ATMI

Guardian®

GS4/GS8

GAS PROTECTIVE SYSTEM

INSTALLATION, OPERATION, AND MAINTENANCE MANUAL

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Safety

Some physical or chemical hazards may exist in the operation and maintenance of the Guardian Gas Protective System. The physical hazards are related to the servicing of the equipment, and the chemical hazards are related to the process chemicals and their by-products.

Information about the safe operation and maintenance of the Guardian thermal oxidizer is provided in the “Safety information” section of this manual.

Review this manual carefully. Always follow approved safety procedures, including the use of lockout/tagout devices, proper clothing, and eye and face protection. Pay particular attention to warnings and precautions provided in this manual.

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Safety Information

This safety section is designed to notify the end user of the Guardian® Gas Protective System that some physical or chemical hazards may exist in the operation and maintenance of the system. The physical hazards are related to the servicing of the system while the chemical hazards are related to the process gases and their by-products, which are abated by the gas protective system.

As with any processing system, malfunction and failure can occur due to unforeseen or uncontrollable circumstances. ATMI, Incorporated, its officers, managers, engineers, and representatives cannot be held responsible for such failure nor for the customer's negligence or misuse of this equipment. At the very least, follow procedures and recommendations outlined in this document for proper system functioning.

S 1 Safety notices and terms

Review this manual carefully. Always follow approved safety procedures, including the use of lockout/tagout devices and proper clothing, eye, and face protection. Pay particular attention to warnings and precautions in this manual.

Examples of warnings used in this manual are shown below. Carefully read instructions anywhere *Warning*, *Danger*, or *Caution* is used in the manual.

DANGER!

This icon indicates an imminently hazardous situation that, if not avoided, will result in death or serious injury.

WARNING!

This icon indicates a potentially hazardous situation that, if not avoided, might result in death or serious injury.

CAUTION!

This icon indicates a potentially hazardous situation that, if not avoided, may result in minor or moderate injury. It is also used to alert against unsafe practices and situations in which improper actions could cause damage to the equipment or product.

Note

This icon indicates special instructions or information which is important but is not related to hazards.

S 2 End user responsibilities

Use only the most current revision of this manual. See the revision number in the footer. The information published by ATMI, Incorporated in engineering specifications, manuals, and guides are correct as of publication date. ATMI, Incorporated is not responsible for product application, including but not limited to compatibility with other equipment.

The end users and their subcontractors must be responsible to ensure that their respective employees receive hazardous communication training which meets or exceeds OSHA 29CFR 1910.120 (“Hazardous Waste Operations and Emergency Response”). End users and their subcontractors who work on the Guardian Gas Protective System are required to ensure that their respective employees are provided with material safety data sheets from their Environmental Health and Safety department for all gases and chemicals which pass through or are treated by the system.

During maintenance of the system, exposure to corrosive, flammable, combustible, or toxic substances can occur. Therefore, personal protective equipment in the form of impervious clothing, gloves, and face shields (eight-inch minimum) should be worn to prevent any possibility of skin contact.

Proper ventilation for the Guardian system and the work area must be maintained to reduce a health or fire hazard.

If exposure to clothing occurs, remove contaminated clothing immediately and place it in closed containers pending disposal or cleaning. Splash-proof safety goggles are required if there is any possibility of eye contact with any of the above substances. Emergency eyewash fountains should be provided in the immediate

work place. It is imperative that each end user follows the policy and procedure set up by their Environmental Health and Safety Department.

During preventative maintenance or service of the Guardian system, personnel must be aware of the potential hazards associated with it. Labels throughout the manual include, but are not limited to, high voltage areas (electronics or electrical enclosures), hot surfaces, and hazardous chemicals.

An additional potential hazard exists in the cleaning of the Guardian thermal oxidizer and any lines connected to the process tool. In many cases the particulate by-products formed may contain hazardous substances. Such substances must then be considered hazardous waste and treated as such. In the likely event that these substances are being vacuumed out of the system or lines to and from the system, the proper equipment for vacuuming such substances must be used. Proper handling procedures defined by the facility's Environmental Health and Safety Department must be adhered to by servicing technicians.

Safety related fault circuits and interlock connections and the emergency off (*EMO*) button are listed and described in Chapter 6, "Alarm operational status." Related electrical schematics are in Chapter 12, "Schematics and diagrams." It is imperative that these sections be read and understood by any end user or their subcontractor service technician prior to servicing the system.

It is important that the system is installed according to this manual, the recommendations of the process tool manufacturer, and all federal, state and local codes and regulations. Connection of the interlocks between the Guardian system and process tool is essential for the operating safety of personnel and equipment. Placement of any additional labels required by local or state agencies must be done during installation.

Verify the operation of end-user inputs during inspection of the Guardian thermal oxidizer fault, interlock, and EMO systems. This includes, but is not limited to, gas detection systems, end point detection, exhaust control systems, exhaust line heat tracing, and exhaust line valves.

When working on any piece of equipment, the service technician must follow all policies, practices and procedures established by the facility's Environmental Health and Safety Department.

S 3 Lock-out / tag-out requirement

A lockout / tagout procedure is required whenever the unanticipated startup of equipment or the release of stored energy could cause injury to anyone. *Lockout* describes a process by which sources of energy that supply or that are contained within equipment are positively locked to prevent the release of this energy while the equipment is being maintained or serviced. *Tagout* describes the purpose of the lockout and identifies the personnel involved. Potential sources of energy that must be locked out and tagged out include electrical energy, kinetic energy from moving parts, and stored energy such as that in capacitors, springs, and elevated materials.

ATMI, Incorporated requires a lockout / tagout procedure to be completed before working on the system. All energy sources for the equipment must be locked and tagged out before beginning work. Each facility may have additional controls on-site. Follow the facility procedures manual when performing lockout / tagout of the Guardian Gas Protective System or any associated equipment. *Group* or *custodial* locks are not acceptable under any circumstances. (A group or custodial lock is one used to represent all people working on the tool or system.) The section below describes a suitable minimum procedure for lockout / tagout. The user's facility procedures manual or authorities having jurisdiction may require a more extensive procedure.

S 3.1 Lockout and tagout procedure

OSHA regulations require that a method, device, or technique be established to ensure that machinery is stopped and isolated from all potentially dangerous energy sources. (The minimum lockout / tagout requirements are described in OSHA 29CFR 1910.147 and 1910.331 through 335.) This section provides a model procedure, which may be adopted to local needs, for facilities that don't have an existing lockout / tagout procedure.

S 3.1.1 Lockout devices

The types of devices that can be used to lock out potential energy sources include:

- locks especially assigned for lockout use
- grounding rods with electrically insulated handles to discharge capacitors
- clamps or holding devices designed for compressed springs

- support devices for elevated machines or elevated machine components
- rotational blocking devices for rotating parts
- stopping devices for hydraulic systems
- shutoff valves for compressed or hazardous gases

S 3.1.2 Performing lockout / tagout

Establish a lockout / tagout log, which lists the date, time, purpose, and the authorized person (originator) performing the lockout. Use it every time lockout / tagout must be performed on the equipment.

To lock out and tag out equipment for maintenance or service, perform the following procedure.

1. Notify anyone who will be affected when the equipment is shut down for maintenance or service.
2. Write the purpose, date, and originator of the lockout in the lockout / tagout log described above.
3. Write the same information on one tagout tag for each source of energy that must be locked out.
4. Shut off each energy source supplying the equipment.
5. Attach a lockout isolating device or lock which cannot be readily removed on each energy source.
6. Attach a tagout tag on each lockout device or in a nearby location that can readily be seen from the lockout device.

The equipment is now locked and tagged out, and work on it can begin.

S 3.1.3 Removing the lockout / tagout

To return the locked-out equipment to service, use this procedure:

1. Remove all tools and other items that were used for the maintenance or service work.
2. Verify that the equipment is ready to be operated.
3. Notify affected personnel that the equipment is ready to be restored to operation.

(Procedure continues on the following page.)

4. Verify that everyone in the area of the equipment is in a safe location.
5. Remove the lockout device and associated tag from each energy source that was locked out.
6. Notify affected personnel that the maintenance or service work is completed and that the equipment is ready for use.
7. Record the time the equipment was returned to operation in the lockout / tagout log.

Receipt and unpacking

Chapter 1

1.1 Receipt and unpacking

The Guardian® Gas Protective System and parts are shipped in one or more containers. Each packing slip indicates the number of crates. Report any signs of rough handling or damage during shipment to the transportation carrier. Inspect all equipment and parts after removal from shipping containers.

Note

Report any broken, damaged, or missing parts immediately to the ATMI Technical Support Help Desk, at (800) 886-1978 or (707) 257-1960.

Theory of operation

Chapter 2

2.1 Introduction

The ATMI Guardian® Gas Protective System is a point-of-use emission abatement device that thermally oxidizes and decomposes process gases and by-products in the effluent streams from semiconductor tools and other manufacturing processes. These process gases and by-products include flammable, pyrophoric, and toxic gases. The patented Guardian combustion chamber ensures the flammable gases are burned and prevents silane bubble formation for most concentrations and flow rates. It also burns flammable purge-panel exhaust gases and flammable pump oil mists and vapors.

The Guardian thermal oxidizer is highly reliable, requires low maintenance, is easily retrofitted into existing systems, and has no negative impact on process equipment. Operation is safe, simple and effective. Waste gases pass through a wall of flame as they are drawn into the combustion area. Air drawn through the oxidizer by the house exhaust system provides oxygen for combustion, dynamically positions the flame, and cools the exhaust gas stream.

An electronic controller monitors the reaction conditions and provides visual and audible warnings of out-of-tolerance conditions. It also initiates a controlled shutdown of process equipment if the Guardian interface is wired to do so.

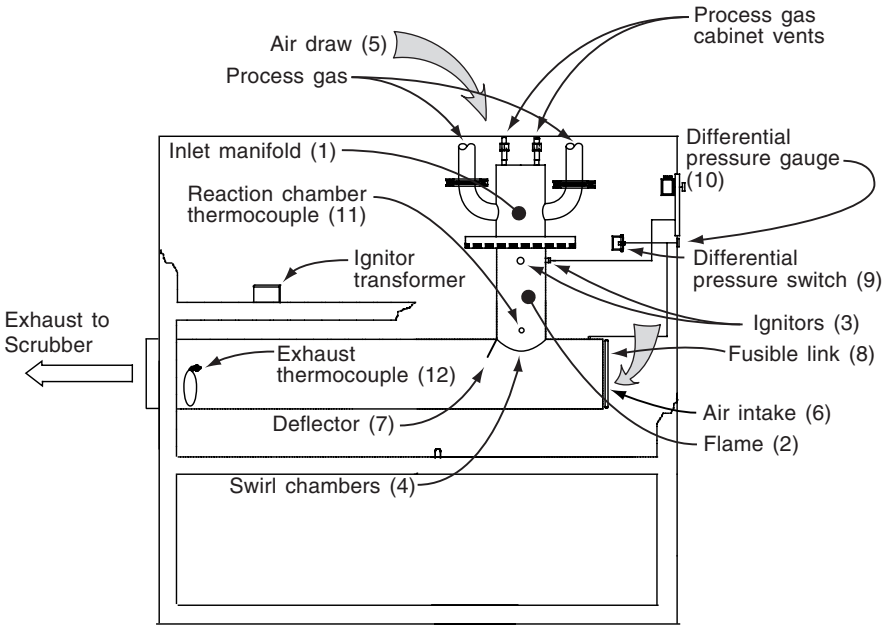
Redundant safety features ensure combustion under most foreseeable situations, including surges of flammable gas.

2.2 Principle of operation

Refer to Figure 2-1, “Guardian operation,” for the locations of the numbered items in parentheses discussed in the following paragraphs.

The system thermally oxidizes typical process gases used in semiconductor manufacturing, such as silane, arsine, phosphine, diborane, and others. The process effluent from a process tool is introduced into the Guardian inlet manifold (1) and through a wall of flame (2), guaranteeing the burning of the residual process gases. Two ignitors (3) generate the flame, which is fed with a small quantity of fuel (hydrogen gas or natural gas) and clean dry air (CDA). Refer to Figure 12-1 “Guardian hydrogen fuel and CDA schematic” or Figure 12-2 “Guardian methane fuel and CDA schematic” for a fuel and air schematic.

Fig. 2-1: Guardian operation



As the gases pass through the flame (2) into the swirl chamber (4), they are met with a perpendicular flow of air drawn through the top of the Guardian cabinet (5), past the fittings, and into the Guardian combustion chamber air intake (6). The perpendicular air flow provides shear to the ignited spent process gases, causing them to swirl and completely mix with air. The swirling action increases the time gases spend in the reaction chamber, prevents silane from forming a self-protecting bubble, ensures complete combustion, and cools the reaction gases before they exit the combustion chamber.

A deflector (7) forces the reacted gases into the middle of the swirl chamber to ensure that the burning process gases are well mixed with the incoming air. The reaction thermodynamics are balanced with intake air flow to keep the exhaust temperature below the high temperature limit switch, which is factory set at 392 °F *(200 °C)*.

The air drawn by the house exhaust system is set to achieve a minimum velocity of 30 fps *(9 mps)*. This is three times the flame front of hydrogen, a fast burning gas. This ensures that the flame does not exit through the air intake. As an added safety feature, a fusible link (8), placed at the air intake, shuts down the fuel supply if flame exits the air intake and melts the link. The air flow is monitored with a differential pressure switch (9) and a differential pressure gauge (10). A thermocouple (11) monitors the combustion chamber temperature. Another thermocouple (12) in the exhaust monitors the exhaust gas temperature.

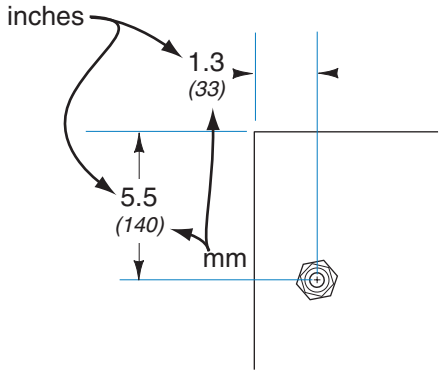
Facilities requirements

Chapter 3

This chapter describes the requirements of the Guardian Gas Protective System location and environment, surrounding clearances, location of inlets and outlets on the cabinet, and specifications.

The illustrations in this section show dimensions in inches, followed by dimensions in millimeters, as shown in Figure 3-1.

Fig. 3-1: Key to dimensions



3.1 Site location requirements

Locate the Guardian system in an area that is:

- well-illuminated
- well-ventilated
- easily accessible to maintenance personnel
- situated so that dust or particulate that may escape during maintenance does not contaminate other areas or equipment
- away from a corrosive atmosphere

Facilities requirements

Site location requirements

3.1.1 Environment

The optimal system environment should be between 32 and113 °F *(0–45 °C)* with a relative humidity between 20 and 85 percent.

Table 3-1: System footprint

	GS4	GS8
Width	19 in *(483 mm)*	21 in *(533 mm)*
Depth	36 in *(914 mm)*	76 in *(1930 mm)*
Height	42 in *(1067 mm)*	58 in *(1480 mm)*
Weight	200 lb *(91 kg)*	600 lb *(273 kg)*

3.1.2 Clearance

Clearance surrounding the Guardian cabinet must be provided to allow access for maintenance. At least three feet *(one meter)* of clearance in front of each panel is recommended.

3.1.3 Facilities requirements

Fig. 3-2: Installation, GS4–front and back views

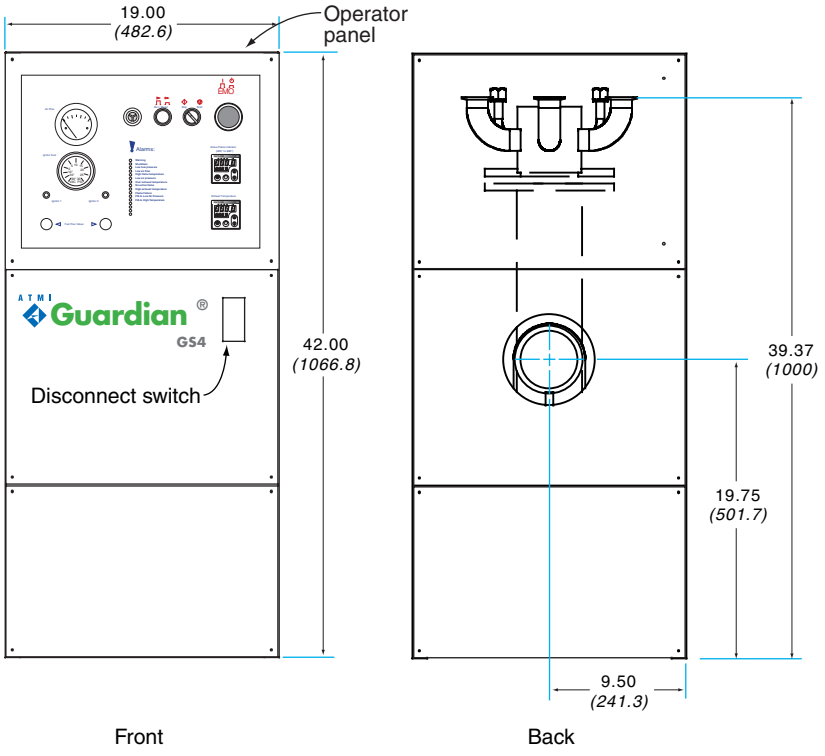


Fig. 3-3: Installation, GS4–top view

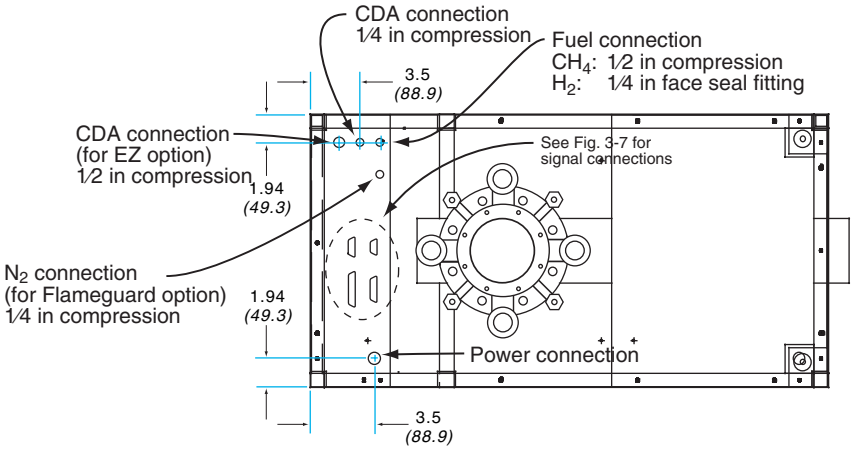
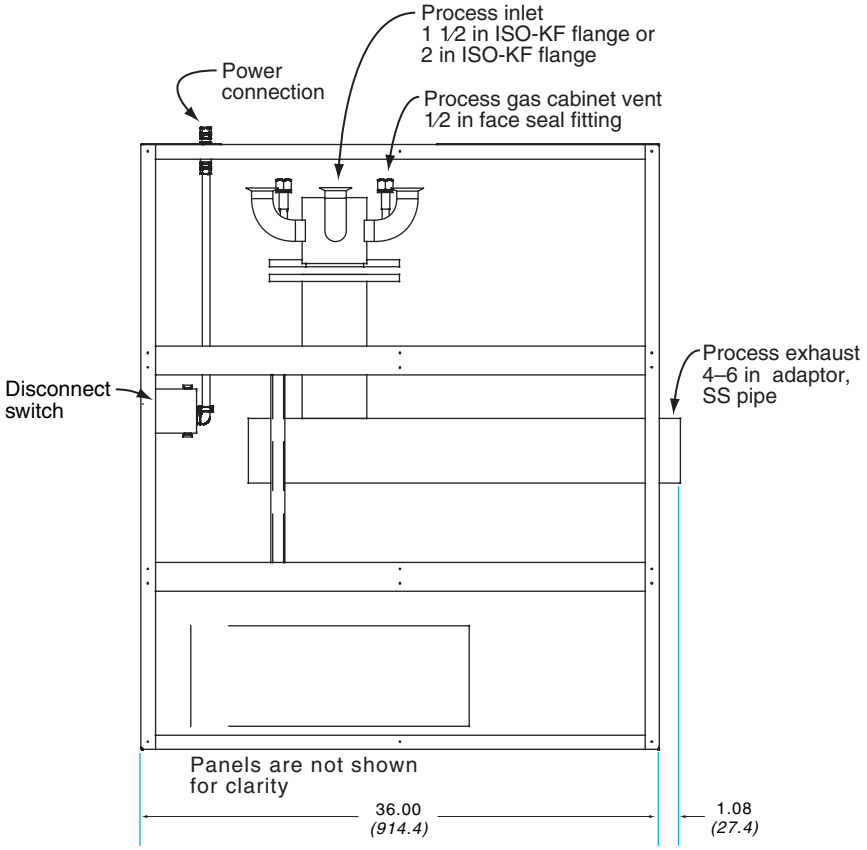


Fig. 3-4: Installation, GS4–side view



Facilities requirements

Site location requirements

Table 3-2: Process inlet parameters, GS4 and GS8

Description	Configuration	Connection	Operational Parameters	
			GS4	GS8
Process inlet	Stainless steel tubing, ISO-KF flange	1 1⁄2 in *(40 mm)* or 2 in *(50 mm)*	4 cfm *(110 lpm)* total; –2.0 to –0.5 in wc *(–50.8 to –12.7 mm wc)*; 41–113 °F *(5–45 °C)*	20 cfm *(600 lpm)* total; –2.0 to –0.5 in wc *(–50.8 to –12.7 mm wc)*; 41–113 °F *(5–45 °C)*
Process gas cabinet vent	Stainless steel tubing, metal face seal fitting	1⁄2 in *(12 mm)*		

Table 3-3: Exhaust requirements, GS4

Description	Configuration	Connection	Operational Parameters
Process exhaust	Stainless steel pipe, plain round end	4 to 6 in *(102 to 152 mm)* adaptor connected to a 6 in by 10 ft *(153 mm by 3 m)* run of stainless steel exhaust duct with a damper located 10 ft *(3 m)* downstream from the system. The damper should have a position locking device, and an ISO flange or equivalent should be used at exhaust connection.	250–550 cfm *(118–260 lps)*; 113 °F *(45 °C)* maximum; –4 to –2 in wc *(–10 to –5 mm wc)*

Table 3-4: Exhaust requirements, GS8

Description	Configuration	Connection	Operational Parameters
Process exhaust	Stainless steel pipe, plain round end	8 to 10 in *(203 to 254 mm)* adaptor connected to a 10 in by 10 ft *(254 mm by 3 m)* run of stainless steel exhaust duct with a damper located 10 ft *(3 m)* downstream from the system. The damper should have a position locking device, and an ISO flange or equivalent should be used at the exhaust connection.	800–2000 cfm *(378–944 lps)*; 113 °F *(45 °C)* maximum; –4 to –2 in wc *(–10 to –5 mm wc)*

Table 3-5: Gas supply requirements, GS4 and GS8

Description	Configuration	Connection	Operational Parameters
Clean dry air (standard system)	80 psi *(552 kPa)*	1⁄4 in *(6 mm)* stainless steel compression fitting	7.5 cfh *(3.5 lpm)* system flow requirement. Customer must install a regulator, shut off valve, and 20 micron filter.
Clean dry air (Flameguard option)	80 psi *(552 kPa)*	1⁄4 in *(6 mm)* stainless steel compression fitting	10.5 cfh *(5.0 lpm)* system flow requirement. Customer must install a regulator, shut off valve, and 20 micron filter.
Clean dry air (EZ Clean option)	80 psi *(552 kPa)*	1⁄2 in *(13 mm)* stainless steel compression fitting	62 cfh *(29.3 lpm)* system flow requirement. Customer must install a regulator, shut off valve, and 20 micron filter.
Nitrogen (flashback arrestor option)	80 psi *(552 kPa)*	1⁄4 in *(6 mm)* stainless steel compression fitting	212 cfh *(100 lpm)* system flow requirement. See Section 9.8, “Flashback arrestor option.”
Hydrogen fuel option	35 psi *(241 kPa)*	1⁄4 in *(6 mm)* stainless steel face seal fitting	53 cfh *(25 lpm)* system flow requirement. Customer must install a regulator, shut off valve, and 20 micron filter.
Methane fuel option	7.5 in wc *(190.5 mm wc)*	1⁄2 in *(12 mm)* stainless steel compression fitting	28 cfh *(13.2 lpm)* system flow requirement. Customer must install a regulator, shut off valve, and 20 micron filter.

Fig. 3-5: Installation, GS8–front and back views

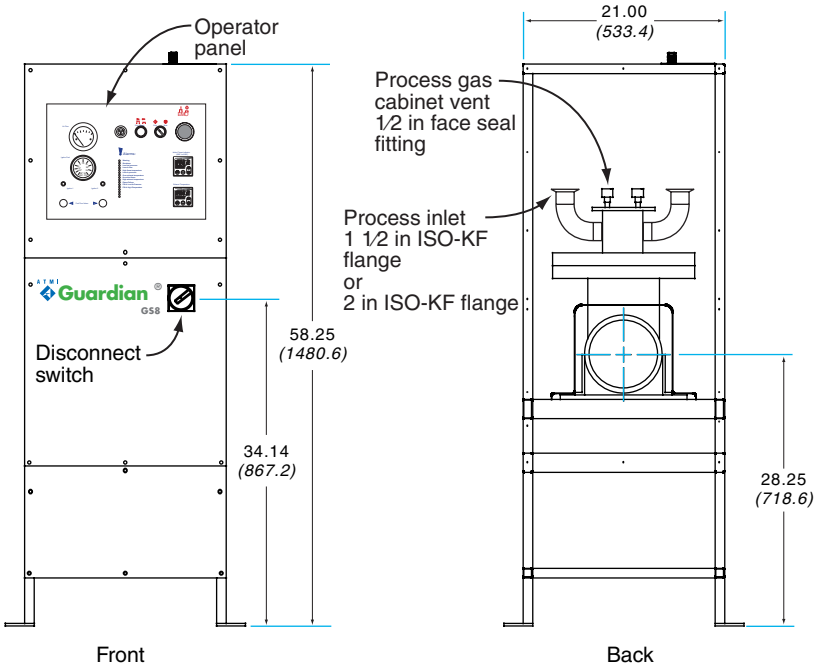
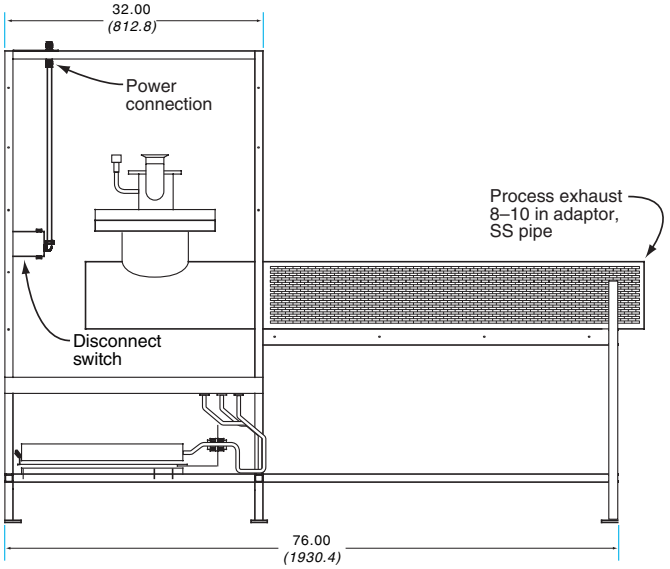


Fig. 3-6: Installation, GS8–side view



3.1.4 Electrical connections

Figure 3-8 shows the connection details for the main power connections and the connections to the remote EMO and alarm relay contacts. Table 3-6 details the electrical requirements of the system.

Supply power to the Guardian through a 7.5 A circuit breaker with lockout / tagout capability.

Fig. 3-7: Signal interface connection detail

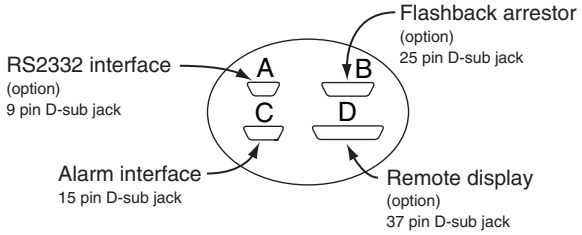


Fig. 3-8: Power and alarm connections, GS4 and GS8

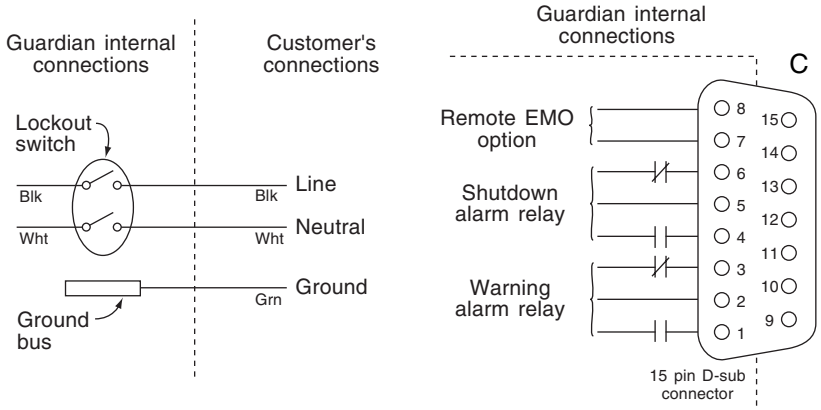


Table 3-6: Electrical requirements, GS4 and GS8

Purpose	Connector	Connection	Voltage
Main power		Terminals on power disconnect switch	120 V, 1 Ø, 50–60 Hz, 4.2 A (Optional: 240 V, 1 Ø, 50–60 Hz, 2.1 A)
RS232 communication option	A	9-pin D-sub connector	Non-powered contacts or low voltage (24 Vdc) signals
Flashback arrestor option	B	25-pin D-sub connector	Non-powered contacts or low voltage (24 Vdc) signals
Alarm signal output interface	C	15-pin D-sub connector	Non-powered contacts or low voltage (24 Vdc) signals
Remote display interface option	D	37-pin D-sub connector	Non-powered contacts or low voltage (24 Vdc) signals

Installation

Chapter 4

4.1 Introduction

ATMI carefully inspects all systems through a quality control program prior to shipment. Inspect the Guardian Gas Protective System when unpacking to ensure that shock and trip indicators have not been tripped during shipment. Prior to installation ensure that flanges and fittings are tight and electrical components are properly seated.

Report any discrepancies immediately to the ATMI Technical Support Help Desk at (800) 886-1978 or (707) 257-1960. Please have the serial number of the system ready to give to the customer service representative.

CAUTION!

Proper installation of the Guardian Gas Protective System is essential.

4.2 Installation procedures

4.2.1 Location

When installing the Guardian thermal oxidizer, ensure that seismic tie downs are used or other bracing is in place to prevent excessive movement during seismic events. Place the cabinet as close as possible to the process exhaust source. Depending on the gas species, long exhaust lines from the process tool require more

frequent maintenance. Some processes require heated exhaust lines to reduce unwanted condensation prior to arriving at the Guardian system. Cool ambient air conditions can also lead to condensation in vacuum pump exhaust lines, which may also require heating.

Fig. 4-1: Footprint, floor mount installation, GS4

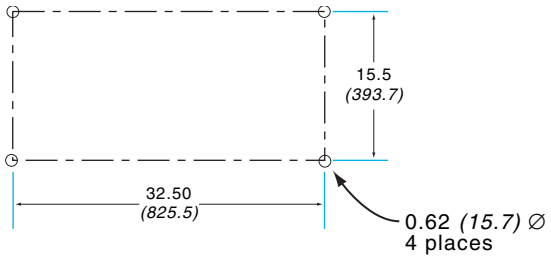


Fig. 4-2: Control panel installation, ceiling mount GS4

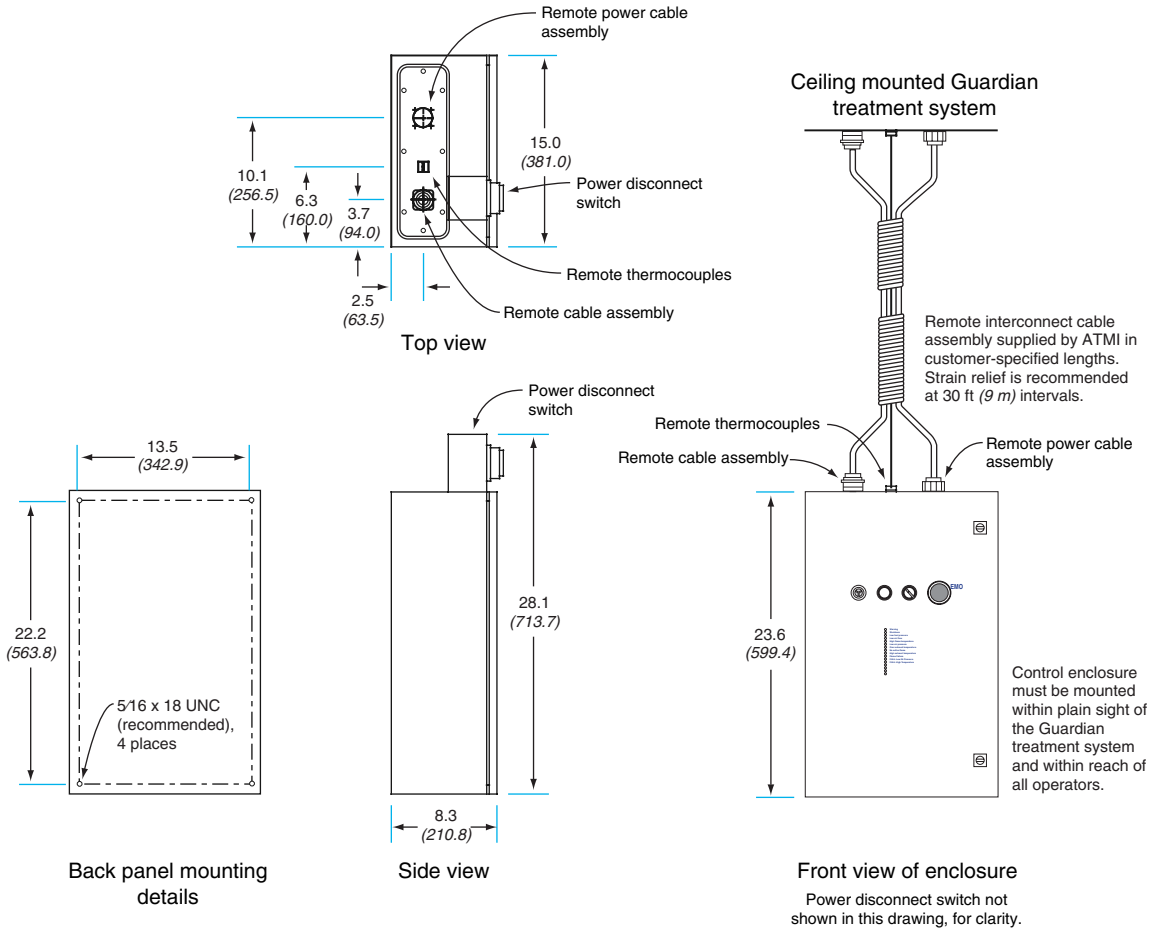
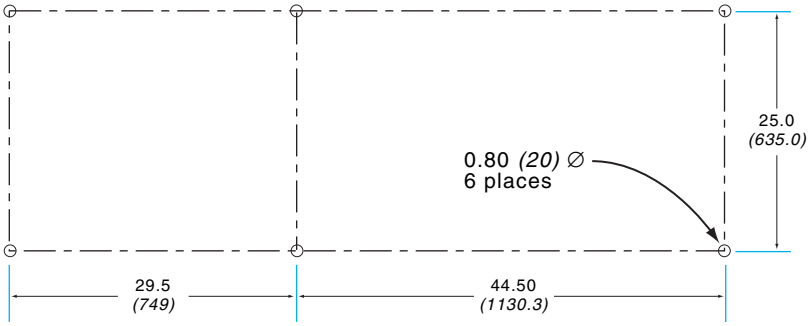


Fig. 4-3: Footprint, floor mount installation, GS8



4.2.2 Flashback arrestor

Since the Guardian oxidizer has a flame, care must be taken to ensure that no flame travels back to the process tool. A flashback arrestor is mandatory on each process line in which the gas stream is at or near atmospheric pressure and contains flammable or pyrophoric components at concentrations above their lower explosive limit. For reduced pressure applications where vacuum pump exhaust gases are within the flammable range, installation of a flashback arrestor is strongly advised.

Any flame propagating up the process exhaust line back toward the tool, caused by air getting into the line, is arrested by the flashback arrestor.

4.2.3 Inlet and exhaust requirements

The length of the line between the process tool or vacuum pump and the Guardian system should be no more than 25 feet *(7.5m)* with a minimum number of bends. The pipe diameter should be the same size as the process tool outlet, the vacuum pump outlet, or the Guardian oxidizer inlet. Each process tool or vacuum pump exhaust and each gas cabinet vent **must** be piped separately and directly to a connection on the Guardian inlet manifold to ensure safe operation. The use of external manifolds to connect the exhaust of more than one tool or pump to the Guardian system is not recommended.

Note

ATMI recommends using stainless steel for connecting to the exhaust duct of the Guardian Gas Protective System.

WARNING!

Tool vacuum pumps feeding the Guardian thermal oxidizer systems *must not* use hydrocarbon-based oils.

WARNING!

The introduction of different gases into a single line upstream of the system can have severe adverse consequences and we strongly advise against such practice. ATMI disclaims all responsibility for any liability arising out of failure to follow this advice.

Vented gas cabinet or valve manifold box purges for non-flammable, corrosive gases such as hydrogen chloride, boron trichloride, and boron trifluoride should be plumbed directly to the house scrubber.

The intake air for the Guardian system is normally room air. However, if it is located in an air-conditioned area, non air-conditioned air should be supplied to the cabinet to ensure optimal operation of the system.

CAUTION!

The intake air is designed to ventilate the cabinet. *Do not* duct the air directly into the air intake opening of the Guardian oxidizer chamber.

The requirements determine the necessary intake air flow. These include exhaust cooling, particulate evacuation, and vacuum pump draw. Increased air flow lowers the temperature of the exhausted gases or allows an increase in the amount of process gases introduced. An exhaust temperature high limit of 392 °F *(200 °C)* is factory set.

The exhaust duct from the Guardian thermal oxidizer must be adequate to carry the exhaust gases to the house exhaust system, and must include a damper located about 10 feet *(3 meters)* from the Guardian exhaust outlet (refer to Table 4-1 for requirements).

Table 4-1: Exhaust and flow rate requirements

	Minimum exhaust duct size (diameter)	House exhaust draw	Minimum air		Maximum air	
			flow rate	velocity	flow rate	velocity
GS4	6 in *(152 mm)*	–4 to –1.5 in wc *(–102 to –38 mm wc)*	250 cfm *(118 lps)*	2865 fpm *(873 mpm)*	550 cfm *(260 lps)*	6302 fpm *(1921 mpm)*
GS8	10 in *(254 mm)*	–4 to –1.5 in wc *(–102 to –38 mm wc)*	800 cfm *(378 lps)*	(1467 fpm) *(447 mpm)*	2000 cfm *(944 lps)*	3667 fpm *(1118 mpm)*

Note

ATMI recommends using stainless steel for connections to the exhaust duct of the Guardian Gas Protective System. Do not use epoxy, putty or any other type of sealant on the exhaust duct.

Cleaning or replacing the exhaust duct work is recommended before the Guardian unit is installed, especially when pump oil is present.

CAUTION!

The damper on the exhaust duct should have a position-locking device to maintain the minimum required flow.

CAUTION!

Care should be taken when removing pump oil because some dissolved pyrophoric or toxic gases may be present. If your process tool is equipped with a wet vacuum pump, refer to Section 8.4, "Special maintenance procedures," for maintenance steps that should be taken to prevent hazards related to vacuum pump oil discharge.

Many of the combustion products of the Guardian thermal oxidizer are solids. These particulates, typically less than five microns in size, are carried through the ductwork and into the house scrubber.

DANGER!

Consider the possibility of toxic compounds existing in the combustion products. For example, if arsine or hydrogen selenide is one of the process gases, the entire system, from the gas cylinder through the scrubber, must be treated as contaminated with arsenic or selenium. In this example, the house scrubber water must be monitored for toxic levels as well.

A toxic gas monitor at the combustion chamber outlet is recommended.

All gas supplies to the Guardian system should be filtered and the pressure regulated according to the specifications in Chapter 3, “Facilities requirements.” A flammable gas detector in the Guardian cabinet may be required by the facility’s safety requirements.

4.2.4 Nitrogen flow requirements

Tables 4-2 through 4-5 list the maximum nitrogen flow rates for the hydrogen-fueled and methane-fueled GS4 and GS8 systems.

Table 4-2: Maximum nitrogen flow–hydrogen-fueled GS4

Air flow (cfm)	Hydrogen flow (lpm)	Nitrogen flow (maximum lpm)
255	15.4	35
273	24.5	155
273	37.8	260
478	15.8	60
482	24.8	155
482	37.5	260

Table 4-3: Maximum nitrogen flow–methane-fueled GS4

Air Flow (cfm)	Methane flow (lpm)	Nitrogen flow (maximum lpm)
250–500	12.5–16.5	100

Table 4-4: Maximum nitrogen flow–hydrogen-fueled GS8

Air flow (cfm)	Hydrogen flow (lpm)	Nitrogen flow (maximum lpm)
775	15	250
775	24.3	240
792	36.8	400
1450	15.4	375
1450	25.1	550
1450	37	650

Table 4-5: Maximum nitrogen flow–methane-fueled GS8

Air flow (cfm)	Methane flow (lpm)	Nitrogen flow (maximum lpm)
855	11.9	110
855	16	155
1413	12.7	110
1413	16.5	155

4.2.5 Other considerations

If the system will be installed in a clean room, ensure that the heat generated and dissipated by the Guardian system and its exhaust ductwork does not affect anything within the process area. An estimate of the maximum heat generated by the system and ductwork can be obtained from Figure 4-4 and Figure 4-5, “Heat load, from system” and Figure 4-6 and Figure 4-7, “Heat load, from SS duct.”

Consider the effect of the noise generated by the combustion chamber on persons working nearby. Also consider the aesthetics of the oxidizer if it is mounted within the work area. Ensure adequate lighting is provided. An audio-enhanced telephone near the Guardian system is suggested.

If desired, the customer’s process tool can be interfaced with the Guardian controls to shut down the tool if the Guardian system has a fault. The Guardian controls can also be connected to a house monitoring system.

Fig. 4-4: Heat load, from system, GS4

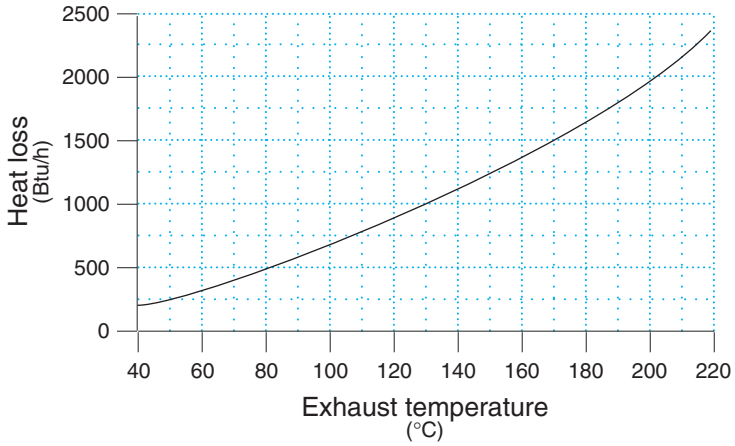


Fig. 4-5: Heat load, from system, GS8

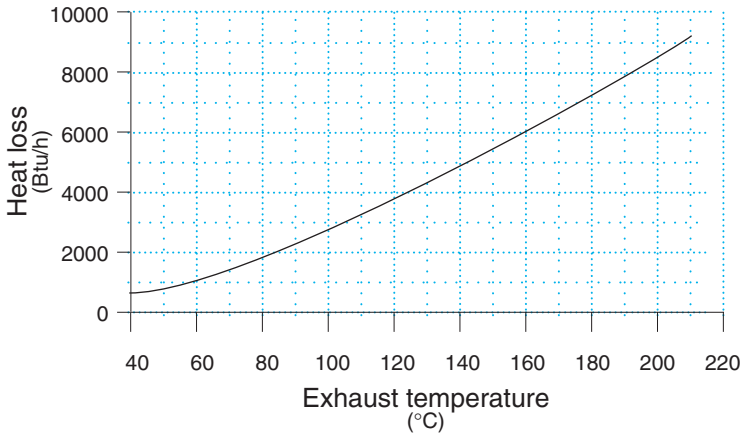


Fig. 4-6: Heat load, from SS duct, GS4

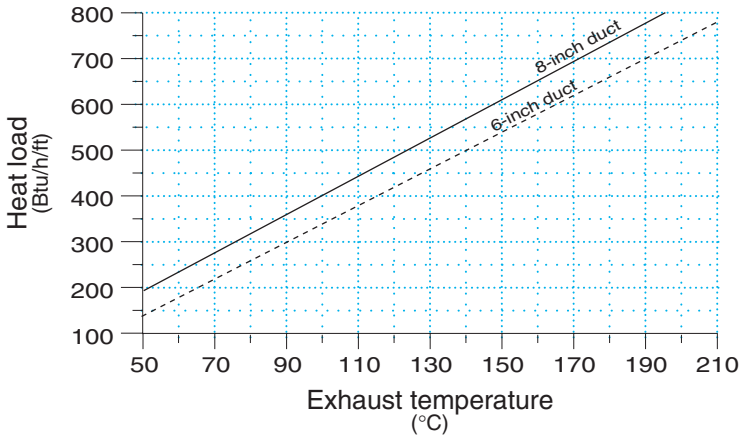
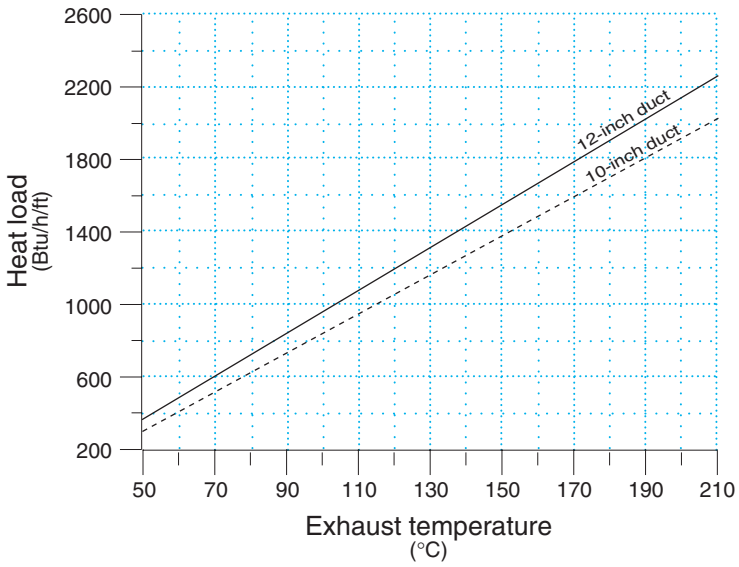


Fig. 4-7: Heat load, from SS duct, GS8



Startup

Chapter 5

5.1 Initial startup

5.1.1 Initial startup procedure

The Guardian Gas Protective System has been fully factory tested. Both temperature controllers and all pressure alarm switches have been adjusted to factory specifications. Perform the following *Initial startup procedure* to confirm complete functionality of the system. During this procedure, you can adjust the temperature alarm and flow alarm setpoints to meet your requirements.

Note

It is important that the fine-tuning steps at the end of this initial startup procedure be done *only after* all tool pump purges are turned ON. Proper Guardian fine-tuning *cannot* be done without the total nitrogen flow being introduced to the Guardian system.

Do not start until you have read through the entire procedure. You must understand this procedure in its entirety before performing it to ensure a proper initial startup of the Guardian system.

5.1.1.1 Pre-startup inspection

1. Verify that all utilities are correctly hooked up to the system according to Table 3-2 through Table 3-6 and that all utilities are turned OFF. Utilities are electricity, house exhaust, fuel, house air (CDA), and house nitrogen (for the flashback arrestor option).

(Procedure continues on the following page.)

2. Verify all process gases are turned off and locked out.
3. Verify that all newly installed gas lines are checked for leaks.

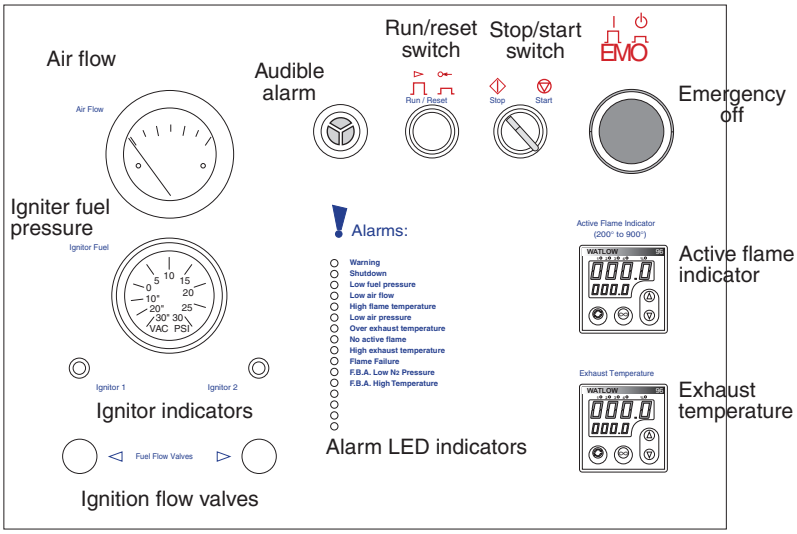
5.1.1.2 Start-up

1. Close the *ignitor flow valves* by rotating them clockwise to the fully closed position (see Figure 5-1).

CAUTION!

Do not overtighten the ignitor flow valves.

Fig. 5-1: Guardian control panel (hydrogen fuel option shown)



2. Press the *EMO* button.
3. Turn the *stop/start* switch to STOP.
4. Turn the *power disconnect* (just below the front control panel) to OFF.
5. Turn on the circuit breaker at the facility power distribution panel.

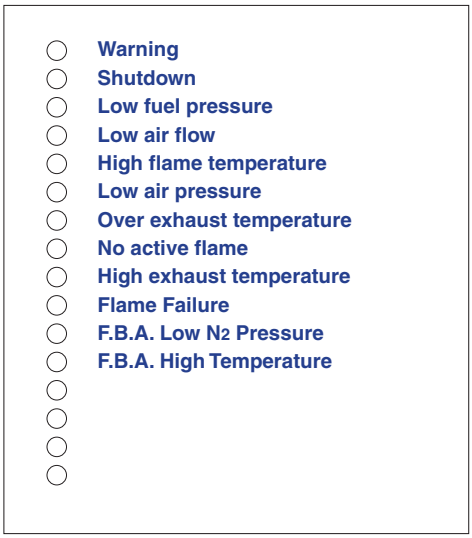
(Procedure continues on the following page.)

6. Turn the *power disconnect* on the thermal oxidizer to ON.
7. Verify that the system is powered on by checking that both temperature controller displays are lit and that the red display shows the ambient temperature.

5.1.1.3 Verify alarms

Figure 5-2 shows a detail of the alarm LEDs on the front panel of the Guardian system.

Fig. 5-2: Guardian control panel–alarm detail



1. Disengage the emergency off circuit by rotating the *EMO* button one-quarter turn clockwise until it pops out.
2. Check that all alarm indicators come on momentarily.

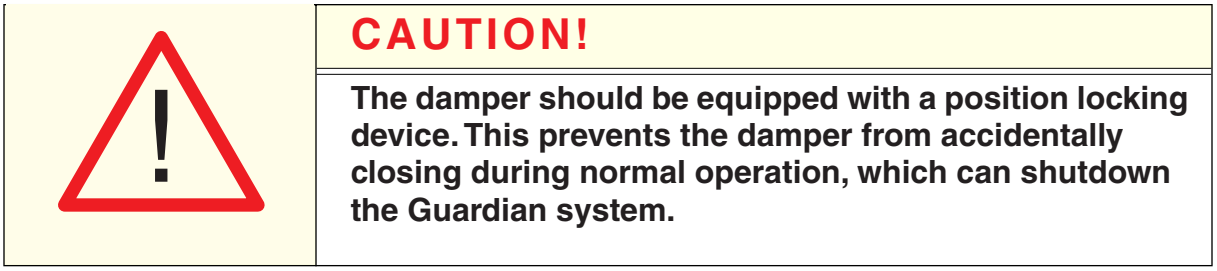
Note

Since the flame failure light is optional, it will not come on with the other alarms if this option is not installed.

3. Verify that active alarm indicators are displayed on the alarm panel, including the *warning* and *shutdown* alarms (see Figure 5-2).

(Procedure continues on the following page.)

4. Adjust the exhaust line airflow damper for a reading of 1.5 in wc on the *air flow* indicator on the control panel.



CAUTION!

The damper should be equipped with a position locking device. This prevents the damper from accidentally closing during normal operation, which can shutdown the Guardian system.

5. Turn on the house CDA and adjust the secondary regulator to 10 psi *(69 kPa)*.
6. Push the *reset* button twice.
7. Check that the *low air pressure* light comes ON.
8. Verify that the active flame controller setpoints are correct.
9. Verify that the exhaust temperature controller setpoints are correct.
10. Disconnect the *exhaust temperature* thermocouple to verify the *high exhaust temperature* alarm indicator.
11. Reconnect the *exhaust temperature* thermocouple.
12. Push the *reset* button twice.

Note

Several seconds may be required for the temperature controller to clear, before the reset button clears the alarm.

5.1.1.4 Introduce fuel

1. Turn on the house fuel gas supply.
2. Perform a leak check on the fuel lines.
3. Turn the *stop/start* switch to the START position.
4. Push the *reset* button twice.
5. Verify that the *ignitor 1* and *ignitor 2* lights on the control panel are lit.
6. Adjust the fuel supply to the Guardian thermal oxidizer at the customer-supplied pressure regulator near the system. Check the *ignitor fuel pressure* gauge on the control panel. This gauge should indicate the pressure specified under Table 3-5, "Gas supply requirements, GS4 and GS8," on page 3-11.
7. Verify that the reading of the *active flame indicator* temperature display begins to increase.


Note

Verify that both spark indicator lamps are illuminated and are rapidly and steadily flickering without going out. When the system is switched to START, the PLC monitors the reaction chamber, looking for a 50 °C rise in temperature. If this change does not occur within 30 seconds, the system shuts down and alarms.

If the system is already above 200 °C when started, the PLC looks for a 25 °C increase.

8. Adjust both *ignition flow valve* knobs to obtain a reaction chamber temperature of 450–600 °C. Adjust the knobs one-quarter turn at a time, and wait for the adjustment to take effect.
9. Adjust CDA regulator to 10 psi *(70 kPa)*.
10. Allow the combustion system to become thermally stable (about 5 minutes).
11. After the reaction chamber temperature is greater than 200 °C, push the *reset* button twice.
12. Verify that the active flame indicator display has stabilized and is maintained within a relatively narrow temperature range.

5.1.1.5 Test emergency off button

1. Press the *EMO* button.
2. Reset the emergency off circuit by rotating the *EMO* button one quarter turn clockwise until the button pops out.
3. Press the *reset* button twice. All alarm indicators should go OFF. The system should restart.

5.1.1.6 Fine tuning

Fine-tune the Guardian Gas Protective System by first reading and understanding the following notice and information, and then performing the procedure.


Note

It is important that the following fine-tuning steps done *only after* all tool pump purges are turned ON. Proper fine-tuning *cannot* be done without the total nitrogen being introduced to the system.

As with any furnace, the Guardian Gas Protective System requires fine-tuning due to process recipe variations and quantities of nitrogen being introduced. The nitrogen limits listed in Table 3-5 must not be exceeded.

Four factors affect the correct operation of the system, and must be brought into balance:

- amount of exhaust air flow
- rate of fuel delivery
- amount of nitrogen being sent to the system, and
- frequency of cleaning and other preventative maintenance.

1. Turn on all nitrogen going to the system inlet (pump purges, gas cabinet trickle purges, etc.).
2. Use a mirror to observe the flame from each ignitor as the adjustments described in Step 3 below are made.
3. Adjust both *ignition flow valve* knobs equally to obtain a reaction chamber temperature of 450–600 °C. As you make these adjustments, remember how far you turn each ignitor flow valve because you will record this information later.

(Procedure continues on the following page.)

Note

The air flow and fuel may require adjustment to offset nitrogen loading.

4. Record the final pressure settings of all facilities and the number of turns (from closed) of the *ignitor flow valves*. Keep all recorded values for future reference.

5.2 Normal startup procedure

To start up the Guardian thermal oxidizer, perform the procedures described in this section.

Note

ATMI's treatment products, including the Guardian Gas Protective System, are not usually shut down except for maintenance or service.

5.2.0.1 Pre-start inspection

1. Verify that all preventive maintenance and service for the system is completed and that all lockouts / tagouts are removed.
2. Close and secure all associated electrical cabinets and enclosures.
3. Verify that all manual valves are in the correct position for normal system operations.
4. If necessary, turn on the *power disconnect*.
5. If necessary, reset the *EMO* button on the front panel.
6. Verify electrical power is present by seeing if the *exhaust temperature indicator* is on.

5.2.0.2 Start-up

1. Turn the *stop/start* switch to the START position.
2. Verify that the digital *active flame indicator* display increases.
3. Verify that the *ignitor* neon lamps are flickering rapidly.
4. Verify that the *active flame indicator* display has stabilized and is maintained within a relatively narrow temperature range.


Note

At this point the Guardian system is operating normally and is ready to accept exhaust gases from the process tool.

5. Check for flame stability after process gas enters the system.

Guardian GS4 / GS8 Startup Form

(The customer must notify ATMI ten business days before the planned start-up date.)
Customer/Location:_____ Date:_____
Contact:_____Start Time:_____ Finish Time:_____

	Model/Serial Numbers	Equipment exhausted to Guardian oxidizer:
Guardian	_____	_____
Flashback arrestor	_____	_____
Others	_____	_____

1. Inlets:_____ x KF 40 50 hooked up
2. Vent lines: _____ x 1⁄2-inch VCR
3. Fuel line leak checked? YES NO
4. Reactor to Guardian line leak checked? YES NO NOT HOOKED UP
5. Restrictions in inlet plumbing? _____
6. Are there any epi reactors? YES NO Are flashback arrestors hooked up? YES NO
7. Vacuum pump(s) N2 vented? YES NO
8. **GS4 Exhaust Flow** = _____ fpm x 0.087 = _____ cfm [G4 minimum = 250 cfm]

   GS8 Exhaust Flow = _____ fpm x 0.394 = _____ cfm [G8 minimum = 800 cfm]

   Measurement method? _____
9. R/C low temp. = _____°C
10. R/C high temp.= _____°C
11. Exhaust high temp.= _____°C
12. Exhaust over temp.= _____°C
13. Exhaust ducts sprinkler-equipped? YES NO
14. Pressure: Fuel = _____ psig CDA = _____ psig N2 = _____ psig (flashback arrestor)
15. Ignitor valve #1 = _____ turns Ignitor valve #2 = _____ turns (fully open = 15 turns)
16. Reaction Chamber temperature = _____°C Exhaust Chamber temperature = _____°C
17. Adj. pressure differential switch _____ Adj. low fuel alarm _____

Customer sign-off:_____ Date:_____

NOTE: This form is to be used by ATMI field service personnel when the Guardian Gas Protective System is started up. If the customer prefers to start the system without assistance from ATMI, a copy of this form should be submitted to ATMI when startup is complete.

Alarm operational status

Chapter 6

6.1 System alarms

The alarms displayed on the Guardian Gas Protective System operator panel are listed in Table 6-1. For each LED indicator, the table shows the condition which created the alarm, the device monitoring that condition, whether the condition shuts the system down or produces a warning, and the delay before an alarm is generated. The locations of the alarm indicators are shown in Figure 5-2 “Guardian control panel–alarm detail.” The alarm relay contacts are available through a 15-pin D-sub jack on the top of the cabinet. In the event of a shutdown, the relay should be used to shut off the flow of exhaust gases from the process tool or gas cabinet.

Note

The customer is responsible for making the alarm connections to the process equipment. During shutdown, the CDA supply, fuel supply, and ignition transformers are off, and treatment by the Guardian System does not occur.

In the table which follows, a warning alarm causes the *warning* LED to light along with the respective alarm LED. A shutdown alarm lights both the *warning* and *shutdown* LEDs in addition to the alarm LED. Pressing *stop/start* or *emo* causes both the *warning* and *shutdown* LEDs to come on.

Alarm operational status

System alarms

Table 6-1: Alarm types and conditions

Alarm LED	Condition	Device	Type	Delay
Low fuel pressure	Hydrogen pressure below 28 psi *(193 kPa)*	Fuel low pressure switch	Shutdown	2 s
	Methane pressure below 1 in wc *(24.5 mm wc)*			
Low air flow	Exhaust pressure below 1 in wc *(25 mm wc)*	Low air flow switch	Shutdown	2 s
High flame temperature	Reaction temperature over 1652 °F *(900 °C)*	Active flame temperature switch	Shutdown	none
Low air pressure	CDA pressure below 60 psi *(414 kPa)*	CDA low pressure switch	Shutdown	2 s
Over exhaust temperature	Exhaust temperature over 446 °F *(230 °C)*	Exhaust temperature switch	Shutdown	none
No active flame	Reaction temperature below 392 °F *(200 °C)*	Active flame temperature switch	Warning	30 s
High exhaust temperature	Exhaust temperature over 392 °F *(200 °C)*	Exhaust temperature switch	Warning	none
Flame Failure (Flamegard option)	No active flame	Infrared flame detector (optional)	Shutdown	none
F.B.A. Low N_2 Pressure	Nitrogen pressure below 80 psi *(552 kPa)*	FBA N_2 pressure switch (optional)	Shutdown	none
F.B.A. High Temperature	Fast-acting thermocouple over 392 °F *(200 °C)*	FBA temperature switch (optional)	Warning	none

Shutdown

Chapter 7

7.1 Normal shut down procedure

To shut down the Guardian Gas Protective System, perform the procedures described in this section.

7.1.0.1 Normal shutdown

1. Turn the *stop/start* switch to STOP.
2. Verify that combustion has stopped by looking at the *active flame indicator*. The temperature of the reaction chamber should begin decreasing immediately.

   The *shutdown* and *warning* LEDs come on and the audible alarm sounds.
3. Press *reset* to silence the audible alarm.

Note

If the system will be shut down for an extended time, the following procedure should also be performed.

7.1.0.2 Extended shutdown

1. Close the utility supply valves.
2. Switch the facilities circuit breaker to OFF.

7.2 Emergency shutdown procedure

The system is equipped with a red *EMO* (emergency off) button on the front control panel. See Figure 5-1, “Guardian control panel (hydrogen fuel option shown).” For an emergency that requires immediate shutdown of the system, press the *EMO* button.

Shutdown

Emergency shutdown procedure

7.2.1 Operation of emergency off controls

When the *EMO* button is pressed, the following happens. Numbers in parenthesis refer to lines on the electrical ladder diagrams, beginning on page 12-94.

1. The open *EMO* switch (23 or 26) de-energizes R1 (26) and R1a (27).
2. Open R1a contacts (8) remove line power from the PLC (9), flame controller (11), ignition transformers (15), and compressed air solenoid relay R5 (17).
3. Open R1 contacts (27) remove 24 Vdc power from all control circuits except the EMO relay circuit on line 26.
4. Loss of 24 Vdc power de-energizes the compressed air solenoid valve (28).
5. Loss of pneumatic control pressure closes and vents the fuel valve, extinguishing the flame.
6. Loss of the 24 Vdc also allows customer warning interface relay K1 (131) and customer shutdown interface relay K2 (133) to de-energize. This sends shutdown and warning alarm signals to the customer's equipment, if connected to do so.

At this point, control air is removed from all pneumatically controlled valves, line power is removed from all components except the 24 Vdc power supply, and power from this supply is removed from all components except the EMO relay circuit.

CAUTION!

The EMO switch does not remove line voltage from the control system. Use the local power disconnect to remove all power from the cabinet before servicing.

Maintenance

Chapter 8

Although the Guardian Gas Protective System operates with minimal maintenance, routine preventive maintenance is advised.

Any solid deposited within the system should be vacuumed when the buildup is about 1⁄2 in *(12 mm)* thick. Complete preventive maintenance is recommended quarterly.

Note

Processes using gases such as tungsten hexafluoride or silicon nitride may create solid oxides which require cleaning more frequently.

ATMI recommends that customers perform regular scheduled preventive maintenance. Refer to Section 8.2, “Factors which affect maintenance requirements,” to understand the factors which affect the frequency of preventive maintenance. ATMI provides a preventive maintenance kit, which contains the items listed in Table 11-2, “Preventive maintenance kit, GS4,” or Table 11-3, “Preventive maintenance kit, GS8.” These items are sold only as kits specific to GS4 or GS8 systems.

8.1 Establishing a preventive maintenance schedule

Maintenance requirements vary due to the wide range of applications and operating parameters. To maximize the operating efficiency of the oxidizer and minimize the occurrence of unscheduled down-time, a comprehensive preventive maintenance (PM) schedule should be implemented. The customer should make frequent inspections following installation and immediately after the addition of a new process tool to the system load.

8.2 Factors which affect maintenance requirements

This section describes those factors that have the greatest impact on scheduled maintenance and frequency.

8.2.1 Amount of particulates

The amount of particulate matter introduced into the thermal oxidizer affects how often it needs to be inspected and cleaned. The following items determine the particulate loading:

- Number of process tools or cylinders connected to the system.
- The type of tool.
- Number of process runs in a given time. Production use requires more frequent maintenance than research and development.
- Process gas type and flow parameters such as:

  SiH_4 10% with N_2 ballast, @ 2 lpm

  SiH_4 90% with PH_3 ballast, @ 200 sccm
- Process tool exhaust line integrity. Any leaks in the exhaust line to the oxidizer could promote premature reaction, causing build-up and potential blockage at the corresponding inlet port.
- System operating parameters.

8.2.2 Hardware integrity

Time has an adverse effect on the efficiency of the system. Factors contributing to this are:

- **Fuel purity:** Inadequate filtration may result in the introduction of contaminants to the ignitor assembly, decreasing efficiency. For example, if the fuel ignitor uses very fine fixed orifices for precise fuel mixing, dust and dirt could restrict fuel flow.
- **Plumbing integrity:** Because compression fittings are used extensively, vibration or other physical forces can weaken connections.

8.2.3 Electrical functionality

- **Wiring:** Wiring should be routed away from the extremely hot surfaces of the reaction chamber and secured. Wiring left dangling after maintenance may contact these surfaces and cause control system or alarm malfunctions.
- **Control system:** The controller should be fully operational to provide the most accurate control and feedback of system operating parameters.
- **Environmental integrity:** Any weather and environmental protection features should be maintained.

8.2.4 Tools and materials

The tools and materials required to maintain and service the Guardian Gas Protective System are listed below.

1	leak detection equipment
1	velocity meter, 1500 to 6000 feet per minute[a]
1	screwdriver, flathead, 1⁄8-inch
1	screwdriver, flathead, 1⁄4-inch
1	screwdriver, flathead, 1⁄4-inch short handle
1	screwdriver, Phillips, 1⁄4-inch
	wrench, Allen head
1	mirror, small
1	vacuum cleaner[b]
1	calibration instrument, thermocouple
1	wrench, open end, 9⁄16-inch
1	wrench, open end, 5⁄8-inch
1	wrench, open end, 3⁄4-inch
1	wrench, box end, 13⁄16-inch
1	wrench, open end, 1-inch
1	wrench, torque
1	thermal fuse
	O-rings
	moly dope
	gaskets

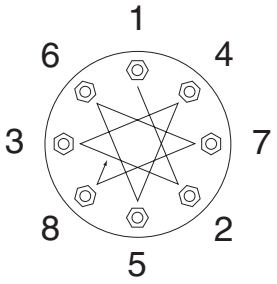
a. A velocity meter that uses a propeller reduces cross sectional area at the system inlet that may temporarily cause false high air flow velocity reading.
b. A toxic vacuum cleaner is required if hazardous solids are present.

8.3 Inlet manifold bolt torque specifications

After completing any maintenance or repair that involves removal of the inlet manifold, the proper torque and tightening sequence must be used to tighten the inlet manifold bolts. A good seal in this part of the system is important because it helps prevent clogging.

Tighten the bolts using the pattern shown in Figure 8-1. Complete the pattern three times, tightening to the to the torque provided in the first, second, or third column of Tables 8-1 through 8-4. These tables list torque values in both IP and SI units and for the GS4 and GS8 systems.

Fig. 8-1: Bolt tightening sequence, inlet manifold



Note

The use of high temperature or automotive spark plug anti-seize compound on the bolts is recommended. If the manifold gasket has a scratch or indentation running from the inner diameter to the outer diameter, it should be replaced.

Table 8-1: GS4 inlet manifold bolt torque specifications–IP units

Bolt location	Tightening torque		
	First pattern	Second pattern	Third pattern
Inlet	108 in•lbs (9 ft•lbs)	216 in•lbs (18 ft•lbs)	324 in•lbs (27 ft•lbs)
Cover Plate	18 in•lbs (1.5 ft•lbs)	36 in•lbs (3 ft•lbs)	55 in•lbs (4.5 ft•lbs)

Table 8-2: GS4 inlet manifold bolt torque specifications–SI units

Bolt location	Tightening torque		
	First pattern	Second pattern	Third pattern
Inlet	11 N•m	25 N•m	35 N•m
Cover Plate	2 N•m	4 N•m	6 N•m

Inlet manifold bolt torque specifications

Table 8-3: GS8 inlet manifold bolt torque specifications–IP units

Bolt location	Tightening torque		
	First pattern	Second pattern	Third pattern
Inlet	108 in•lbs (9 ft•lbs)	216 in•lbs (18 ft•lbs)	324 in•lbs (27 ft•lbs)
Cover Plate			
8-bolt	26 in•lbs (2 ft•lbs)	53 in•lbs (4 ft•lbs)	60 in•lbs (5.0 ft•lbs)
6-bolt	35 in•lbs (3 ft•lbs)	70 in•lbs (6 ft•lbs)	105 in•lbs (8.8 ft•lbs)

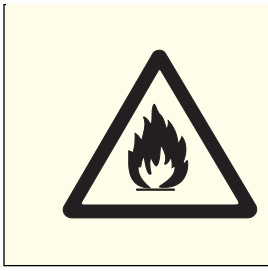
Table 8-4: GS8 inlet manifold bolt torque specifications–SI units

Bolt location	Tightening torque		
	First pattern	Second pattern	Third pattern
Inlet	300 N•m	600 N•m	900 N•m
Cover Plate			
8-bolt	2.3 N•m	4.6 N•m	6.8 N•m
6-bolt	4 N•m	8 N•m	12 N•m

8.4 Special maintenance procedures

8.4.1 Prevention of liquid pump oil discharge

A situation may arise in which pump oil from the process vacuum pump is discharged to the Guardian system as a liquid rather than as a mist or vapor. The symptom of this situation is an over-temperature alarm at the discharge end of the system.



WARNING!

Tool pumps feeding Guardian systems *must not* use hydrocarbon-based oils.

8.4.2 Possible causes of oil discharge

There are two possible causes of liquid pump oil discharge:

- **The pump oil reservoir is overfilled.** The excess pump oil immediately begins to move through the pump and discharges as a heavy stream of highly flammable liquid.
- **The gate valve on the pumping station fails to function at the start of pumpdown**. The large amount of air introduced through the pump inlet pushes substantial volumes of oil from the reservoir to the discharge port of the pump.

8.4.3 Maintenance solutions for oil discharge

- **Ensure that the pump oil reservoir level can be observed.** Every oil-type vacuum pump has a liquid level indicator, usually a simple sight glass on the side of the oil reservoir. Maintenance personnel should clean the sight glass during routine oil changes. The inability to see the oil level through an obscured sight glass is the primary cause of over-filled pumps.

CAUTION!

Care should be taken when removing excess pump oil because some dissolved pyrophoric and/or toxic gases may be present.

- **Test the pumping station gate valve.** An essential part of every preventive maintenance checklist is to verify the operation of the gate valve on a pumping station. Improper operation of this valve can lead to a serious safety problem (either a fire in the oxidizer or widespread deposits of flammable oil throughout the ventilation ducts).

8.5 Scheduled monthly preventive maintenance

If any aspect of the monthly PM is questionable, complete the quarterly preventive maintenance procedure.

Inspect the flashback arrestor (if equipped) following the recommendations in the instructions for the flashback arrestor. See Section 9.8.6.

8.5.1 Oil reservoir and gate valve

1. Clean the vacuum pump sight glass.
2. Verify that the pump oil reservoir level is below the *high* mark.
3. Check the proper operation of the gate valve on the pumping station at the start of pumpdown.

8.5.2 Combustion chamber

1. Remove the plain cabinet side panel by removing the screws.
   - Look for loose hardware, such as chamber restraining hardware.
   - Check the exhaust duct connection to chamber assembly.
   - Inspect the process line inlets, ensuring they are tight and secure.
2. Listen and feel for unusual vibrations and noises.

WARNING!

Some surfaces may be very hot.

(Procedure continues on the following page.)

3. Inspect the condition of wiring. Check for:
   - loose connections
   - frayed insulation
   - discoloration
4. Leaktest all fuel and process lines to the system with a hydrogen sniffer or equivalent.

8.5.3 Chamber dynamics

1. Record the reaction chamber and exhaust temperatures.
2. Measure and record the chamber air flow velocity.
3. Verify presence of firing voltage at the control panel; see Figure 5-1, "Guardian control panel (hydrogen fuel option shown)." *Ignitor* lights should be steady and bright with only a slight flicker.
4. Remove the rear panel of the Guardian cabinet.
5. Visually inspect the combustion chamber components. Look for a buildup of solids on or around the chamber throat and deflector plate.


Note

Tungsten hexafluoride gases may deposit solid oxides which require cleaning more frequently. The Flameguard option should be considered for this type of application. Refer to Chapter 9, "Service operations."

8.6 Scheduled quarterly preventive maintenance

WARNING!

Ensure that the house scrubber is ON before doing work on the system. *NEVER* perform work on a Guardian thermal oxidizer when the house scrubber is off.

8.6.1 Standard inspections and tests

8.6.1.1 Preliminary procedure

1. Inform the proper personnel of maintenance activity.
2. Complete the scheduled monthly preventive maintenance procedure.
3. Turn off and lock out all process equipment connected to the system. Shut off all hazardous gases at each cylinder. To prevent the discharge of process and vent gases to the system, completely purge all gas lines with nitrogen. Make sure all lines to the thermal oxidizer are free of process gases.
4. If necessary, turn off the audible alarm by pressing the *reset* button once.
5. Turn off the CDA.
6. Turn the *stop/start* switch to STOP. The flickering *ignitor condition* lights on the ignitor fuel panel will go out.
7. Turn off the main power by turning the disconnect switch off. The indicator lights will go out.
8. Turn off the electricity at the facility circuit breaker. See Section S 3.1, “Lockout and tagout procedure,” for suggested lockout/tagout procedures.
9. Allow the system to cool for thirty minutes, or until the ignitors are cool enough to touch.

Scheduled quarterly preventive maintenance

8.6.1.2 Inspect and clean ignitors

1. Don appropriate safety gear. Treat the Guardian Gas Protective System and ductwork as if it contains toxic material.
2. Verify that the flange bolts are tight.
3. Remove the top plate to access the combustion chamber.
4. Use a vacuum cleaner with a HEPA filter to remove the solid materials deposited on the inside of the chamber. These are typically a soft, chalk-like substance. It is sometimes more effective if you use an appropriately sized brush before vacuuming. After cleaning, let air flow through the chamber to remove any particulates.
5. Remove the gas inlet flange.
6. Inspect the gas inlet area for any corrosion, deposits and buildup.
7. Remove any deposits using the toxic vacuum.
8. Verify that the nitrogen pressure at the process pump (if a low pressure tool is in use) is at least 5 psi *(35 kPa)*. Adjust if necessary.
9. Inspect all seals and sealing surfaces.
10. Replace gasket using the appropriate part number. See Chapter 11.
11. Install the flange using anti-seize compound on the bolts before tightening the nuts.
12. Inspect the ignitors.
    a. Remove each ignitor.
    b. Examine the firing tip electrodes for unusual wear, corrosion, cracked ceramic, etc.

(Procedure continues on the following page.)

c. Install the ignitor plugs, replacing any ignitors which are obviously fouled or worn.

Note

The ignitor plugs are now installed without the side electrodes.

d. Remove the ignitor assembly.

e. Inspect both the assemblies and the ignitor ports for any deposits.

f. Check the flow limiting orifices in the fuel pilot line for blockage.

g. Clean the ignitor port and the orifices.

h. Reinstall the ignitor assembly.

8.6.1.3 Inspect flashback arrestor

If flashback arrestors are present, inspect them according to the instructions for the flashback arrestor.

1. Check the flashback arrestor:
   a. Remove the flashback arrestor.
   b. Inspect the interior for any deposits, such as powder or oils.
   c. Visually inspect the integrity of the thermocouple and verify that it operates.
2. Inspect the nitrogen port for blockage.
3. Verify the thermocouple setpoint of the flashback arrestor controller.
4. Inspect all seals and sealing surfaces.
5. Replace O-rings:
   - Part number 121-0001-00 for KF-40
   - Part number 121-0006-00 for KF-50
6. Reassemble flashback arrestor.
7. Install the flashback arrestor.
8. Reconnect the thermocouple and nitrogen gas inlets.
9. Check all lines for leaks.

Scheduled quarterly preventive maintenance

8.6.1.4 Test thermocouples

Refer to Figure 2-1 on page 2-4 for the location of components mentioned in this procedure.

1. Remove each thermocouple and test for accuracy and integrity with any standard thermocouple tester. Treat any buildup on thermocouple as toxic material.

Note

The act of removing the thermocouple removes most of the particulate buildup on the thermocouple.

2. Measure thermocouple output on an appropriate instrument.
3. Reinsert or replace thermocouples.
4. Tighten fittings firmly.

8.6.1.5 Inspect fusible link

Refer to Figure 2-1 on page 2-4 for the location of components mentioned in this procedure.

1. Inspect the integrity of the nylon tubing at the air intake of the combustion chamber.
2. Replace worn tubing with part number 422-0004-00.

8.6.1.6 Complete maintenance procedures

1. Clean all mating surfaces.
2. Reassemble.

Note

ATMI can regularly check the customer's controllers and remote alert monitors as a service option. Contact ATMI for more information.

3. Turn on the power at the circuit breaker.
4. Start the system using the procedure in Section 5.2, "Normal startup procedure."
5. Inform proper personnel that maintenance is completed.

8.6.2 Differential pressure switch

Use this procedure to set or check the differential pressure switch. This switch is set to 1.0 in wc *(25 mm wc)* at the factory. Turn the adjustment screw clockwise to increase the setpoint or counter-clockwise to decrease the setpoint.

1. Remove the cover to expose the setpoint adjustment screw.
2. Turn the screw counterclockwise all the way out.
3. Push the reset button once.
4. Verify that the *low air flow* light goes out.
5. Turn the screw clockwise until the solenoid releases CDA or the *low air flow* alarm comes on.
6. Turn the screw counterclockwise one turn.
7. Replace the plastic cover.
8. Push the *reset* button twice.
9. Lower the air flow to verify the trip point.
10. Increase the air flow to the desired level.

Service operations

Chapter 9

WARNING!

ATMI requires lockout / tagout to be performed before working on any equipment. All energy sources to the equipment must be locked and tagged out before beginning work. See Section S 3.1 "Lockout and tagout procedure" for more information on lockout and tagout.

9.1 Control system

The Guardian Gas Protective System control system is based on a programmable logic controller (PLC). The control system consists of the operator controls mounted on the front panel and an electronics chassis, mounted on horizontal slides in the bottom compartment of the cabinet. The operator controls, except the fuel control valves and pressure gauges, are duplicated on the remote panel of ceiling mount GS4 systems.

Note

In an alarm condition, the system provides both an audible warning and a visual indication of the cause. Pushing the *reset* button once silences the audible warning. After the abnormal condition is cleared, pushing the *reset* button again clears the indication and unlatches the alarm relays.

The control system is *fail-safe*. The fuel valve closes when the *EMO* button is pressed or when there is a power failure. The fuel valve is pneumatically operated and the pneumatic control air valve

is electrically operated. The pneumatic control air also goes through a fusible link located in the air intake. If the flame exits the air intake, the fusible link melts and shuts off the fuel.

The Guardian controls monitor air flow, fuel pressure, exhaust temperature, and the active flame. Many of the monitoring devices detect the same event using different methods. For example, both a *high exhaust temperature* alarm and a *low air flow* alarm indicate a scrubber fan failure or an exhaust line blockage or break.

The monitoring devices include:

- fuel low pressure switch
- CDA low pressure switch
- cooling air low flow switch
- exhaust high temperature switch and indicator
- loss of active flame switch and indicator

9.2 Operator controls

The operator controls that are accessible from the front of the Guardian system are listed below. See Figure 5-1, “Guardian control panel (hydrogen fuel option shown)” on page 5-26.

- main power disconnect
- *EMO* (emergency off) red mushroom-head button
- *stop/start* selector switch
- *reset* button
- *active flame indicator*
- *exhaust gas temperature indicator*
- fuel metering valves
- *ignitor fuel pressure* gauge
- air flow gauge
- spark indicators
- alarm indicators

As an option, you may provide a remote emergency off relay or a remote shutdown relay. Refer to Chapter 12, “Schematics and diagrams.”

9.3 Temperature controllers

The two temperature controllers are delivered installed, tested, and configured as shown in Table 9-1. No adjustment is normally required. Consult the Watlow factory manual, included in the document package shipped with the system, for complete instructions for setting up these controllers.

The upper red display shows the operating temperature in degrees Celsius and the lower green display shows the setpoint. The setpoint is set to 200 °C at the factory. Consult the Watlow manual for instructions on changing the alarm setpoints.

9.3.0.1 Set-up temperature controller

1. Set the *input type* DIP switch on the controller chassis to a thermocouple input. Position 2 should be in the ON position.
2. After installing a new controller, with power on, press and hold both the *up* and *down* arrow keys for approximately five seconds. The displays change to read the setting for the CAL mode.The lower display shows the parameter and the upper display shows the current setting.
3. Set the controller/monitor to the values listed in Table 9-1. **Do not change the CAL parameter to YES**.

Table 9-1: Temperature controller settings

Page	Menu	Parameter		Setting	
		Symbol	Description	Exhaust	Flame
Operations	Monitor	Pcnt	percent output	0	0
	User	A-M	auto/manual mode	Auto	Auto
		Aut	auto-tune	off	off
		AtSP	auto-tune setpoint	90	90
		CAL 1	calibration offset	0	0
	PID 1	Pb1	propband 1	0	0
		Hys1	hysteresis 1	2	2
	Alarm	A2hi	alarm 2 high	230	900

Table 9-1: Temperature controller settings *(Continued)*

Page	Menu	Parameter		Setting	
		Symbol	Description	Exhaust	Flame
Setup	Input 1	SEn1	sensor type	TC	TC
		In 1	input type 1	K	K
		rL 1	range low 1	–200	–200
		rh 1	range high 1	1250	1250
		dEC 1	decimal 1	0	0
		Ftr 1	input software filter 1	0	0
	Output 1	Ot 1	output 1	cool	heat
	Output 2	Ot 2	output 2	AL	AL
		Aty2	alarm type 2	Proc	Proc
		Ahy2	alarm hysteresis 2	2	2
		LAt2	latching 2	NO	NO
		SIL2	silencing 2	NO	NO
		Sid2	alarm active sides 2	HIGH	HIGH
		Lgc2	alarm logic 2	ALO	ALO
		Anu2	alarm annunciation 2	YES	YES
	Global	Unit	units type	US	US
		C-F	C or F	C	C

9.4 KF purge kit

Note

The KF purge kit is no longer offered as an option. Information is included in this chapter for existing systems which have this option installed.

The KF purge kit option keeps unused ports of the Guardian thermal oxidizer inlet manifold clean and dry by introducing a slight nitrogen purge. The purge also prevents flammable gases that are lighter than air from collecting in unused ports.

9.5 KF clean kit

Note

The KF clean kit is no longer offered as an option. Information is included in this chapter for existing systems which have this option installed.

The KF clean kit option cleans the inlet manifold port and prevents the accumulation of solids by using a tube that directs a jet of nitrogen at the port.

9.6 EZ-Clean option

Note

The EZ-Clean™ option is no longer offered as an option. Information is included in this chapter for existing systems which have this option installed.

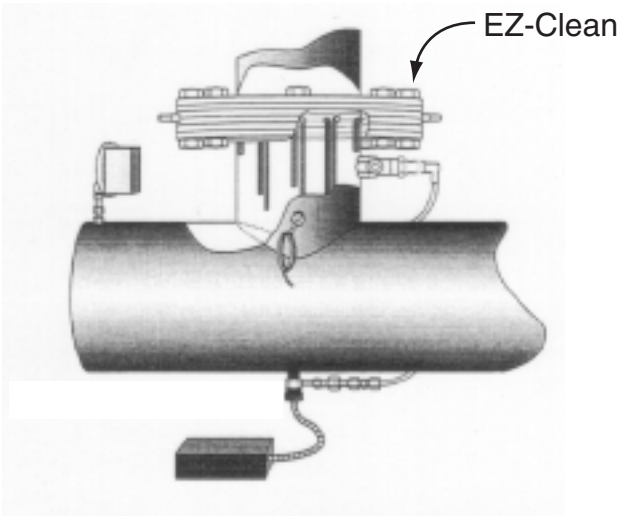
9.6.1 Description

Compressed dry air is periodically pulsed along the walls of the reaction chamber when this option is installed. This reduces particle buildup on the walls and the reaction chamber thermocouple, thus extending the service period between required maintenance. Also, exhaust gases from some processes (for example, silicon nitride and tungsten) produce a heavy particulate buildup on the thermocouple. This can result in a false low reaction temperature alarm. In either case, the installation of the EZ-Clean™ option with the Flameguard™ option improves the overall performance of the system.

9.6.2 Principle of operation

The EZ-Clean option uses strategically placed tubes of different lengths along the walls of the combustion area. These *blow-down* tubes, which have small holes spaced along their length, fit into a flange which has a common manifold (see Figure 9-1). This manifold is pulsed with high pressure air. The air exits the holes in the tubes at a high velocity, dislodging any particulate buildup on the wall.

Fig. 9-1: EZ-Clean option



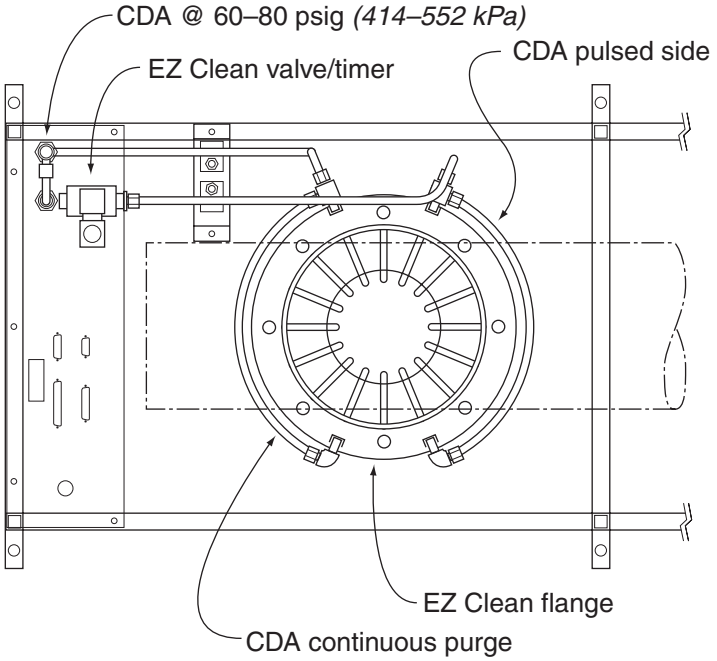
A timer module controls the air pulse. The timer controls the *off time* (pulse interval) and the *on time* (pulse duration). See Figure 9-3 on page 9-60.

In addition to the pulse, secondary ports on the EZ-Clean flange introduce a continuous purge of air to prevent process gases from entering and reacting inside the tubes. A check valve in the line ensures that the air supply is isolated from the process gas lines. A continuous flow of 0.4–0.7 cfm *(10–20 lpm)* is maintained by an orifice on the purge side.

9.6.3 Installation

The EZ-Clean assembly is provided as part of the Guardian thermal oxidizer. The PLC provides 24 Vdc for the timer. An unregulated clean dry air supply pressure of 60–80 psi *(414–552 kPa)* is required.

Fig. 9-2: EZ-Clean installation



9.6.4 Startup

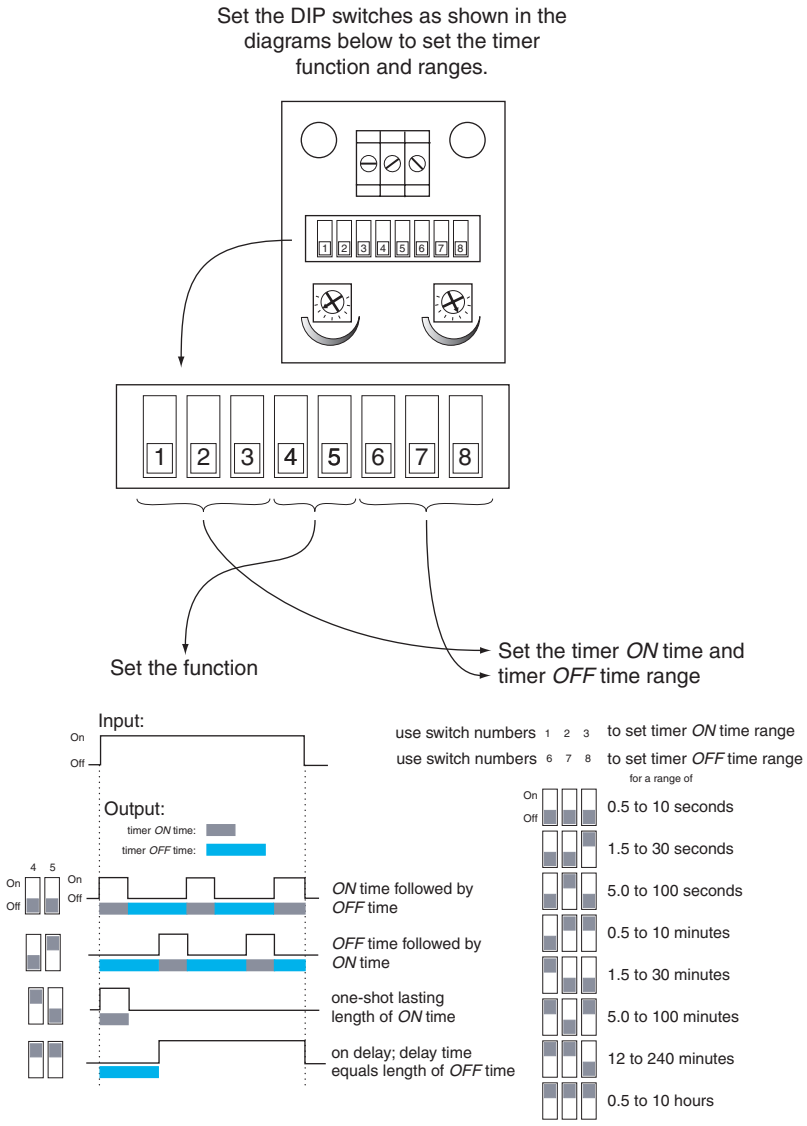
9.6.4.1 EZ-Clean startup

1. Start the Guardian system according to the startup procedure in Chapter 5, “Startup,” if it has been shut down.

(Procedure continues on the following page.)

2. Set the CDA supply pressure to 60–80 psi *(414–552 kPa)*. This pressurizes both sides of the EZ-Clean. CDA begins flowing on the continuous purge side at a flow rate of 0.4–0.7 cfm *(10–20 lpm)*.
3. The *on time* and *off time* of the EZ-Clean timer is adjustable. First, select a range using the DIP switches (see Figure 9-3). Then use the potentiometers to set the desired time within the selected range.
4. Short pulses at regular intervals are more effective in keeping the combustion chamber clean. The *on time* and *off time* should be set by the customer. The on time setting can be set between 1 and 15 seconds, and the off time can be set between 6 and 50 minutes. The optimal setting depends on the processes which are exhausted to the oxidizer and the desired maintenance schedule. After the system has been in operation for a month or so, the optimal settings can usually be determined.

Fig. 9-3: EZ-Clean timer DIP switches



9.6.5 Troubleshooting

The problems described in the following sections, and their solutions, may be encountered with the EZ-Clean option.

9.6.5.1 The EZ-Clean option is not effective

1. Check the CDA supply pressure. It should be 60–80 psi *(414–552 kPa)*.
2. Check for visible blockage of the holes on the blow-down tubes.

(Procedure continues on the following page.)

3. When preventive maintenance is performed, shut down the Guardian system as explained in Chapter 7, “Shutdown.”
4. Remove the EZ-Clean flange.
5. Visually inspect for any blockage.
6. Clean and reinstall the EZ-Clean flange.
7. Restart the system following the procedure in Chapter 5, “Startup.”

Note

Buildup varies between different applications, depending on the number and type of connected tools and the amount and type of process gases being used.

9.6.5.2 Frequent flameout

If *low reaction temperature* alarms occur frequently, the EZ-Clean option may be a cause of the problem in addition to the other causes listed in Chapter 6, “Alarm operational status.”

1. Lower the CDA supply pressure and check if the flameout problem disappears.

9.6.5.3 Low air flow alarm

If the l*ow air flow* alarm occurs frequently, the EZ-Clean option may be a cause of the problem in addition to other causes listed in Chapter 6, “Alarm operational status.”

1. Verify that proper air flow rates are maintained in the system. Refer to Table 3-5 for the proper air flow rate recommendations.
2. Lower the CDA pulse pressure. The normal operating range is 60–80 psi *(414–552 kPa)*.

9.7 Flameguard option

9.7.1 Description

The Guardian Flameguard™ option is a flame detecting device that supplements the reaction chamber thermocouple in monitoring the presence of a flame. It is very effective on equipment in which exhaust gases from processes such as silicon nitride and tungsten create heavy particulate buildup on the thermocouple. This buildup

sometimes insulates the thermocouple and causes a false *low temperature* alarm on the controller. The Flameguard option can be used, along with the EZ-Clean option, to avoid these false alarms.

9.7.2 Principle of operation

The Flameguard option uses two infrared scanners, an upper and a lower, to provide redundant flame sensing. Because the location and size of the flame varies during gas scrubbing, the use of two scanners helps prevent false alarms, especially during high nitrogen pump purges that reduce the size and intensity of the flame.

The scanners are calibrated to sense infrared (IR) emissions from combustion and are not affected by ultraviolet emissions caused by the discharges from the spark ignitors. This reduces the possibility of false flame detection.

The lower IR scanner is mounted at the bottom of the horizontal tube of the Guardian combustion chamber and is purged by a small amount of CDA to cool it and keep it clean. The upper scanner is mounted at the combustion chamber and is cooled by a nitrogen purge. Each scanner sends its signal to a controller mounted inside the cabinet. If neither scanner detects a flame, an alarm is sent through the control panel to provide a signal at the customer interface alarm connector. This alarm can be used to shut down the process. If the lower scanner is blocked by particulate buildup, the upper scanner still senses the presence of flame.

9.7.3 Troubleshooting

To troubleshoot the Flameguard option, follow the procedure in this section.

9.7.3.1 Troubleshoot the Flameguard option

1. With a strong flame in the combustion chamber, measure the voltage at the positive and negative terminals at the top of the Flameguard controller.
2. If the voltage is less than 2.0 Vdc, check to make sure that the scanners are clean.
3. Replace the controller, if necessary.

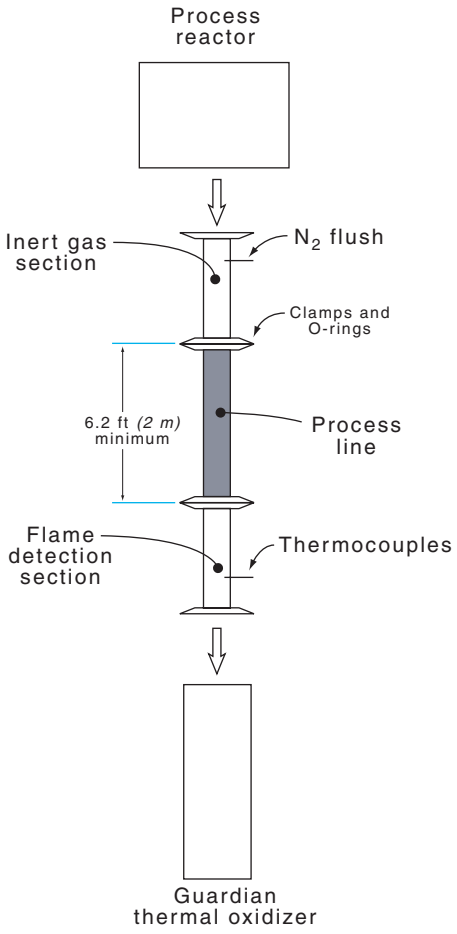
9.8 Flashback arrestor option

9.8.1 Description

A flashback arrestor is a safety device that arrests flashback during operation of the Guardian system. It is installed in the line between a process tool and the Guardian oxidizer, and remains passive until needed.

The Guardian Gas Protective System mixes oxygen with flammable gases and ensures direct flame combustion over a broad range of gas mixtures and concentrations in a controlled reaction. Under abnormal conditions air can leak, through an open valve or a crack, into the process line ahead of the combustion chamber. A mixture of hydrogen and air above the lower flammability limit may then develop in the inlet line to the oxidizer. When this mixture reaches the ignition source, a flashback can occur. The flashback arrestor quenches the flashback.

Fig. 9-4: Flashback arrestor schematic



The arrestor works without causing upstream pressure or temperature fluctuations. Potential flame fronts are controlled close to their source, away from sensitive manufacturing processes. The arrestor does not rely on high back-pressure to indicate a flashback, which is typical of other flashback arrestor designs. This maintains uniform conditions at the process tool.

9.8.2 Principle of operation

The flashback arrestor has two sections; see Figure 9-4. The *flame detection section* is installed close to the Guardian thermal oxidizer

on the process line. The *inert gas section* is installed near the process tool. The inert gas section **cannot** be closer than 6.2 ft *(2 m)* upstream of the flame detector section.

A hydrogen/air mixture has a maximum flame front velocity of 8.2 fps (*2.5 mps)*. The time it takes for the flashback arrestor controller to initiate a nitrogen purge in response to a high thermocouple reading is less than 0.5 second. In this lag time the flame front travels 4.1 ft *(1.25 m)*. The two-meter distance between the flame detection and inert gas sections provides enough time for the controller to initiate the nitrogen purge once a flame is detected. This distance includes a fifty percent safety margin.

A pressure switch installed in the nitrogen purge line monitors the purge pressure. If the pressure falls below a preset limit of 60 psi *(414 kPa)*, the switch sends a signal to the flashback arrestor controller. The controller in turn can send a signal to the Guardian system, warning the operator that there is a problem with the nitrogen supply to the inert gas section.


Note

The flashback arrestor arrests hydrogen/air mixtures. It is not designed for mixtures of other pyrophoric or flammable gases, such as silane.

9.8.3 Specifications

Table 9-2: Flashback arrestor specifications

	Model KF-40	Model KF-50
Dimensions (length x diameter)	2 pieces each: 12 in x 1.5 in *(305 mm x 38 mm)*	2 pieces each: 12 in x 2 in *(305 mm x 51 mm)*
Inlet fitting	4 KF-40 clamps and 4 O-rings (provided)	4 KF-50 clamps 4 O-rings (provided)
Construction	304 SS	
Thermocouple	Type K, with a response time of 500 milliseconds	
Pressure sensor	Pressure switch, with a setpoint of 60 psi *(414 kPa)*	
Controller	Proprietary design that allows four FBAs to be monitored by a single controller (Refer to Section 9.9, “Flashback arrestor controller.”)	
Controller dimensions (L x H x W)	12.5 in x 4 in x 5.5 in *(317.5 mm x 102 mm x 140 mm)*	
Thermocouple relay	Factory preset at 392 °F *(200 °C)* (adjustment set and sealed)	
Nitrogen requirement	3.5 cfm @ 100psi *(100 lpm @ 690 kPa)*	
Nitrogen fitting	1⁄4 in SS compression fitting	

9.8.4 Installation

9.8.4.1 Install the flashback arrestor option

The clamps and O-rings needed to install the flashback arrestor are provided.

1. Install the flame detection section on top of the Guardian inlet flange with two KF clamps and O-rings.

Note

The flame detection section must be mounted directly to the Guardian system inlet manifold.

2. Install the inert gas section at least 6.2 ft *(2 m)* upstream from the flame detection section using two KF clamps and O-rings.

(Procedure continues on the following page.)

3. Insert the thermocouple into the thermocouple port, if not already installed.
4. Make connections to the desired channel:
   a. Connect the thermocouple to the *TC* terminals at the back of the flashback arrestor controller.
   b. Connect the pressure switch to the *PRESS* terminals of the same channel.
   c. Connect the nitrogen solenoid to the N_2 terminal of the same channel.
5. Connect a 100 psi *(690 kPa)* nitrogen line to the corresponding solenoid valve with a 1⁄4 in *(6.5 mm)* stainless steel compression fitting.
6. If more flashback arrestors are being connected to the same controller, the relay (part number 390-0001-00) must be installed in the channel being used for the corresponding arrestor.
7. Before starting the flow of process gases, read Chapter 5, “Startup.”

9.8.5 Startup

During installation of the system, the exhaust lines from the process tools are open to the atmosphere and filled with air. Introducing hydrogen or a process gas may result in an uncontrolled flashback. To avoid this, purge the exhaust lines with nitrogen or another inert gas long enough to remove all air in the line. (This is similar to startup procedures for the process tool. Allow nitrogen to flow until the process tool is brought on-line.) If the Guardian oxidizer has been shut down, see Chapter 5.

9.8.5.1 Start up a system with a flashback arrestor

1. Ensure the exhaust lines containing hydrogen or other flammables are properly purged with nitrogen.
2. Turn on the nitrogen flow to the inert gas section by unplugging the controller.
3. With the nitrogen purge on, verify the exhaust line purge and then start the system ignitors.

(Procedure continues on the following page.)

4. Wait for about one minute and then shut off the nitrogen flow by plugging in the flashback arrestor-controller and pressing the *temp reset* button.
5. Introduce hydrogen into the exhaust system from the process tool.
6. Using a portable hydrogen leak detector, pass the probe over all connections in the exhaust line. Pay special attention to the connections at either end of the flashback arrestor and the thermocouple connection on the flashback arrestor body.
7. If the hydrogen concentration exceeds, for example, 10 ppm at any connection, remake the connection utilizing a new seal.
8. Replace parts if necessary and then perform the purge and leak test procedures from Step 1 again.

9.8.6 Maintenance

A maintenance schedule for the Guardian Gas Protective System should include the flashback arrestor. Monthly maintenance is recommended until specific conditions determine that a longer time is acceptable. Use caution when handling and cleaning the flashback arrestor, since the particle deposits on the walls may contain toxic or flammable materials.

9.8.6.1 FBA maintenance: preliminary procedure

1. Make sure the process gas flows have been stopped and the shutdown purging process has been completed.
2. Carry out the maintenance program for the Guardian system described in Chapter 8.
3. Disconnect the nitrogen line, thermocouple, and all electrical power supplies to the controller.

9.8.6.2 FBA maintenance: procedure

1. If necessary, wear protective clothing and disconnect both sections of the flashback arrestor using the quick disconnect KF clamps. The flashback arrestor sections may have to be isolated in a plastic bag.
2. Visually inspect the inner walls of the flame detection section and the inert gas section for any deposits, such as powder or oil. If deposits are found:
   a. Remove the thermocouple.
   b. Clean the thermocouple in an appropriate manner, taking into consideration any potential hazardous characteristics of the deposits. The deposits may be removed by blowing down with air or nitrogen, cleaning with solvent or water, or scrubbing with a brush.
3. Verify the setpoint of the thermocouple using the Guardian Controller/Monitor Tester or another appropriate device. The setpoint is 200 °C.
4. Inspect all seals and sealing surfaces for corrosion.
5. Reassemble the flashback arrestor and install it in the process line.
6. Reconnect the nitrogen purge line, the thermocouple, and all electrical connections.

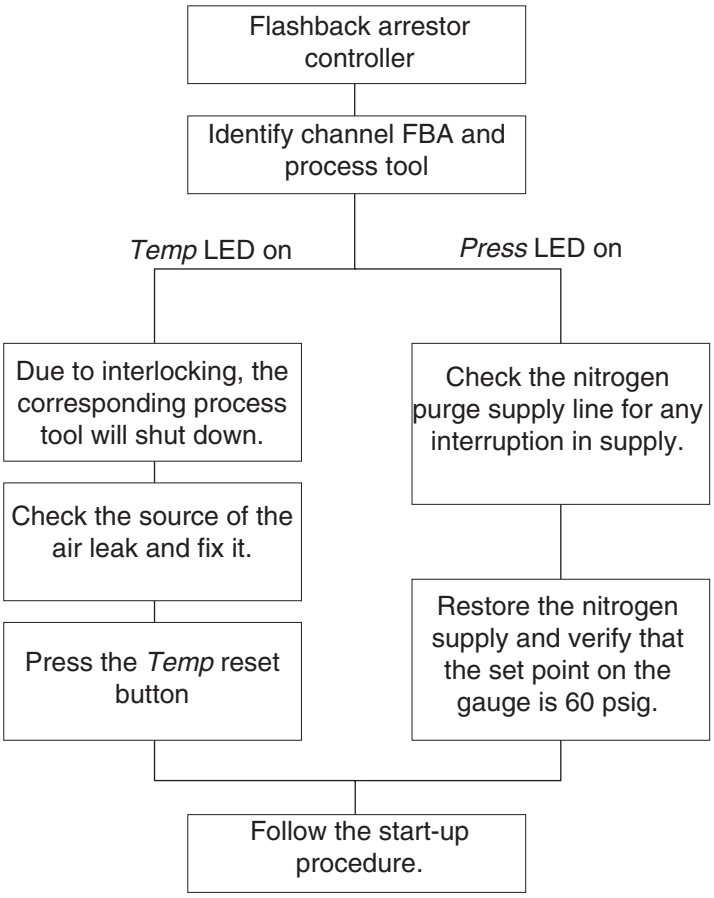
9.8.6.3 FBA maintenance: complete the procedure

1. Follow the startup procedure of the Guardian unit, as outlined in Chapter 5.

9.8.7 Troubleshooting

When an alarm condition is sensed by the flashback arrestor controller, it sends signals to the Guardian system and to the process tool, if it is connected. The flow chart in Figure 9-5, “Flashback arrestor troubleshooting,” shows the sequence of steps to take to respond to an alarm condition.

Fig. 9-5: Flashback arrestor troubleshooting



9.9 Flashback arrestor controller

9.9.1 Description

The flashback arrestor controller continually monitors the status of individual arrestors and provides an alarm. It can transmit a signal to a specific process tool when either a flame front or a loss of nitrogen purge supply pressure is detected.

A single Guardian system can handle process gases from several process tools. A flashback arrestor should be installed in the line from each tool in which a flammable gas mixture may exist. Each flashback controller monitors up to four flashback arrestors, provides a signal to shut down the affected tool, and sends an alarm signal to the Guardian control system.

Flashback arrestor controller

9.9.2 Principle of operation

The flashback arrestor controller responds to two situations:

- a flame in the flame detection section
- low nitrogen purge supply pressure

9.9.2.1 Flame detection

When the thermocouple in the flame detection section senses a temperature higher that the preset value of 392 °F *(200 °C)*, which indicates a flame, the controller activates the solenoid valve to initiate a nitrogen purge in the inert gas section. It also turns on the *temp* indicator for that channel on the top panel (see Figure 9-6, “Flashback arrestor connections and indicators”). The nitrogen reduces the flammable gas mixture concentration below the lower flammability limit and arrests the propagation of the flame front. The controller is in an alarm condition for every arrestor that is actuated.

The alarm signal can be transmitted to the Guardian controls through the *temp* terminals of the left connector on the flashback arrestor controller. The appropriate LED on the front panel of the Guardian system lights.

The Guardian controller cannot identify which of the flashback arrestors is in an alarm condition, but only indicates that an alarm condition exists in at least one of them. However, the alarm signal from each arrestor is connected to the corresponding process tool through the *process* output of the corresponding channel. It shuts down and purges the process tool that is providing the flammable mixture. The specific channel in alarm is shown by an LED on the flashback arrestor controller.

When a flashback arrestor alarms, the likely cause is an air leak into the exhaust line. It is necessary to identify the source of the leak in the exhaust line and fix it. The leak may be from a line inadvertently left open, a poor seal, or a line failure. Correct each of these conditions, then press the *temp reset* button on the top panel of the arrestor controller to reset the alarm. The nitrogen purge continues until the *reset* button is pressed.

9.9.2.2 Loss of nitrogen purge supply

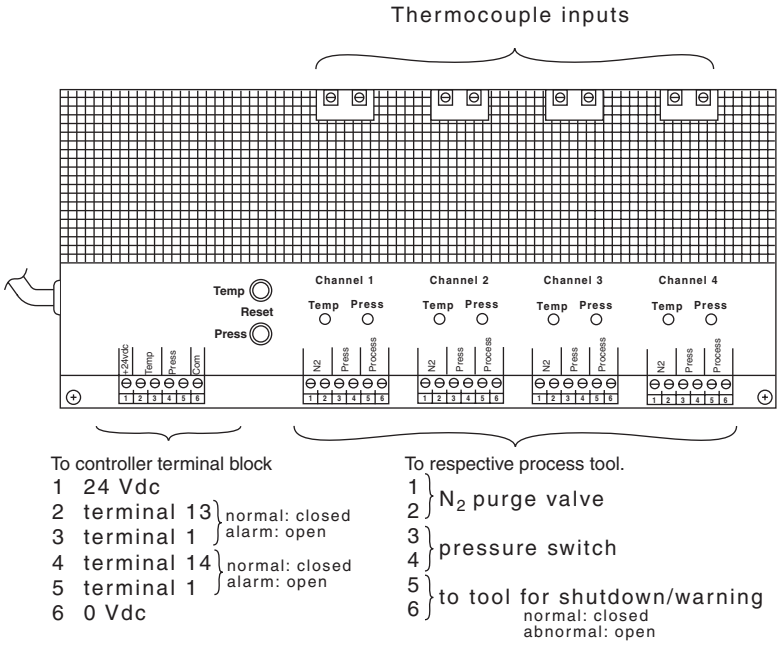
A pressure switch installed on the nitrogen purge supply line to the flashback arrestor sends a signal to the con-

troller if the line pressure drops below the setpoint of 60 psi *(414 kPa)*. The *press* indicator light on the top of the controller lights. The *press* terminals of the left connector on the flashback arrestor controller can be connected to the Guardian control system. If configured this way, a warning signal is sent to the operator, who should immediately check the nitrogen purge line for a loss of pressure. The process should be shut down if any fitting is loose or needs to be replaced. A loose or faulty fitting may create an air leak into the purge line. Tighten or replace the fitting and flush the purge line with nitrogen long enough to ensure that the purge line is free of air. If the problem is a loss of the nitrogen supply, the customer should shut down the process tool and restore the nitrogen supply. Then press the *press reset* button for that particular controller to reset the alarm condition.

Note

A quick way of initiating a nitrogen purge is to disconnect the pressure switch from the flashback arrestor controller.

Fig. 9-6: Flashback arrestor connections and indicators



9.9.3 Installation

Place the controller near the Guardian system, in a location where the LEDs on the controller can be seen. The connections to the flashback arrestor controller are shown in Figure 9-6.

The controller signal is also routed to the Guardian system. Pre-labeled wires are provided for these connections. This lets any flashback arrestor alarm to be signaled to the tool operator or remote locations.

Four channels monitor four flashback arrestors simultaneously. Each channel has input terminals for the thermocouples on the back of the controller and output terminals for the nitrogen purge and the process alarm on the top. The connection for the pressure switch is also on the controller.

The *process* alarm output of each channel connects to the respective process tool for shutdown or an operator warning. In normal operation the circuit is closed; it opens for an abnormal situation. The process tool associated with the flashback arrestor in the alarm mode can be shut down for a flashback condition, or the operator can be warned of a loss of nitrogen purge supply.

In addition to the above signals, the flashback arrestor controller provides auxiliary signals through the connections on the top left of the controller when any of the channels are active. These signals are transmitted to the Guardian alarm relays through the connector on the top of the Guardian cabinet. The output across terminals two and three is closed during normal operation. It opens when a flashback occurs in any one of the channels, transmitting a signal to the Guardian controller for an alarm display.

Similarly, the output across terminals four and five remains closed when the nitrogen purge supply pressure is satisfactory. This circuit opens, sending a signal to the Guardian system, if the purge supply is interrupted in any flashback arrestor.

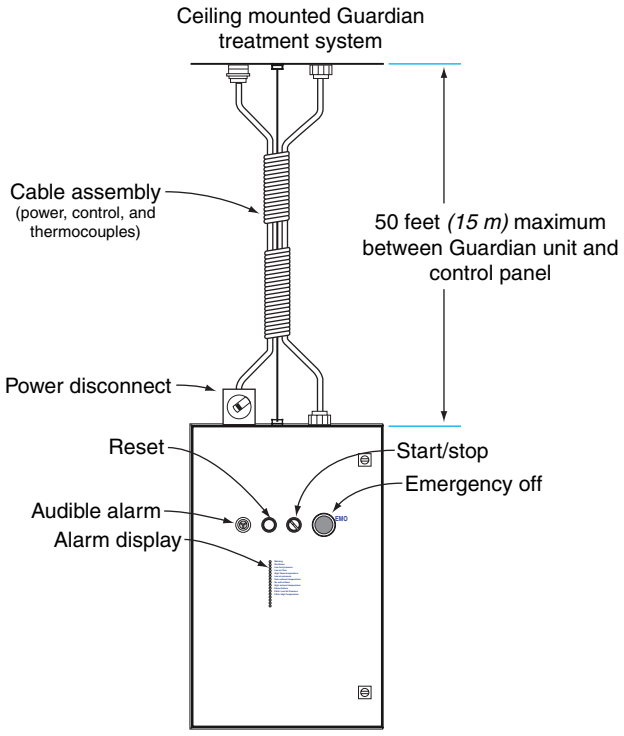
9.10 Ceiling-mounted GS4 with remote control panel

The remote control panel option allows the GS4 Guardian Gas Protective System to be mounted separately from the control panel. This provides greater flexibility, for installations where floor space is limited, by allowing the Guardian system to be mounted on the ceiling or in a chase area. The remote control panel can be mounted up to fifty feet *(15 meters)* away from the system. Remote panel features include *alarm status*, *EMO*, *stop/start*, *reset*, and *audible alarm* controls.

9.10.1 Principle of operation

The remote control panel connects to the Guardian system, which routes power through a cable harness to the remote panel (see Figure 9-7). Power and control signals from the remote panel return to the Guardian system. The output from the programmable logic controller in the remote control panel goes to the alarm display in both the remote control panel and Guardian system. Thermocouples in the Guardian system send their signals to the remote control panel through a separate cable harness assembly.

Fig. 9-7: Remote control panel for ceiling mounted GS4



All operator functions are provided at both the Guardian control panel and the remote control panel. The oxidizer cannot be turned on unless both the remote control panel and the Guardian system itself

are reset and in RUN mode. Power disconnect switches are provided at both locations. Maintenance cannot be performed at the Guardian system or inside the remote panel unless the power disconnects are open at both places.

Note

Users and service personnel are required to follow all lockout / tagout procedures specified by OSHA 29CFR 1910.147 and SEMI S293 requirements (as outlined in Section S 3.1, "Lockout and tagout procedure") before any service is performed.

9.10.2 Specifications

The electrical power specifications for a Guardian Gas Protective System with the remote control panel are identical to the one without the remote control option.

9.10.3 Installation

Installation of the remote control panel involves installing the ceiling-mounted Guardian cabinet and the wall-mounted remote control panel, and routing the cable harnesses between them using strain relief measures. Refer to the installation drawing in Chapter 4, "Installation."

9.10.3.1 Install ceiling mounted Guardian system

1. Refer to Section 4.1, "Introduction," for details for installing the Guardian base unit. In addition to these guidelines, when hanging the Guardian base unit from a ceiling:
   - Ensure that the support structure used to mount the Guardian thermal oxidizer is structurally sound and can support at least 200 lbs *(91 kg)*. Follow all appropriate building and local codes.
   - Insure that the location selected provides a minimum front and side clearance of 24 in *(610 mm)*, and back and top clearance of 36 in *(914 mm)* for service access and duct work.
2. Mount the base unit using Unistrut® P3000 rails, 1⅝ in *(41 mm)* square, or equivalent. The maximum unsupported length of the strut should be 48 in *(1219mm)*.

(Procedure continues on the following page.)

3. Holes are provided for 1⁄2 in x 13 UNC x 2 1⁄2 in long bolts (grade 5 minimum) on the bottom frame of the Guardian cabinet for fastening it to the Uni-strut rails. Use lock washers or locking nuts.
4. Mount the remote control panel using 5⁄16 in *(8 mm)* hex bolts or lag screws and flat washers in a location that allows operators to reach it .

CAUTION!

The remote control panel should be mounted within sight of the Guardian cabinet. Otherwise, a hazard may result from starting the system from the remote control panel without ensuring that all personnel are clear. Installing the remote control panel outside of direct sight of the Guardian system violates OSHA and SEMI S2 safety requirements.

9.10.4 Startup

Startup for the remote controlled Guardian system is the same as the standard system. Refer to Chapter 5, “Startup.”

9.10.5 Maintenance

There are no additional maintenance requirements for the remote control panel. Refer to Chapter 8, “Maintenance,” for detailed maintenance guidelines for the Guardian thermal oxidizer.

9.10.6 Troubleshooting

There are no additional troubleshooting procedures for the remote controlled Guardian system. Refer to Chapter 10, “Troubleshooting,” for troubleshooting guidelines.

9.11 Reference testing

The pipe length between the process equipment or vacuum pump and the Guardian thermal oxidizer should be no more than 25 ft *(7.6 m)* with a minimum number of bends. The pipe diameter should remain the same size as the tool outlet, pump outlet, or the Guardian system inlet.

To test the performance of the system during a power failure, ventilation to the Guardian Gas Protective System was interrupted by turning off the blower motor serving the system. The results of

twenty tests were averaged. The average time for the blower fan to wind down to zero rpm was 16.5 seconds. In the facility selected for this series of tests, the blower fan exhausted a 7,500 cfm *(3540 lps)* water scrubber. Using a tracer gas whose flow was interrupted at the same time as the blower shutdown, the Guardian combustion chamber completely consumed all the tracer gas in a 25 ft *(7.6 m)* length of process line in an average time of 5.5 seconds.

Note

While the relationships among scrubber size, velocity of air flow, exhaust line dimensions, and wind-down time varies, it is important to understand the precise circumstances which prompted the 25-foot guideline.

ATMI believes that the data generated by our testing serves as a useful standard by which to make specific risk assessments in positioning individual Guardian systems for various applications.

Further testing was conducted to determine the rate at which gases at this site's process tool exhaust line could be evacuated by the Guardian system under conditions of power loss and ventilation interruption.

Based on these tests, the Guardian oxidizer evacuated residual toxic exhaust gases to a distance of 25 ft *(7.6 m),* with a safety factor of three to one, when power is completely lost. The safety factor is reduced as the length of the exhaust line increases.

Troubleshooting

Chapter 10

10.1 Troubleshooting and failure analysis

For troubleshooting the Guardian Gas Protective System, the electrical schematics of the Guardian control system should be available for reference. See Chapter 12, “Schematics and diagrams.” The following sections describe solutions to some of the problems which can arise.

10.1.1 Low air flow

1. Check the facility exhaust air flow with an air velocity meter. The velocity should be about equal to the velocity listed in Table 3-3 or Table 3-4, “Exhaust requirements,” on page 3-10.
2. Check the set point of the differential pressure switch.
3. Verify that the differential pressure switch operates correctly. Fix or replace, as required. Reset alarm.

10.1.2 Low air pressure

1. Check the CDA supply pressure. Correct if necessary. Reset alarm.
2. Check the nylon fusible link for leaks. Replace it if necessary. Reset alarm.

10.1.3 Low fuel pressure

1. Check the fuel supply. It should provide the pressure and flow rate shown in Table 3-5, “Gas supply requirements, GS4 and GS8,” on page 3-11. Correct if necessary. Reset alarm.
2. Check the fuel pressure switch set point (see Figure 5-1 “Guardian control panel (hydrogen fuel option shown),” on page 5-26). It should be set to the value shown in Table 10-1. Correct if necessary. Reset alarm.

Table 10-1: Fuel pressure switch setpoint

Fuel type	Pressure setting
Hydrogen	28 psi *(193 kPa)*
Methane	< 1 in wc *(25.4 mm wc)*

3. Check pneumatic fuel shut off valve. Fix or replace if necessary. Reset alarm.

10.1.4 No active flame

1. Pull out thermocouple to remove solid build-up. (The act of pulling out the thermocouple removes most of the build-up.) Replace if necessary.
2. Check for flame. Check for adequate fuel and CDA delivery and pressure. Check and clean ignitor orifices. Check the nylon fusible link for leaks.
3. Verify that the flow metering valves on the front panel are open the correct number of full turns.
4. Check the exhaust air flow with an air velocity meter. Table 4-1, “Exhaust and flow rate requirements,” on page 4-19, shows the correct range.
5. Check the thermocouple for correct reading. (Switching the active flame indicator and exhaust temperature thermocouples may accomplish this.) Replace thermocouple if defective. Reset alarm.

(Procedure continues on the following page.)

6. Check for excess inert gas delivery; refer to Tables 4-2 through 4-5 starting on page 4-20. Check the process tool or vacuum pump for a broken mass flow controller. Check gas cylinders for broken diaphragms or other damage. A high pumpdown rate in low pressure processes may result in a temporary flameout. If so, provide a soft pumpdown of the process tool.
7. Check the configuration menu of the temperature controller. Correct or replace, if necessary.

10.1.5 High flame temperature

1. Check that the fuel pressure specified in Table 10-2 is correct.

Table 10-2: Fuel pressure requirements

Fuel type	Pressure requirement
Hydrogen	35 psi *(241 kPa)*
Methane	7.5 in wc *(190.5 mm wc)*

2. Check that the temperature is about the same as written in the Guardian GS4 / GS8 Startup Form, completed on page 33, when no process gases are flowing.
3. Check to see if an additional process tool or process chamber was added to the Guardian system.
4. Check to see if a process change has caused an increased flow of flammable gas into the Guardian system.
5. Check to see that the flow valves on the front panel are open the correct number of full turns.
6. Check exhaust air flow with an air velocity meter. Velocity should be the value given in Table 4-1, “Exhaust and flow rate requirements.”
7. Check for a loose, disconnected, or broken thermocouple wire. Correct or replace if necessary. Reset alarm.

(Procedure continues on the following page.)

8. Check the thermocouple for correct reading. (Switching the active flame indicator and exhaust temperature thermocouples may accomplish this.) Replace the thermocouple if necessary. Reset alarm.
9. Check the process tool or gas cylinders for conditions that can supply excess flammable gas. Correct if necessary. Reset alarm.
10. Check the configuration menu of the temperature controller. Correct if necessary.

10.1.6 Over exhaust temperature

1. Check that the fuel pressure as specified in the fuel supply parameter listed in Table 10-2 is correct. Reset alarm.
2. Check that the temperature is about the same as written in the Guardian GS4 / GS8 Startup Form, completed on page 33, when no process gases are flowing.
3. Check to see that the flow valves on the front panel are open the correct number of full turns.
4. Check exhaust air flow with an air velocity meter. Velocity should be the value given in Table 4-1, “Exhaust and flow rate requirements.”
5. Check for a loose, disconnected, or broken thermocouple wire. Correct or replace if necessary.
6. Check the thermocouple for correct reading. (Switching the active flame indicator and exhaust temperature thermocouples may accomplish this.) Replace thermocouple if necessary.
7. Check the process tool or gas cylinders for conditions that can supply excess flammable gas. Correct if necessary. Reset alarm.
8. Check fuel flow valves. Correct or replace if necessary. Reset alarm.
9. Check the configuration menu of the temperature controller. Correct if necessary.

10.1.7 Flame failure

1. Check that the Guardian system has power, the ignitor power is turned on, the fuses are not blown, and the ignitor plug wires are connected. Correct as required. Reset alarm.
2. Verify power to the system as specified in the main power given in Table 3-6, “Electrical requirements, GS4 and GS8,” on page 3-13, is correct.

10.1.8 Process tool does not shut down

1. Check the controller for correct programming. An error light on the top of the PLC will be illuminated.
2. Check the connection between the Guardian system and the process tool. Refer to the process tool manual or contact the process tool manufacturer for information about the interface to the process tool.
3. Check the electrical alarm interface connections between the Guardian system and the process tool. Verify that the correct alarm relays are used.
4. Check the configuration menu of the temperature controller. Correct if necessary.

10.1.9 Flameguard option

1. Check the scanners for the presence of particulate matter. Clean if necessary.
2. Check fuses and electrical connections between the scanners, Flameguard controller, and Guardian control panel.
3. Check the connections on the process tool exhaust line to the Flameguard for leaks. Tighten if necessary.

10.1.10 Ignitor bulbs

1. Check the ignitor power and correct. Reset alarm. Check neon indicator lamp.

(Procedure continues on the following page.)

2. Remove the ignitor plug. Check for any deposits. Clean and reinstall the ignitor plug. Reset the alarm. Check the lamp.


Note

The side electrode has been removed from the ignitor plug.

3. Check the wiring to lamp for loose connection. Repair if necessary. Check the lamp.
4. Replace the neon indicator lamp.

Parts

Chapter 11

This chapter provides the part numbers of preventive maintenance kits and spare parts kits available from ATMI. Additional tables list the part numbers of the contents of each of these kits. The last group of tables provide part numbers for individual major parts which may be needed to service the Guardian Gas Protective System. To order any of the kits or parts, contact the ATMI Technical Support Help Desk at (800) 886-1978 or (707) 257-1960.

11.1 Kit part numbers

Part numbers for the five available maintenance and spares kits for the Guardian GS4 and GS8 systems are shown in Table 11-1.

Table 11-1: Kit part numbers

ATMI Part Number	Description	see Table
6324-00	preventive maintenance kit, GS 4 ceiling mount or floor mount; H_2 fueled	11-2
6324-01	preventive maintenance kit, GS 8, CH_4 fueled	11-3
6325-00	spare parts kit, GS 4, floor mount, H_2 fueled	11-4
6325-01	spare parts kit, GS 8, CH_4 fueled	11-5
6325-02	spare parts kit, GS 4, ceiling mount, H_2 fueled	11-6

11.2 Preventive maintenance kits

Spare parts kits are available from ATMI and are recommended with the first Guardian system order for each customer's location. Refer to the following tables for more information.

Table 11-2: Preventive maintenance kit, GS4

ATMI Part Number	Description	Qty
	thermocouple	
720-0011-01	straight (for no Flameguard)	2
720-0011-02	right angle (with Flameguard)	2
720-0038-00	dual junction	2
740-0024-00	ignitor plug	2
104-0008-00	1⁄4 in Swagelok ferrule	5
104-0001-00	1⁄4 in Swagelok nut	5
100-0001-00	1⁄4 in tube insert	5
740-0035-02	GS4 flange gasket, graphite	2
101-0018-00	Swagelok gasket, stainless steel	2
101-0019-00	Swagelok gasket, copper	8
215-0003-00	O-ring, stainless steel	2
422-0004-00	nylon tubing, 16 in length	1
740-0035-04	GS4 top hat gasket, graphite	1

Table 11-3: Preventive maintenance kit, GS8

ATMI Part Number	Description	Qty
	thermocouple	
720-0011-03	straight	2
720-0038-00	dual junction	2
740-0024-00	ignitor plug	2
104-0008-00	1⁄4 in Swagelok ferrule	5
104-0001-00	1⁄4 in Swagelok nut	5
100-0001-00	1⁄4 in tube insert	5
740-0035-01	GS8 flange gasket, graphite	2
101-0018-00	Swagelok gasket, stainless steel	2
101-0019-00	Swagelok gasket, copper	8
215-0003-00	O-ring, stainless steel	2
422-0004-00	nylon tubing, 16 in length	1
740-0035-03	GS8 top hat gasket, graphite	1

11.3 Spare parts kits

ATMI recommends a spare parts kit, which the customer should buy with the Guardian unit. The spare parts kit contains all the items in the PM kit and additional parts which may need to be replaced after an extended period of use. These items are sold only as a kit specific for either a GS4 or GS8.

Table 11-4: Recommended spare parts kit, GS4

ATMI Part Number	Description	Qty
0281-04	panel fastener	10
4162-00	fuse block	5
440-0003-00	fuse, slow blow, 0.5 A, 3 AG	5
720-0021-00	neon indicator light	2
810-0027-00	ignitor wire lines	1
4288-00	relay, PCB, DPDT, 110 Vac	1
4289-00	LED indicator, 220 Vac	1
4164-00	relay, PCB, DPDT, 24 Vdc	1
4165-00	LED indicator, 24 Vdc	1
5834-02	controller, Watlow 96, 24 V	1
5843-02	fuse, 5 A, 600 V	2
6324-00	PM kit, GS4	1

Table 11-5: Recommended spare parts kit, GS8

ATMI Part Number	Description	Qty
6106-01	panel fastener	10
4162-00	fuse block	5
440-0003-00	fuse, slow blow, 0.5 A, 3 AG	5
720-0021-00	neon indicator light	2
220-10815-00	ignitor wire lines	1
4288-00	relay, PCB, DPDT, 110 Vac	1
4289-00	LED indicator, 220 Vac	1
4164-00	relay, PCB, DPDT, 24 Vdc	1
4165-00	LED indicator, 24 Vdc	1
5834-02	controller, Watlow 96, 24 V	1
5843-02	fuse, 5 A, 600 V	2
6324-01	PM kit, GS8	1

Table 11-6: Recommended spare parts kit, GS4 (ceiling)

ATMI Part Number	Description	Qty
0281-04	machine screw	10
4162-00	fuse block	5
440-0003-00	fuse, slow blow, 0.5 A, 3 AG	5
720-0021-00	neon indicator light	2
810-0027-00	ignitor wire lines	1
4288-00	relay, PCB, DPDT, 110 Vac	1
4289-00	LED indicator, 220 Vac	1
4124-00	relay, PCB, DPDT, 24 Vdc	1
4165-00	LED indicator, 24 Vdc	1
5834-00	controller, Watlow 96, 24 V, with retransmit	1
5843-02	fuse, 5 A, 600 V	2
6324-00	PM kit, GS4	1

11.4 Major parts

In addition to purchasing all of the parts listed in the previous tables, a customer can purchase the major parts listed below. The tables are organized by available options.

Table 11-7: Major parts list, base system

ATMI Part Number	Description
720-0007-00	valve, solenoid, CDA shutoff
415-0001-00	low pressure differential switch
200-0001-00	Minihelic gauge
720-0006-00	ignitor power supply
5428-00	disconnect switch
	latching switch (stop/start):
4312-01	two position body
0897-02	contact block, normally open
	reset switch:
0897-02	pushbutton body
6030-00	contact block, normally open
5384-02	controller, Watlow 96 (for floor-mounted GS4)
4227-00	alarm indicator, PCB

Table 11-8: Major parts list, ceiling mounted GS4

ATMI Part Number	Description
5834-00	controller, Watlow 96, with retransmit (for ceiling-mounted GS4)

Table 11-9: Major parts list, hydrogen system

ATMI Part Number	Description
720-0022-00	hydrogen ignitor
105-0001-00	orifice, fuel, 0.004 in
105-0002-00	orifice, air, 0.01 in
730-0069-00	fuel pressure switch
730-0070-00	control valve
210-0004-00	shutoff valve

Table 11-10: Major parts list, methane system

ATMI Part Number	Description
4464-00	methane ignitor
105-0003-40	orifice, fuel, 0.040 in
105-0003-40	orifice, air, 0.040 in
483-11984-00	fuel pressure switch
210-0006-00	control valve
4454-01	shutoff valve

Table 11-11: Major parts list, flashback arrestor option

ATMI Part Number	Description
720-0016-00	thermocouple
720-0018-00	solenoid valve
104-0023-00	nut, 1⁄16 in
426-14623-00	ferrule, one piece, 1⁄16 in

(Tables continue on the following page.)

Parts

Major parts

Table 11-12: Major parts list, E-Z Clean option

ATMI Part Number	Description
4314-01	timer controller
105-0003-21	orifice, EZ-Clean, 0.021 in

Table 11-13: Major parts list, Flameguard option

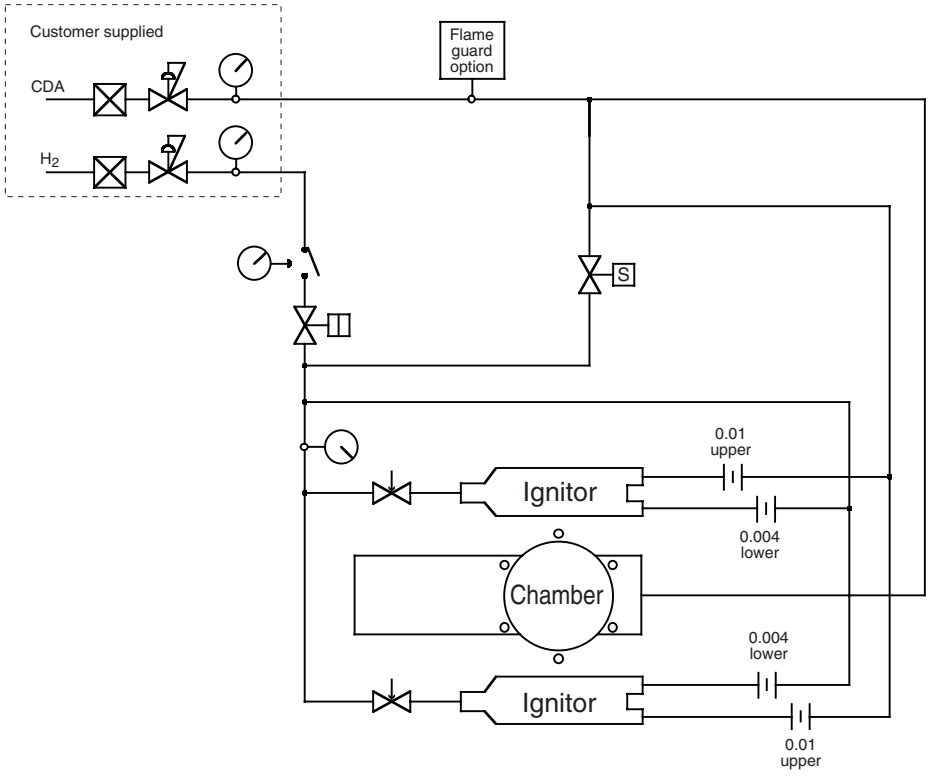
ATMI Part Number	Description
6736-00	IR scanner, lower
6737-00	IR scanner, upper
6739-00	Flameguard delay module
6740-00	Flameguard amplifier module
720-0038-01	Thermocouple, dual junction

Schematics and diagrams

Chapter 12

12.1 Piping and instrumentation diagrams

Fig. 12-1: Guardian hydrogen fuel and CDA schematic



Schematics and diagrams

Piping and instrumentation diagrams

Fig. 12-2: Guardian methane fuel and CDA schematic

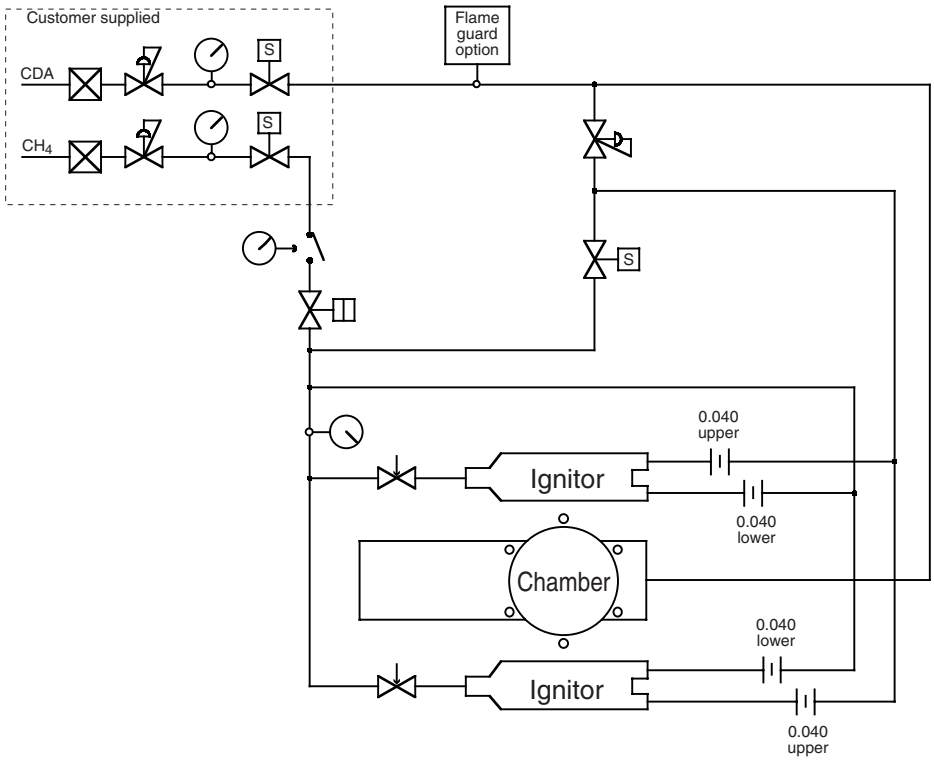


Fig. 12-3: Process and instrumentation diagram (P&ID)

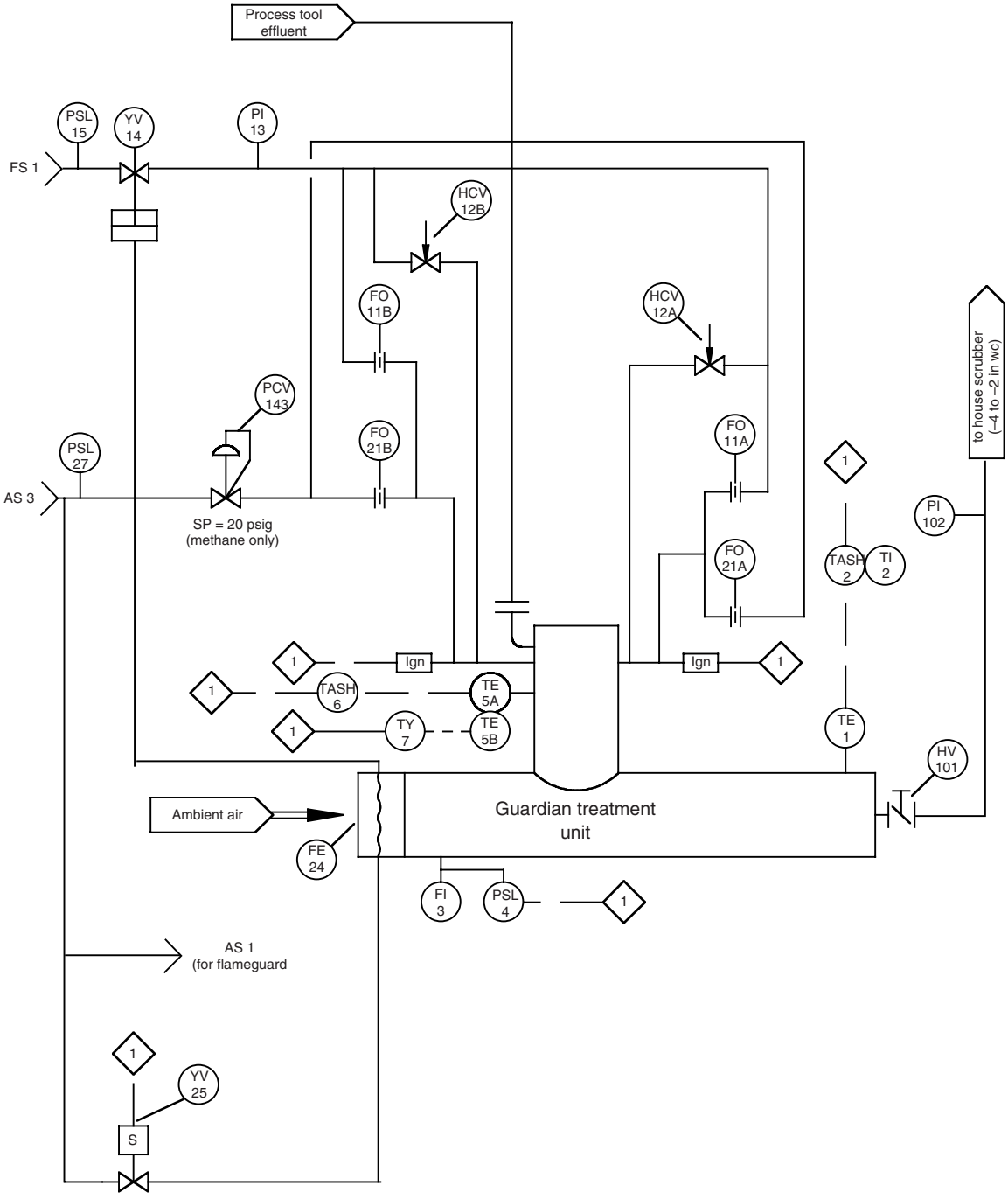


Fig. 12-4: Customer connection requirements P&ID

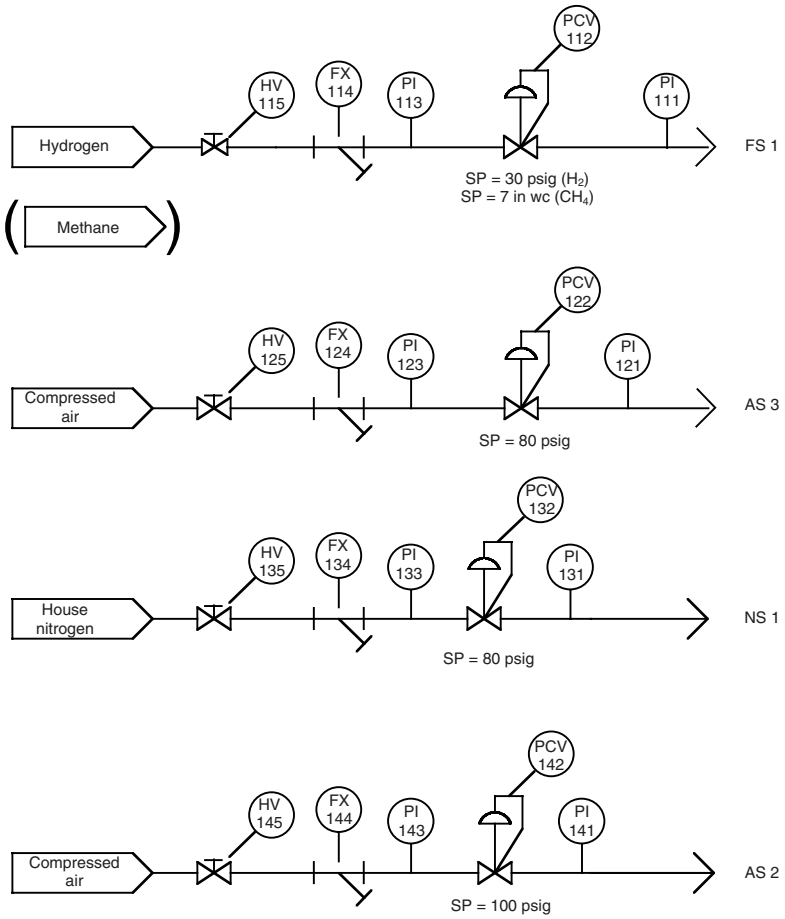


Fig. 12-5: EZ-Clean P&ID (optional)

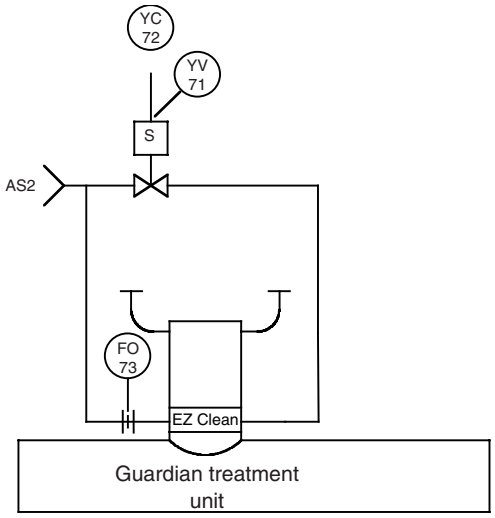


Fig. 12-6: Flameguard P&ID (optional)

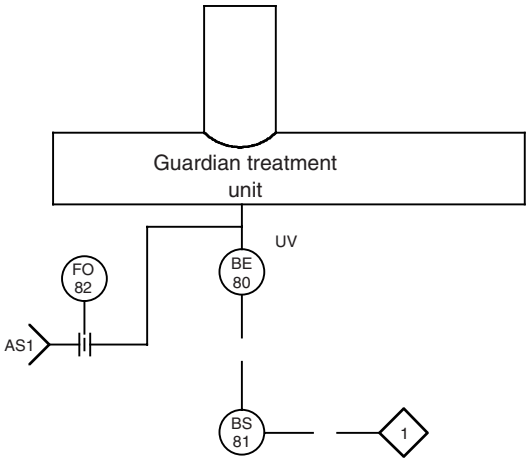
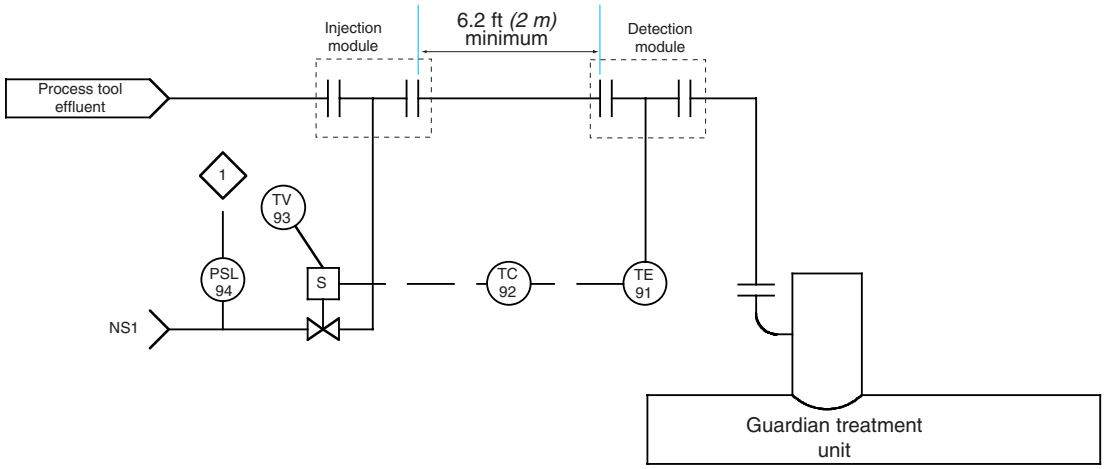


Fig. 12-7: Flashback arrester P&ID (optional)



12.2 Electrical ladder diagrams

Fig. 12-8: Line voltage ladder diagram

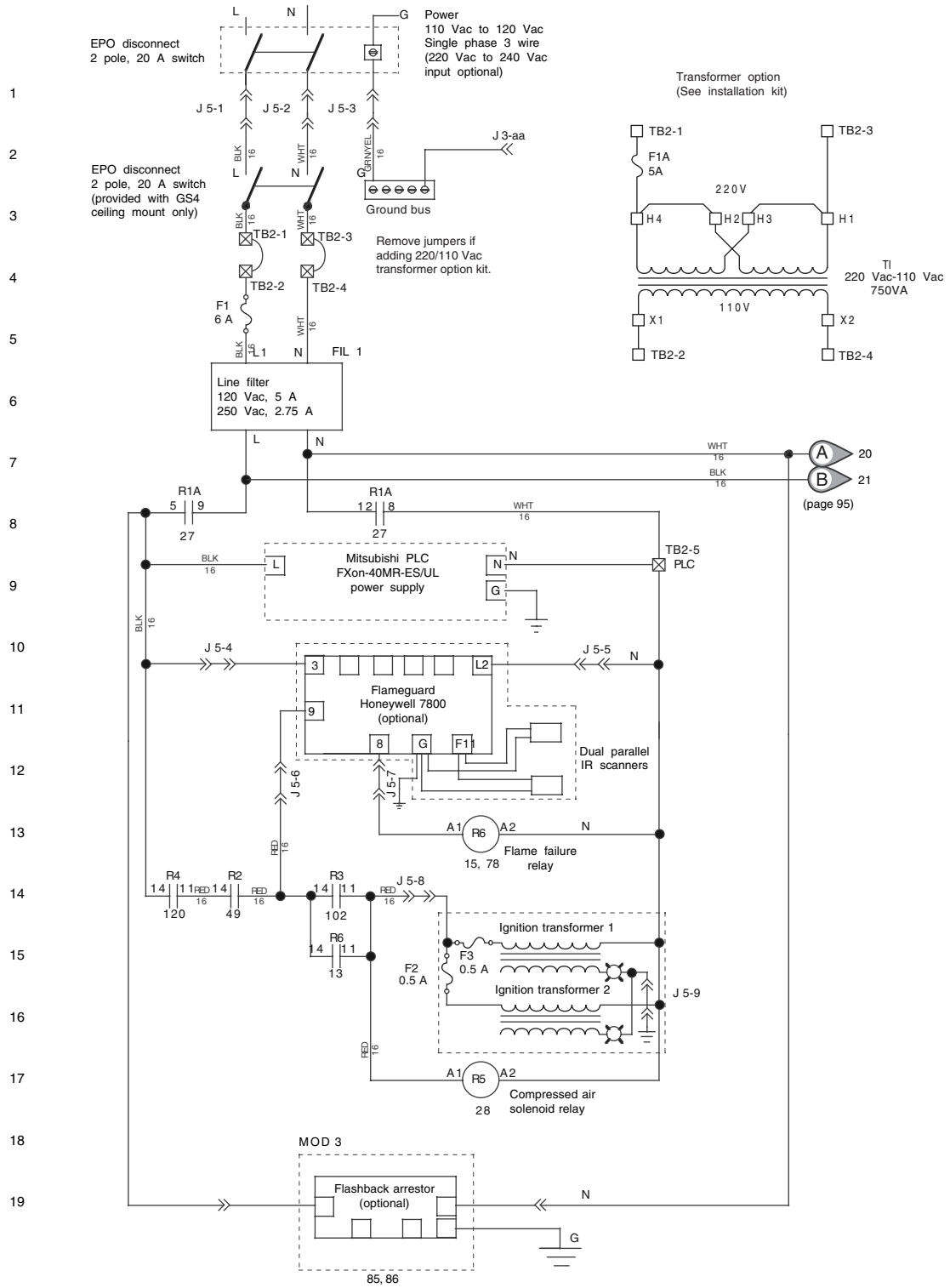


Fig. 12-9: Low voltage ladder diagram

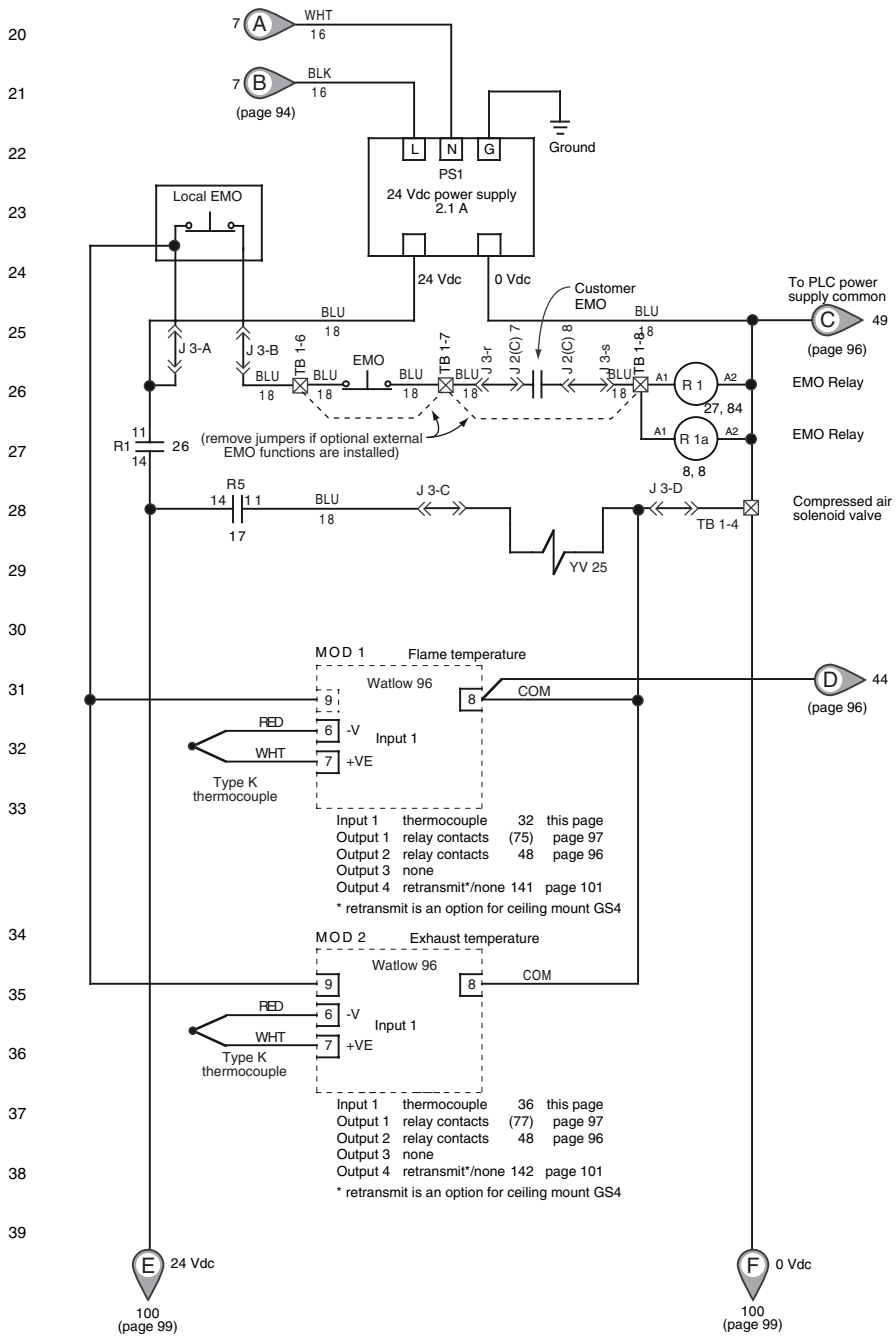


Fig. 12-10: Digital safety monitoring

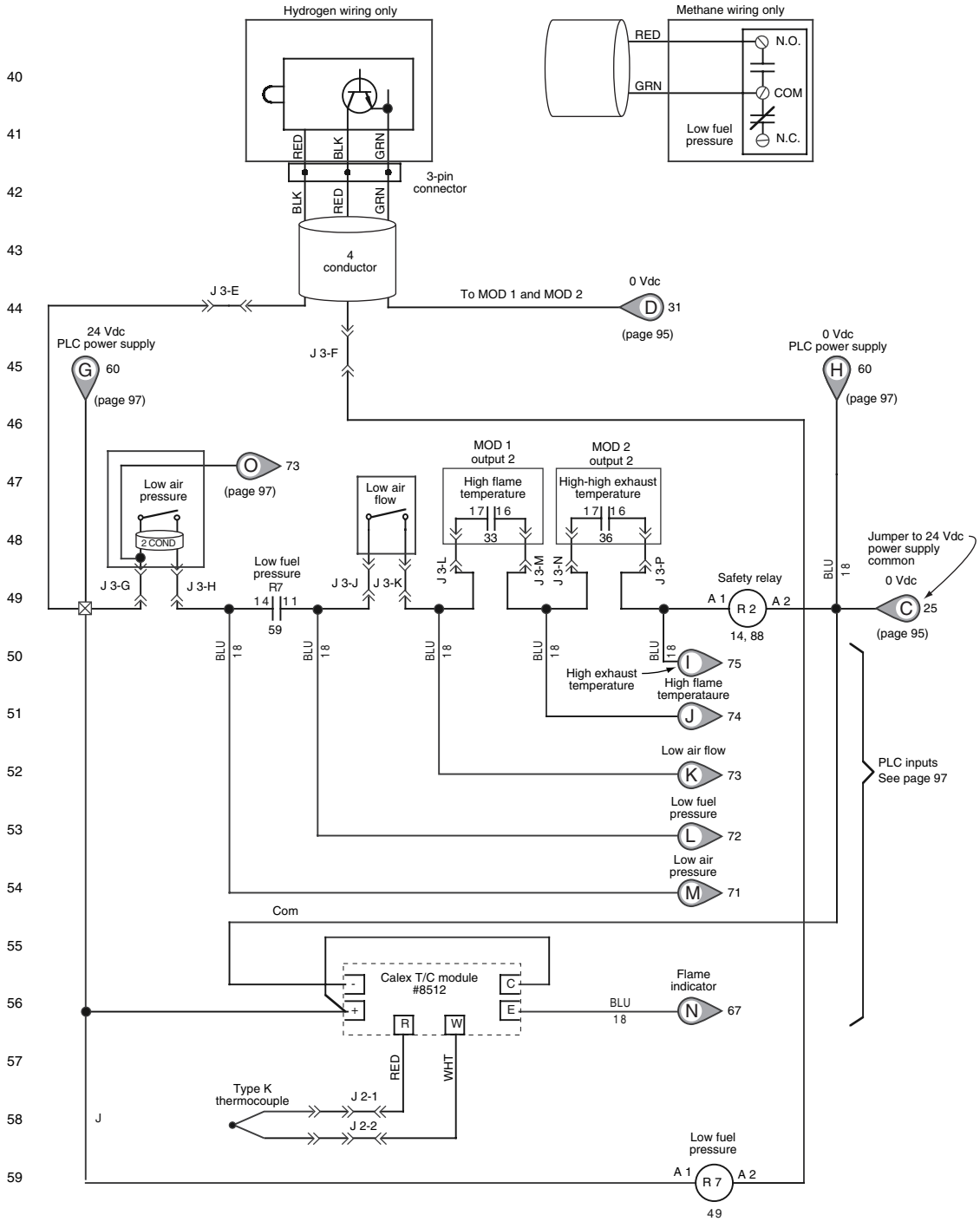


Fig. 12-11: PLC input–part 1: digital safety inputs

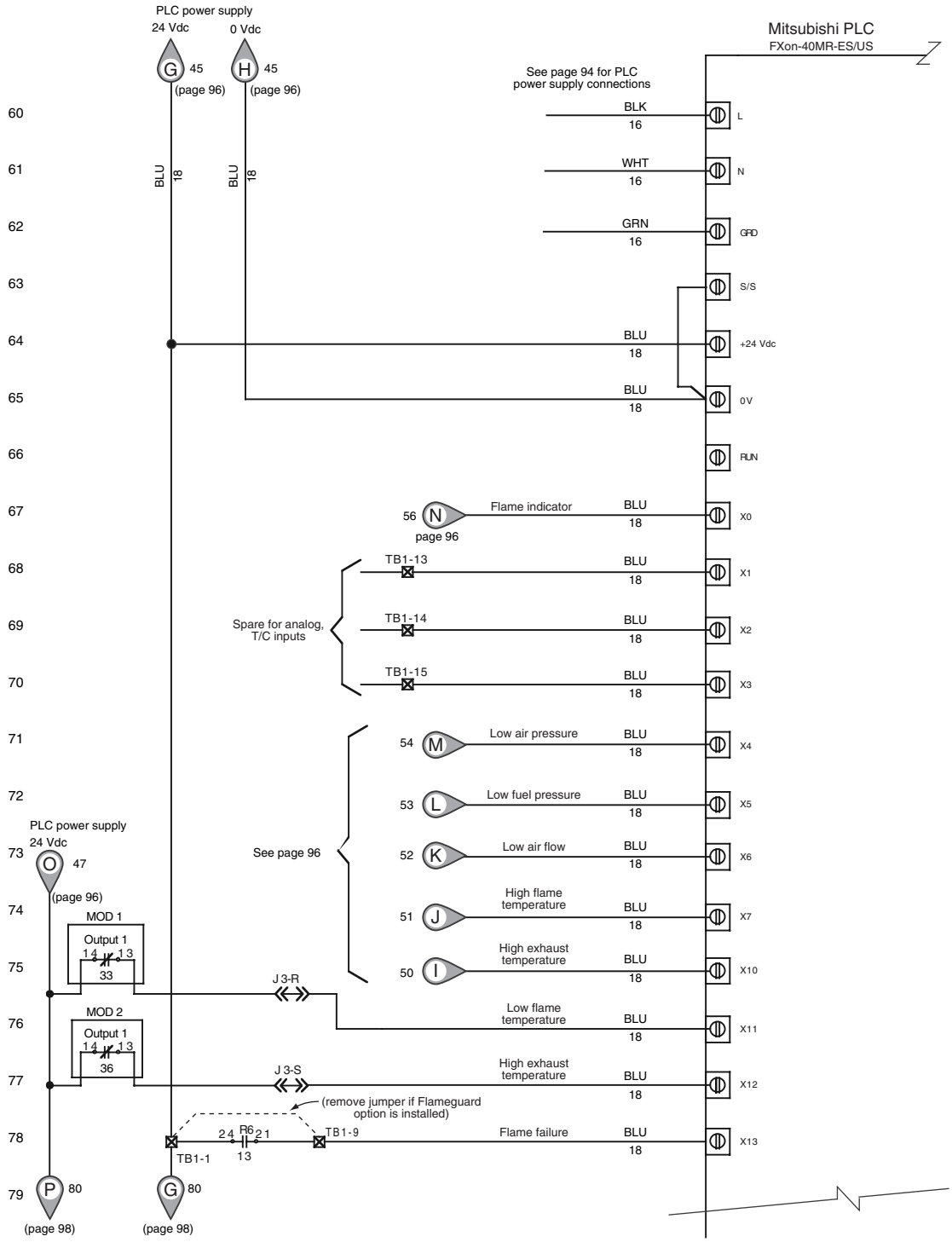


Fig. 12-12: PLC input–part 2: user inputs and FBA interlocks

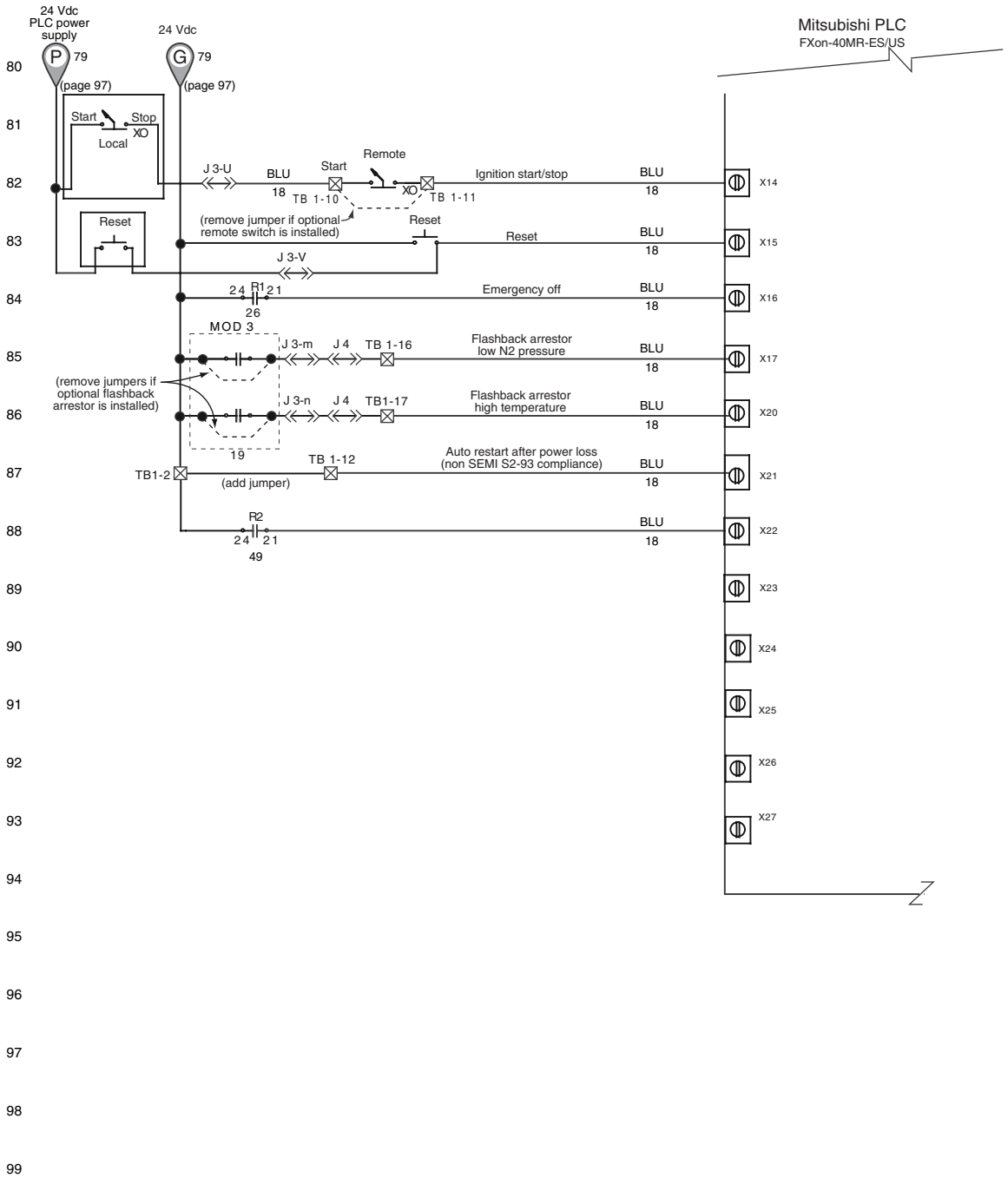


Fig. 12-13: PLC output–part 1: start relay and alarms

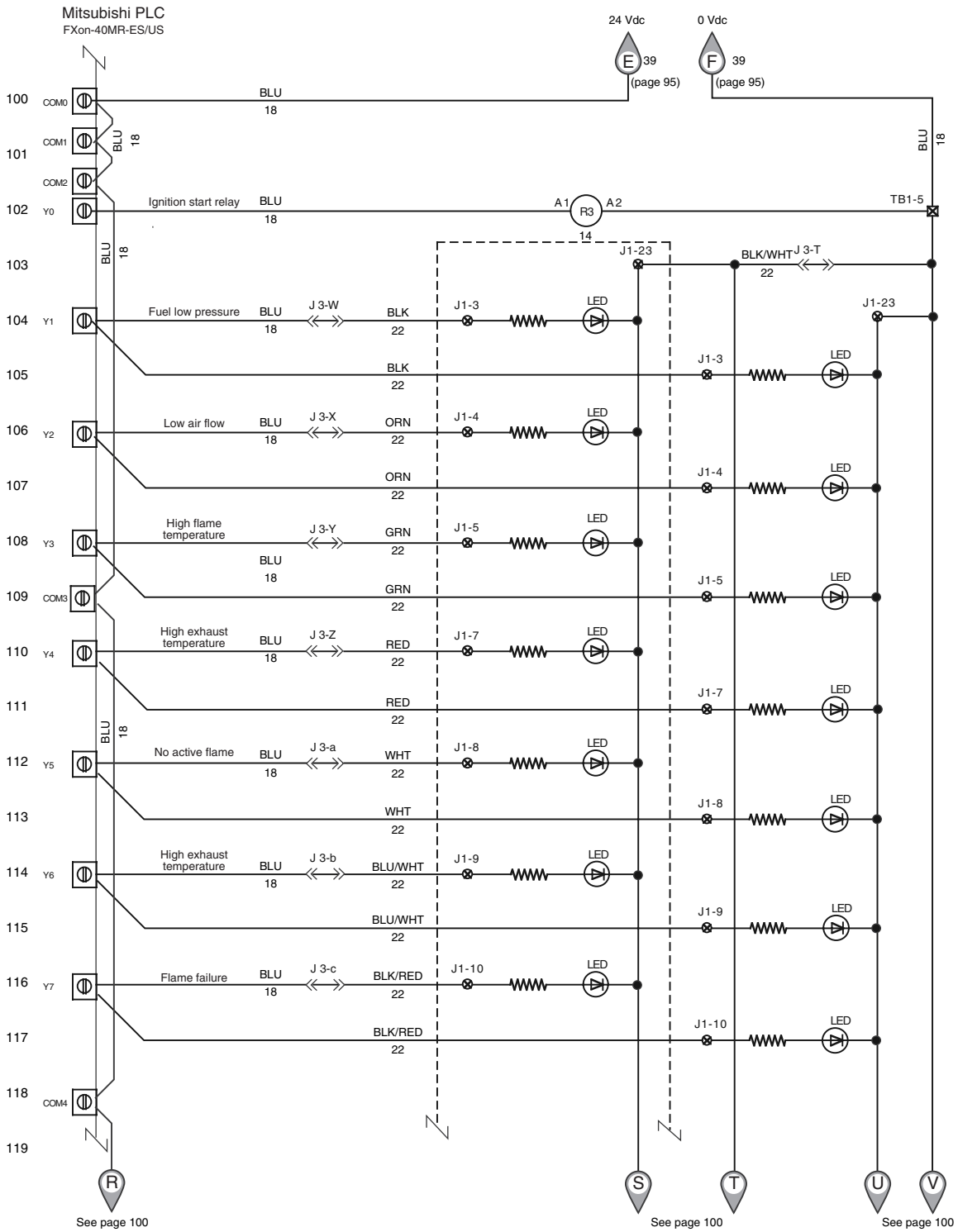


Fig. 12-14: PLC output–part 2: alarms and customer interface

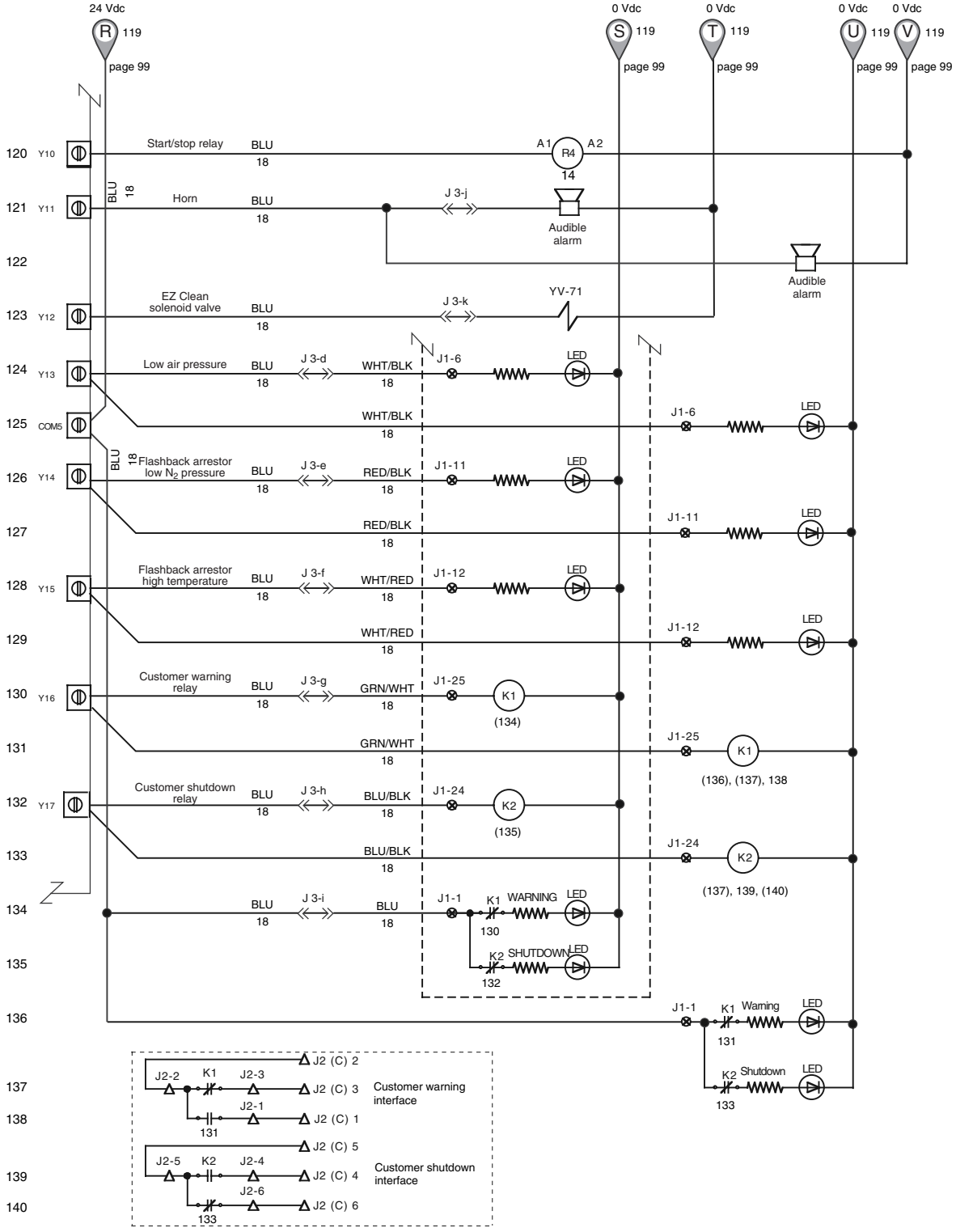
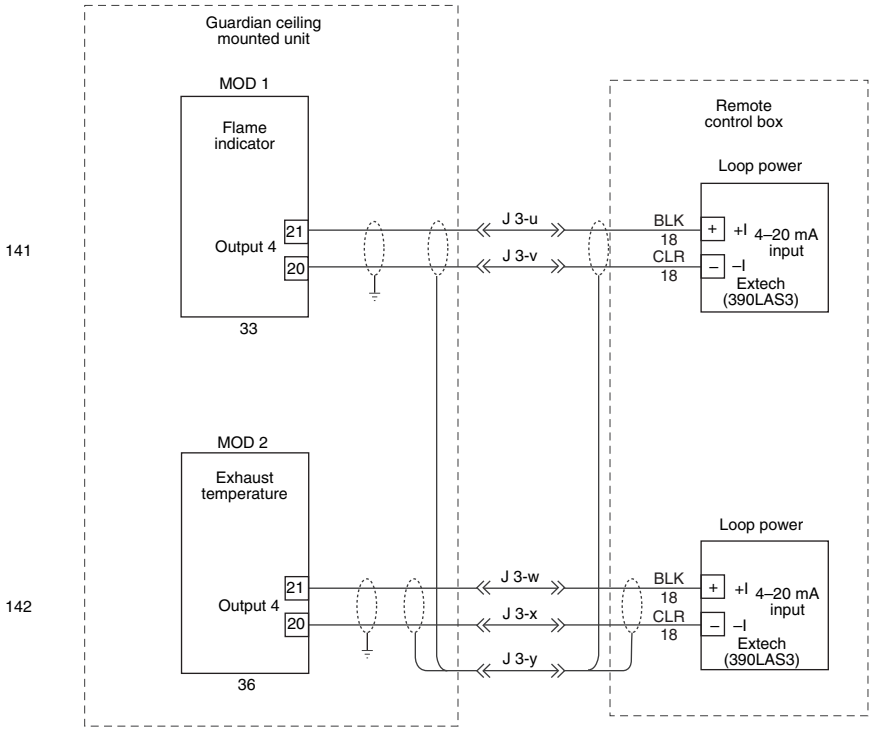


Fig. 12-15: GS4 ceiling option analog retransmitter



Certifications

CE Declaration of Conformity CE

Application of Council Directive(s) EMC (89/336/EEC), Low Voltage (73/23/EEC) & Machinery (89/393/EEC)

Standards to which Conformity is Declared EN 50082-2:1992; EN 55011:1991; EN 60204-1:1992; SEMI S2-93

Manufacturer's Name ATMI Inc.
Manufacturer's Address 830 Latour Court
Napa, CA 94558
USA

Type of Equipment Point of Use Fume Scrubber
Model Number Guardian 4/8 and GS-4/GS-8
Serial Number (If Applicable)

Importer's Name(s)/Address(es)

European market Partner B.V. (Netherlands)
Minderbroederslaan 25,
NL-6001 AG Weert
Netherlands

HTS srl (Italy)
High Technology Solutions
Via delle Torri Bianche, 3
Palazzo Larice, 3° piano
20059 VIMERCATE (MI)
Italy

ATMI GmbH. (Europe)
Benediktstrasse 1,
P.O. Box 16
D-82069 Hohenschaftlarn
Germany

I, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s) and Standard(s).

San Jose, California, USA
Place of Issuance

March 29th, 2002
Date of Issuance*

Signature of Authorized Representative

Jeff Farrell
Name of Authorized Representative

Director, Engineering
Title of Authorized Representative

*Issued in place of Declaration of Conformities signed on 9/30/96 by Michael Hayes and 4/30/98 by Mark Holst.