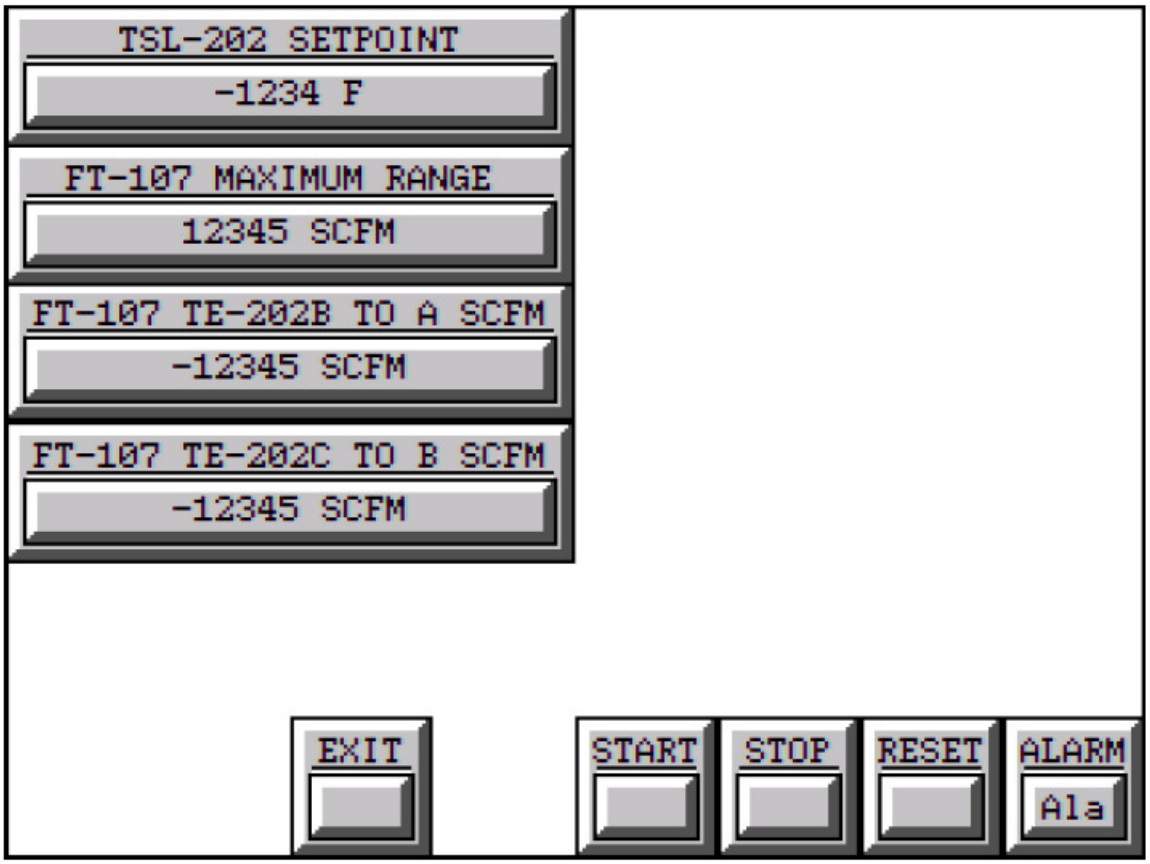
Configuration Screen



Access the "Configuration" screen by entering a password to adjust various operating parameters. The setpoint appears for the flare low temperature switch and flow rate values required for automatic thermocouple selection. Press any of the values to adjust the corresponding setpoint.

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VIII. COMMISSIONING

NOTICE

The presence of a qualified John Zink Company representative is recommended for initial operation.

Process and Instrument Diagram Review

The equipment is fabricated according to the reference drawings. Operating personnel need to review the Process and Instrument Diagram and become familiar with the equipment.

Mechanical Review

Verify all equipment, including valves and control components, are functional prior to operation. Also, before beginning flare operation, complete the following:

1. Verify all equipment is installed according to the reference drawings.
2. Verify all electrical devices are connected to the proper power sources.
3. For the recommended chromel-alumel type K thermocouples, the red wire is negative (-) and the yellow wire is positive (+). Confirm the thermocouple extension wire is adequate for the radiation exposure and is proper for the particular thermocouple (KX wire with insulation for Type K thermocouples).

NOTICE

Cross connecting red and yellow thermocouple wires anywhere in the circuit will nullify the thermocouple signal.

4. All system pipe must be dry and free of dirt or foreign material, including the pilot gas pipe. Verify the pilot gas pipe is dry and unobstructed by removing the mixer orifice and strainer screen, if applicable, and blowing with clean, dry air. Replace the orifice and screen when clear flow exists.
5. Verify all drain and vent valves are closed and all drain and vent plugs are secure.
6. Close all manual and isolation valves initially.
7. Verify all disconnect handles are in the OFF position.
8. Verify all circuit breakers inside the control panels are in the OFF position.
9. Place all selector switches in the OFF or CLOSED position.
10. Verify pilot gas pressure is adjusted properly (no pressure is displayed on the pressure gauge until the corresponding solenoid opens).
11. Verify the hand valve supplying compressed air or nitrogen to the automatic block valve solenoid is closed.

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12. Confirm operating setpoint values are as follows:

Description	Parameter Tag	Default Value
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	
[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

NOTICE

These setpoint values are recommended for initial operation and may require adjustment to satisfy specific operating conditions.

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IX. SYSTEM OPERATION

Preparation

1. Place all circuit breakers inside the control panels in the ON position.
2. Place all disconnect handles in the ON position.
3. Place the "Panel Power" switch in the ON position and the "Power On" light illuminates.
4. Open the hand valve supplying compressed air or nitrogen to the automatic block valve solenoid and confirm adequate pressure is available.
5. Open the pilot gas hand valve.
6. Select continuous pilot operation by pressing the "Auto" continuous pilot button.
7. Open fully the manual butterfly valve at the corresponding gas blower inlet and outlet.
8. Position the manual air damper louvers approximately 50% open.

Start-up

1. Press the "Reset" button to clear any residual conditions from the program memory.
2. Begin flare operation by pressing the "Local" and "Start" buttons, respectively.
3. The purge cycle begins and continues for five minutes. During this cycle, the “Flare Operating” light flashes. Once the purge cycle is complete, the ignition sequence begins.
4. The pilot gas solenoid opens and the ignition transformer energizes for ten seconds, igniting the pilot.
5. The flame scanner verifies pilot ignition and the automatic block valve opens.
6. Modulation of the air damper louvers begins and the "Flare Operating" light illuminates one minute after the closed limit switch for the automatic block valve releases.

⚠ WARNING

All personnel stand clear from flare air damper openings during initial operation. Flame flashback through these openings is possible until the flare operating temperature is achieved.

7. The pilot gas solenoid closes one minute after the open limit switch for the automatic block valve is achieved.

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Operation

Flare

1. As temperature inside the flare enclosure increases, the temperature control module sends a signal to the air damper actuator which adjusts accordingly to maintain the specified operating temperature.
2. Once the flare is operating and the position of the automatic air damper louvers is relatively stable, adjust the manual air damper louvers to approximately the same position as the automatic air damper louvers.
3. Automatic selection of the proper automatic temperature control thermocouple is dependent on the instantaneous gas flow rate and the maximum methane concentration. If the methane concentration is significantly less, the automatic selection criteria will require adjustment.

Pilot

1. Adjust each pilot gas pressure regulator until a stable, light blue flame with a defined cone shape exists.
2. For intermittent pilot operation, fuel gas is supplied to the pilot and the pilot gas solenoid, SV-303, closes one minutes after the open limit switch, ZSO-102, for the automatic block valve, SOV-102, is achieved.
3. If required, a continuous pilot feature is available. Press the “Auto” to activate or press, “Off” to deactivate and continue in intermittent pilot mode.
4. When the continuous pilot is operating and minimal flow is detected by the gas flow meter, FE-107, the Flare Low Temperature fault condition is disabled. Then once sufficient gas flow is detected, Flare Low Temperature again is enable.

Pressure Control Valve

1. For "flare only" operation, the control valve does not modulate and instead is maintained fully open.
2. For "facility only" operation, the control valve does not modulate and instead is maintained fully closed.
3. For the "both" operating scenario, the pressure control module sends a signal to the control valve actuator which adjusts accordingly to maintain the specified operating facility pressure.
4. A minimum amount of landfill gas is necessary to ignite the flare initially and maintain operating temperature. A minimum limit for the pressure control valve, PCV-110, requires initial adjustment to establish a minimum position which provides an adequate amount of landfill gas.

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Gas Facility

1. Press the "Auto" button for the gas facility to interact through remote signals. One signal originates at the facility, indicating the facility is available to receive landfill gas, and one signal originates at the flare, indicating no fault condition exists so landfill gas is available. Operation only is permitted when both signals agree.

Shutdown

Normal Shutdown

A normal shutdown is available whenever the operator needs to discontinue flare operation. To discontinue only flare operation, press the "Off" button on the "Flare Control" screen and the following occurs:

- purge air blower discontinues, if operating
- pilot gas solenoid closes, if open
- ignition transformer discontinues, if energized
- automatic block valve closes, if open
- automatic damper louvers open fully
- pressure control valve closes, if open.

Alternately, press the "Stop" button to discontinue only flare operation. Then the "Flare Fault" light illuminates, and the following occurs:

- purge air blower discontinues, if operating
- pilot gas solenoid closes, if open
- ignition transformer discontinues, if energized
- automatic block valve closes, if open
- automatic damper louvers open fully
- pressure control valve closes, if open.

To discontinue interaction with the gas facility, press the "Off" button for the gas facility.

When the system is not operating for an extended duration, also complete the following:

- place the "Panel Power" switch in the OFF position
- close all manual and isolation valves
- place all selector switches in the OFF or CLOSED position.

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NOTICE

To start the flare system again after addressing any reason for a shutdown, the fault condition must be cleared by pressing the "Reset" button.

Power Failure

A power failure is caused by disrupting electrical service. The following occurs:

- purge air blower discontinues, if operating
- pilot gas solenoid closes, if open
- ignition transformer discontinues, if energized
- automatic block valve closes, if open
- automatic damper louvers are maintained in the last position
- pressure control valve is maintained in the last position.

Once power is restored, the system attempts operation automatically.

Fault Conditions

Flare High Temperature Shutdown occurs when the dedicated thermocouple detects temperature above the temperature switch setpoint value.

Flare Low Temperature Shutdown occurs when the selected temperature control thermocouple detects temperature below the temperature switch setpoint value for ten minutes consecutively.

Pilot Flame Failure and Shutdown occur during the ignition sequence, after three unsuccessful attempts, when flame is not detected by the flame scanner.

Main Flame Failure and Shutdown occur once the ignition sequence is complete, after three unsuccessful attempts, when flame is not detected by the flame scanner.

Automatic Block Valve Failure (Failed to Open or Failed to Close) occurs when dedicated limit switches are unable to confirm proper valve position.

Separator High Level occurs when liquid level in the separator vessel becomes too high and the level switch is activated.

Depending on the particular operating scenario selected and fault condition, some or all of the following occur:

- "Flare Fault" light illuminates
- purge air blower discontinues, if operating
- pilot gas solenoid closes, if open
- ignition transformer discontinues, if energized

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- automatic block valve closes, if open
- automatic damper louvers open fully
- pressure control valve closes, if open.

An operator reset is required to continue operation.

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X. SYSTEM TESTING

DANGER

ARC FLASH AND/OR SHOCK HAZARD

High voltages capable of causing injury or death are associated with this equipment. Use extreme caution when servicing electrical enclosures or any other electrical components. Disconnect the electrical source of any circuit on which service is being performed and lock open the corresponding disconnect switch. Ensure electrical enclosures and components are grounded properly before applying power.

Lamp Test

a. Press the "Lamp Test" button.
b. All panel lights illuminate.

Purge Failure

a. Press the "Stop" button.
b. Disconnect tubing from the purge air pressure switch.
c. Press the "Reset" button.
d. Press the "Start" button.
e. Purge air blower operation begins and the "Flare Operating" light flashes.
f. After one minute, the "Flare Operating" light diminishes, the "Flare Fault" light illuminates, and system operation discontinues.
g. Press the "Reset" button.
h. The "Flare Fault" light diminishes.
i. Connect tubing to the purge air pressure switch.

Pilot Flame Failure and Shutdown

a. Press the "Stop" button.
b. Close the pilot gas hand valve.
c. Press the "Reset" button.
d. Press the "Start" button and the "Flare Operating" light flashes.
e. Purge air blower operation begins and the purge cycle continues for five minutes.
f. Upon completing the purge cycle, the ignition sequence begins.
g. The pilot gas solenoid opens and the ignition transformer remains energized for ten seconds.
h. The flame scanner is unable to detect flame.
i. The pilot gas solenoid closes and the purge cycle and ignition sequence are attempted again automatically.
j. After the third unsuccessful attempt to detect pilot flame, the "Flare Operating" light diminishes, the "Flare Fault" light illuminates, and system operation discontinues.
k. Press the "Reset" button.
l. The "Flare Fault" light diminishes.
m. Open the pilot gas hand valve.

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Flare High Temperature Shutdown

a. Press the "Stop" button.
b. Place the "Panel Power" switch in the OFF position.
c. Inside the Flare Control Panel, adjust the dial on the flare high temperature switch to approximately 200 °F.
d. Place the "Panel Power" switch in the ON position.
e. Press the "Reset" button.
f. Press the "Start" button and the "Flare Operating" light flashes.
g. Allow the purge cycle to complete and the pilot to ignite.
h. After the automatic block valve opens, monitor the value appearing on the temperature control module.
i. Upon exceeding the setpoint on the flare high temperature switch the "Flare Operating" light diminishes, the "Flare Fault" light illuminates, and system operation discontinues.
j. Press the "Reset" button.
k. The "Flare Fault" light diminishes.
l. Place the "Panel Power" switch in the OFF position.
m. Inside the Flare Control Panel, return the dial on the flare high temperature switch to 2000 °F.

Automatic Block Valve Failure

a. Press the "Stop" button.
b. Disconnect the compressed air or nitrogen source from the automatic block valve solenoid.
c. Press the "Reset" button.
d. Press the "Start" button and the "Flare Operating" light flashes.
e. Allow the purge cycle to complete and the pilot to ignite.
f. The automatic block valve is unable to open.
g. After 45 seconds, the open limit switch for the automatic block valve is not achieved.
h. The "Flare Operating" light diminishes and the "Flare Fault" light illuminates.
i. Press the "Reset" button.
j. The "Flare Fault" light diminishes.
k. Connect the compressed air or nitrogen source to the automatic block valve solenoid.

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XI. TROUBLESHOOTING

Problem: The "Panel On" light does not illuminate.
Possible Causes:

- main circuit breaker is off
- "Panel Power" switch is off
- light bulb is defective
- power is not connected to the panel
- connecting wires are loose

Problem: The purge cycle does not begin.
Possible Causes:

- automatic block valve limit switches are not satisfied
- flame scanner detects flame
- power is not connected to the motor starter or motor
- motor starter circuit breaker is off
- motor starter contact is not closed
- motor starter holding coil is defective
- motor starter overload relay requires resetting

Problem: The purge cycle fails.
Possible Causes:

- pressure switch contact is not satisfied
- either pressure switch sensing port is partially or fully obstructed
- pressure switch sensing tube is disconnected
- power is not connected to the pressure switch
- connecting wires are loose

Problem: The pilot does not ignite.
Possible Causes:

- pilot gas hand valve is closed
- pilot gas source is insufficient
- pilot orifice is plugged
- ignition wire is loose or broken
- ignition transformer is defective
- pilot electrode is defective
- pilot insulators are broken
- pilot gas pressure regulator requires adjustment
- pilot gas solenoid is not functioning properly
- power is not connected to the ignition transformer or pilot gas solenoid

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Problem: Pilot flame is not detected after igniting the pilot.
Possible Causes:

- flame scanner relay is not functioning properly
- flame scanner is not sensing flame
- scanner lens is dirty
- flame scanner amplifier is not functioning properly
- scanner is not installed properly
- scanner is not functioning properly
- connecting wires are loose

Problem: The automatic block valve does not open.
Possible Causes:

- compressed air or nitrogen source is insufficient
- automatic block valve solenoid is not wired correctly
- valve motion is obstructed inside the pipe
- power is not connected to the automatic block valve solenoid
- corresponding control relay is not functioning properly
- connecting wires are loose

Problem: The automatic damper does not operate correctly.
Possible Causes:

- signal wire is loose or broken
- temperature control module is not functioning properly
- actuator is defective
- thermocouple input to the control module is defective
- corresponding control relay is not functioning properly.

Problem: Flame Failure or Shutdown occurs.
Possible Causes:

- gas flow rate or methane content is low
- flame scanner failed
- flame scanner amplifier failed
- automatic damper actuator failed
- flame arrester is plugged
- flare tips are plugged

Problem: Flare High Temperature Shutdown occurs.
Possible Causes:

- thermocouple is damaged or defective
- gas flow rate or methane content is high
- thermocouple wires are reversed
- automatic damper actuator is not operating properly
- high temperature switch is not set or operating properly

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- connecting wires are loose

Problem: Flare Low Temperature Shutdown occurs.
Possible Causes:

- gas flow rate or methane content is low
- incorrect temperature control thermocouple elevation is selected
- thermocouple wires are reversed
- low temperature setpoint is incorrect
- automatic damper actuator is not operating properly
- flame arrester is plugged
- flare tips are plugged
- connecting wires are loose

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XII. MAINTENANCE

NOTICE

The following maintenance summary is designed only as a guideline and does not identify all areas or components requiring maintenance attention. A maintenance program must be developed considering existing company policy, operational experience, and manufacturer requirements. This operating manual is to be used in conjunction with, and does not replace, any company policies.

General

1. Refer to manufacturer literature in Section XVIII, "Manufacturer Information" for specific maintenance requirements of individual components.
2. Review operation and calibration procedures for individual instruments in Section XVIII, "Manufacturer Information" as recommended by the manufacturer.
3. Inspect all flanges and connections for indications of leaking. Repair or replace if necessary.

Flare

1. Visually inspect flare tips and flare stack for damage or deterioration.
2. Inspect the exterior surface for indications of heat degradation. Paint discoloration may indicate insulation damage.
3. Assess overall integrity of the internal insulation once a month. Torn or worn insulation may result in equipment damage. Repair if necessary.
4. Remove the flare tip for cleaning if an obstruction is suspected. Measure pressure differential between the flare inlet flange and the flare tip exit. If the value exceeds 5" H_2O, then clean the tips.
5. Inspect all thermocouple assemblies and replace at least once each year.
6. Inspect the pilot assembly, ignition rod, electrode, and insulators for damage once every three months. Repair or replace if necessary.
7. Verify pilot gas supply pressure and pilot ignition.
8. Inspect flame detection components. Clean the flame scanner lens and vent port.
9. Verify proper operation of air damper louvers and lubricate if necessary.
10. Remove the flame arrester element for cleaning every six months. Measure pressure differential across the arrester element. If the value exceeds 5" H_2O, then clean the element.

Panel

1. Confirm control logic is functioning properly and all input and output signals are correct.
2. Verify all safety shutdown devices every three months per Section X, "System Testing".
3. Inspect all electrical enclosures for any apparent corrosion or moisture.
4. Confirm all enclosure and actuator heaters are functioning.
5. Confirm integrity of conduit seals, if applicable.
6. Verify supply power voltage.
7. During operation, observe motor current and voltage.

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8. Confirm chart recorder operation.

Miscellaneous

1. Remove and clean any filter elements or mesh strainers every three months.
2. Monitor differential pressure for the mist elimination element inside the ZMS Moisture Separator. If the value exceeds 5" H_2O, then clean the element.
3. Annual calibration, as a minimum, is recommended for any analyzer or flow meter.
4. Verify sufficient pressure is available from the compressed air or nitrogen source.
5. Inspect any gauges and valves for deterioration.

NOTICE

An enclosure heater is installed in the Flare Control Panel, PNL-101, to prevent internal corrosion. Individual electric motors may contain integral heaters also to prevent internal corrosion. Ensure all heaters are connected to a reliable power supply and operated continuously, especially during outside storage or when operation is discontinued for an extended duration. Consult wiring diagrams in Section XIII, "Reference Drawings" for additional details.

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XIII. REFERENCE DRAWINGS

D-F-9169848-150	Process and Instrument Diagram
D-F-9169848-301	Enclosed Biogas Flare
ST-11912	KE-1/ST Pilot
D-F-9169848-303	ZMS Moisture Separator
D-F-9169848-400, Sheet 1	Panel Rack Assembly
D-F-9169848-401	Wiring Diagram
D-F-9169848-402	Wiring Diagram
D-F-9169848-403	Wiring Diagram
D-F-9169848-404	Wiring Diagram
D-F-9169848-405	Wiring Diagram
D-F-9169848-406	Wiring Diagram
D-F-9169848-407	Wiring Diagram

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XIV. SPECIFICATION SHEETS

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XV. PROCESSOR LOGIC PROGRAM

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XVI. RECOMMENDED SPARE PARTS

	Component	Tag Number	Part Number	Quantity
1.	Flame Scanner	BE-203	1090686	1
2.	Flame Relay	BS-203	1090687	1
3.	Thermocouple Element Only	for TE-201 for TE-202A for TE-202B for TE-202C	1195449	4
4.	Pilot Electrode	ST-10356	1278104	1
5.	Pilot Ignition Rod Insulator	for ST-11912	0003587	3
6.	Pilot Assembly	ST-11912	1125707	1
7.	Ignition Transformer	IT-1	0002558	1
8.	Sight Glass Assembly	CA-ST-0600	0008170	1
9.	Panel Light Bulb	for PNL-101	1013634	3
10.	Pilot Gas Pressure Regulator	PCV-302	1260113	1
11.	Pilot Gas Solenoid	SV-303	1273357	1
12.	Pilot Gas Pressure Gauge	PI-305	0022961	1
13.	Purge Air Pressure Switch	PDSL-204	0024372	1
14.	Damper Actuator	for TCV-202A for TCV-202C	1042314	1
15.	Level Switch	LSH-101 LSHH-101 LSL-101	0001703	1

Please call John Zink Company at (918) 234-2751 for spare part assistance.

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XVII. SAFETY DATA SHEETS

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XVIII. MANUFACTURER INFORMATION

1. Allen Bradley
2. American Fan
3. American Warming
4. Ashcroft
5. Automatic Switch (ASCO)
6. Automation Direct
7. Bettis
8. Dwyer
9. Enardo
10. Fisher
11. Flowseal
12. IRIS Systems
13. Kenco
14. Linc
15. Raymond Control
16. Rosemount
17. Thermal Instrument
18. Thermo Sensors
19. TopWorx
20. Worcester
21. Xomox
22. Yokogawa

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