VERSUM MATERIALS

Installation / Operation / Maintenance Manual

GASGUARD®

Distribution System AP11

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This Installation and Operation Manual is subject to change without notification. For current technical information please call Product Support at (866)624-7677 from continental U.S., or write Versum Materials, Inc., 7201 Hamilton Blvd, Allentown, PA 18195, attention: Product Support.

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Revision Control Summary

Chapter	Revision	File Name
Cover • Update Chapter Revs	Rev-8	MNL000171.doc
Chapter 1 – Safety Warnings • Updated safety features	Rev-7	MNL000172.doc
Chapter 2 – Dimensions & Mounting • Changed stack dim to 6”OD	Rev-6	MNL000173.doc
Chapter 3 – Tubing Connections • General update	Rev-4	MNL000174.doc
Chapter 4 – Electrical Connections • General update for AP1574 and AP1580	Rev-5	MNL000175.doc
Chapter 5 – Helium Leak Check • Administrative updates	Rev-3	MNL000176.doc
Chapter 6 – Functional Checklist • Administrative updates	Rev-5	MNL000177.doc
Chapter 7 – System Description • Administrative updates	Rev-5	MNL000178.doc
Chapter 8 – Operating Procedures • Administrative updates	Rev-3	MNL000179.doc
Chapter 9 – Troubleshooting • Admin Update To Footer Links	Rev-4	MNL000180.doc
Chapter 10 – Maintenance • Added Section Titles On Page 1	Rev-3	MNL000181.doc
Chapter 11 – System Specific Information • Added AP1574, AP1580, and mfgr column	Rev-7	MNL000182.doc
Appendix A – UHP Tubing & Fitting Specification • Revise for Multiple Gas Equipment Systems	Rev-2	MNL000138.doc

Appendix B – N2 MSDS

Rev-3 MNL000139.doc

- Revise for Multiple Gas Equipment Systems

Appendix C – PED Assessment

Rev-3 MNL000140.doc

- Revise for Multiple Gas Equipment Systems

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Chapter 1

Safety Warnings

Please read the following safety warnings carefully before installing the equipment.

1.1 Introduction

This section is meant to communicate to the user any hazards involved with the equipment.

The following paragraphs will define the hazard warnings used and describe the icons found in various sections of the manual and on the equipment. The hazard warning labels used in the manual will correlate with those used on the equipment.

1.1.1 Level or Intensity of Hazard

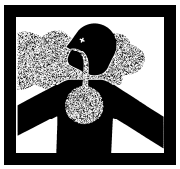
Indicates an immediate hazard, which if not avoided, will result in death or serious injury.

Indicates a potentially hazardous situation, which if not avoided, could result in death or serious injury.

Indicates a potentially hazardous situation, which if not avoided, may result in a minor or moderate injury. It may also be use to alert against unsafe practices.

1.1.2 Hazard Types (Symbols)

This symbol is a safety alert symbol.



This symbol represents asphyxiant, toxic or corrosive gases. Gases used with the Gasguard can cause personal injury or death.

This symbol can represent one or more of the following conditions:

Explosive gases! Gases used with the Gasguard can cause an explosion when combined with air.

The formation for explosive gas mixtures of flammable gas and air when exposed to an ignition source.

Pyrophoric gases which will ignite spontaneously without the presence of an ignition source when exposed to air.

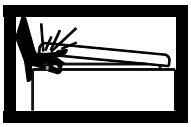
Energy release which may result from pneumatic or hydraulic pressure rapidly escaping from a portion of the equipment.

This symbol represents flammable gases. Gases used with the Gasguard can cause flammable atmospheres.

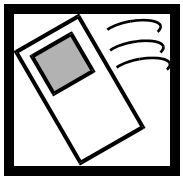
This symbol represents PPE (Personal Protective Equipment). Proper PPE shall be worn when working with this system.

This symbol represents electrical shock hazard.

This symbol warns of potential strain or injury when lifting cylinders.

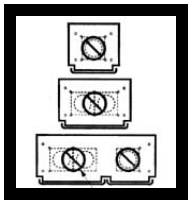


This symbol warns of a pinch hazard. This hazard exists on enclosure doors equipped with automatic closers.



This symbol warns of the possibility of the system tipping over if it is not installed properly. Personal injury could result.

This symbol indicates the need for head protection.



This symbol cautions against the improper anchoring of enclosures.

1.2 Important Safety Warnings

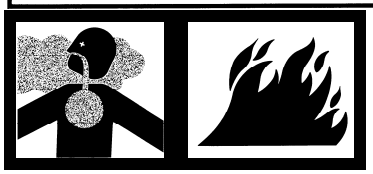
⚠WARNING

Failure to read, understand and follow the safety information found in this section could result in personal injury and death.

⚠CAUTION

The operator must read and understand this safety section before operating the system. All operating and maintenance personnel must receive training and instruction by Versum Materials, Inc.

⚠WARNING



All cylinder storage areas must be continually monitored with an air quality monitor to prevent the danger of a hazardous atmosphere.

⚠CAUTION

Before using the system, review your company's requirements for use of toxic, corrosive, flammable, pyrophoric, oxidizers and inert gas cylinders and electrically powered equipment. You must be thoroughly trained in your company's safety procedures and safety equipment (self-contained breathing apparatus, emergency shutdown systems, plant alarm locations, etc.)

Do not use this device in any manner other than specified in this manual.

Do not make any changes to the equipment independently. INJURY or DEATH may result from unauthorized modifications. All modifications to equipment MUST be approved in writing by an Versum Materials, Inc.' Representative.

1.3 Inert Gas Hazards

High concentrations of nitrogen, helium, or other inert gases can cause an oxygen deficient atmosphere in a confined area which can cause DEATH. All personnel must read and understand the material safety data sheet(s) (MSDS) for the specific gas(es) being used.

Oxygen concentrations of 19.5% or less can greatly increase the hazard of asphyxiation to personnel. Before working in an area where nitrogen, helium or other inert gases could be present, check the area with an oxygen monitor to be sure the oxygen concentration is between 19.5% and 23%. While working in the area, the oxygen concentration needs to be monitored with a continuous oxygen monitor. Always provide adequate ventilation in the work area to decrease the risk of an oxygen deficient atmosphere.

Personnel in an oxygen deficient atmosphere will not realize they are being asphyxiated. Breathing of pure inert gases will cause immediate unconsciousness. Symptoms of asphyxia include:

- Rapid breathing
- Nausea
- Vomiting
- Inability to move
- Convulsive movements
- Collapse
- Abnormal pulse
- Rapid fatigue

- Faulty judgment
- Insensitivity to pain
- Abnormal emotions

Remove any personnel in an oxygen deficient atmosphere to fresh air. ***Get medical attention immediately. Positive pressure breathing apparatus must be worn by any rescuers entering a suspected oxygen deficient atmosphere.***

Nitrogen gas may accumulate in low or confined areas. All requirements of OSHA 1910.146 (Confined Space Guidelines) must be met when inert gases may be present in confined spaces. Self contained breathing apparatus is required (cartridge or filter type gas masks cannot be used). See the information on personal protective equipment in this section for details.

When entering a confined area or area which may contain high inert gas concentrations, a **"Buddy System"** must be used. One person should remain outside the suspect area, but within view of the other person. This method ensures that the other person can respond in the event of an emergency.

1.4 Pressurized Fluids / Gases

⚠CAUTION

Pressurized gas and water sprinkler lines can injure personnel and damage equipment. Never tighten or loosen a fitting when it is under pressure.

The house nitrogen supply lines can contain pressures of 100+ psig (6.9+ barg). The water sprinkler lines contain pressures of 30 psig (2.1 barg). Exercise care when working around these lines. Ensure that pressure has been vented before breaking any connection. Tag out and lock out the line before doing any work. ***Follow Typical Minimal Lockout or Tagout System Procedures described by Occupational Safety and Health Admin., Labor Para. 1910.147.***

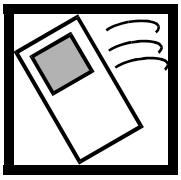
1.5 Electrical Hazard

Electric shock can cause personal injury or death.

The control circuits for the system use 115/220 VAC, 50/60 Hz. Do not attempt to work on the system without first turning the power off and tagging out and locking out the electrical supply disconnect switch per plant lock out procedures. ***Follow the Typical Minimal Lockout or Tagout System Procedures described by Occupational Safety and Health Admin., Labor Para. 1910.147.***

1.6 Falling Equipment Hazard

This system is a top heavy device. If it is not properly installed, it could fall and injure, crush or kill personnel working in the area.



When moving and installing the system, extreme care needs to be taken to support it properly. Due to the top heavy nature of the system, when moving or if not installed properly, it could tip over, injuring, crushing or possibly killing personnel in the area. Moving and setting equipment shall be done only by those persons having proper training and qualification in lifting and rigging.

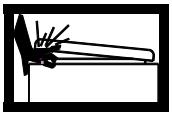
1.7 Gas Cylinder Handling Hazard

Improper handling and storage of compressed and liquefied gas cylinders could cause injury or death.

Restrain gas cylinders during storage and use. Keep protective cap on cylinder when not dispensing gas. Lifting gas cylinders could cause strain or injury. See Safetygrams found in the Safety section of the Operation Manual.

1.8 Pinch Hazard

A pinch hazard exists on enclosure doors equipped with automatic closers.



1.9 Personal Protective Equipment

Personal protective equipment, as defined in this section, must be worn when working with this system.

Personal protective equipment is designed to protect personnel from inadvertent risk. The listed personal protective equipment must be worn regardless of operator or technician level of training and qualifications.

The minimum personal protective equipment required for operating and maintaining the GASGUARD system is dependent on the hazard category of the gas(es) being used. When a gas meets more than one hazard category, the PPE for the most hazardous category ***must*** be used. Refer to the hazard warnings in Section 1.10 for the hazards of the gas(es) being used.

In addition to the personal protective equipment, the following safety equipment is highly recommended and is required when VERSUM MATERIALS, INC. personnel operate this equipment. This equipment should be supplied by the customer prior to operating the GASGUARD system.

- Safety shower
- Emergency phones
- Eye wash

- Gas leak detection system for gases to be used (ex: MDA)

  The gas leak detection system must warn personnel (through visible and audible alarms located near the system) of a hazardous atmosphere. The gas sensor(s) need to be set up to alarm at the lowest level of hazard of exposure. Upon activation of an alarm, follow the established shutdown procedures for your system.

- Scrubber with a pollution abatement system sized for maximum potential upset flow of hazardous gas.
- Adequate ventilation as described in section 3.7.

If you are unsure what personal protective equipment list to follow for the gases being used, <u>DO NOT</u> continue. Failure to understand the hazards and use the proper personal protective equipment may cause INJURY or DEATH. Contact Versum Materials, Inc. for the gas category.

Personal Protective Equipment for the gas categories follows:

Personal Protective Equipment for Toxics

- Toxic gas leak detection (ex. MDA)
- Self contained positive pressure breathing apparatus
- Long sleeved Nomex suit
- Safety glasses with side shields
- Leather gloves
- Safety shoes

NOTE: Most highly toxics (diborane, germane phosphine) are also flammable. Nomex suit is not required for non-flammable toxics (ex: nitrogen dioxide, boron trifluoride). All gases in Section 1.12 using the warning sign with POISON GAS on the left and FLAMMABLE GAS on the right <u>REQUIRE</u> the Nomex suit.

Personal Protective Equipment for Corrosives

- Corrosive gas leak detector (ex. MDA)
- Self contained positive pressure breathing apparatus
- Level C acid suit (jacket with bib overalls)
- Safety glasses with side shields
- Leather gloves
- Safety shoes

NOTE: Either air quality monitoring or self contained breathing apparatus is required for corrosive gases. Versum Materials, Inc. recommends the use of both. It is not required to use both, however at least one MUST be used at all times.

Personal Protective Equipment for Pyrophorics

- Pyrophoric gas leak detection (ex: MDA)
- Hard hat (fire hat with brim recommended)
- Long sleeved Nomex suit
- Face shield
- Safety glasses with side shields
- Leather gloves
- Safety shoes

Personal Protective Equipment for Flammables

- Hard hat (fire hat with brim recommended)
- Long sleeved Nomex suit

- Face shield
- Safety glasses with side shields
- Leather gloves
- Safety shoes

Personal Protective Equipment for Inerts

- Oxygen depletion monitor
- Safety glasses with side shields
- Leather gloves
- Safety shoes

1.10 Hazard Warnings

The following hazard warnings detail system hazards. Follow the warnings to avoid personal ***injury or death. Do not work on the system before reading and understanding the following warnings.*** The hazard warnings include:

- Toxic Gases Hazards
- Corrosive Gases Hazards
- Flammable and Pyrophoric Gases Hazards
- Oxidizer Hazards
- Inert Gas Hazards
- Pressurized Gases
- Cylinder Handling Hazards
- Electrical Hazards

Not all of the gas related hazards may apply to your system. For example, you may not be using any gases in the oxidizer class.

⚠WARNING

Some gases have more than one hazard. For example, fluorine is toxic, corrosive and also an oxidizer.

The Pressurized Gases Cylinder Handling Hazards and Electrical Hazard warnings apply to all GASGUARD systems.

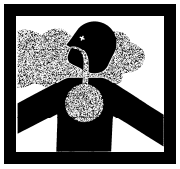
⚠WARNING

The following is general information on typical gas hazards. It is not a substitute for training and use of Material Safety Data Sheets by all operators.

1.10.1 Toxic Gas Hazards

⚠WARNING

Many of the gases used in the Gasguard system could cause personal INJURY OR DEATH at very low concentrations.



Many of these gases provide no physical warning signs (i.e. coughing, throat irritation, burning sensations, shortness of breath) to alert personnel of exposure to toxic levels.

Personal protective equipment required for use with toxic gases is detailed in Section 1.9 of this manual.

A list of most of the toxic gases used in the GASGUARD system follows:

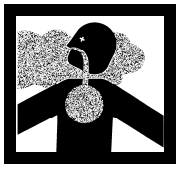
Ammonia	**Hydrogen fluoride**
Arsine	**Hydrogen sulfide**
Boron trichloride	**Methyl chloride**
Boron trifluoride	**Nitrogen dioxide**
Carbon monoxide	**Nitrogen trifluoride**

Chlorine	**Phosphine**
Chlorine trifluoride	**Phosphine mixtures**
Diborane	**Phosphorous pentafluoride**
Diborane mixtures	**Silane**
Dichlorosilane	**Silicon tetrachloride**
Disilane	**Silicon tetrafluoride**
Fluorine	**Sulfur tetrafluoride**
Germane	**Trichlorosilane**
Hydrogen bromide	**Tungsten hexafluoride**
Hydrogen chloride	

1.10.2 Corrosive Gas Hazards

⚠ DANGER

Corrosives such as chlorine, fluorine and ammonia will irritate and burn human tissue. They can cause personal INJURY and DEATH.



Exposure to very small concentrations of corrosive gases can cause severe irritation of the eyes and respiratory system. At higher concentrations, they can cause ***severe personal injury or death***.

Section 1.9 of this manual lists the personal protective equipment required for use with corrosive gases.

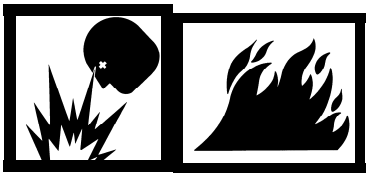
A list of most of the corrosive gases used in the GASGUARD system follows:

Ammonia	**Hydrogen chloride**
Boron trichloride	**Hydrogen fluoride**
Boron trifluoride	**Hydrogen sulfide**
Chlorine	**Nitrogen dioxide**
Chlorine trifluoride	**Phosphorous pentafluoride**
Dichlorosilane	**Silicon tetrachloride**
Fluorine	**Silicon tetrafluoride**

Hydrogen bromide **Tungsten hexafluoride**

1.10.3 Flammable and Pyrophoric Gas Hazards

⚠WARNING ***Flammable and pyrophoric gases could cause fire, explosions, personal injury or death.***



Pyrophoric gases will spontaneously ignite in air

Pyrophoric gases do not need a source of ignition to burn. However, low concentrations may accumulate without pyrophoric ignition (i.e. silane can accumulate up to a concentration of 2 molar percent [number of moles of silane per fixed volume of air] before spontaneous ignition occurs). Pyrophoric gases will ignite in the presence of oxygen.

Flammable mixtures can burn or explode

Fire and explosion hazards can be controlled by preventing the formation of combustible fuel-oxidant mixtures and by eliminating sources of ignition such as sparks, open flames or other heat sources.

Flammable mixtures will burn when ignited and can explode when the concentration is above the lower explosive limit (LEL) and below the upper explosive limit (UEL) for that specific gas. Some flammable gases may accumulate as pockets in enclosed areas and subsequently explode if an ignition source is present. A flammable gas also presents an asphyxiating hazard in sufficient quantities to reduce oxygen concentration below 19.5%, however fire/explosion is typically the primary hazard.

Adequate ventilation is necessary

Adequate ventilation helps reduce the possible formation of flammable mixtures in the event of a flammable gas leak. See tables in section 3.7 which list the exhaust requirements per enclosure size for all gases.

NOTE: To avoid any possible hazardous reactions (i.e. fire, explosion, extremely corrosive or toxic mixtures) never vent incompatible gases out the same duct!

Continually monitor the atmosphere

Continually monitoring the atmosphere with a gas leak detector will alert the operator to a flammable or explosive atmosphere in the area.

NOTE: The installation of a hydride detector is strongly recommended for silane and other pyrophoric gases to detect leaks or pockets of gas that may not spontaneously ignite!

Versum Materials, Inc. strongly recommends installation of a hydride detector to detect gas pocketing of pyrophoric gases.

Guidelines to avoid forming combustible mixtures

Avoid forming combustible mixtures by adhering to the following:

- Do not admit flammable gases into an area that contains oxygen/air. Do not admit oxygen/air into an area that contains flammable gases.
- Maintain a small positive pressure in systems to prevent air from leaking into them when the equipment is shut down.
- Avoid venting of flammable gases through vents that do not contain an inert atmosphere.

Personal protective equipment required for use with pyrophoric and flammable gases is listed in Section 1.9. ***Note that the personal protective equipment (PPE) for pyrophorics differs from the flammables. Be sure to use the proper PPE.***

A list of most of the pyrophoric gases used in the GASGUARD system follows:

Diborane	**Phosphine**
Disilane	**Silane**

A list of most of the flammable gases used in the GASGUARD system follows:

Acetylene	**Germane**
Ammonia	**Hydrogen**
Arsine	**Hydrogen mixtures**
Carbon monoxide	**Hydrogen sulfide**

Diborane	**Methane**
Diborane mixtures	**Methyl chloride**
Dichlorosilane	**Methyl fluoride**
Disilane	**Trichlorosilane**

1.10.4 Oxygen and Other Oxidizer Hazards

Systems using oxygen or other oxidizers (i.e. nitrous oxide, fluorine) have specific guidelines for specifying equipment, materials of construction and system cleanliness. Failure to comply with materials of construction and system cleanliness could result in injury or death.

Follow safe practices when using oxygen or oxidizers (chlorine and fluorine)

Oxygen concentrations in excess of 23% significantly increase the hazard exposure to personnel and equipment. Those materials which burn in air will burn more violently and explosively in oxygen/oxidizer enriched atmospheres. Guidelines for oxygen systems are found in CGA Pamphlet G-4.4. (Contact your gas supplier or the Compressed Gas Association to order CGA Pamphlets.) Only those personnel who have read and understand the hazards of oxygen or oxidizers and safe practices for these systems should be permitted to operate and maintain the system.

Use only equipment specifically designed for oxygen or oxidizer service.

Inappropriate materials of construction increase the danger of ignition of pipelines and controls. Pipe sizing is just as important to ensure all velocity restrictions for oxygen or oxidizers are met. Do not substitute components or equipment without considering these hazards. Refer to CGA Pamphlet G-4.4 for guidelines and specifications of oxygen systems. (Contact your gas supplier or the Compressed Gas Association to order CGA Pamphlets.)

Maintain oxygen cleanliness at all times.

All equipment and piping in contact with oxygen or oxidizers must be cleaned to specifications outlined in CGA Pamphlet G-4.1. (Contact your gas supplier or the Compressed Gas Association to order CGA Pamphlets.) Failure to clean components and piping increases the danger of ignition and fire. Note that the cleaning solvent must be thoroughly removed before the equipment can be placed into service. Maintain cleanliness during assembly, installation, and repair.

No open flames, smoking, or sparks permitted near oxygen equipment.

Since many materials will burn in oxygen/oxidizer enriched atmospheres, the best method in preventing fires is to eliminate sources of ignition. Where this control equipment is being used or where concentrations of oxygen are greater than 23%, avoid open flames, sparks, or sources of heat. Never weld on a pressurized line flowing oxygen or an oxidizer. Make sure signs are posted warning personnel that oxygen or oxidizers are in use.

Do not substitute oxygen for compressed air.

Substituting oxygen for compressed air is dangerous. ***Explosions can occur when oxygen is substituted for air.*** Chances are the instrument air equipment is not compatible or cleaned for oxygen service. Oxygen used to clean off equipment or clothing could come in contact with a source of ignition (spark, flame, or other) and ignite. In some cases, the elevated oxygen levels could linger even after the source has been shut off. Never tie into an oxygen system for personal breathing purposes.

A list of most of the oxidizers used in the GASGUARD system follows:

Chlorine	**Nitrogen trifluoride**
Chlorine trifluoride	**Nitrous oxide**
Fluorine	**Oxygen**

1.10.5 Inert Gas Hazards

High concentrations of nitrogen, helium, or other inert gases will cause an oxygen deficient atmosphere in a confined area which can cause DEATH. All personnel must read and understand the Material Safety Data Sheet(s) (MSDS) for the specific gas(es) being used.

Oxygen concentrations of 19.5% or less can greatly increase the hazard of asphyxiation to personnel. Before working in an area where nitrogen, helium or other inert gases could be present, check the area with an oxygen monitor to be sure the oxygen concentration is between 19.5% and 23%. While working in the area, the oxygen concentration needs to be monitored with a continuous oxygen monitor. Always provide adequate ventilation in the work area to decrease the risk of an oxygen deficient atmosphere. **Read Safetygram 17 "Dangers of Oxygen Deficient Atmospheres" included in the safety literature in Section 1.14 of this manual.**

Any time an oxygen deficient atmosphere is suspected, the proper personal protective equipment must be used. See the information on personal protective equipment in Section 1.9 for details.

Personnel in an oxygen deficient atmosphere will not realize they are being asphyxiated. Breathing of pure inert gases will cause immediate unconsciousness.

Symptoms of asphyxia include:

- Rapid breathing
- Nausea
- Vomiting
- Inability to move
- Convulsive movements
- Collapse
- Abnormal pulse
- Rapid fatigue
- Faulty judgment
- Insensitivity to pain
- Abnormal emotions

Remove any personnel in an oxygen deficient atmosphere to fresh air. ***Get medical attention immediately. Use cardiopulmonary resuscitation if the victim is not breathing. Positive pressure breathing apparatus must be worn by any rescuers entering a suspected oxygen deficient atmosphere.***

Nitrogen gas may accumulate in low or confined areas. All requirements of OSHA 1910.146 (Confined Space Guidelines.) must be met when working with inert gases in confined spaces. Self contained breathing apparatus is required (cartridge or filter type gas masks cannot be used). See the information on personal protective equipment in this section for details.

When entering a confined area or area which may contain high inert gas concentrations, a **"Buddy System"** must be used. One person should remain outside the suspect area, but within view of the other person. This method ensures that the other person can respond in the event of an emergency.

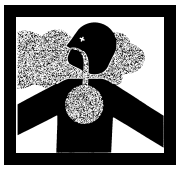
Personal protective equipment required for use with inerts is listed in Section 1.9.

A list of inert gases used in the GASGUARD system follows:

Argon	**Halocarbon 115**
Carbon Dioxide	**Halocarbon 116**

Halocarbon 11	**Helium**
Halocarbon 12	**Krypton**
Halocarbon 13	**Neon**
Halocarbon 14	**Nitrogen**
Halocarbon 22	**Perfluoropropane**
Halocarbon 23	**Sulfur Hexafluoride**
Halocarbon 113	**Xenon**

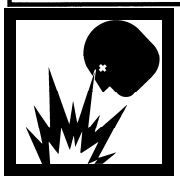
⚠WARNING



Any gas, in addition to those listed above, used in the GASGUARD system could potentially displace the oxygen in the air and cause asphyxiation.

1.10.6 Pressurized Gases

⚠WARNING



Pressurized gas lines could injure personnel and damage equipment. Never tighten or loosen a fitting when it is under pressure.

The process and purge gas cylinders can contain pressures up to 2650 psig in the USA. In Europe, cylinders can contain pressures up to 200 barg. A leak from a loose mechanical fitting, component or a ruptured/failed component can expose the operator to a high pressure gas stream or projectile. ***Read the cylinder handling warnings in Section 1.10.7 and the safety literature on cylinder handling in Section 1.13***.

The house nitrogen supply lines can contain pressures of 100+ psig (7+ barg). Exercise care when working around these lines. Insure that pressure has been vented before breaking any connection. Tag out and lock out the line before doing any work. ***Follow Typical Minimal Lockout or Tagout System Procedures described by Occupational Safety and Health Admin., Labor Para. 1910.147 found in Section 1.11.***

1.10.7 Cylinder Handling Hazards

⚠WARNING ***High pressure gas cylinders could be extremely hazardous when not handled properly.***

Proper training, maintenance, leak testing and mechanical connection procedures can prevent operators from being exposed to high pressure gas streams. ***Use the cylinder change out procedures in Section 8.3.2, "Process Cylinder Procedures."***

- Do not use a wrench or other device to close diaphragm type cylinder valves. This could cause diaphragm rupture and valve failure which ***could result in personal injury or death.*** Contact your gas supplier for the maximum torque (ft./lbs. or N/m) allowed on diaphragm type cylinder valves. Certain gases are supplied with cylinder valves without handwheels. Use ***only*** the tool specified by your gas supplier to open and close diaphragm type cylinder valves to avoid over torquing these valves.
- If a cylinder valve protection cap is extremely difficult to remove, do not apply excessive force or pry the cap loose. Attach a label to the cylinder identifying the problem and notify the personnel responsible for returning cylinders about the defective cylinder. Obtain another cylinder. Do not attempt to open a frozen cap as this would damage the cylinder valve and ***could result in personal injury or death.***
- Do not rotate the cylinder using the cylinder valve handle. This may open the cylinder valve and cause a high pressure gas leak.
- ***NEVER*** replace the gas specified for use in the distribution system with another type of gas. Incompatible gases could cause fires, explosions or extremely corrosive or toxic mixtures which can ***cause personal injury or death.*** If another type of gas is required for use in the gas distribution system, contact Versum Materials, Inc. immediately.
- A valve outlet sealing cap ***must*** be supplied on all toxic, corrosive and pyrophoric gases. Consult your gas supplier if there is no sealing cap on any of the above types of gas cylinders.

- Cylinder valves are available with removable flow restrictor orifices in the valve outlet for use with gas cylinders. This flow restrictor orifice significantly limits the rate of release of gas from the valve outlet during transportation, storage and use, due to a valve or system failure. Verify that your gases are supplied in cylinders with valves that have the appropriate flow restrictor orifice. Note that there are different size flow restrictor orifices available. Verify that the correct size is being used for your specific situation. A quality control program should be established to assure that your supplier has installed the correct flow restrictor orifice in the valve outlet after the filling operation has been completed.

1.10.8 Electrical Hazards

Electric shock could cause personal injury or death.

The control circuits for the system use 115/220 VAC, 50/60 Hz. Do not attempt to work on the system without first turning the power off and tagging out and locking out the electrical supply disconnect switch per plant lock out procedures. ***Follow the Typical Minimal Lockout or Tagout System Procedures described by Occupational Safety and Health Admin., Labor Para. 1910.147 found in Section 1.11 of this manual.***

1.10.9 Purge Gas Backstream Hazard

Avoid low pressure condition in purge gas cylinder to prevent a backstream hazard.

The purge gas system incorporates a pressure indicating gage which will provide the means of displaying a low purge gas cylinder pressure condition (usually 200 psig [14 barg] minimum). The cylinder should be changed out at this point to prevent process gas from backstreaming into the purge gas cylinder.

1.11 Typical Minimal Lockout or Tagout System Procedures

NOTE: The following OSHA document is included to help you develop a lockout/tagout procedure for the Gasguard System. A written procedure is required for any work performed under

lockout/tagout. It must be reviewed, approved and understood by all participants who are trained to perform the work. (Occupational Safety and Health Admin., Labor Para. 1910.147)

Although OSHA does not have jurisdiction outside the United States of America, it is Versum Materials, Inc. recommendation that Lockout, or Tagout procedures be followed, except where local laws are more stringent.

General

Lockout is the preferred method of isolating machines or equipment from energy sources. To assist employers in developing a procedure which meets the requirements of the standard, the following simple procedure is provided for use in both lockout and tagout programs. This procedure may be used when there are limited number of types of machines or equipment or there is a single power source. For a more complex system, a more comprehensive procedure will need to be developed, documented and utilized.

Lockout (or Tagout) Procedure for (Name of Company)

Purpose

This procedure establishes the minimum requirements for the lockout or tagout of energy isolating devices. It shall be used to ensure that the machine or equipment is isolated from all potentially dangerous energy, and locked out or tagged out before employees perform any servicing or maintenance activities where the unexpected energization, start-up or release of stored energy could cause injury (Type(s) and Magnitude(s) of Energy Hazards).

Responsibility

Appropriate employees shall be instructed in the safety significance of the lockout (or tagout) procedure (Name(s)/Job title(s) of employees authorized to lockout or tagout). Each new or transferred affected employee and other employees whose work operations are or may be in the area shall be instructed in the purpose and use of the lockout or tagout procedure (Name(s)/Job title(s) of affected employees and how to notify).

Preparation for Lockout or Tagout

Make a survey to locate and identify all isolating devices to be certain which switch(s), valve(s) or other energy isolating devices apply to the equipment to be locked or tagged out. More than one energy source (electrical, mechanical, or others) may be involved. (Type(s) of energy isolating means).

Sequence of Lockout or Tagout System Procedure

1. Notify all affected employees that a lockout or tagout system is going to be utilized and the reason therefore. The authorized employee shall know the type and magnitude of energy that the machine or equipment utilizes and shall understand the hazards thereof.
2. If the machine or equipment is operating, shut it down by the normal stopping procedure (depress stop button, open toggle switch, etc.).
3. Operate the switch, valve, or other energy isolating device(s) so that the equipment is isolated from its energy source(s). Stored energy (such as that in springs, elevated machine members, rotating flywheels, hydraulic systems, and air, gas, steam or water pressure, etc.) must be dissipated or restrained by methods such as repositioning, blocking, bleeding down, etc. (Type(s) of stored energy methods to dissipate or restrain).
4. Lockout and/or tagout the energy isolating devices with assigned individual lock(s) or tag(s) (Method(s) selected, i.e., locks, tags, additional safety measures, etc.)
5. After ensuring that no personnel are exposed, and as a check on having disconnected the energy sources, operate the push button or other normal operating controls to make certain the equipment will not operate (Type(s) of equipment checked to ensure disconnections).

⚠CAUTION ***Return operating control(s) to neutral or off position after the test.***

6. The equipment is now locked or tagged out.

Restoring Machines or Equipment to Normal Production Operations

1. After the servicing and/or maintenance is complete and equipment is ready for normal production operations, check the area around the machines or equipment to ensure that no one is exposed.
2. After all tools have been removed from the machine or equipment, guards have been reinstalled and employees are in the clear, remove all lockout or tagout devices. Operate the energy isolating devices to restore energy to the machine or equipment.

Procedure Involving More Than One Person

In the preceding steps, if more than one individual is required to lockout or tagout equipment, each shall place his/her own personal lockout device on the energy isolating devices(s). When an energy isolating device cannot accept multiple locks or tags, a multiple lockout or tagout device (HASP) may be used. If lockout is used, a single lock may be used to lockout the machine or equipment with the key being placed in a lockout box or cabinet which allows the use of multiple locks to secure it. Each employee will then use his/her own lock to secure the box or cabinet. As each person no longer needs to maintain his/her lockout protection, that person will remove his/her lock from the box or cabinet (Name(s)/Job title(s) of employees authorized for group lockout or tagout).

Basic Rules for Using Lockout or Tagout System Procedure

All equipment shall be locked or tagged out to protect against accidental or inadvertent operating when such operation could cause injury to personnel. Do not attempt to operate any switch, valve or other energy isolating device where it is locked or tagged.

Entry No.	Description
1.	Name of Company
2.	Type(s) and Magnitude(s) of energy and hazards
3.	Name(s)/Job title(s) of employees authorized to lockout or tagout
4.	Name(s)/Job title(s) of affected employees and how to notify
5.	Type(s) and Location of energy isolating means
6.	Type(s) of stored energy
7.	Method(s) selected, i.e. locks, tags, additional safety measure, etc.
8.	Type(s) of equipment checked to ensure disconnections
9.	Name(s)/Job title(s) of employees authorized for group lockout or tagout

1910.147 29 CFR Ch.XVII (7-1-90)

1.12 Safety Signs and Labels

The following sign is located on the exterior door of the Gasguard enclosure.

DANGER

PRODUCTS USED IN THIS SYSTEM MAY BE HAZARDOUS TO HEALTH SAFETY AND THE ENVIRONMENT

THIS PRODUCT HANDLING EQUIPMENT SHOULD ONLY BE USED BY TRAINED, AUTHORIZED OPERATORS. Before using, read and understand the user manual for this equipment and the Manufacturer's Material Safety Data Sheet(s) for the product(s) in use. Copies can be obtained from your Supervisor.

WHEN USING THIS EQUIPMENT:

1. ON ENCLOSED SYSTEMS, MAKE SURE EXHAUST SYSTEM IS ON AND WORKING.
2. MAKE SURE PRODUCT BEING DISPENSED BY THIS SYSTEM IS THE SAME AS IDENTIFIED ON THE PRODUCT LABEL. IF NOT, OTHER HAZARDS MAY BE PRESENT. CONTACT YOUR SUPERVISOR IMMEDIATELY.
3. VISUALLY INSPECT EQUIPMENT FOR ALARMS, SIGNS OF LEAKAGE, CORROSION, OR MECHANICAL FAILURE. IF PRESENT, CONTACT YOUR SUPERVISOR IMMEDIATELY.
4. PURGE THE EQUIPMENT WITH INERT GAS BEFORE CHANGING CONTAINER (SOURCE SYSTEMS) OR MAKING REPAIRS. USE AUTOMATIC SEQUENCES IF AVAILABLE.
5. FOR SOURCE SYSTEMS, CHECK CONTAINER VALVE CONNECTION FOR LEAKS AFTER CHANGING CONTAINER.
6. CHECK EQUIPMENT FOR LEAKS AFTER MAINTENANCE OR IF THE SYSTEM HAS BEEN PHYSICALLY DISTURBED.
7. CLOSE THE PRODUCT SUPPLY VALVE WHEN NOT IN USE AND/OR WHEN EMPTY.
8. WEAR THE REQUIRED PERSONAL PROTECTIVE EQUIPMENT (PPE) FOR THE PRODUCT BEING DISPENSED.
9. THIS UNIT MAY SUPPLY OR GET SUPPLIED FROM OTHER EQUIPMENT. IN AN EMERGENCY, VERIFY THE SUPPLY SOURCE SYSTEM IS ALSO SHUT DOWN.

IN AN EMERGENCY, CONTACT YOUR SUPERVISOR. IF THE SYSTEM IS LEAKING, OR IF FURTHER ASSISTANCE IS REQUIRED, CALL THE VERSUM MATERIALS EMERGENCY RESPONSE PHONE NUMBERS.

800-523-9374 (Continental USA, Canada, Puerto Rico)

610-481-7711 (All other Locations)

VERSUM MATERIALS, INC
1919 VULTEE STREET
ALLENTOWN, PA 18103

VERSUM MATERIALS

The following label is located on the GASGUARD controller. This label is required if the GASGUARD distribution system is located in a Class I, Division II rated area (United States) or in a Group 2, Category 3 (Zone 2) ATEX rated area (Europe). Acetylene systems will have the same label as shown below, but they will be approved for NEC Class I, Division 2, Groups A, B, C, and D Locations.

APPROVED FOR NEC CLASS I, DIVISION 2, GROUPS B, C AND D LOCATIONS

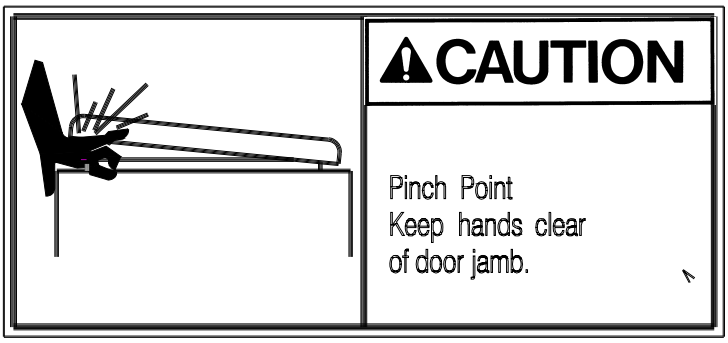
WARNING PRESSURIZED ENCLOSURE

"This enclosure shall not be opened unless the area is known to be free of flammable materials or unless all devices within have been de-energized. If power has been removed, power shall not be restored after enclosure has been opened until enclosure has been purged for 20 minutes at a flow rate of 25 CFH." Purged and pressurized enclosure conforms to NFPA496. Type Z Requirement. Approved for NEC CLASS I, DIVISION 2, GROUP B, C, AND D LOCATIONS."

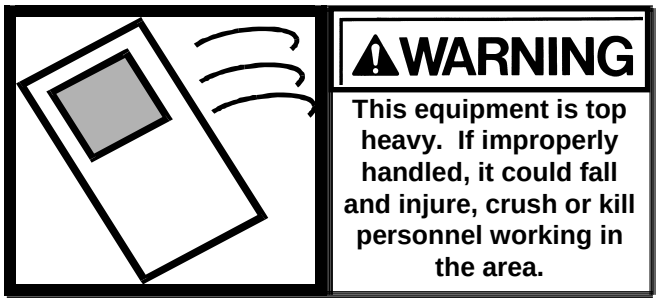
WARNING ASPHYXIATION HAZARD

"This enclosure contains inert gas and may be an asphyxiation hazard. This enclosure also contains a flammable substance that may be within the flammable limits when exposed to air."

The following label appears inside doors of enclosures.



The following label appears on enclosures. It is located on the back of the enclosure, approximately 12” (305 mm) from the top.



The following eleven labels are specific to the gases being used. They are located on the door of the GASGUARD enclosure. They are identical to the labels on the process gas cylinder in the GASGUARD cabinet to provide verification that the correct process gas is being installed and used.

NOTE: The signs shown below are United States DOT classifications. They are not to be used to classify gas hazards. Refer to the appropriate MSDS provided with the system documentation.

The following label would be used with the gases listed below it:

THIS EQUIPMENT IS DESIGNED FOR USE WITH:

Boron trifluoride

Chlorine

Carbon tetrachloride

Nitrogen dioxide

Nitric oxide

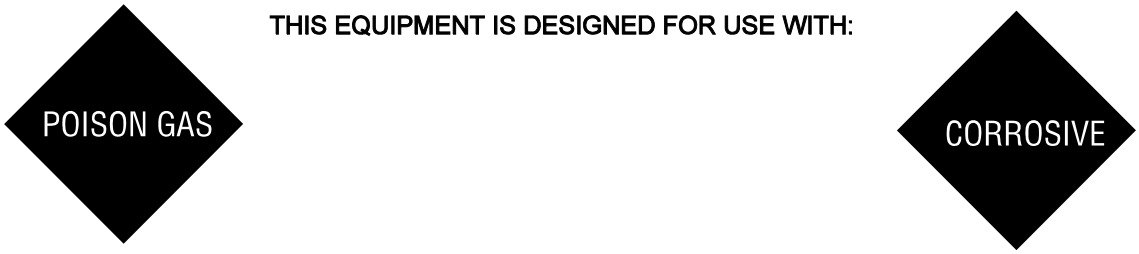
Phosphorous pentafluoride

Sulfur dioxide

Sulfur tetrafluoride

Tungsten hexafluoride

The following label would be used with the gases listed below it:



Boron trichloride

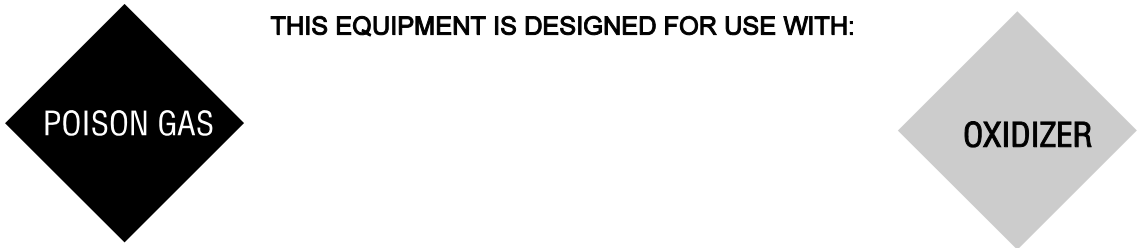
Hydrogen bromide

Hydrogen chloride

Hydrogen fluoride

Silicon tetrafluoride

The following label would be used with the gases listed below it:



Fluorine

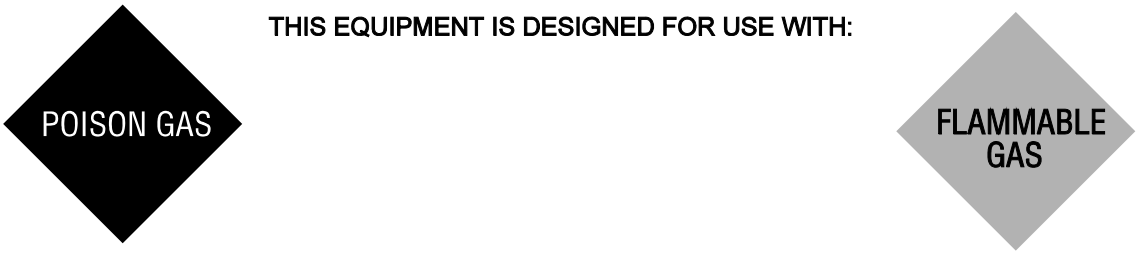
Fluorine mixtures

The following label would be used with the gases listed below it:

THIS EQUIPMENT IS DESIGNED FOR USE WITH:

Acetylene
Butane
Disilane
Deuterium
Ethane
Ethanol mixtures
Ethylene
Halocarbon 32
Halocarbon 41
Hydrogen
Hydrogen mixtures
Isobutane
Isobutylene
Methane
Methyl chloride
Methyl silane
Propane
Silane
Silane mixtures

The following label would be used with the gases listed below it:



Arsine mixtures

Carbon monoxide

Diborane mixtures

Dichlorosilane

Diethyl telluride

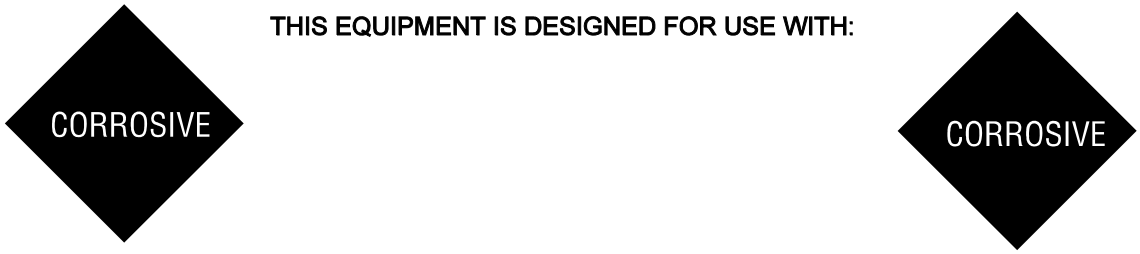
Germane

Hydrogen selenide

Hydrogen sulfide

Phosphine mixtures

The following label would be used with the gases listed below it:



Silicon tetrachloride

The following label would be used with the gases listed below it:

Chlorine trifluoride

The following label would be used with the gases listed below it:

THIS EQUIPMENT IS DESIGNED FOR USE WITH:

Ammonia
Argon
Carbon dioxide
Halocarbon 11
Halocarbon 12
Halocarbon 13
Halocarbon 13B1
Halocarbon 14
Halocarbon 21
Halocarbon 22
Halocarbon 23
Halocarbon 113
Halocarbon 115
Halocarbon 116
Halocarbon 125
Halocarbon 128
Halocarbon C141B
Halocarbon C318
Helium
Krypton
Neon
Nitrogen
Nitrous oxide
Perfluoropropane
Sulfur hexafluoride
Teteafluoroethane
Xenon

The following label would be used with the gases listed below it:

Oxygen	**Nitrogen trifluoride**
Oxygen mixtures	**Nitrogen trifluoride mixtures**

1.13 Equipment Safety Features

Dependent on the design of your specific system, the following safety features may be incorporated into the GASGUARD system:

- Warning labels and gas identification labels are placed on the outside door of each enclosure (see Section 1.12).
- The enclosure has a self-closing cabinet door with locking mechanism.
- Enclosure doors may have a self-closing 1/4" thick wire reinforced safety glass windows or fixed viewport.
- Fault and Shutdown alarms notify the operator through the alarm horn, light and alarm label on the controller of a problem with the system. In addition, the Shutdown alarms close all pneumatic valves and abort the controller program.
- Excess flow sensors are installed, when required, to shut off the flow of gas in the event of downstream equipment failure.
- An exhaust monitor verifies ventilation through the enclosure.
- The system may utilize a positive shutoff regulator. This type of regulator is designed to close tightly if the pressure builds above the setpoint because the diaphragm is mechanically connected to the valve poppet. Be aware that the regulator may leak if the regulator seat is damaged, corroded or soiled.
- An ultraviolet infrared (UV/IR) detector or temperature switch is installed for pyrophoric gas systems.
- A temperature switch is recommended for flammable and strong oxidizer gas systems.
- Pressure relief valves may be incorporated into the design to prevent overpressurization of the process line and downstream equipment and to protect the inert purge system.
- Manual operation access is denied during the presence of a shutdown alarm.
- An "EMERGENCY STOP" pushbutton is located on the controller panel.
- A password security system prevents unauthorized personnel to operate or modify the GASGUARD controller menu.
- Customer I/O capability is available for remote shutdown and gas detection signals.

1.14 Safety Literature for Handling and Use of Gas Cylinders

The following safety literature, ***must be read and understood.***

Safetygram 10	Handling, Storage and Use of Compressed Gas Cylinders
Safetygram 11	Emergency Action in Handling Leaking Compressed Gas Cylinders
Safetygram 14	Don't Turn a Cylinder into a Rocket
Safetygram 15	Cylinder Safety Devices
Safetygram 23	Cylinder Valves

Material Safety Data Sheets for all gases used in system

1.15 Safety Literature for Handling and Use of Instrument Nitrogen Supply

The safety literature listed below ***must be read and understood.***

Safetygram 2	Gaseous Nitrogen
Safetygram 17	Dangers of Oxygen Deficient Atmospheres

Nitrogen Material Safety Data Sheet

Chapter 2

Dimensions and Mounting

Section 1 **Outline Dimensions**

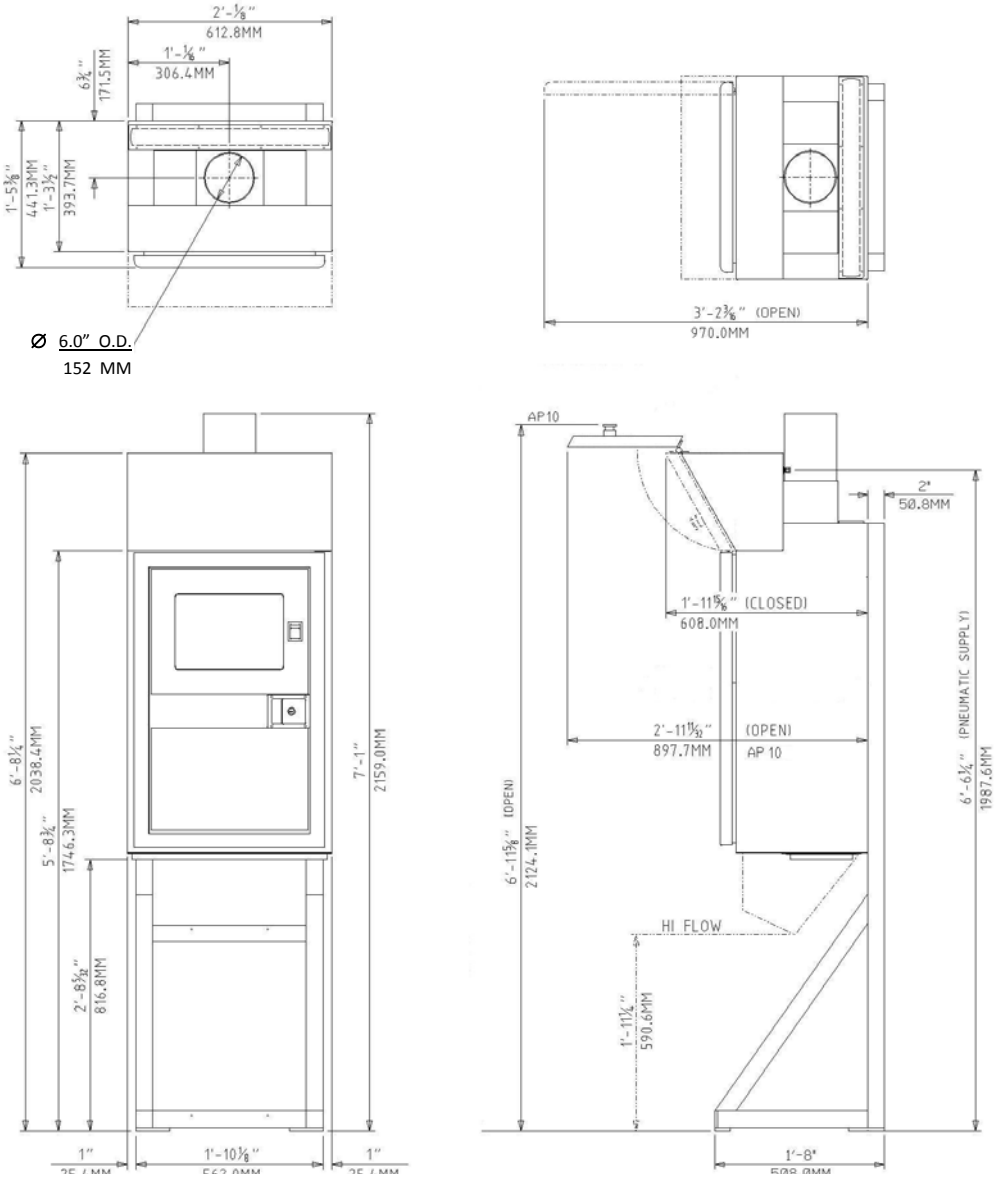
Section 2 **Mounting Hole Locations**

Note: The dimensions included in this section are intended for familiarization purposes. For system specific details, refer to the installation drawings supplied. An installation drawing (INS) will be provided upon request.

2.1 Outline Dimensions

For overall dimensions see the following Outline Dimension figures. Chapter 2 Section 2.1.1 contains the 24" Distribution Systems (4 stick) figures, Chapter 2 Section 2.1.2 contains the 30" Distribution Systems (6 stick or 8 stick) figures.

2.1.1 Outline Dimension Figures for 24” Distribution Systems (4 stick)

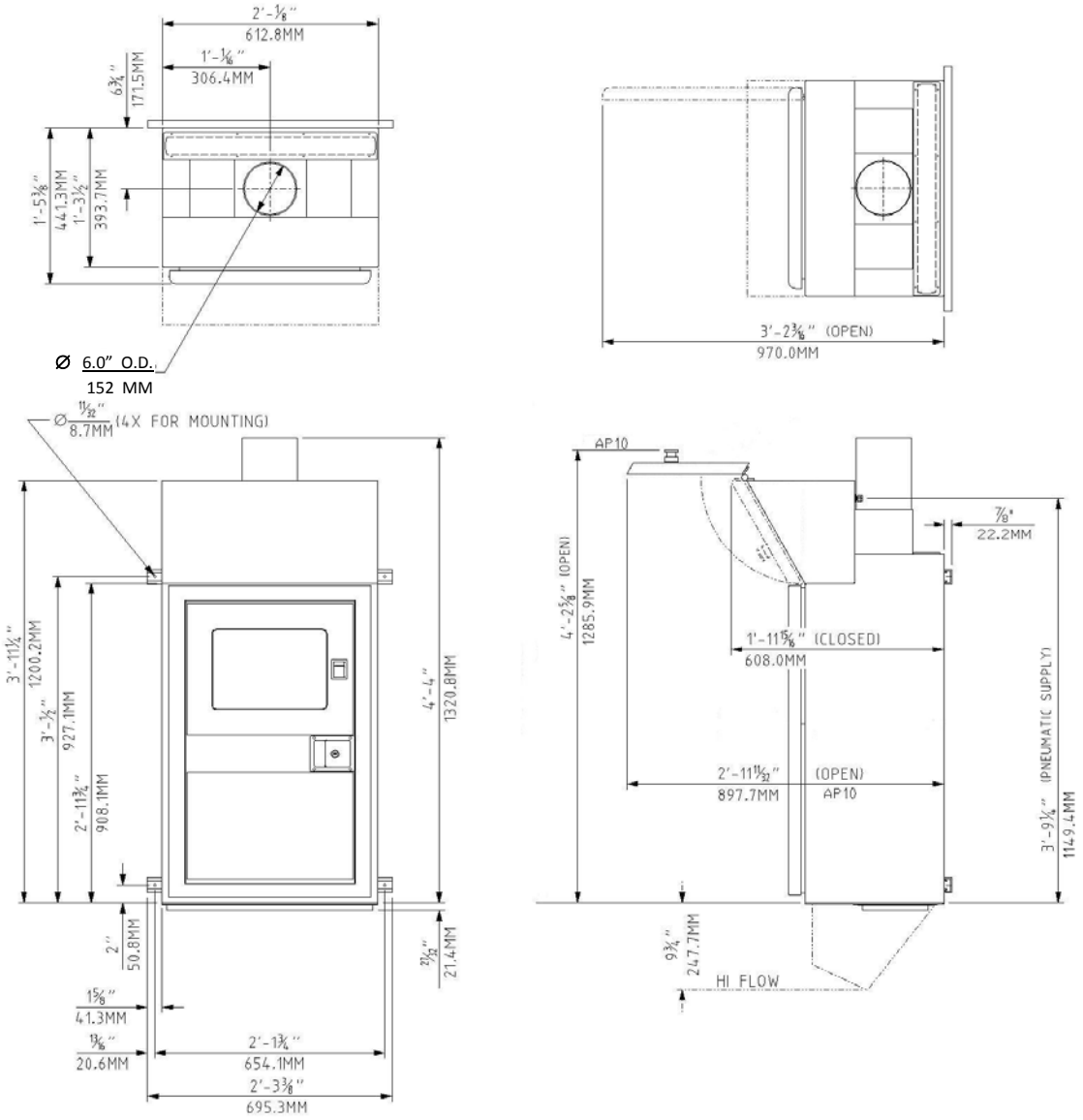


2.1.1.1 24” Valve Manifold Box Rack

Approximate Weight = 275 Pounds (124.74 Kilograms)

Figure 2.1.1.1: Outline Dimensions
24” Valve Manifold Box Rack (4 stick)

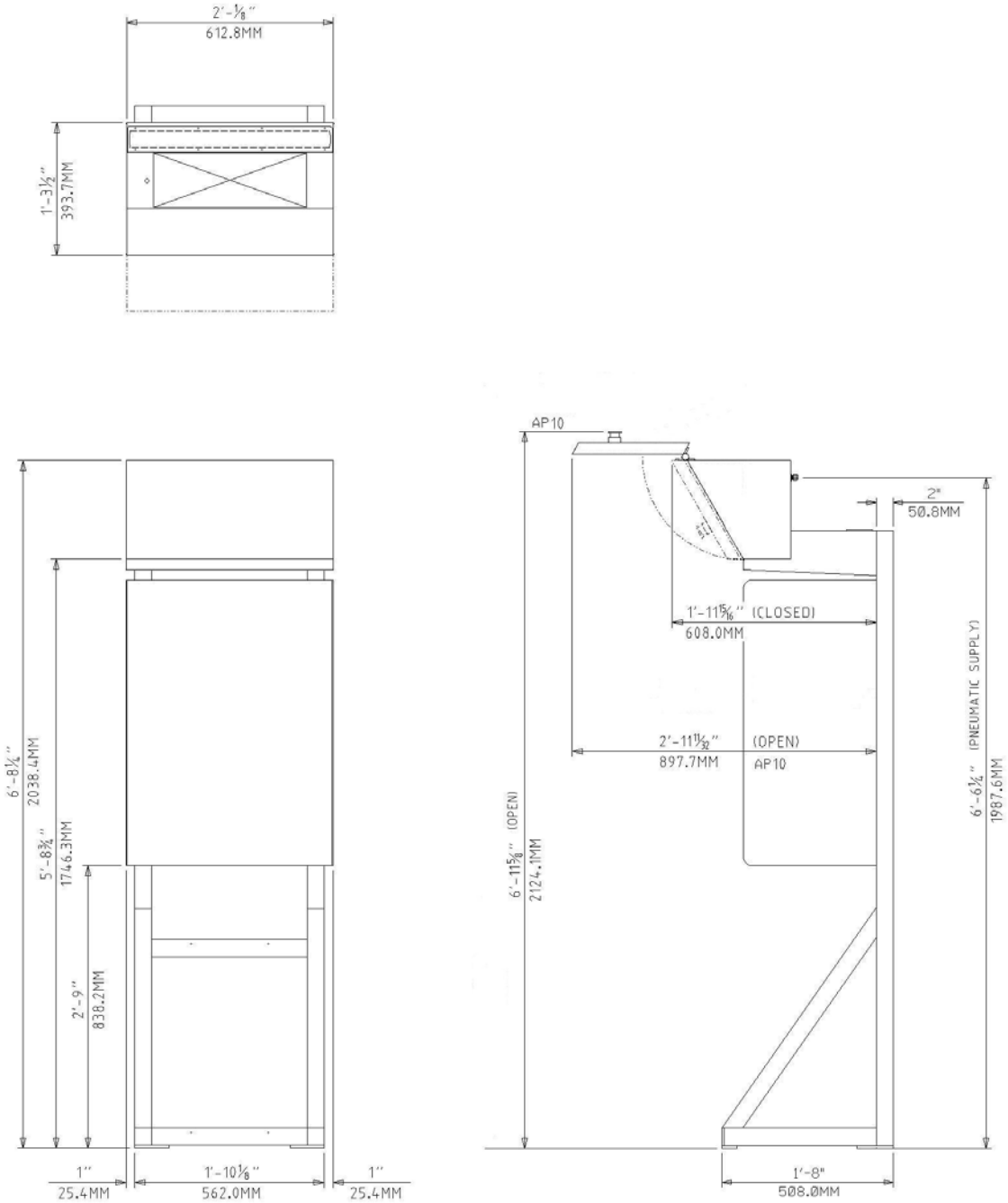
2.1.1.2 – 24” Valve Manifold Box Wall Mount



Approximate Weight = 200 pounds (90.72 kilograms)

Figure 2.1.1.2: Outline Dimensions
24” Valve Manifold Box Wall Mount (4 stick)

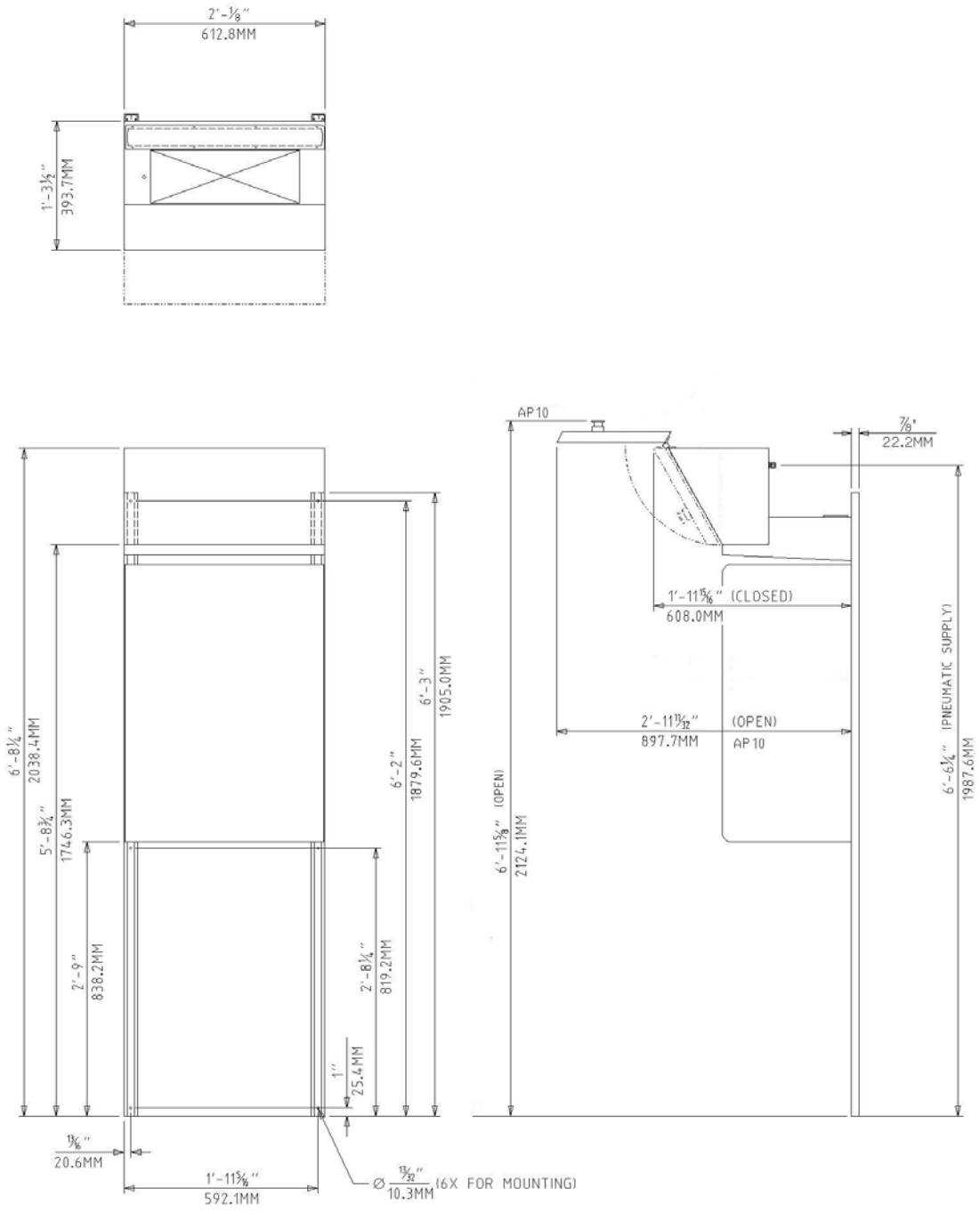
2.1.1.3 – 24” Valve Manifold Panel Rack



Approximate Weight = 275 pounds (124.74 kilograms)

Figure 2.1.1.3: Outline Dimensions
24” Valve Manifold Panel Rack (4 stick)

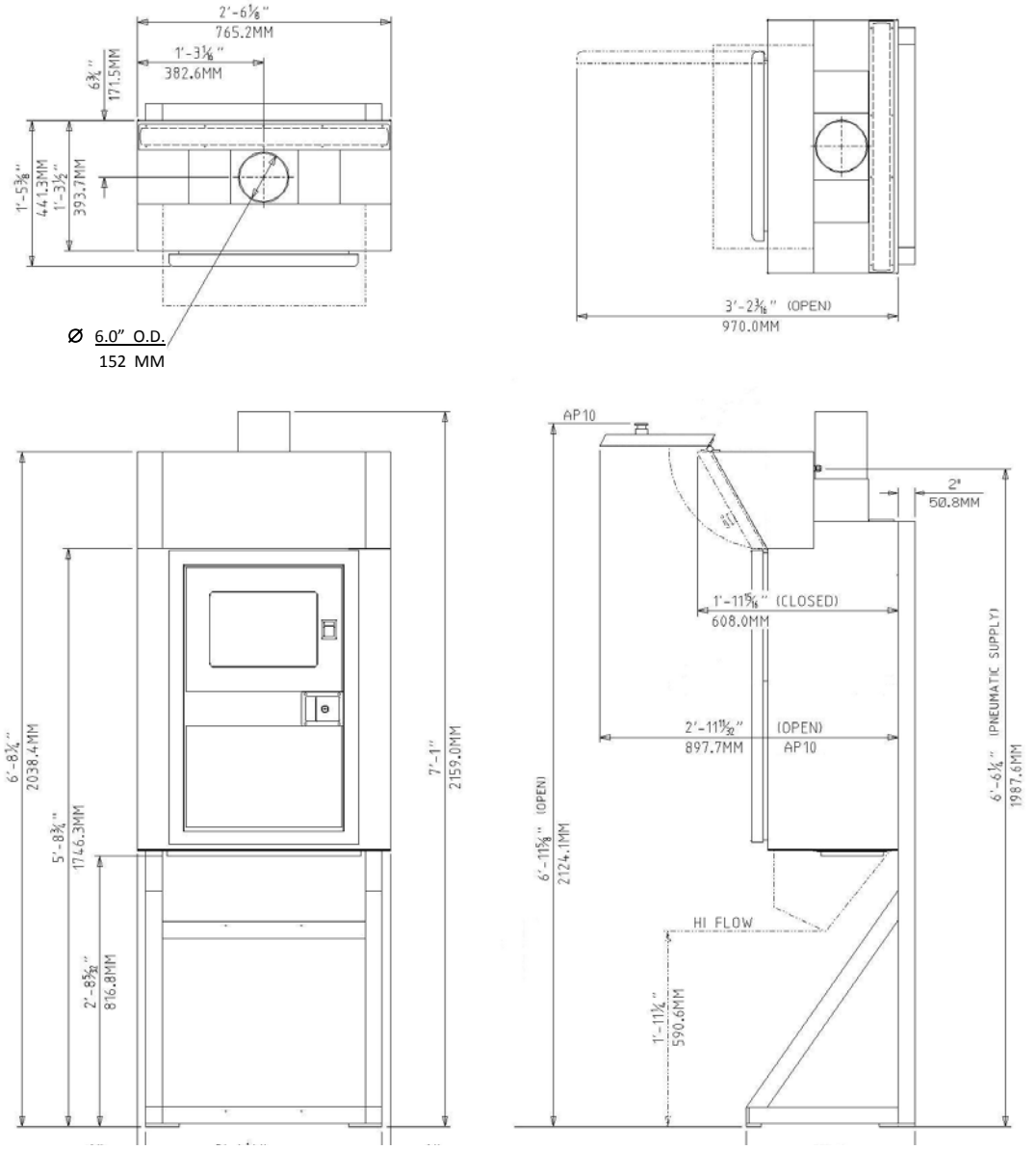
2.1.1.4 – 24” Valve Manifold Panel Wall Mount



Approximate Weight = 200 pounds (90.72 kilograms)

Figure 2.1.1.4: Outline Dimensions
24” Valve Manifold Panel Wall Mount (4 stick)

2.1.2 Outline Dimension Figures for 30” Distribution Systems (6 stick or 8 stick)

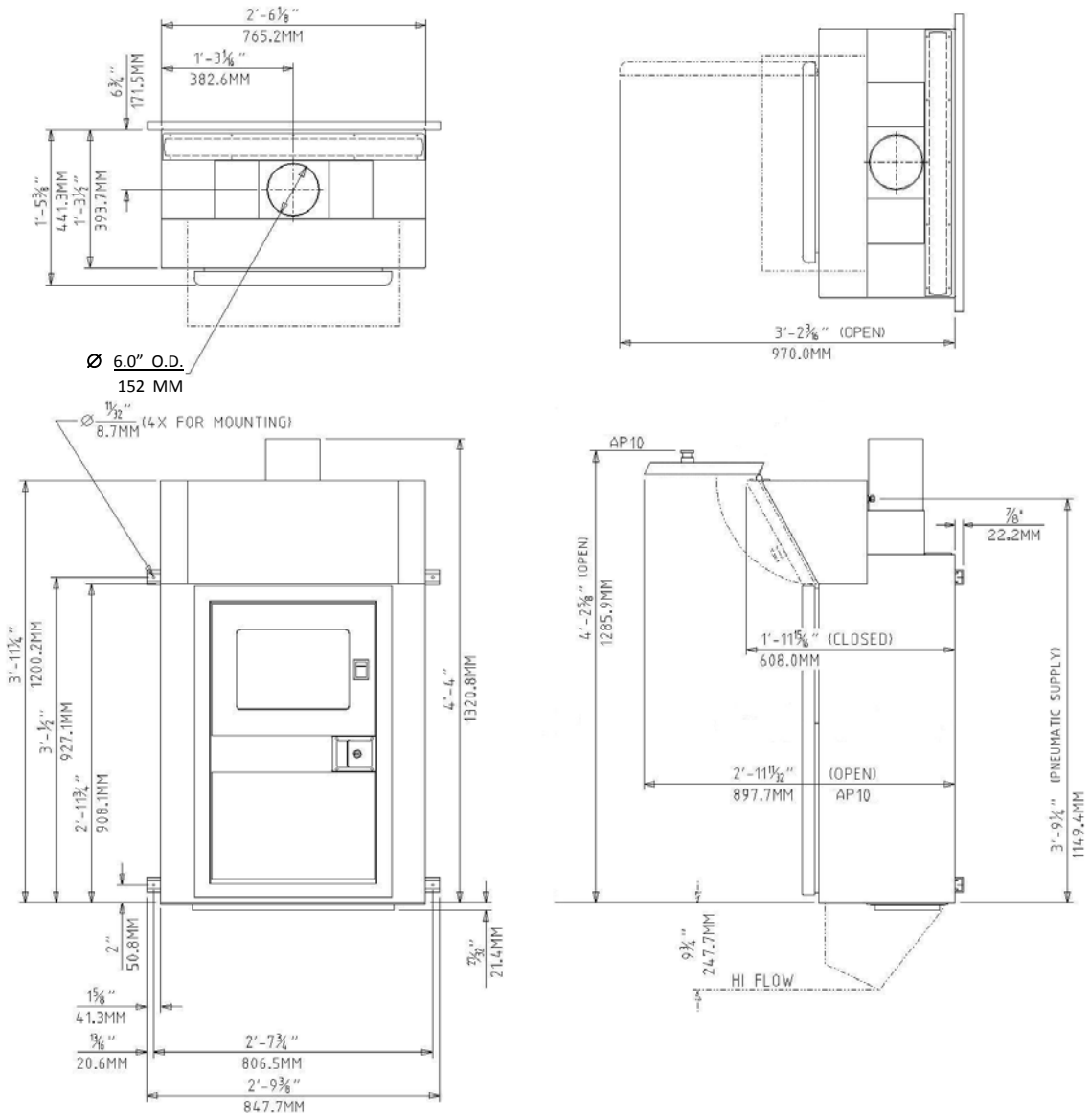


2.1.2.1 – 30” Valve Manifold Box Rack

Approximate Weight = 300 Pounds (136.08 Kilograms)

Figure 2.1.2.1: Outline Dimensions
30” Valve Manifold Box Rack (6 stick or 8 stick)

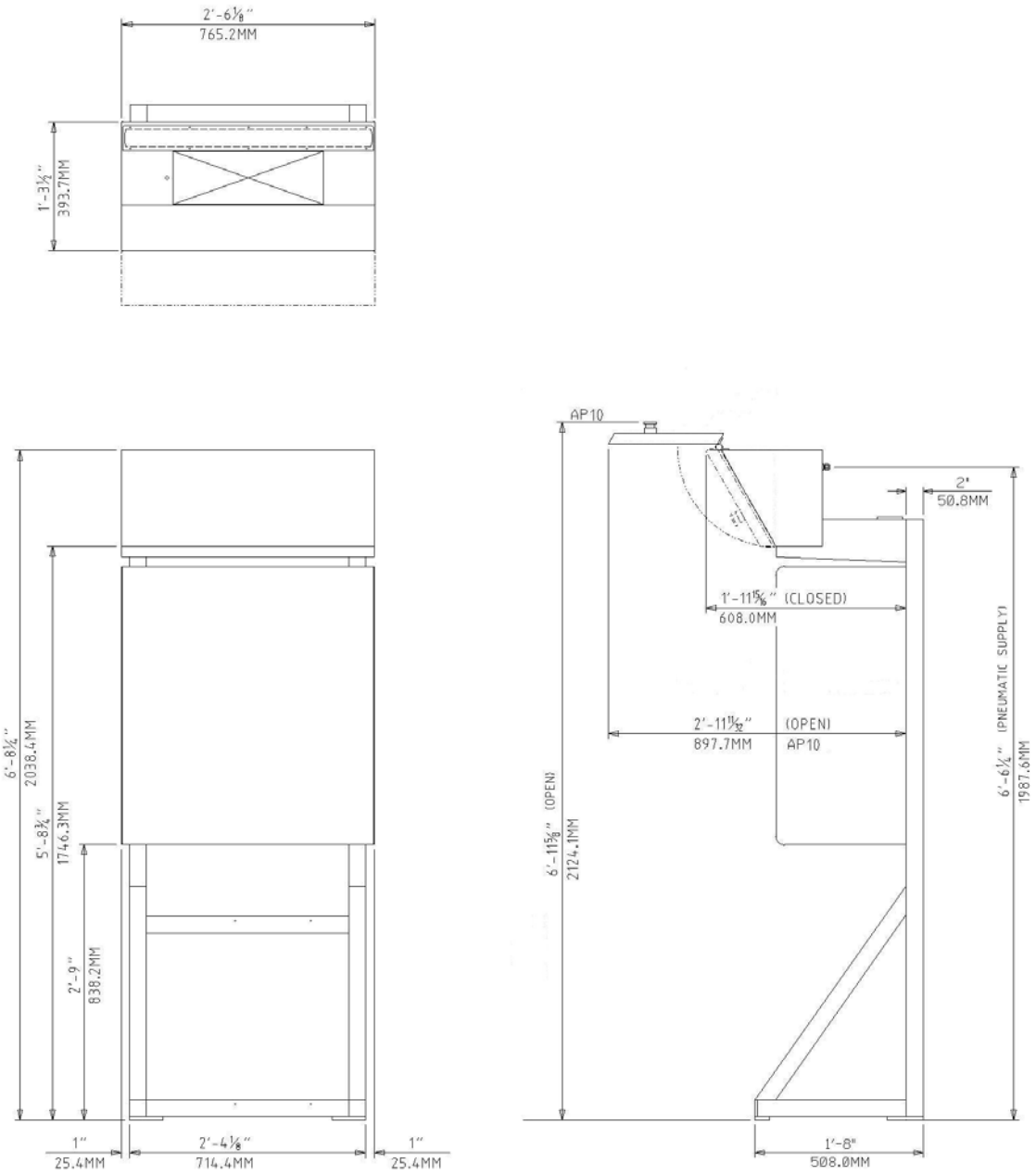
2.1.2.2 – 30” Valve Manifold Box Wall Mount



Approximate Weight = 250 pounds (113.40 kilograms)

Figure 2.1.2.2: Outline Dimensions
30” Valve Manifold Box Wall Mount (6 stick or 8 stick)

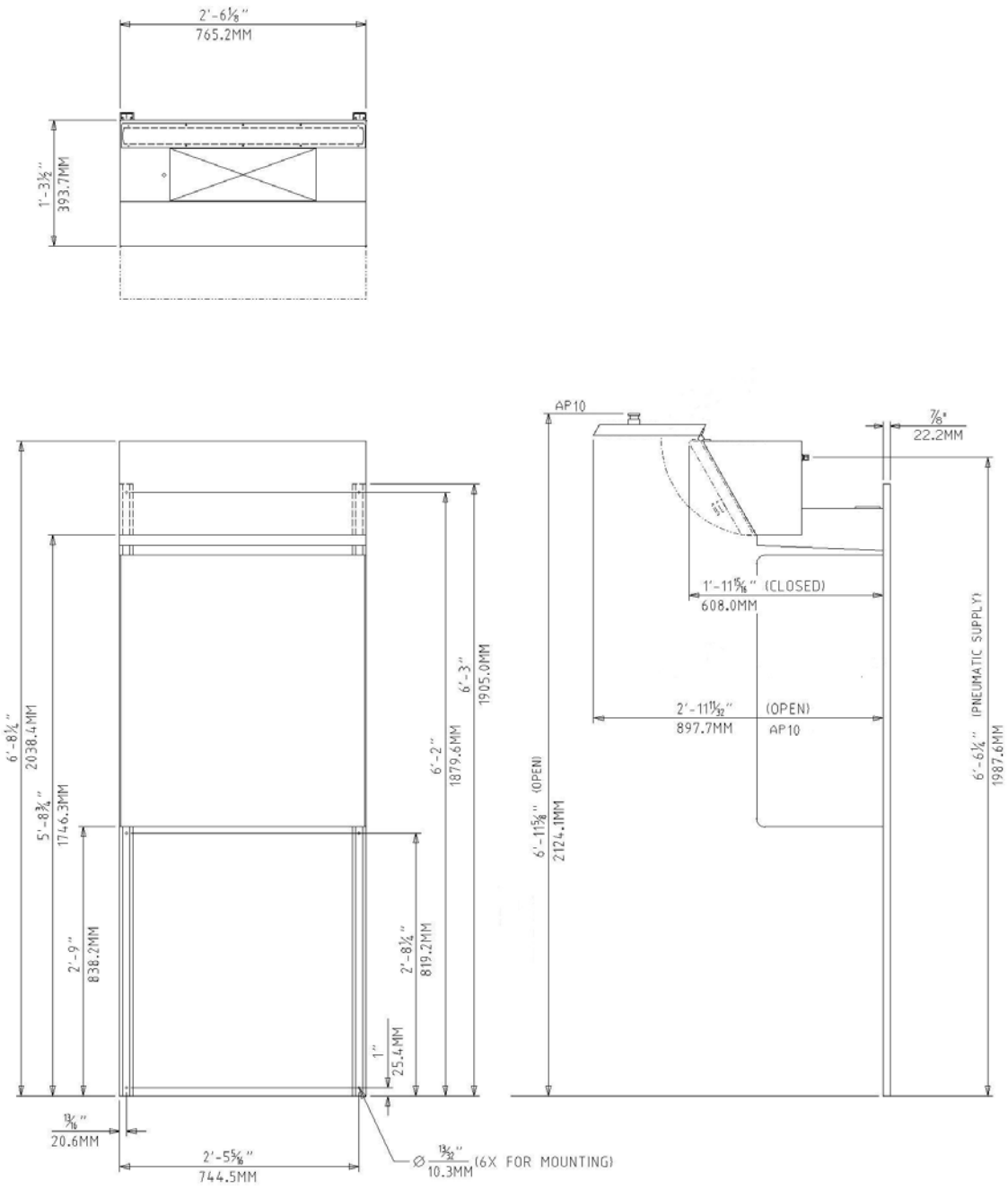
2.1.2.3 – 30” Valve Manifold Panel Rack



Approximate Weight = 300 pounds (136.08 kilograms)

Figure 2.1.2.3: Outline Dimensions
30” Valve Manifold Panel Rack (6 stick or 8 stick)

2.1.2.4 – 30” Valve Manifold Panel Wall Mount



Approximate Weight = 250 pounds (113.40 kilograms)

Figure 2.1.2.4: Outline Dimensions
30” Valve Manifold Panel Wall Mount (6 stick or 8 stick)

2.2 Mounting Hole Locations

The GASGUARD® Distribution System racks are mounted to the facility floor using four (4) anchors, one in each corner of the base.

Highest tension load when resisting tip over is approximately 580 pounds (2580 N) per anchor, as calculated utilizing seismic accelerations specified by SEMI S2-93A. The facility floor mounting location should be clean and must be level.

The GASGUARD® Distribution System Wall Mounts are mounted to vertical walls or supporting structure using four (4) 11/32" (8.7 mm) diameter holes, two (2 ea.) in the horizontal Unistrut® channels mounted to the back of the VMB system assemblies or six (6) 13/32" (10.3 mm) diameter holes, three (3 ea.) in the vertical Unistrut® channels mounted on the back of the VMP system assemblies.

For 24" VMB or VMP rack anchoring see Chapter 2 Section 2.2.1. For 30" VMB or VMP rack anchoring see Chapter 2 Section 2.2.2.

2.2.1 Rack Anchoring for 24” Distribution Systems (4 stick)

For 24” rack anchoring see the following Mounting Hole Location Figure for proper floor location of four (4) 9/16” (14.3 mm) diameter holes in the frame base.

2.2.1.1 – Mounting Hole Locations 24” Valve Manifold Box Rack (4 stick)
or 24” Valve Manifold Panel Rack (4 stick)

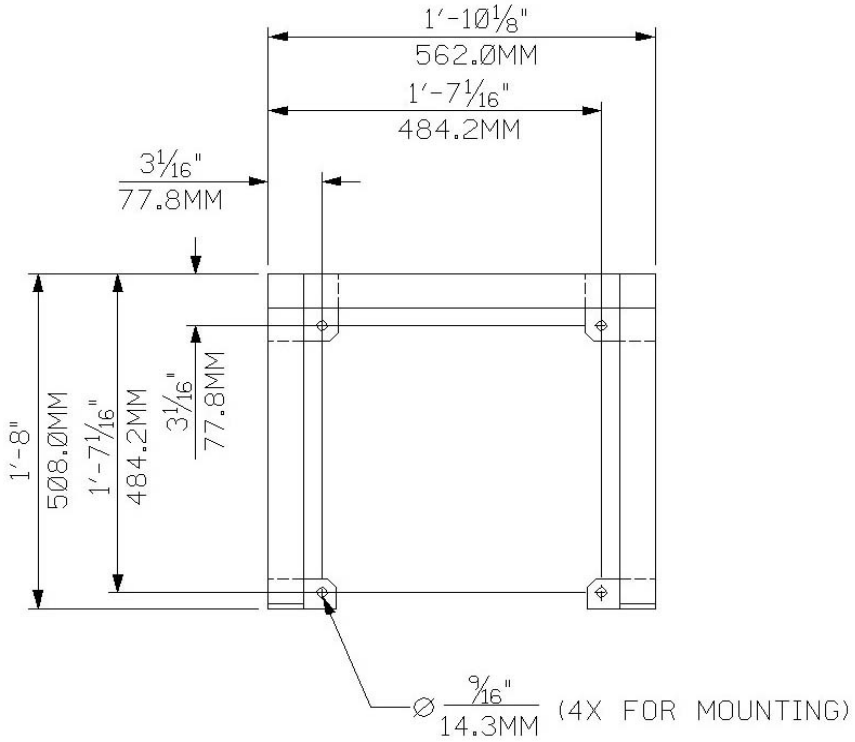


Figure 2.2.1.1: Mounting Hole Locations
24” Valve Manifold Box Rack (4 stick)
or 24” Valve Manifold Panel Rack (4 stick)

2.2.2 Rack Anchoring for 30” Distribution Systems (6 stick or 8 stick)

For 30” rack anchoring see the following Mounting Hole Location Figure for proper floor location of four (4) 9/16” (14.3 mm) diameter holes in the frame base.

2.2.2.1 – Mounting Hole Locations 30” Valve Manifold Box Rack (6 stick or 8 stick) or 30” Valve Manifold Panel Rack (6 stick or 8 stick)

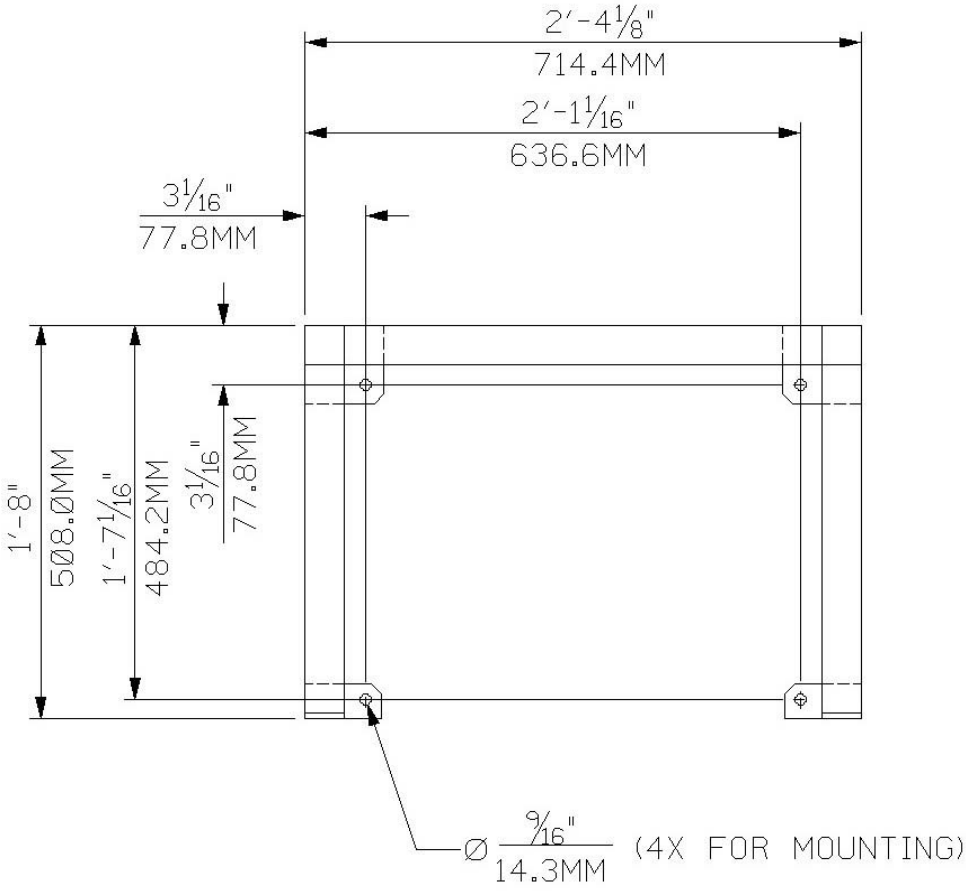


Figure 2.2.2.1: Mounting Hole Locations
30” Valve Manifold Box Rack (6 stick or 8 stick)
or 30” Valve Manifold Panel Rack (6 stick or 8 stick)

Chapter 3

Tubing Connections

All tubing connections to the GASGUARD® Distribution System should be designed and installed in adherence to all local piping codes and should comply with the intent of ASME B31.3 "Chemical Plant and Petroleum Refinery Piping." Tubing must be sized to flow the maximum amount of gas required by the process system. Tubing is normally constructed of 316L stainless steel. Hastelloy C22 is sometimes specified by the customer for corrosive gases. Verify the tubing material type on the Specification Sheet supplied with the order.

All tubing connections are made at the top rear of the distribution system. Connections that terminate with a VCR fitting are either capped or plugged at the factory and are ready for connection to the facility piping. Connections that terminate with open tube ends are bagged for shipping purposes. Process and purge lines are double bagged and taped for shipment. Vent and venturi supply lines are single bagged and taped. All tube ends have been faced and are ready for welding to facility piping. Welding should be performed using established high purity welding techniques. Verify all tubing connections with the flow schematic, or Installation drawing (INS drawing) prior to welding.

Note: When internal terminations are specified, specific inlet/outlets end with VCRs inside of this enclosure. Field installation is made at this point. Refer to Specification Sheet or INS drawing to verify if the internal termination option applies.

3.1 Tubing Interconnections

The following tube connections are recommended for a Gasguard Distribution System:

Process outlet:	1/4" (6.4 mm) diameter, 0.035" (0.9 mm) wall thickness
Optional coax	1/2" (12.7 mm) diameter, 0.049" (1.2 mm) wall thickness
Optional process outlet	3/8” (9.5 mm) diameter 0.035” (0.9 mm) wall thickness
Optional coax	5/8” (15.8 mm) diameter 0.049” (1.2 mm) wall thickness
Optional process outlet:	1/2" (12.7 mm) diameter 0.049" (1.2 mm) wall thickness
Optional coax	3/4” (19.05 mm) diameter 0.065” (1.7 mm) wall thickness
Venturi inlet:	1/4" (6.4 mm) diameter, 0.035" (0.9 mm) wall thickness
Purge inlet:	1/4" (6.4 mm) diameter, 0.035" (0.9 mm) wall thickness
Vent outlet:	3/8" (9.5 mm) diameter, 0.035" (0.9 mm) wall thickness or 1/4" (6.4 mm) diameter, 0.035" (0.9 mm) wall thickness
Bonnet Vent Outlet:	1/4" (6.4 mm) diameter, 0.035" (0.9 mm) wall thickness

Specific piping connections for this system can be found on the INS Drawing. An INS drawing is provided only when specifically requested by the customer. Please contact your Versum Materials, Inc. representative for assistance.

3.2 Process Line Connection

The process line connection can be furnished in one of two configurations: Standard Bulkhead or Coaxial Bulkhead.

The standard bulkhead permits a single process out line to penetrate the enclosure, while providing an acceptable seal for enclosure ventilation purposes. Figure 3.1 shows a standard bulkhead.

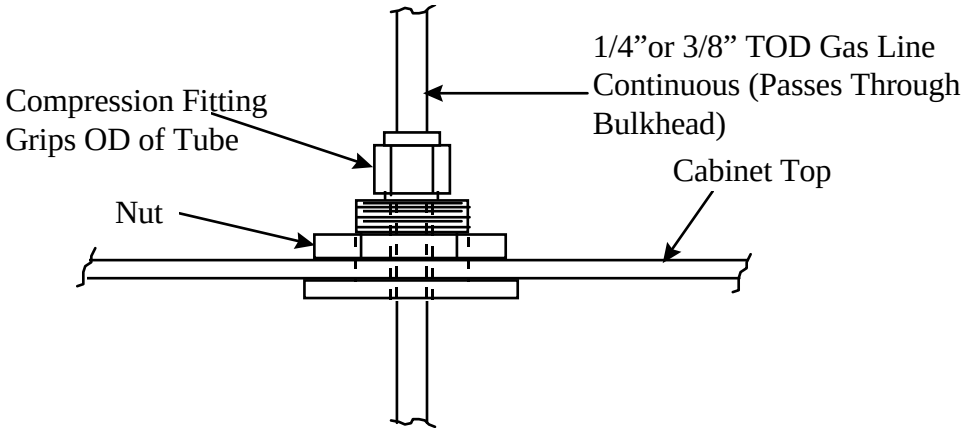


Figure 3.1: Standard Bulkhead

The coaxial bulkhead permits a single process out line to penetrate the enclosure, while providing an acceptable seal for enclosure ventilation purposes. In addition, the coaxial bulkhead provides a termination point for an outer secondary containment tube. The outer secondary containment tube, or jacket, is connected directly to the coaxial bulkhead. The outer secondary containment continues through the coaxial bulkhead and terminates as a branch on the coaxial bulkhead inside the enclosure. This branch on the outer secondary containment may remain open, be dead ended, or be pressurized with inert gas, depending on the method chosen to monitor the secondary containment tube for leaks.

Two methods of monitoring are typically used: gas detection or pressure decay of the annular space. An open or vented annular space is monitored at the open end with a toxic gas detection system (customer supplied), and vented to a scrubbed exhaust system. The pressure decay technique requires the annular space to be pressurized with inert gas (typically nitrogen) above the process gas delivery pressure (typically 100 psig/6.9 barg) and monitored for decay with a pressure switch. Pressure decay indicates either a process gas leak or jacket leak. It is Versum Materials, Inc. recommendation, and standard practice, to configure this alarm as a source system shutdown.

Note: The method of monitoring the outer secondary containment for leaks may be dictated by local codes, such as the Toxic Gas Ordinance.

⚠CAUTION

For coax tubing on silane lines, the pressure decay method with an inert gas (not air) must be used.

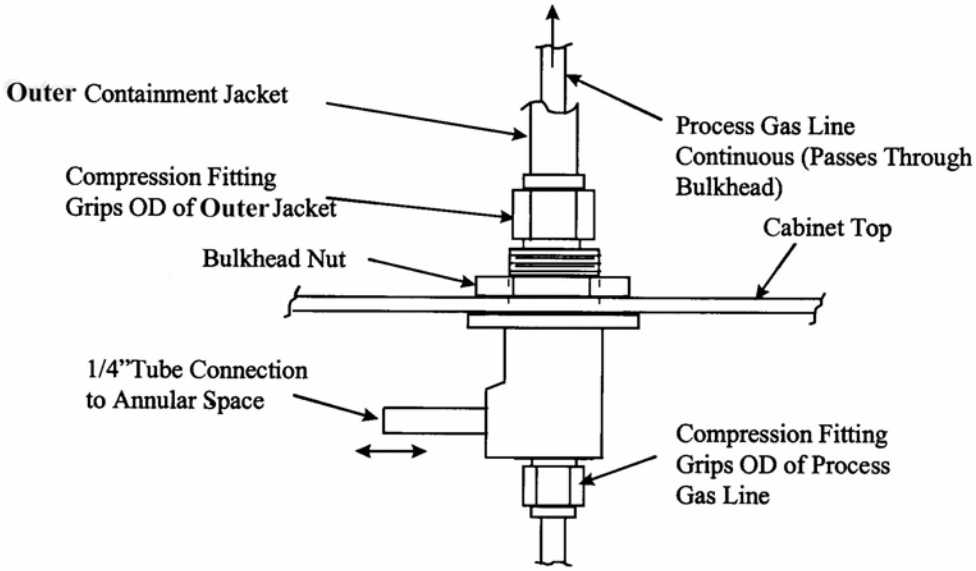


Figure 3.2: Coax Bulkhead

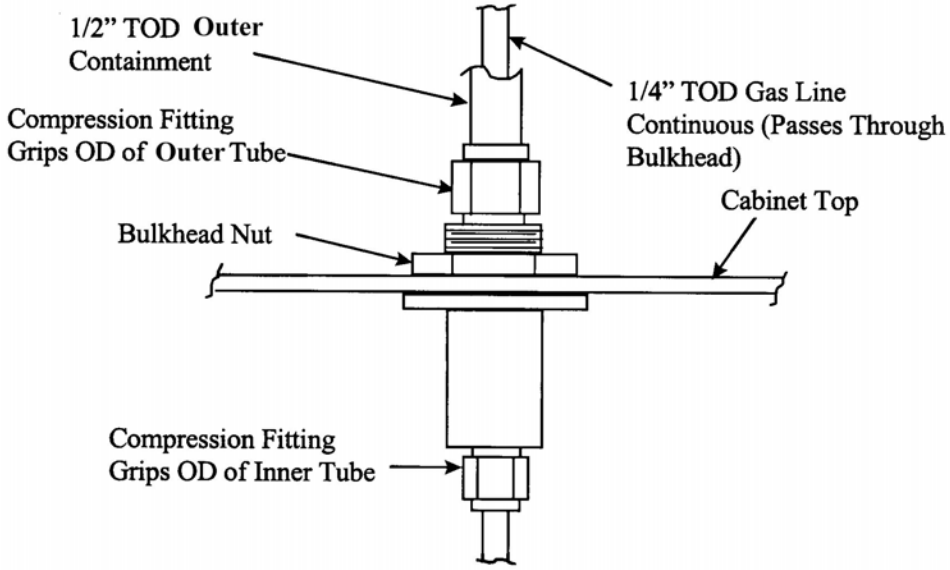


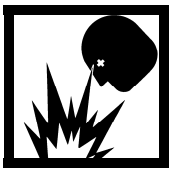
Figure 3.3: Dead End Coax Bulkhead

3.3 Vent Line

3.3a Vent Line

The vent line must be piped directly to an acceptable pollution abatement system designed for the specific gas being vented. Process gas will be introduced into the vent line during the Rough Line stick evacuation cycle. At this time, 50-60 LPM (106-127 CFH) of nitrogen is also being sent into the line through the vacuum venturi loop.

⚠WARNING



Process gas can be introduced to the vent system at any time in the event of certain multiple component failures, therefore the vent line and pollution abatement system should be capable of handling a full process gas cylinder release in the event of catastrophic failure.

When multiple gases are to be vented, ensure compatibility before plumbing vents together. Contact your Versum Materials, Inc. Representative for this information. A nitrogen trickle purge is constantly bled into the vent line to maintain an inert atmosphere when hazardous gases are being used. For this reason, a trickle purge valve, V7, is furnished with a 0.009”(0.25 mm) orifice. The flow rate of this trickle purge is approximately 2-5 LPM (4-10 CFH). Figure 3.4 depicts a typical trickle purge assembly.

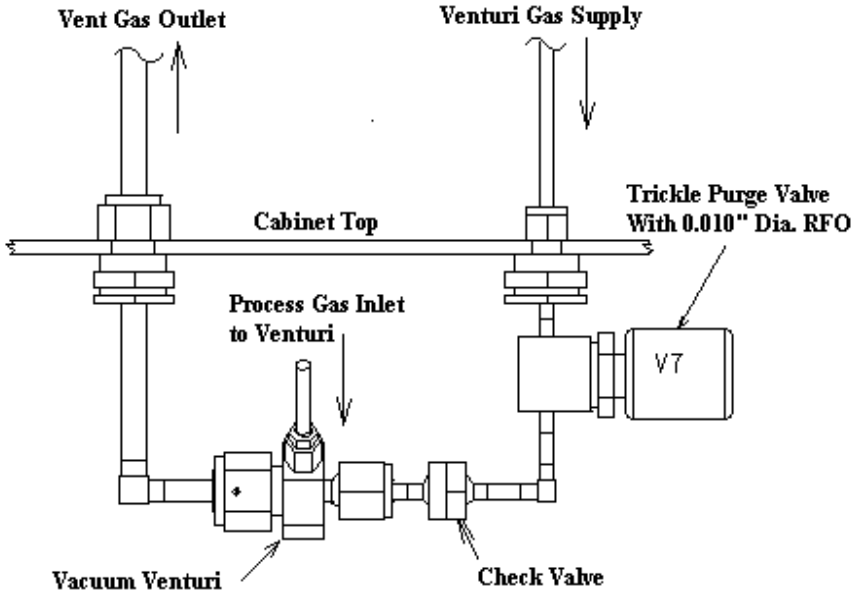


Figure 3.4: Typical Trickle Purge Assembly

3.3b Bonnet Vent Relief Outlet Line

For Open systems (Racks, Wallmounts, VMPs, etc.) containing silane: The Bonnet Vent Outlet must be kept open to allow gas to escape. It must not be sealed or routed into other vent lines. It may be covered with a loose fitting cap to prevent water intrusion provided that it does not prevent gas from escaping. If the standard outlet location is directed in an unsafe manner (i.e. towards flammable construction materials, personnel walkways, etc.) or presents another potentially unsafe situation the outlet must be rerouted to a safe location during installation. Gas detectors and/or UV/IR detectors should be used in the surrounding area to monitor for a potential leak.

For Enclosed systems (Cabinets, VMBs, etc.) containing silane: The Bonnet Vent Outlet must be kept open to allow gas to escape into the exhaust system. It must not be sealed or routed into other vent lines. Downstream ventilation dampers must not be designed to fail closed or close on gas detection. The bonnet vent outlet should be located upstream of the exhaust gas monitor to detect a potential leak.

Reference PTB 2002-02, ” Silane Regulator Bonnet Vent Routing” Rev B.

3.4 Venturi Line

Versum Materials, Inc. strongly recommends separate venturi supply source rather than a houseline source.

Most process cylinder pressures are significantly higher than houseline operating pressures. In the event of multiple failures of certain process panel components, there is a remote possibility of back contamination of the houseline source connected to the vacuum venturi.

Contact your Versum Materials, Inc. representative for design details.

The venturi line requires 75-95 psig (5.2-6.6 barg) of nitrogen to adequately produce the vacuum needed during purge cycles. The supply is usually taken from a bulk liquid source, but it can also originate from a cylinder manifold system. The vacuum generator will demand a flow of 50-60 LPM (106-127 CFH) of nitrogen during purge cycles.

Venturi Vent Line Sizing

The vacuum venturi is extremely susceptible to vent line back pressure, and cannot tolerate more than 0.5 psi back pressure. If back pressure exceeds 0.5 psi, the AP10 controller will fail and abort the purge sequence on insufficient vacuum. It will be impossible to continue until the restriction is eliminated. The recommended vent line sizes below should be used when installing the vacuum venturi vent line. Transitions to larger tubing should be made within 1 ft. of the piping enclosure.

Recommended Vent Line Sizes:

Line Length Minimum Recommended Tube Diameter
1 ft. through 5 ft. 1/2" tube
5 ft. through 100 ft. 3/4" tube
100 ft. through 400 ft. 1" tube
Over 400 ft. 1-1/2" tube

The venturi vent line must be piped to a safe location away from personnel exposure. It is recommended that the customer consult and design the vent system to all applicable codes. The emergency vent discharge opening should be constructed to prevent blockage from weather and animals. Vent gases will be introduced into the emergency vent lines whenever a purge or conditioning sequence is run. Do not combine vent lines, instead, route individual vent lines to an appropriately sized vent header.

3.5 Purge Line

A purge line or nitrogen purge cylinder may be the source of purge gas for the distribution system. This purge line must be connected to a designated purge source for the distribution system. The typical pressure required during purging is 80-90 psig (5.5-6.2 barg) for most gases, 70-80psig for very low vapor pressure gases, and 20-30 psig for acetylene VMBs. If an external purge source is used, sufficient over pressure protection must be provided. Do not exceed the distribution system component maximum allowable working pressure (MAWP) in the event of purge source regulator failure.

⚠CAUTION

The purge gas source for the GASGUARD® Distribution System should be used only to purge other gas source systems or VMBs handling the same process gas. It must not be used to purge systems handling incompatible process gases. It is recommended that the purge gas cylinders be placed in an exhausted enclosure. Purge gas must not be supplied from a low pressure bulk gas source.

3.6 Pneumatic Supply

A pneumatic supply of inert gas without oxygen is recommended for our controllers. **It is strongly recommended to not use clean dry air for pneumatic supply.** The pneumatic supply may be shared in the controller between the pneumatic solenoids and the enclosure inerting/pressurizing service (Z-purge). Clean dry air may promote the corrosion of electrical connectors for interconnecting power cables. The presence of oxygen enhances the corrosion effect and may result in deterioration of controller performance.

This nitrogen supply needs to be regulated to 85-95 psig (5.9-6.6 barg). The flow rate required for pneumatic valve operation is negligible. If compressed air is used as the pneumatic source, the compressor shall be located in a non-classified area. If the air intake line for the compressor passes through a classified location, the line shall be made of a non-combustible material designed to prevent leakage and protect against mechanical damage. If electrical power for the purge air is required, this power shall be on a separate disconnect or before the gas ***distribution system*** disconnect.

In NEC Class I, Division 2 applications (in U.S.A.) and in ATEX Zone (Group) 2, Category 3 (in Europe) this supply is also used for Type Z purge of the electrical enclosure. The Type Z purge is required to

maintain a positive pressure at or above 0.1" H_2O (24.9 Pa) as dictated by the National Fire Protection Agency (NFPA) and the European directives (ATEX). In applications where Type Z purge is required, the controller will be equipped with a pressure switch to monitor the pressure. The Type Z purge will require a flow rate of approximately 2.5-2.8 LPM (5-6 CFH).

Typically this supply is taken from a houseline nitrogen source. A 1/4" Swagelok® connection at the back of the controller is provided for the pneumatic supply inlet connection as shown in Figure 3.5. Piping for the pneumatic supply must be protected from mechanical damage. Maximum allowable working pressure is 100 psig (6.9 barg). Over-pressurization protection, such as a safety relief valve, must be provided for the internal solenoids.

⚠CAUTION

Solenoids may be damaged and system valves may fail to close if pneumatic pressure exceeds 100psig.

3.6.1 Z-purge Procedure

The Z purge pressure is controlled by a needle valve at rear of controller. After opening the controller in a suspected hazardous area it is necessary to use the following procedure to re-establish the Z-purge before operating the controller:

1. Close the controller front and tighten both latches completely.
2. Open the needle valve 4 to 5 turns (counter-clockwise). Allow the controller to purge for 20 minutes.
3. Adjust needle valve to satisfy the "Z-Purge" alarm (approximately 2 total turns open).

Flow requirements to operate the solenoid valves are very small, less than 1 LPM (2 CFH). If Type Z purge is required, a flow rate of 3-10 LPM (6-21 CFH) will be needed, depending on the tightness of the individual controller and the installation.

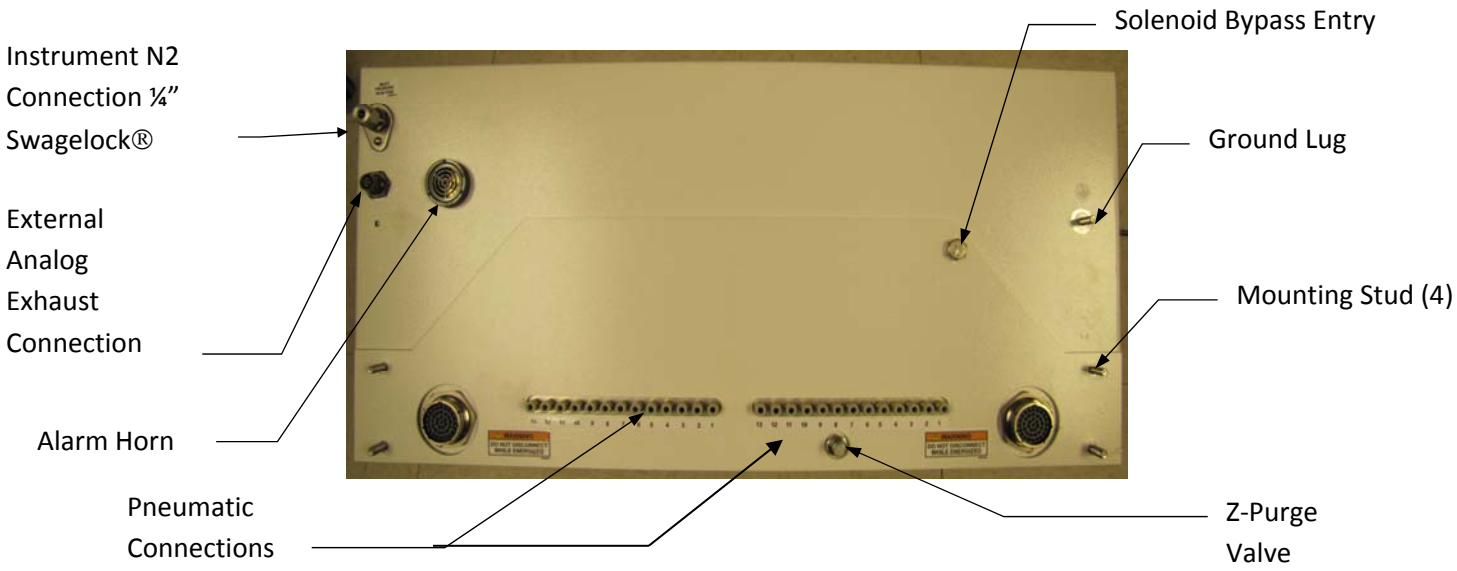


Figure 3.5: Rear View of GASGUARD® AP11 Controller

3.7 Enclosure Exhaust System Requirements

1. In order to meet SEMI S2 criteria in HPM (Hazardous Production Material) gas service, the enclosure should control emissions into the room to less than 25% TLV (Threshold Limit Value) of the HPM gas in the event of an internal leak.

2. In order to meet NFPA criteria (U.S.A. only) in HPM gas service, air velocity across the opened access hatch (where access window is used) must meet the following velocity requirements to minimize potential operator exposure to hazardous gas: 200 feet per minute average, with 150 feet per minute minimum at any point (61 meters per minute average, with 46 meters per minute minimum).

⚠CAUTION

When the complete VMB door is fully opened, face velocity requirements are not met. For enclosures with full door access only (i.e., VMB's without an opening window/access port) it must be verified that no hazardous leak exists prior to opening the door. Any suspected or detected leak must be isolated upstream at the source system or via local pneumatic control valves within the VMB, before opening the door. Do not open VMB door until leak has been isolated.

3. In order to meet NFPA (U.S.A. only), CGA G-13 and Versum Materials, Inc. minimum recommended safety requirements for enclosed Silane gas service, volumetric air flow through the cabinet must be at least 250 times the maximum potential leak rate.

⚠WARNING

The values listed in the tables below should serve as a guideline for reference only. Enclosure ventilation systems must:

(1) Be designed, installed, and balanced to suit individual facility requirements.

(2) Comply with applicable local, state, and federal codes.

This exhaust system must be independent of any general plant exhaust system and must be designed for the types of gases being used. Ensure only compatible gases are fed into each exhaust system. Be certain the exhaust system power and shut down interlocks comply with all applicable local, state, and federal codes (i.e., UFC and NFPA code in U.S.) Requirements.

The tables below list the exhaust requirement for the GASGUARD® VMB enclosure to meet IFC and NFPA code requirements.

The tables below list the exhaust requirement for the GASGUARD® enclosures to meet the above code requirements.

Silane Exhaust rates apply to GASGUARD® Source System supplied VMBs only. VMBs supplied by a bulk source must have a 0.040 inch or smaller orifice installed in the inlet connection in order to use these rates.

Table 1: Minimum Exhaust Requirements for GASGUARD® High Flow Enclosures Containing Silane to meet NFPA and CGA Requirements of 250x Potential Leak Rate Dilution

	Access Port Closed			Access Port Open		
Enclosure Size [1]	exhaust flow (cfm)	static pressure (in H20)	velocity pressure (in H20)	exhaust flow (cfm)	static pressure (in H20)	velocity pressure (in H20)
4 Stick (24 inch) high flow VMB	625	-0.8	0.63	625	-0.8	0.76
8 Stick (30 inch) high flow VMB	625	-0.8	0.64	625	-0.8	0.76

Notes: [1] All vent stack duct sizes are 6 inch (154 mm) diameter.

[2] "Access Hatch Open" values produced average velocities greater than 200fpm the access hatch opening at all points.

[3] No Baffles were used on window or in interior.

[4] Exhaust rates apply to Gasguard Source System supplied VMBs only. VMBs supplied by a bulk source must have a 0.040 inch or smaller orifice installed in the inlet connection in order to use these rates.

Table 2

Minimum Exhaust Requirements for GASGUARD® High Flow Enclosures Containing Disilane (Dilution of maximum potential leak to < ½ LFL)

	ACCESS HATCH CLOSED [2]						ACCESS HATCH OPEN [3]			
Enclosure Size [1]	exhaust flow (cfm)	static pressure (in H20)	velocity pressure (in H20)	exhaust flow (m3/m)	Static pressure (Pa)	velocity pressure (Pa)	exhaust flow (cfm)	velocity pressure (in H20)	exhaust flow (m3/m)	velocity pressure (Pa)
24 inch high flow VMB	375	-0.4	-0.23	10.6	-100	-57	400	-0.26	11.3	-65
30 inch high flow VMB	450	-0.5	-0.33	12.7	-124	-82	470	-0.36	13.3	-90

Table 3: Exhaust Recommendations for Gasguard Equipment Containing

Gases with a TLV ≥ 0.20 ppm (25% TLV > 0.050 ppm) except SiH4, Si2H6, and SiH3Cl

	Access Port Closed				Access Port Open					
	Maximum ERC **[1]**	Exhaust Flow	Static Pressure	Velocity Pressure	Exhaust Flow	Velocity Pressure	Average Duct Velocity	Minimum Face Velocity	Average Face Velocity	Baffle
	ppm	*scfm*	*inches H2O*	*inches H2O*	*scfm*	*inches H2O*	*fpm*	*fpm*	*fpm*	
No ESI **[2]**	0.029	75	-0.5	0.05	318	0.255	1622	180	220	None
ESI	< 0.029	75	-1.5	0.15	237	0.775	1210	210	236	33%

Notes: [1] ERC (Expected Release Concentration) values are taken from actual test data.

[2] ESI (Exhaust Stack Insert) may have been specified by the customer to enhance the readability of the exhaust pressure monitor. Refer to the system's Specification Sheet to determine if this option is used.

[3] These exhaust flow values are applicable to the 30 inch and 24 inch standard flow Gasguard VMB enclosures.

[4] All standard Gasguard enclosures are sized for a 6 inch outer diameter (OD) duct connection to the vent stack.

[5] "Access Hatch Closed" values have been measured, or calculated at the exhaust stack duct.

[6] The actual values presented in "Access Port Open" are from experiments done on a two-cylinder source system enclosure. Due to the similar design and smaller access port of the VMB enclosure, balancing to Tables 3 and 4 will satisfy meet or exceed NFPA face velocity requirements on enclosures equipped with an openable window.

Table 4: Exhaust Recommendations for GASGUARD® Equipment Containing

Gases with a TLV between 0.050 and 0.20 ppm (25% TLV: 0.0125 - 0.050 ppm) except SiH4, Si2H6, and SiH3Cl

[Includes the following pure (100%) gases: Chlorine Trifluoride, Diborane, Arsine]

	Access Port Closed				Access Port Open					
	Maximum ERC **[1]**	Exhaust Flow	Static Pressure	Velocity Pressure	Exhaust Flow	Velocity Pressure	Average Duct Velocity	Minimum Face Velocity	Average Face Velocity	Baffle
	ppm	*scfm*	*inches H2O*	*inches H2O*	*scfm*	*inches H2O*	*fpm*	*fpm*	*fpm*	
No ESI **[2]**	0.007	120	-0.5	0.01	272	0.14	1392	240	266	33%
No ESI	< 0.007	120	-1	0.05	349	0.26	1783	200	248	None
ESI	< 0.007	120	-1	0.2	214	0.55	1095	180	216	33%
ESI	< 0.007	120	-1.5	0.2	270	0.94	1380	180	200	None

Notes: [1] ERC (Expected Release Concentration) values are taken from actual test data.

[2] ESI (Exhaust Stack Insert) may have been specified by the customer to enhance the readability of the exhaust pressure monitor. Refer to the system's Specification Sheet to determine if this option is used.

[3] These exhaust flow values are applicable to the 30 inch and 24 inch standard flow Gasguard VMB enclosures.

[4] All standard Gasguard enclosures are sized for a 6 inch outer diameter (OD) duct connection to the vent stack.

[5] "Access Hatch Closed" values have been measured, or calculated at the exhaust stack duct.
[6] The actual values presented in "Access Port Open" are from experiments done on a two-cylinder source system enclosure. Due to the similar design and smaller access port of the VMB enclosure, balancing to Tables 3 and 4 will satisfy meet or exceed NFPA face velocity requirements on enclosures equipped with an openable window.

Table 5

Monochlorosilane (SiH3Cl)

	Access Port Closed		Access Port Open	
enclosure size [1]	Exhaust flow (cfm)	Static pressure (in H20)	Exhaust flow (cfm)	Average Duct Velocity (fpm)
Standard Flow VMB, 30 inch and 24 inch	225	-1.6	320	3100

Notes: [1] All vent stack duct sizes are 6 inch (154 mm) diameter.

3.7.1 Exhaust Flow Clarifications and Definitions:

1. Silane and disilane enclosures are equipped with an extended high flow floor which contains the UV/IR and provides increased ventilation area. Reference Chapter 2 for illustration. Do not block air inlets.
2. High-impact polycarbonate baffles are not supplied, or available for the access hatch of 1 cylinder standard flow cabinets, high flow Silane VMBs, or high flow Disilane VMB's.
3. The throat diameter of all enclosures is 6" inches. The building ventilation system will likely require a larger duct size diameter. Building ventilation systems must (1) be designed, installed, and balanced to suit individual facility requirements, and (2) comply with applicable local, state, and federal codes.
4. Definitions:

   Static pressure - The suction pressure provided by the exhaust system measured near the entrance of the 6" (154 mm) OD round exhaust duct. Static pressure does not provide a verification of exhaust flow. See velocity pressure.

Velocity pressure - Moving air creates a force, or pressure component, that can be measured by means of a pitot tube and differential pressure measuring device such as a pressure switch or pressure transmitter. These devices can be used to verify exhaust flow and provide a visual, digital, or analog signal; they only provide an approximation of the exhaust flow rate. They cannot provide an accurate measurement of exhaust flow due to their location and air flow characteristics in the round exhaust duct located on the enclosure.

High-impact polycarbonate baffle - A clear high-impact polycarbonate window closing off 33% of the access hatch area when the window is opened. This baffle reduces air flow requirements through the hatch.

Figure 3.6 shows the typical exhaust hook-up location. See the Installation Drawing (INS) for specific location and size of exhaust duct on valve manifold enclosure. An INS drawing is provided only if specifically requested by the customer.

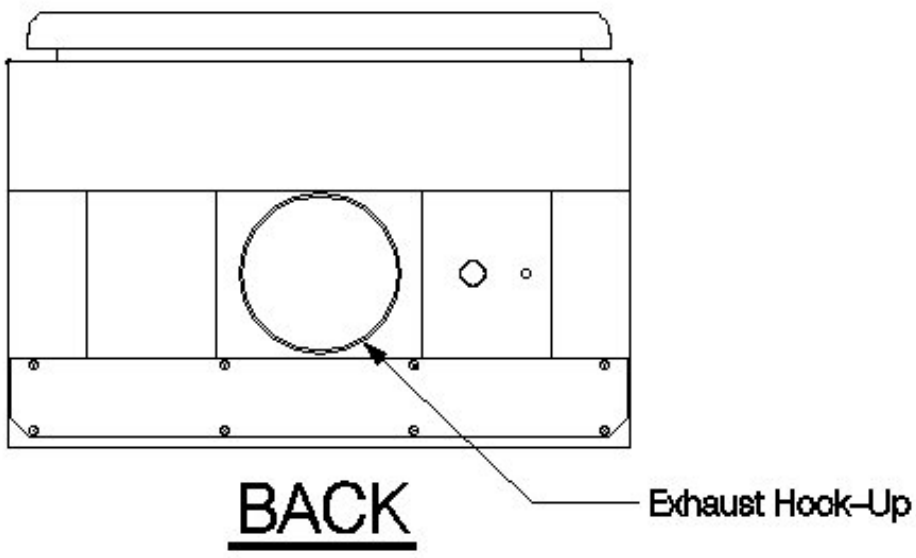


Figure 3.6: Exhaust Hook-Up Location

3.8 Weld Shield Gas, Purge Gas Connection (Optional)

This VCR connection port provides a convenient point to introduce inert shielding gas for welding, purge gas and certification gas during installation and testing of the distribution system. The connection is teed from the purge gas inlet line and includes a manual shut-off valve, "Weld Gas Inlet" (MV32 or MV30). It is located on the inside right of the enclosure where temporary tubing can be inserted and connected to the VCR fitting. When the temporary gases are no longer required, the valves should be closed and the VCR connection capped.

Do not connect high pressure gas directly to the weld gas port. A pressure reducing regulator with a maximum delivery pressure of 100 psig (6.89 barg) should be used on the high pressure inert gas supply. A safety relief device set at 150 psig (10.34 barg) should be installed downstream of the pressure regulator.

3.9 Helium Leak Test Port (Optional)

A helium leak test port may be provided on the vent header for connection to a helium mass spectrometer. Two manual valves are included in the assembly. The Leak Test Isolation Valve (MV31) isolates the helium leak test port, and the Vent Isolation Valve (MV22 or MV32) isolates the downstream vacuum venturi/vent system to achieve vacuums required for inboard leak testing upstream. An access hole is provided for insertion of the vacuum hose from the leak detector into the enclosure for hookup to the VCR port. When leak testing is complete, the Leak Test Isolation Valve (MV31) must be closed and the VCR port capped. The Vent Isolation Valve, (MV22 or MV32), should be opened and left open during normal operation of the distribution system.

This port is for vacuum service only. Do not connect pressurized gas to this port.

3.10 Hazardous Gas Leak Detection System (Customer Requirement)

A gas leak detection system must be installed by the customer for all toxic gases used in the distribution system. The detection points must include the interior of the distribution system and the upstream source cabinet. If a leak is detected, the system must provide a signal that will alarm and shutdown the distribution system and/or the gas cabinet, if dictated by local codes. See specific I/O field wiring drawings provided in the document envelope, supplied with this manual.

A hydride leak detection system is highly recommended for silane and other pyrophoric gases. Although these gases will normally ignite and burn immediately when they leak to atmosphere, under certain conditions they can pocket and detonate with devastating force. A hydride monitor can detect leaking silane and shutdown the system eliminating or reducing the risk and size of explosion.

When located indoors, a flammable gas detection system must be installed by the customer for all flammable gases used in the distribution system. The detection points must include the interior of the distribution system and when an enclosure is used. When no enclosure is used, area monitors may satisfy the requirement. If a leak is detected, the system must provide a signal that will shutdown the distribution system if dictated by local codes. If no local controller is used, the alarm must shutdown the upstream source equipment if dictated by local codes. When the system is sited outdoors, no monitor is required.

Chapter 4

Electrical Connections

All electrical connections must comply with Article 300 - Wiring Methods and Article 500 - Hazardous (Classified) Locations of the National Electric Code (NEC), if installed in the United States. Reference to the use of this equipment in Hazardous Locations only applies to installations located within the United States of America. These systems are also Explosive Atmosphere Directive approved for use in the European Community and have been reviewed by a third party test lab.

Range of Environmental Conditions:

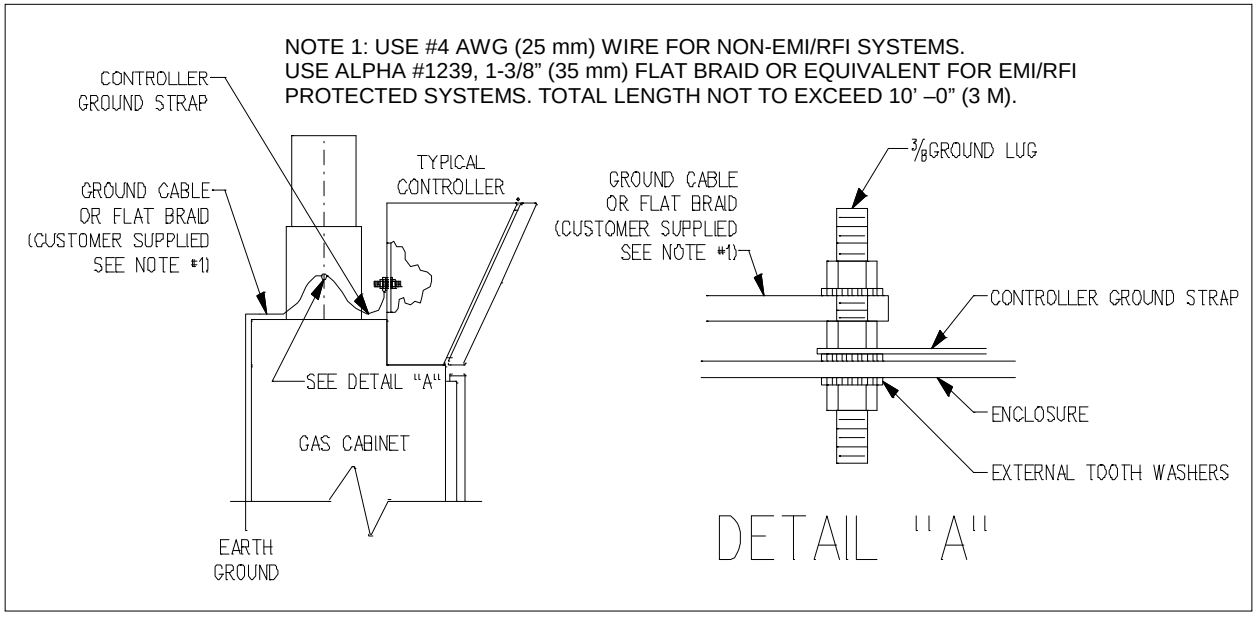
- -20 to 60° C Optional Outdoor Temperature Range
- 95% Maximum Relative Humidity
- 2000 Meters Above Sea Level, Maximum
- 100 to 240 VAC Nominal Voltage Range, 3 wire, 50 to 60 Hertz
- ± 10% Fluctuation of Nominal Voltage Range
- Short Circuit Current Rating (SCCR) is 10 kA

4.1 Grounding Method

The equipment must be grounded in accordance with Article 250 - Grounding in the National Electrical Code, if installed in the United States. The customer is responsible for connections to earth ground. A ground connection is supplied in the controller for this purpose.

On the plenum of the enclosure there is an additional split bolt terminal for connection hookup to the facilities grounding network. Figure 4.1 shows a suggested grounding method for a typical system. This drawing may not be applicable to your specific system.

Figure 4.1: Suggested Grounding Method



Use of #4 AWG ground wire will not maintain CE marking. Use Alpha #1239, 1-3/8" flat braid or equivalent for CE marked systems (total length not to exceed 10 feet or 3 meters).

After grounding the overall resistance must be measured. This resistance for the equipment ground to the grounding electrode should not exceed one ohm (1Ω). Check the effectiveness of grounding by using a ground resistance meter (i.e., an AEMC clamp on ground resistance tester or equivalent).

4.2 Power Supply Connection

Each GASGUARD® System should be installed with an independent external circuit interrupting device to remove power from the unit when maintenance on the controller is required and should be Lockout/Tagout capable. This device should be rated as a minimum at 240 volts, 3 amps, 50/60 Hz and 10,000 rms symmetrical ampere interrupting capacity. The device should be accessible to the operators, marked as the disconnecting device for the gas distribution system, and must have the on/off position clearly marked for the operator, and should be near the distribution system.

The power input must be wired to the terminals shown below. For additional detail on the power connection, see Figure 4.2a, 4.2b, depending on your configuration.

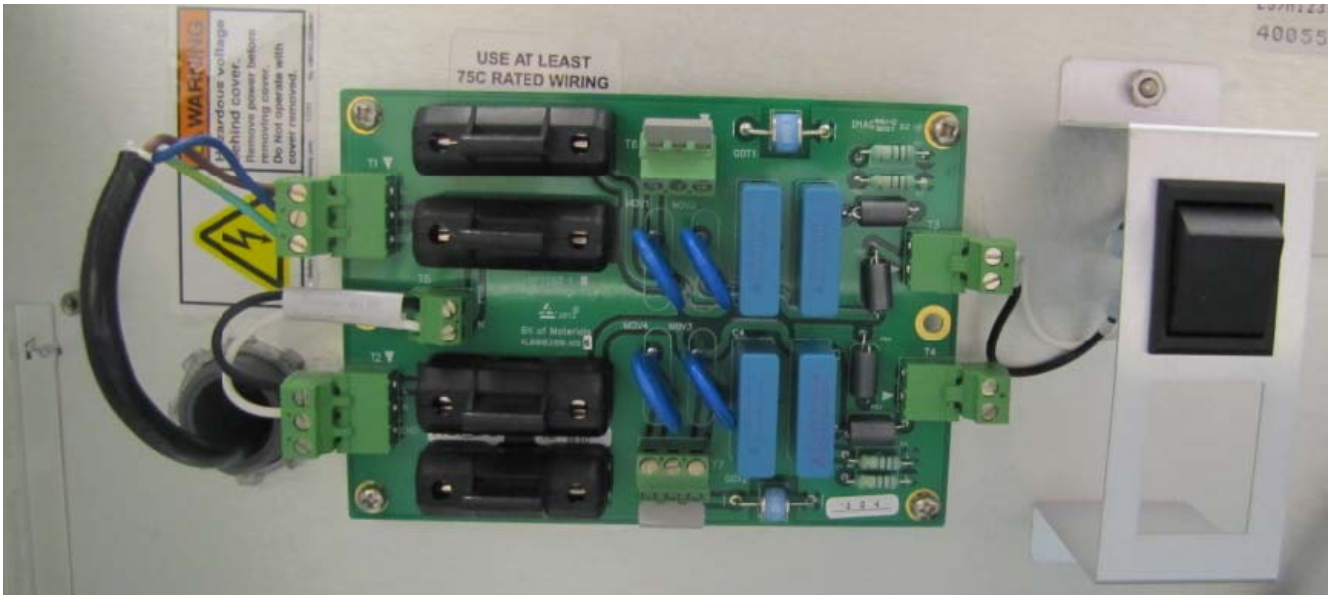


Figure 4.2a: Single Power Supply Terminal Connection

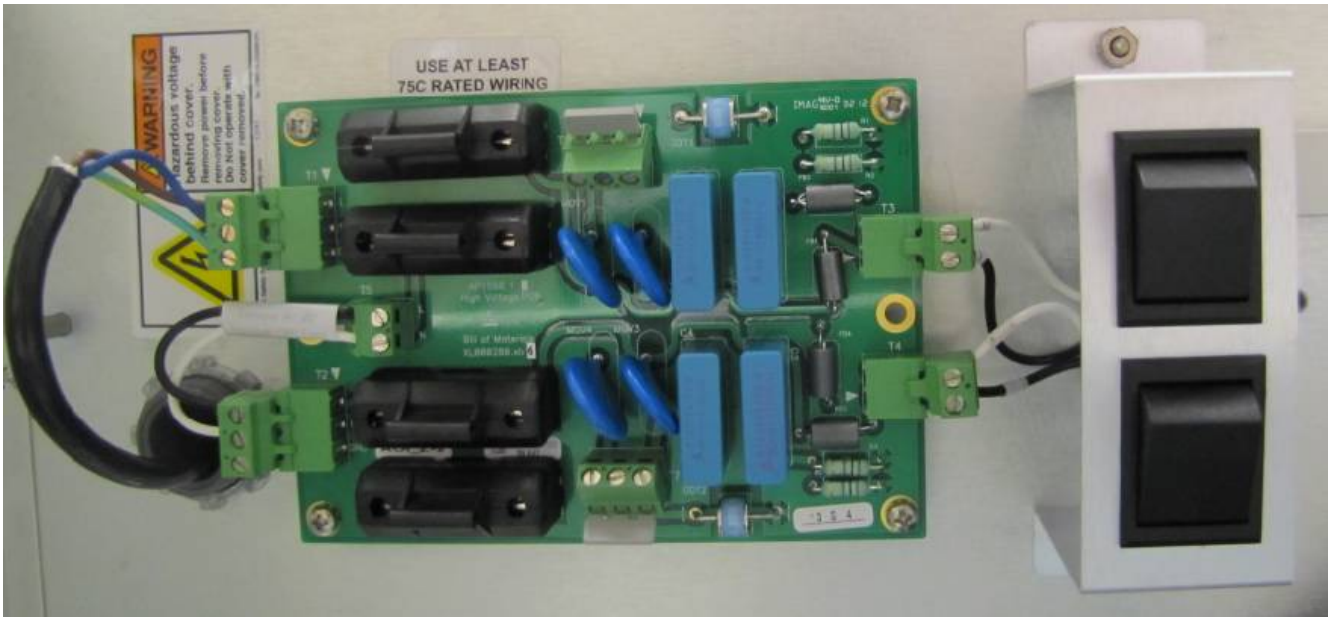


Figure 4.2b: Dual Power Supply Terminal Connection

The power requirements are as follows:

100-240 VAC @ 150 VA maximum, 3 wire

The controller power is the same for idle, average, and peak and is less than 0.125 KW.

NOTE: Power wiring must be sized to deliver the required voltage at the rated current. Voltages should be checked at each cabinet after installation to ensure proper levels. Wire size should not exceed 12AWG (3.3 mm^2). An optional kit is available to allow use of 10AWG (5.26 mm^2) wire.

Replaceable fuses - F1a, F2a, F3a, and F4 located on the power board are 4A super quick acting fuses. See the Spare Parts List in Chapter 11 for Manufacturer and part number specifications.

Use at least 75C rated wiring for the mains supply.

4.3 Field Connections

In NEC Class I, Division 2 areas (only in the U.S.A.), a conduit seal ("pour fitting") or equivalent must be installed between each electrical connection point on the enclosure and the electrical source. Liquid tight flexible conduit can be installed between the GASGUARD® AP11 connectors and the conduit seals to facilitate these connections. A maximum length of 18" (457 mm) is allowed between the last pour fitting and the enclosure connector. All conduits shall be sealed in accordance to Sections 501-5, 502-5 or 504-70 of the National Electric Code. See Figures 4.2 and 4.5 for details.

NOTE: For Systems approved for installation and use in Explosive Atmospheres (Europe), refer to section 4.7 for additional instructions.

In classified hazardous areas – Do not separate electrical terminations or connectors while energized due to risk of electrical arc or spark which can ignite potentially flammable atmospheres.

A 1-1/8" (28.6 mm) diameter hole for 3/4" conduit is supplied for connecting the 120/240 VAC power supply to the system. The conduit hole is located on the top of the controller enclosure. Two additional holes are supplied for customer I/O and/or Ethernet Cable. Figure 4.4a below.

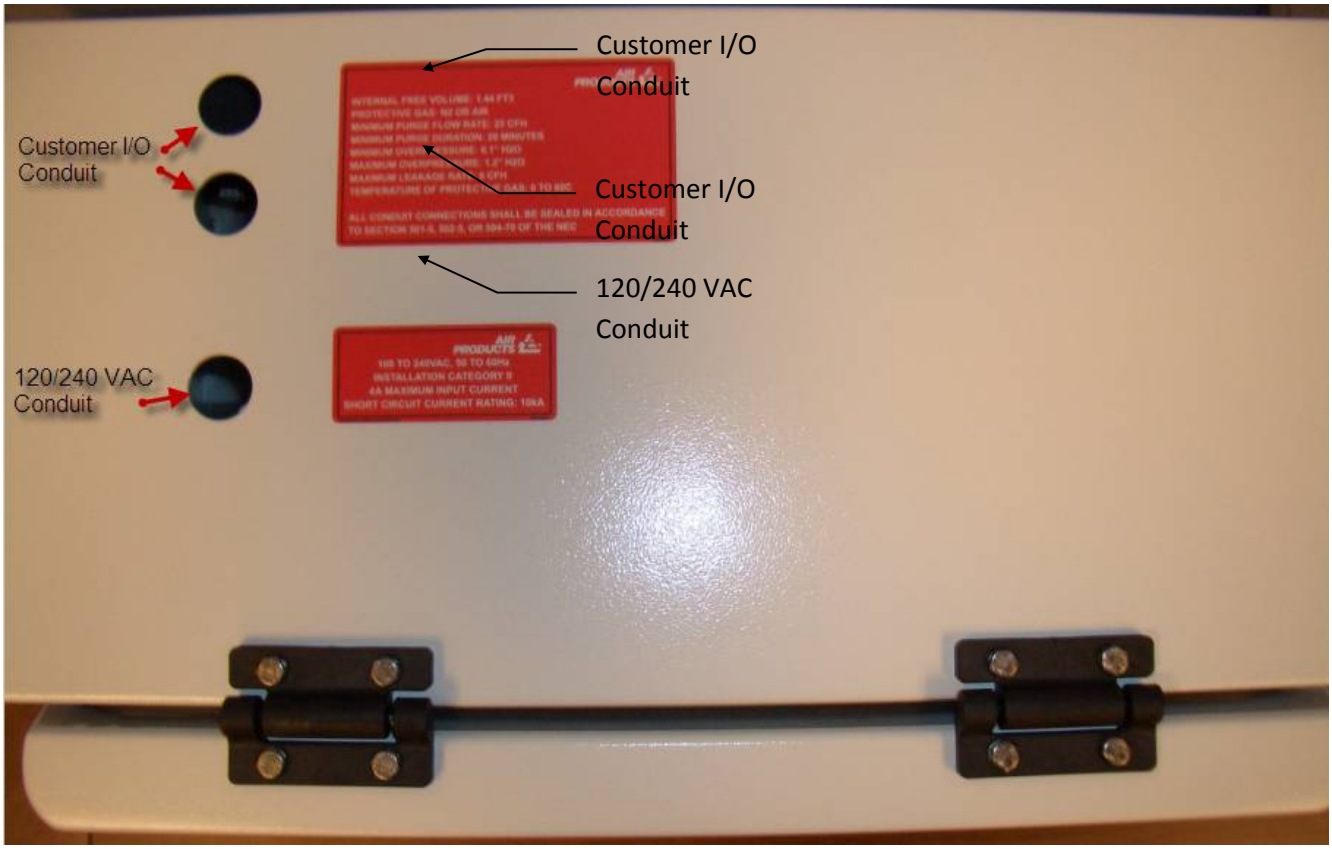


Figure 4.4a: Top View of GASGUARD® AP11 Controller

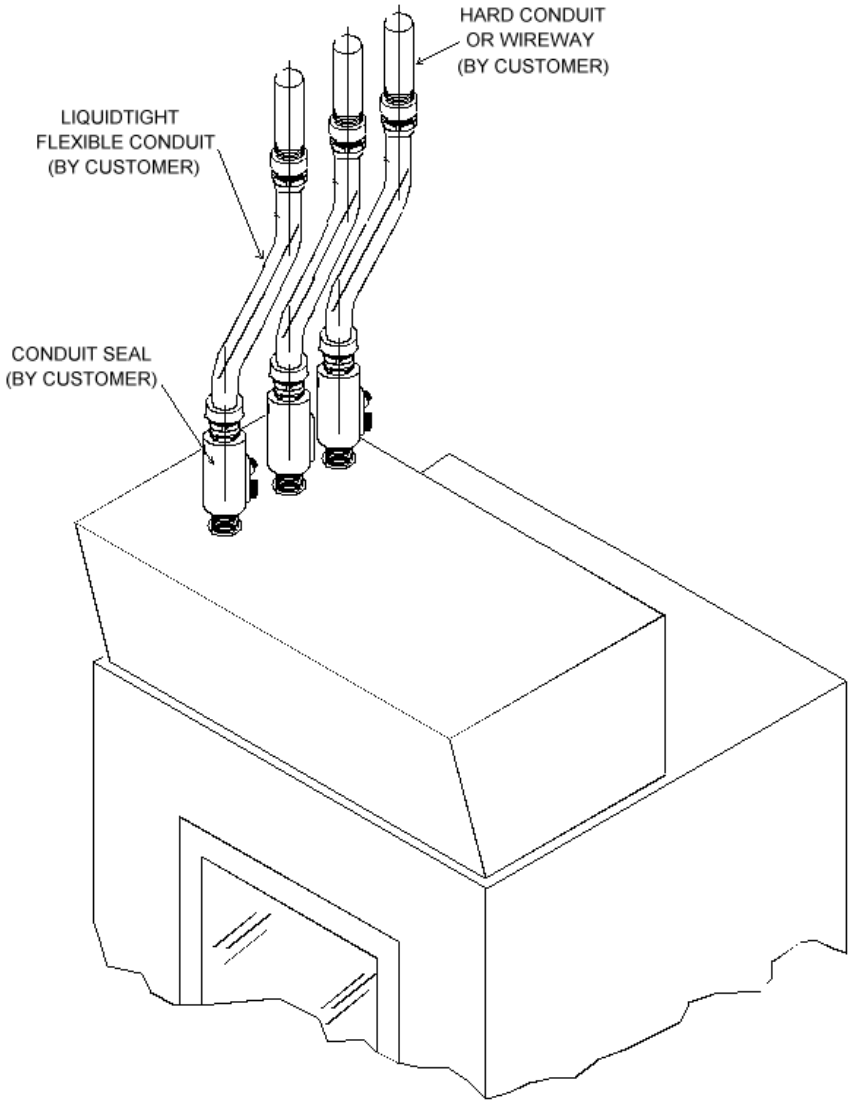


Figure 4.5: Conduit and Conduit Seals

4.4 External I/O Communication

(Optional expansion Customer I/O board available upon request)

Connections between the GASGUARD® AP11 controller and external I/O devices are made at the customer board terminals located inside the controller, on the left side wall. See Figure 4.6 for details on the location of the connections.

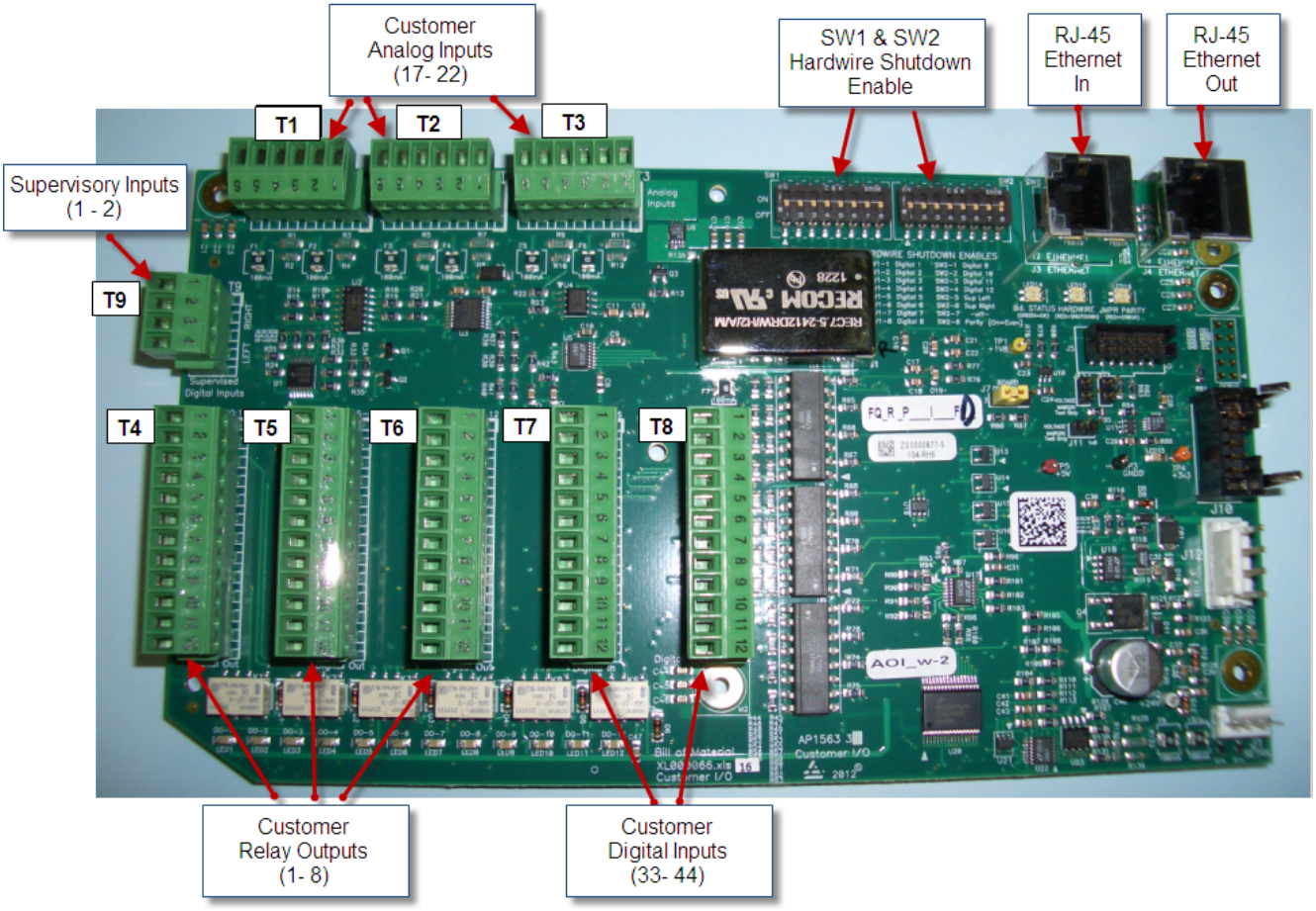


Figure 4.6a: AP1563 Customer I/O Terminal Blocks

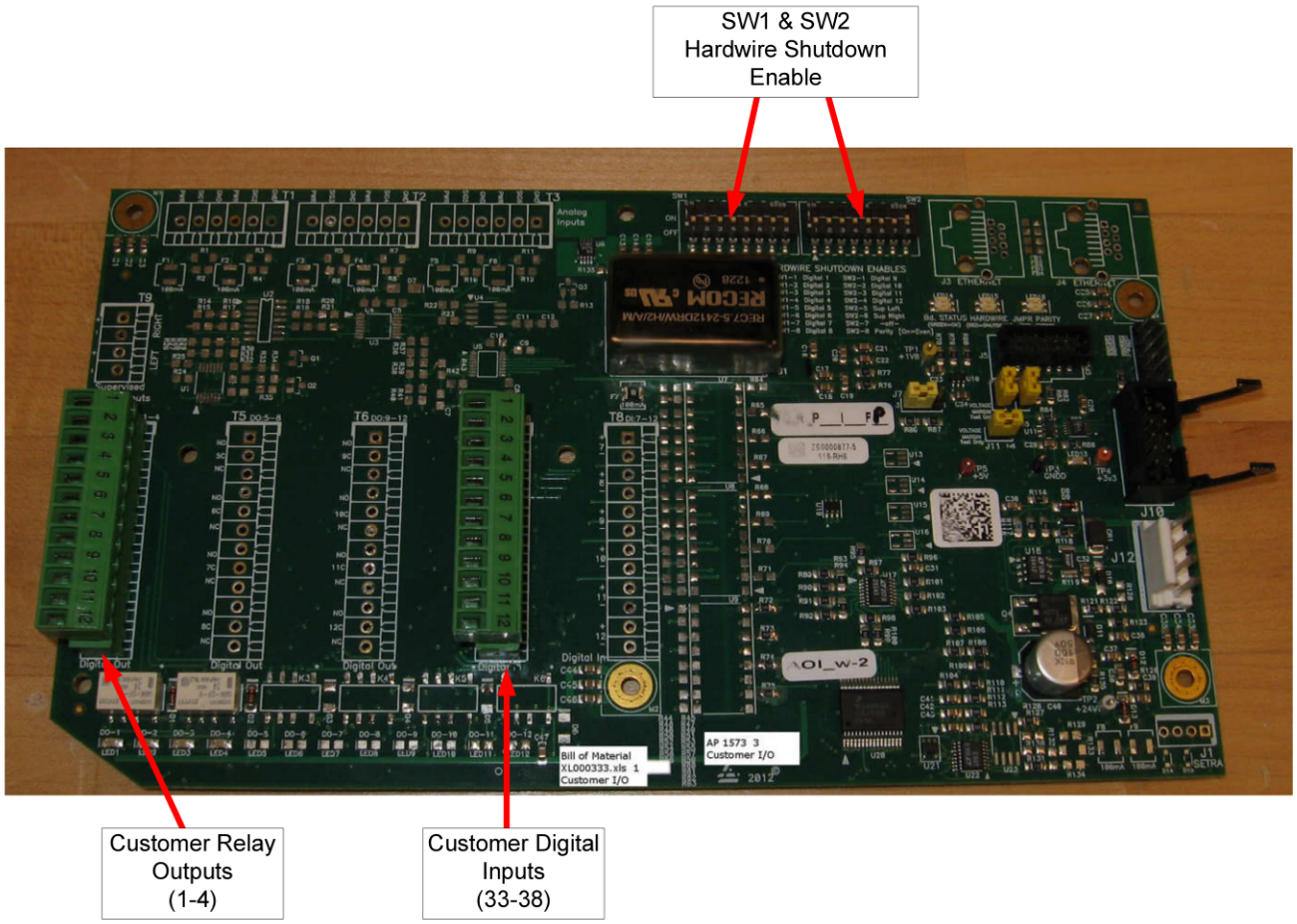


Figure 4.6b: AP1573 Customer I/O Lite Terminal Blocks

The tables on the next two pages list recommended external I/O communications and detail digital output and digital input connections.

Specific I/O field wiring connections for this system are found on the drawings in the document envelope, supplied with each system.

Additional I/O circuit boards may have been purchased as an option with this specific system. If so equipped, termination for the additional points will be shown in the drawings located in the document envelope.

4.4.1 Supervised Inputs

(Requires optional AP1563 Customer I/O board)

The system supports two supervised inputs from the customer interface. Supervised inputs are digital inputs, which are monitored via a window comparator. These inputs are monitored for normal operation, alarm type, and fault conditions.

A normally open switch is to be used as an input device. This switch must have a 10 kilo-ohm resistor in parallel with the contacts. When the switch contacts are open the circuit will provide a signal, which represents a normal operating condition. When the switch contacts are closed, the circuit will provide a signal which indicates an alarm condition. An open wire in this circuit, or a short circuit, will produce an out of range signal, which indicates a circuit fault.

Switch contacts must be rated for 20ma @ 24VDC. Switch contacts must be dry contact and external wiring should not have any form of power applied to them.

Typically, supervised inputs are used with the life safety system. Figure 4.7 shows the supervisor input wiring for use with the life safety system.

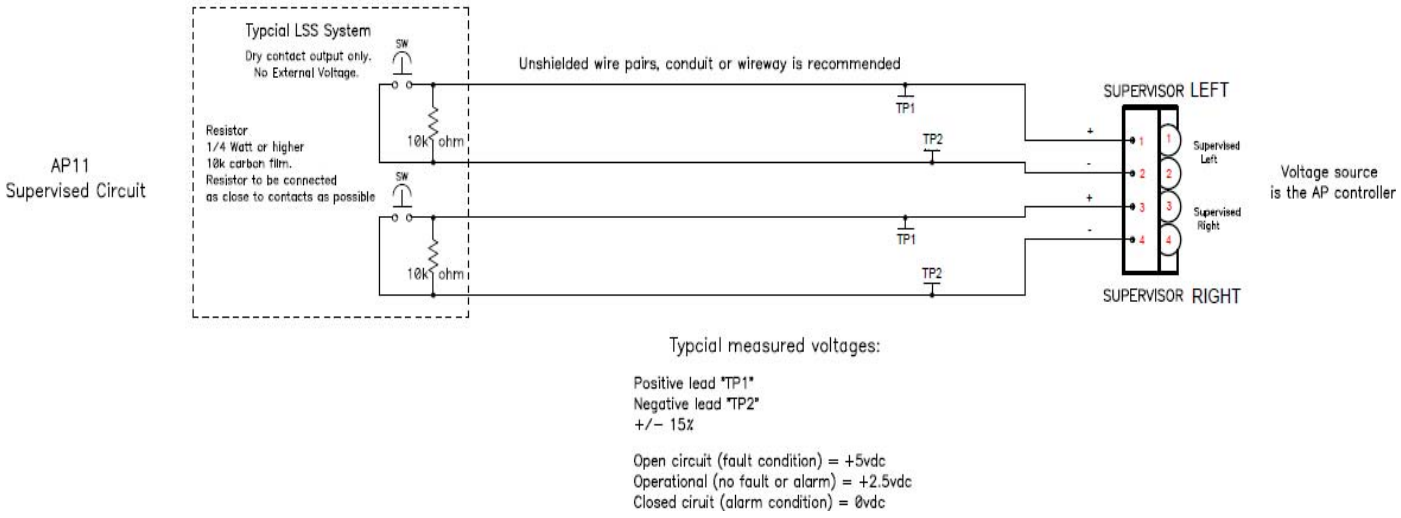


Figure 4.7: Supervisory Input Wiring

4.4.2 Available External I/O Communications

(Requires optional Customer I/O board)
*** Requires optional AP1563**

Digital Outputs	Response
Fault Alarm	Notify when fault alarms occur
Shutdown Alarm	Notify when shutdown alarms occur
Gas unavailable	Notify process tool that gas is unavailable

Digital Inputs	Response
Remote Shutdown	Shutdown GASGUARD® System
Vent system unavailable	Prevents purge modes from starting

Supervised Inputs	Response
Life Safety Shutdown *	Shutdown GASGUARD® System

The GASGUARD® System is equipped with a "vent unavailable" feature which prevents process gas from being vented from the panel if the scrubber system is not operating. Use of this feature requires the installation of a hardwire between the controller and the scrubber. Failure to utilize this feature may result in the discharge of process gas to a non-functioning vent system.

Digital Outputs Dry (Customer)

(Requires optional Customer I/O board)

* Requires optional AP1563

24 VDC @ 2 Amp maximum

Relay Output #	Customer Brd NO T4	COMMON T4	NC T4
1	T4-1	T4-2	T4-3
2	T4-4	T4-5	T4-6
3	T4-7	T4-8	T4-9
4	T4-10	T4-11	T4-12
5	T5-1	T5-2	T5- 3
6	T5-4	T5-5	T5-6
7*	T5-7	T5-8	T5-9
8*	T5-10	T5-11	T5-12
9*	T6-1	T6-2	T6-3
10*	T6-4	T6-5	T6-6
11*	T6-7	T6-8	T6- 9
12*	T6-10	T6-11	T6-12

Digital Inputs (Customer)

(Requires optional Customer I/O board)

 # Requires optional AP1563

Digital Input #	Customer Brd Signal	Customer Brd Return	Hardwire Switch Position
5 / 6*#	T9-LEFT (+)	T9-LEFT (-)	SW2-5
7 / 8*#	T9-RIGHT (+)	T9-RIGHT (-)	SW2-6
33*	T7-1	T7-2	SW1-1
34*	T7-3	T7-4	SW1-2
35*	T7-5	T7-6	SW1-3
36*	T7-7	T7-8	SW1-4
37*	T7-9	T7-10	SW1-5
38*	T7-11	T7-12	SW1-6
39*#	T8-1	T8-2	SW1-7
40*#	T8-3	T8-4	SW1-8
41*#	T8-5	T8-6	SW2-1
42*#	T8-7	T8-8	SW2-2
43*#	T8-9	T8-10	SW2-3
44*#	T8-11	T8-12	SW2-4

* Each digital-input can be individually configured to provide a hardwire shutdown alarm function. Figures 4.6a and 4.6b optional Customer I/O PCBs provide the location of SW1 & SW2 hardwire switches.

To configure an input as a hardwire, the corresponding switch shown in the above table must be set to the ON position.

SW2-8 Parity Switch setting:
- "On" if total number of active hardwire circuits is 0, 2, 4, 6, 8, 10, or 12.
- "Off" if total number of active hardwire circuits is 1, 3, 5, 7, 9, or 11.
(PCB parity LED will be green when switches are configured correctly)

A digital-input that is in the OPEN state and configured as a hardwire will have the same functional effect as pressing the EMO (Emergency Stop) switch.

Analog Inputs (Customer)
(Requires optional AP1563 Customer I/O board)

Analog inputs supplied power at 24VDC fused @ 100 mA each w/ 100 Ω series resistor.

Analog Input #	Customer Brd Signal	Customer Brd 24 VDC+	Customer Brd GND
17	T1 - 5	T1 - 6	T1 - 4
18	T1 - 2	T1 - 3	T1 - 1
19	T2 - 5	T2 - 6	T2 - 4
20	T2 - 2	T2 - 3	T2 - 1
21	T3 - 5	T3 - 6	T3 - 4
22	T3 - 2	T3 - 3	T3 - 1
23 *	J1 - 4	J1 - 1	
24 *	J1 - 2	J1 - 3	

* Analog Input # 23 supports Setra Exhaust sensor #1 & Input #24 supports Setra Exhaust sensor #2

User Power (Customer)
(Requires optional AP1563 Customer I/O board)

The AP11 customer board supports six Analog-Input (AI) channels, each of which can be independently configured for **0-5V** or **4-20mA** inputs. Three user-connections (per channel) are provided: +24V-power, +24V-gnd, and signal. A common isolated power-supply is used for all channels, however each channel's power is individually fused/current-limited. The combined power-supply loading of all channels must be less than **200mA**. In some configurations, it may be possible to exceed this limit. It is the users responsibility to ensure this constraint is not violated. The following sections provide detailed guidelines on how to connect and use the customer board.

There are 3 types of devices as shown in Figure 4-8 below. (AP11 connections are shown on the left)

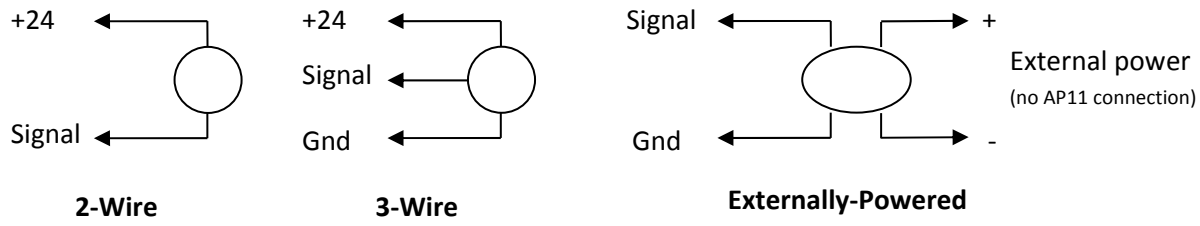


Figure 4-8

2-Wire (4-20mA) Device: Device has 2 wires: power and signal. The device draws up to 20 mA.

3-Wire Device (Powered from AP11): Device has 3 wires: power, signal, and ground. The current draw should be included on the manufacturer's data sheet and should be plugged into the table below.

Externally-Powered: These devices receive power for their operation from another source and interface with the AP11 using 2 wires: signal and ground.

There are two calculations that must be performed when connecting Analog devices to an AP11.
1. The total current-consumption calculation of AP11-powered devices
2. The cable-resistance calculation for each device connection

The following sections provide detailed examples on how to perform these calculations.

Current-Consumption Calculations for AP11-powered devices:

The current-consumption calculation is necessary to ensure the total draw of all connected devices is less than the 200mA capacity of the Customer Board. If using all 2-wire devices, no calculation is required as the AP11's capacity is sufficient for this configuration. For all other cases, use the following table to determine the current-consumption.

Type	Number of Devices	Multiply by current draw per device	Total
2-Wire (4-20mA) Device		X 20 mA	= mA
3-Wire Device		X mA	= mA
Externally-Powered Device		X 0 mA	= 0 mA
		TOTAL (Sum of Above) Can **NOT** exceed 200 mA	mA

Note: If the manufacturer specifies power consumption in watts instead of current in milliamps, assume that the device is receiving 15V and approximate the current draw as follows:

$$Miliamps = \frac{Watts}{15V * 1000}$$

EXAMPLE:
An AP11 needs to connect to three 2-wire devices and two 3-wire devices and one externally-powered device. The manufacturer of the 3-wire device specifies that it will draw no more than 50 mA.

Type	Number of Devices	Multiply by current draw per device	Total
2-Wire (4-20mA) Device	*3*	X 20 mA	= *60* mA
3-Wire Device	*2*	X *50* mA	= *100* mA
Externally-Powered Device	*1*	X 0 mA	= 0 mA
		TOTAL (Sum of Above) Can **NOT** exceed 200 mA	*160* mA

In this example, the calculated current draw (160mA) is below the AP11's capacity (200mA) so the configuration is valid.

Cable-Resistance Calculation:

Resistance in the cables used to connect field-devices to an AP11 results in voltage-drops that must be considered. These voltage-drops directly subtract from the power-supply's output used to power a device. The resultant voltage (as seen by the device) must be sufficient to satisfy the minimum excitation voltage specification for a given device to operate properly. This specification is available from the manufacturer of the device.

To satisfy a devices excitation spec, the "actual" cable-resistance must be less than the "maximum" cable-resistance that can be supported. Example calculations are shown below. It should be noted that calculations differ for each of the device types.

2-Wire (4-20mA) **Device:** Device has 2 wires: power and signal. The device draws up to 20 mA.

The maximum cable resistance is equal to the minimum voltage seen at the power pin on the AP11 minus the minimum excitation voltage of the device (as provided by manufacturer) minus the voltage caused by the input resistance of the AP11 all divided by the maximum current of the device.

$$Max\ cable\ resistance = \frac{20.8V - min.\ excitation\ voltage - 3V}{0.02\ A}$$

Cable resistance is calculated as the resistance per meter times the number of meters that the signal travels. IMPORTANT: Both the wire going to and returning from the sensor must be included.

Cable resistance = Ohms per meter * meters of cable * 2 (this is for wire to and from sensor)

EXAMPLE:

A sensor with an excitation spec of 10v is at the end of a 100 meter 22/2 cable. The manufacturer specifies that the 22 AWG wire has a resistance of 0.0527 ohms/meter.

$$Max\ cable\ resistance = \frac{20.8V - 10V - 3V}{0.02\ A} = \frac{7.8V}{0.02A} = 290\ ohms$$

Cable resistance = 0.0527 ohms/meter * 100 meters * 2
(actual) = 10.54 ohms

The calculations confirm that the "actual" cable resistance (10.54 ohms) is less than the Max cable resistance (290 ohms) so the excitation specification is satisfied.

3-Wire Device (Powered from AP11): Device has 3 wires: power, signal, and ground.

The current draw and minimum operating voltage of the device should be included on the manufacturer's data sheet. The voltage seen by the device is reduced by the resistance of the cable going to the device and by a 100 ohm resistor within the AP11. Calculations to determine the maximum cable resistance are shown in Figure 4-9 below:

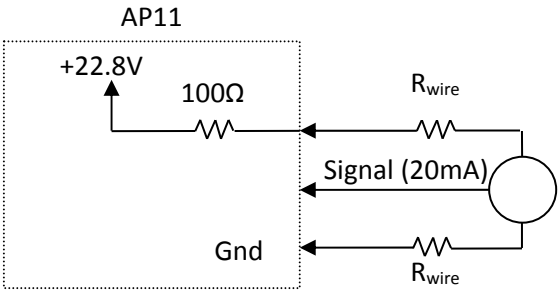


Figure 4-9

Excitation Voltage (V_E): Minimum opearating voltage of the device as specified by the manufacturer

Current Draw (I_L): The amount of current the sensor draws as specified by the manufacturer. This is measured in Amps.

> Note: If the manufacturer specifies power consumption in watts instead of current in milliamps, assume that the device is receiving it's minimum voltage and approximate the current draw as follows:

$$Amps = \frac{Watts}{Minimum\ Voltage}$$

Max Cable Resistance: The maximum resistance of the wiring to and from the sensor.

$$Max\ Cable\ Resistance = \frac{22.8V - V_R - 100 * I_L}{I_L - .01}$$

Cable resistance is calculated as the resistance per meter times the number of meters that the signal travels. IMPORTANT: Both the wire going to and returning from the sensor must be included.

Cable resistance = Ohms per meter * meters of cable * 2 (this is for wire to and from sensor)

EXAMPLE:

A sensor that draws 50 mA and has a minimum excitiation voltage of 15V is at the end of 100 meters of 22/3 cable. The manufacturer specifies that the 22 AWG wire has a resistance of 0.0527 ohms/meter.

$$Max\ Cable\ Resistance = \frac{22.8V - 12 - 100 * 0.02A}{0.02A - 0.1} = 70\ ohms$$

Cable resistance = 0.0527 ohms/meter * 100 meters * 2
(actual) = 10.54 ohms

The calculations confirm that the “actual” wire resistance (10.54 ohms) is less than the max wire resistance (70 ohms) so the excitation specification is satisfied.

4.5 USB Connection Port

GASGUARD® AP11 controller USB port is located on the face of the controller. The USB port allows a USB connection to be made without having to open the controller door. Electrical devices should never be operated, connected to, or disconnected from the USB port unless the area surrounding the equipment is known to be free of flammable material. The USB port on the face of the controller will also have a warning label (Figure 4.10) for operation in a flammable area.

Each USB connector type is 2.0 format. 4ea USB ports available inside the controller, with one of the ports extended externally to the AP11 controller door as shown in Figure 4.11

Safety standards require that the AP11 front-panel USB port be tool accessible. To meet the standard, a Lindy USB Port Blocker (see Figure 4.11a) will be factory installed on all AP11 controllers. In order to use the USB port, the USB Port Blocker plug must be removed using the provided Lindy key (one will ship with every unit). Remember, electrical devices should never be operated, connected to, or disconnected from the USB port unless the area surrounding the equipment is known to be free of flammable material. When finished using the USB port, the USB Port Blocker plug must be reinstalled along with the USB cover.

Figure 4.10: USB Port Warning Label

Figure 4.11: AP11 Controller with USB Port on the Face of the Controller

Figure 4.11a: Lindy USB Port Blocker and Key

4.6 GASGUARD® Networking

4.6.1 General Description

Remote monitoring of Gasguard® systems can be attained using the Gasguard® OPC Server software or VERSUM MATERIALS, INC.'s SCADA system, GCS (Global Communications System). Either method can provide continuous on-line 24 hour per day monitoring of the status of all connected GASGUARD® Cabinets, VMBs and BSGS systems. The GASGUARD® AP11 communicates to GCS or OPC via Ethernet.

4.6.2 GCS Ethernet Network Wiring Configuration

A GCS is typically integrated into the site's Ethernet network. Figure 4.11 depicts the typical network architecture of a GCS. In most instances, the GCS is connected to two separate networks. One subnet will interconnect only the gas controller equipment, while the other subnet will be the connectivity to the overall site Local Area Network. Using this architecture, the gas controller network traffic will not be adversely affected by other nodes on the site LAN; furthermore, if the site needs to disconnect the GCS from their network -- for instance when a remote support person accesses the system via modem – the ability to monitor the gas controller network will not be affected. The connection to the site LAN allows for connectivity from office PC's to the GCS for WebView sessions as well as ODBC data downloads. The GCS may also be equipped with additional options which will require its connectivity to additional LAN's. Such will be the case if the GCS will need to supply gas availability data to a site's tool annunciation system. GCS uses standard TCP/IP network protocol to communicate over all networks.

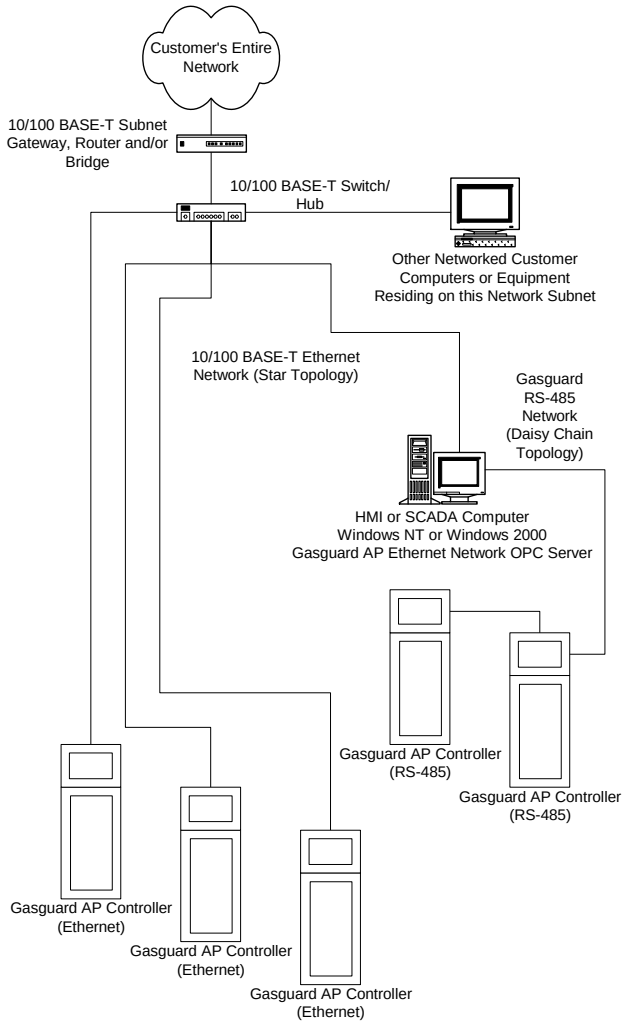


Figure 4.12 Typical GCS Network Architecture

4.6.3 GASGUARD AP11 Controller Connections

The network electrical connection is made on the Customer I/O board and is a standard RJ-45 connector.

Optional RJ-45 network connection is available on the Customer I/O board.
(If a Customer I/O board is present, the network connection is made to the Customer I/O board)

See Figure 4.13 & 4.14 for the location of the network connections.

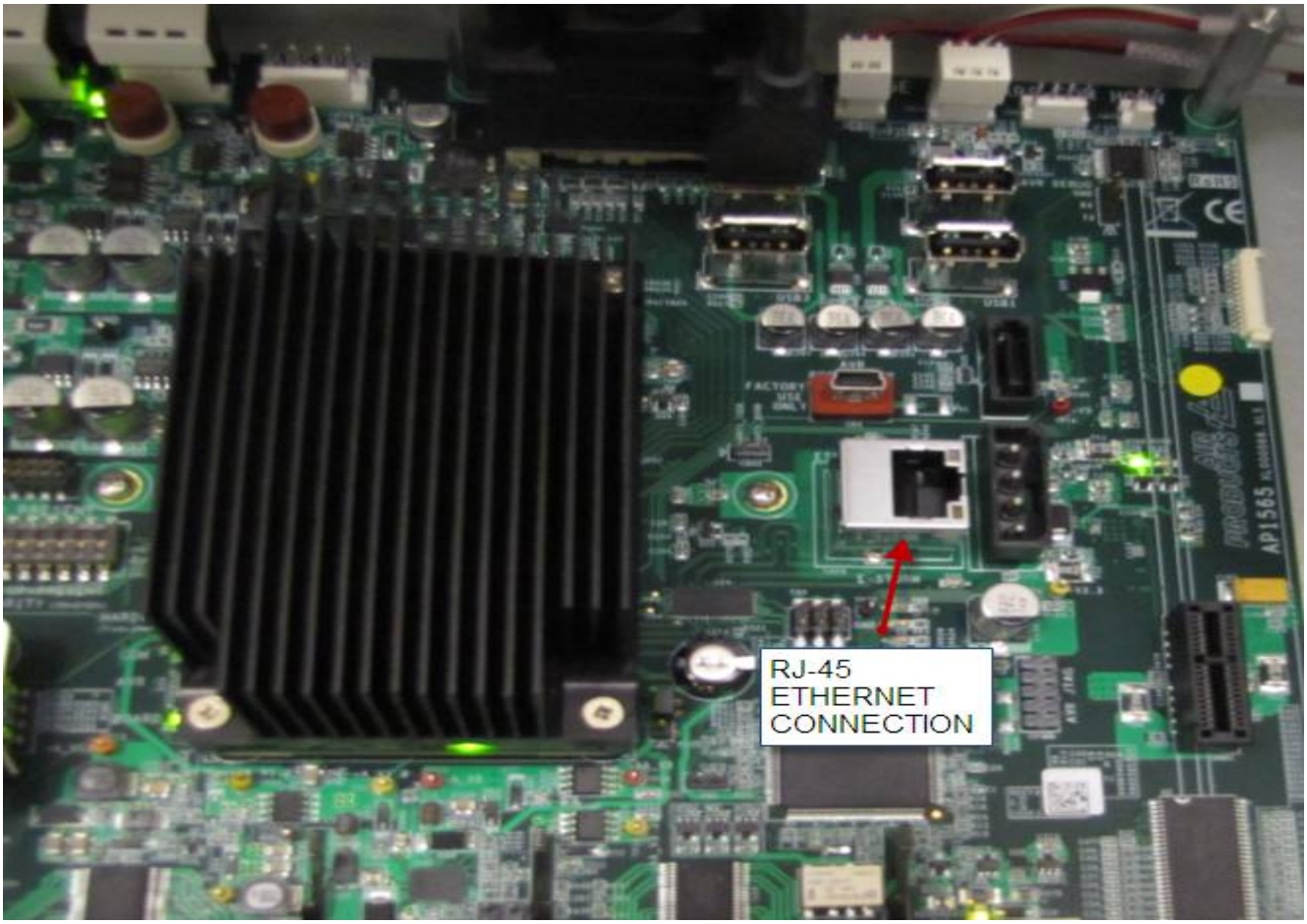


Figure 4.13: GASGUARD® AP11 Customer board Ethernet connection

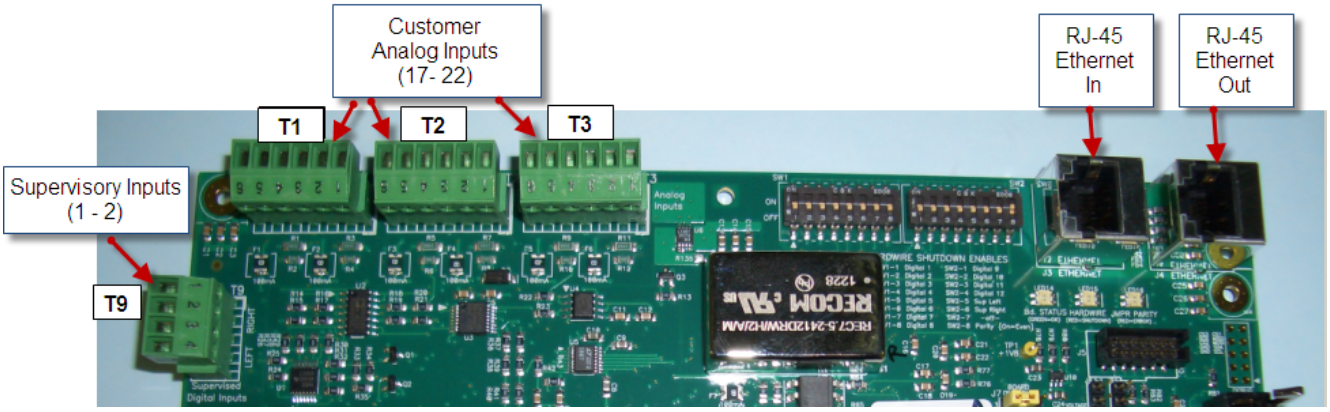


Figure 4.14: GASGUARD® AP11 Customer board Ethernet connection (optional board)

Optional Customer I/O board capacity provides 12ea customer digital input alarm circuits, 12ea customer digital output circuits, and 6ea customer analog input circuits.

See Figures 4.15 for jumper configurations for Customer I/O board options.

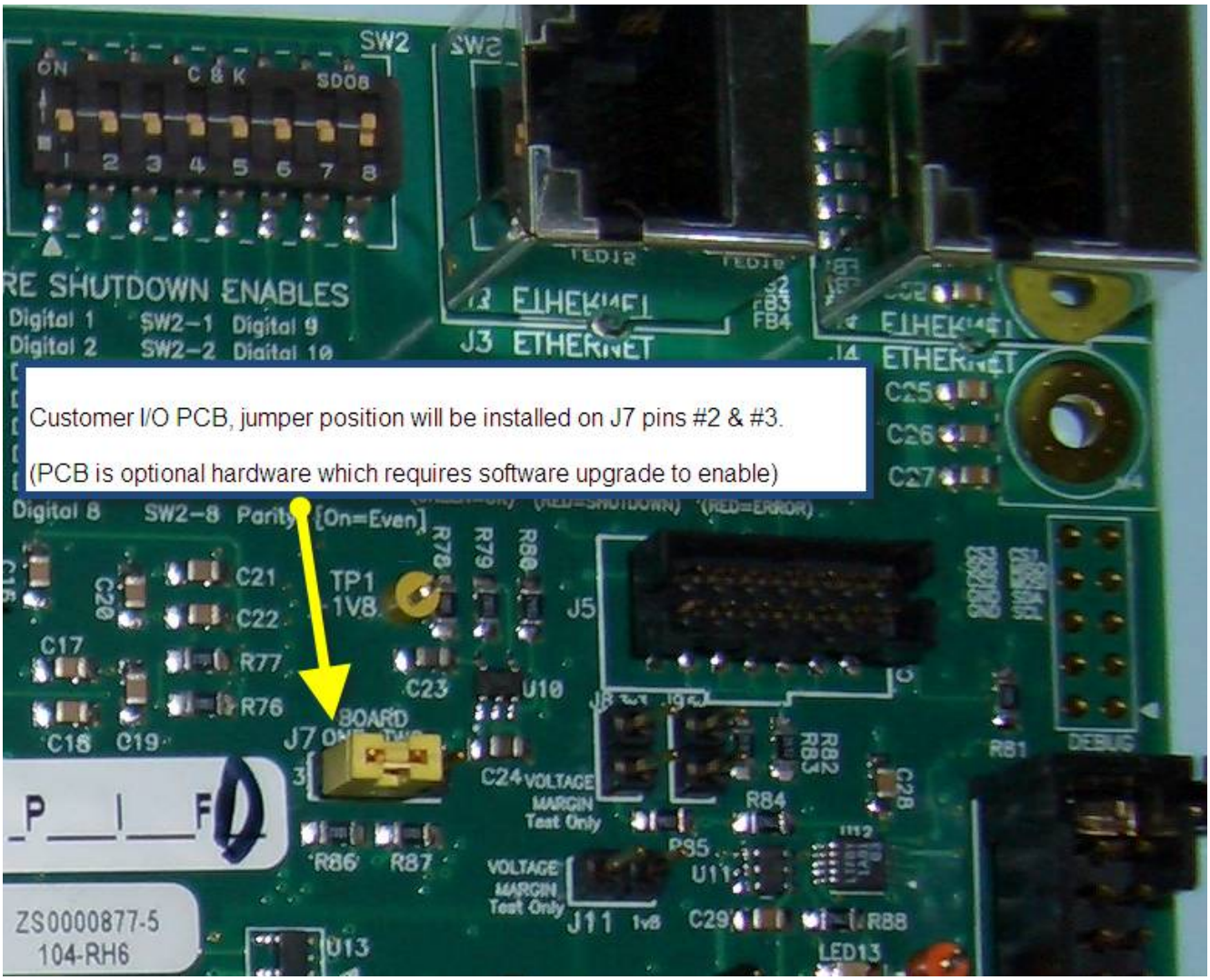


Figure 4.15: GASGUARD® AP11 Customer board "J7" jumper configurations (optional board)

4.7 Explosive Atmosphere (ATEX) Installations

GASGUARD® AP11 controllers that have the label shown in Figures 4.16 have been certified to comply with European Union ATEX Directive 94/9/EC of the European Parliament and Council when properly installed in accordance with the guidelines and instructions referenced in this section.

GASGUARD® AP11 controllers with the following labels attached for explosion protection are of Group II, Category 3; intended for use only in areas where explosive atmospheres of gas are unlikely to occur, or if they do occur are likely to do so infrequently or for a short period.

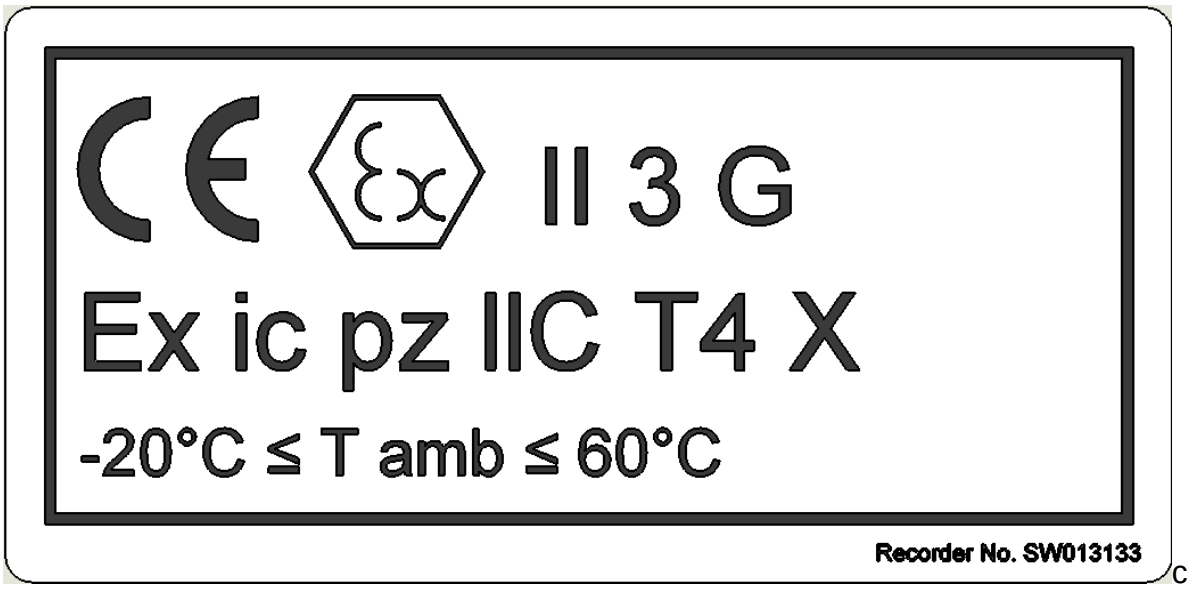


Figure 4.16: AP11 ATEX Label

4.7.1 Label Markings

The ATEX label placed on the AP11 controller includes the following information (symbols follow in order starting at the upper left corner):

- The CE Symbol which reflects conformity with the European Directives
- The Hexagonal “Ex” Symbol for Explosive Atmosphere
- The equipment group symbol for the electrical apparatus which is II. All industry gases are classified as Group II gases.
- The equipment category number 3. The equipment category number 3 means the equipment is suitable for an environment where an explosive atmosphere is unlikely to occur, occurs infrequently, or occurs for only a short period of time.
- The atmosphere symbol “G”. “G” means that product is safe in an explosive GAS atmosphere.
- Symbol “Ex”. This symbol stands for the equipment has been tested under the latest European Harmonized Standard for use in Explosive Atmospheres.
- Symbol “ic” for intrinsic safety.
- Symbol “pz” for pressurization. Pressurization prevents the ingress of an explosive atmosphere to a space that may contain a source of ignition. This is used for the controller.
- Symbol “IIC’ for the apparatus gas group.
- The symbol indicating the maximum surface temperature, T6. T6 indicates that the maximum surface temperature does not exceed 85°C.
- The symbol “X” for special conditions of installation and relevant use for safety. The normal ambient temperature range in the ATEX standard is considered to be -20°C to 40°C. Since the temperature range for the AP11 varies from the normal range, an X is included on the label markings.
- The ambient temperature range, Ta.

4.7.2 Special Conditions for Safe Use (X)

- **Environmental Limits**
  - Gasguard® AP11 controllers are intended for indoor installation. They have been evaluated for installation in locations providing adequate protection against the entry of water.
  - AP11 controllers are intended for use in ambient temperatures in the range of -20°C to +60°C and should not be used outside this range.
  - DO NOT rub the surface of the touch screen with a dry cloth. Electrostatic charge generated by the friction may result. When cleaning the face with a damp cloth, take the measures of an electrostatic discharge such as earth band, ionic shower, etc.
- **Installation Conditions**
  - When installing the equipment, appropriate precautions must be taken to ensure that the equipment has been connected to earth. Refer to Section 4.1 of this manual for more information.
  - Installation of this equipment shall be carried out in accordance with the installation standards for potentially explosive atmospheres. Installation, startup and maintenance must be carried out only by personnel trained in explosion protection.
- **Power Supply**
  - Input power supply specs must not exceed the maximum values as listed in Section 4.2 of this manual.
- **Maintenance**
  - Before opening the controller enclosure ensure that there is no danger of explosion in the atmosphere and wait at least 10 minutes after the power has been removed.
  - Before turning the power supply ON, be sure to close the enclosure cover tightly and securely fasten the latch. Ensure that z purge is operating and functional for at least 20 minutes prior to turning the power on.
  - Only Versum Materials, Inc. qualified personnel should service the controller. Substitution of components (other than those recommended by Versum Materials, Inc.) may impair its suitability for use in hazardous locations.

Chapter 5

Helium Leak Testing

All personnel **must** be trained in helium leak detector operations. Consult your leak detector manufacturer for leak detector operations training.

The customer is responsible for ensuring that all field piping to the GASGUARD® Distribution System be completely leak tight. Leak testing should be performed in accordance with the current industry standard, SEMI (Semiconductor Equipment and Materials International) #F1-90, Specification for Leak Integrity of Toxic Gas Piping Systems and all applicable codes. A suitable helium leak detector is required to attain the level of sensitivity required by the above standard.

There are several methods of helium leak testing. The two most often used are:

Inboard - The component being tested is evacuated to a negative pressure and sprayed externally with helium.

Outboard - The component is pressurized with helium and sniffed externally with the detector.

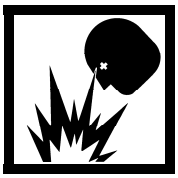
NOTE: It is recommended that the internal GASGUARD® Distribution System tubing, which was helium leak tested at the factory, be rechecked at this time to ensure no leaks have developed during installation or shipment. Consult Versum Materials, Inc. for proper helium leak detection procedures.

In order to adequately leak test the GASGUARD® Distribution System internal and external piping, the pneumatic emergency shutoff and automated valves within the cabinet must be operated. These valves can be manually opened and closed through "Manual Mode" operation on the front keypad of the GASGUARD® controller. Versum Materials, Inc. **strongly recommends** that all operators receive training by an Versum Materials, Inc. representative prior to operating the GASGUARD® Distribution System in "Manual Mode". Operations training is an additional service provided for a cost. The cost of this service may have been *pre-arranged* during the sale and scope review of the project. Contact your Versum Materials, Inc. representative to discuss this.

To operate these valves, the pneumatic supply hookup (Section 3.6 of this manual) and the electrical power connection (Section 4.2 of this manual) installation must be completed.

How to Perform Helium Leak Checking in Manual Mode

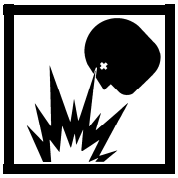
⚠WARNING



Operating in Manual Mode can cause the following hazards which can result in PERSONAL INJURY OR DEATH.

- ***Process gas could be forced into the purge panel and/or purge gas cylinder.***
- ***Opening purge panel valves when high pressure process gas is present.***
- ***High pressure process gas could be unintentionally vented.***
- ***Opening vent valves when high pressure process gas is present.***

⚠WARNING



No <u>process gas supply</u> should be connected at this time. If supply is or was connected, <u>do not continue</u>, as personal injury or death can result. Contact an Versum Materials, Inc. representative for system verification.

NOTE: Due to the potential hazards listed above, Manual Mode operation requires a second or higher level security code.

NOTE: Prior to shipment, the GASGUARD® Distribution System panel has been certified to strict cleanliness specifications. Improper operation of the valves in "Manual Mode" could result in contamination of the gas panel

NOTE: A pneumatic supply connected to the controller with 85-95 psig (5.9-6.6 barg) of nitrogen must be available to actuate the valves.

NOTE: Shutdown alarms (indicated by the red SHUTDOWN LED being lit) will not allow you to access and open valves in manual mode, therefore making a leak test invalid. If a shutdown alarm is present, contact a Versum Materials, Inc. representative for system verification prior to leak testing.

1. Enter second level (or higher) security code (check with appropriate Versum Materials, Inc. representative for proper password) as follows:

Touch anywhere on the graphics portion of the screen.

You will see a pop-up window entitled: “Password”

Using the keypad, type in the password.

Press OK

If the password is correct, the Main Menu will be displayed. If the password is incorrect, “Invalid Password" will be displayed at the base of the pop-up window.

2. From the Main Menu screen, select which process line using the drop down menu or the left and right arrow keys.
3. Press the Manual Mode pushbutton.
   3.1. Another window will pop-up entitled: “Manual Mode”
   3.2. A legend, located on the graphics panel, indicates the valve status color scheme. The legend shows which color (red or green) is used to designate if a valve is open or closed.
4. Follow the procedures below to open and close valves. (Valves that can be controlled manually are shown highlighted with a yellow square box around them.)

To open a valve:

4.1. Select the valve by touching the screen.

4.2. The valve state menu will appear. Confirm that you want to open the valve by pressing Open Valve Pressing Cancel will close the menu leaving the valve closed.

To close a valve:

4.1. Select the valve by touching the screen.

Extreme care must be taken when operating valves manually. Only those valves required for adequate leak testing should be opened.

5. When leak testing is complete, press Cancel to return to the Main Menu.

NOTE: Any valves left in open position will be closed automatically.

6. From the Main Menu screen, press Logout to return to normal display.

Distribution System must not be left unattended in Manual Mode, as access to the system in Manual Mode is open to anyone.

Chapter 6

Functional Checklist

Section 1 **Distribution System Utility Checklist**

Section 2 **Distribution System Field Start-up Checklist**

After all connections have been made and installation of the distribution system is complete, the appropriate Versum Materials, Inc. Representative should be contacted to schedule the final on-site functional check. This functional check must be made prior to start-up. The functional check is an additional service provided for a cost. The cost of this service may have been *pre-arranged* during the sale and scope review of the project. Contact your Versum Materials, Inc. Representative to discuss this. The Versum Materials, Inc. Technical Representative and/or Megasys® Technician will ensure that all the mechanical and electrical components in the distribution system are functioning properly and all programmed sequences are operational.

A copy of the completed distribution system functional checklist should be supplied to Versum Materials, Inc. for placement into the distribution system maintenance file. The Distribution System Utility Checklist is found on the following two pages.

6.1 Distribution System Utility Checklist

_____ 1. Distribution system located and mounted to floor or wall (see Section 2).

_____ 2. Distribution system exhaust duct installed, functioning and monitored for loss of exhaust (see Section 3.7).

_____ 3. Grounding wire installed (distribution system and controller) and checked for less than 1 ohm resistance (see Section 4.1).

_____ 4. Electrical power (120/240 VAC, 50/60 Hz) connected (see Section 4.2).

_____ 5. Remote I/O wiring installed and checked (see Section 4.4).

_____ 6. Gasguard Network wiring installed (if applicable) and configured on the host (see Section 4.5 and 4.6).

_____ 7. Process line installed and helium leak tested (see Section 3.2).

_____ 8. Vent line installed and helium leak tested (see Section 3.3).

_____ 9. Venturi line installed, leak tested and 75-95 psig (5.2-6.6 barg) of nitrogen available (see Section 3.4).

_____ 10. Purge line installed and helium leak tested (see Section 3.5).

_____ 11. Pneumatic supply connected to controller and 85-95 psig max. (5.9-6.6 barg) of nitrogen available (see Section 3.6).

_____ 12. AP11 distribution system internal piping helium leak tested (see Section 5).

_____ 13. Purge cylinder available, if required.

_____ 14. Hazardous gas monitor installed and operating.

Inspection Sign-Offs

Electrical

Mechanical

Quality

Safety

VERSUM MATERIALS, INC. (Field Start-Up Checklist Complete)

6.2 VERSUM MATERIALS, INC. AP11 DISTRIBUTION SYSTEM FIELD START-UP CHECKLIST

CUSTOMER _____SYSTEM # _____ SERIAL #_____

DEVICE DESCRIPTION _____MODEL# _____

GAS TYPE _____START DATE _____ FINISH DATE _____

TOOL NAME _____ TECH REP _____

CUSTOMER SYSTEM LABEL _____

VISUAL INSPECTION

PIPING/MECHANICAL	**Check off line item when completed** **Sign and date when section completed**	
	Branch 1-4 (A-D)	**Branch 5-8 (E-H)**
Perform visual inspection to verify all mechanical and electrical connections have been made.		
Distribution System labeled correctly per Specification Sheet.		
No nylon collars stripped.		
Distribution System information received: (circle) Specification Sheet, Flow Schematic, Customer I/O Drawing, Inspection and Test sheet (leak test and certification), Quality Inspection and Test sheet (functional test), Installation and Operation Manual		
All open connections sealed.		
General appearance satisfactory.		
Verify leak test from Distribution system source to P.O.U. complete.		
Verify corrosive or toxic scrubber and incinerator operational and running		
Pitot tube installed with correct 90° orientation		
Tel tails installed		
Verify distribution system exhaust is functioning		

VERSUM MATERIALS, INC. AP11 DISTRIBUTION SYSTEM FIELD START-UP CHECKLIST

PIPING/MECHANICAL (cont.) **Check off line item when completed** **Sign and date when section completed**		
	Branch 1-4 (A-D)	**Branch 5-8 (E-H)**
Panel under pressure ≥20 psig & ≤ 25 psig (1.4 barg ≥ ≤ 1.7 barg)		
Correct venturi pressure present Minimum 75 psig (5.2 barg)		
Correct pneumatic pressure present 85 psig to 95 psig max. (5.9-6.6 barg)		
Purge cylinder installed, if required		
Gas detection system operational		
Secondary containment installed		

SECTION COMPLETED SIGNATURE_____ DATE _____

Notes: _____

VERSUM MATERIALS, INC. AP11 DISTRIBUTION SYSTEM FIELD START-UP CHECKLIST

ELECTRICAL	**Check off line item when completed** **Sign and date when section is completed**	
	Branch 1-4 (A-D)	**Branch 5-8 (E-H)**
Earth ground installed		
120v/220v electrical complete (circle)		
Graphics panel condition satisfactory		
Elect. sealoffs poured		
I/O wired per DWG # EE-_____		
Verify heat tape power		

SECTION COMPLETED SIGNATURE_____ **DATE** _____

Notes: _____

VERSUM MATERIALS, INC. AP11 DISTRIBUTION SYSTEM FIELD START-UP CHECKLIST

CONTROLLER	**Branch 1-4 (A-D)**	**Branch 5-8 (E-H)**
Ensure all cable connections are seated properly		
Does the Graphic Insert match the Configuration?		
E-stop guard in place		
Carrier Board LEDs all green		
Panel L Board LEDs all green		
Panel R Board LEDs all green		
Customer Board LEDs all green		
Door Board LEDs all green		
Caution: Ensure valves can be operated safely before addressing the next 3 steps.		
Do all valves operate?		
Manual mode operation		
No audible solenoid leaks		
Firmware Versions:		
Controller EXE Version _____		
DLL Version _____		
Startup EXE Version _____		
Controller Memory Load _____		
OS Image Version _____		
BIOS Version _____		
I/O Processor Version _____		
Configuration File Rev. _____		
External Shutdown wired		
Supervisory circuit utilized		
Correct program loaded / version _____		
Program name and date _____		
Life safety system utilized (yes / no)		
Verify port and loop # indicated on the controller		
Distribution system name		
Port number		
Channel number		
IP Address (Ethernet Only)		
IP Subnet Mask (Ethernet Only)		
Default Gateway (Ethernet Only)		
AP11 distribution system communicating with network		
Controller door adjustment		
Z – purge set @ ≥ 0.1" H20 (24.9 Pa)		
Adjust / Balance +5v Power Supply(s)		

SECTION COMPLETED SIGNATURE_____ **DATE** _____

Notes: _____

VERSUM MATERIALS, INC. AP11 DISTRIBUTION SYSTEM FIELD START-UP CHECKLIST

CALIBRATION **Verify analog scaling (psig) with program documentation**

Transducers must be powered up a minimum of 15 minutes. Zero and span should be checked a minimum of 4 times to insure repeatability.

Check and record the pressure before and after calibration in psig

Analog #	Label					
		Zero	Zero	Span	Span	Completed
		Before	After	Before	After	
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						

SECTION COMPLETED SIGNATURE_____ DATE _____

Notes: _____

VERSUM MATERIALS, INC. AP11 DISTRIBUTION SYSTEM FIELD START-UP CHECKLIST

FUNCTIONAL TEST - DIGITAL ALARMS

Record label from software documentation. Record, verify and test the digital alarms and the hardwire shutdowns. Note: Appropriate Hardwire switch must be ON for hardwire shutdown to be activated.

Digital In #	Label	Hardwire SD loc.	Checked
1	Emergency Stop	---	
2	Z-purge	---	
3	Power Supply #1	---	
4	Power Supply #2	---	
5*	Supervised Input #1 FAULT	---	
6*	Supervised Input #1 ALARM	---	
7*	Supervised Input #2 FAULT	---	
8*	Supervised Input #2 ALARM	---	
9	Left Terminal Box Switch 1	---	
10	Left Terminal Box Switch 2	---	
11	Left Terminal Box Switch 3	---	
12	Left Terminal Box Switch 4	---	
13	Left Terminal Box Switch 5	---	
14	Left Terminal Box Switch 6	---	
15	Left Terminal Box Switch 7	---	
16	Left Terminal Box Switch 8	---	
17	Left Terminal Box Switch 9	---	
18	Left Terminal Box Switch 10	---	

*** These Digital input alarm circuits require optional Customer I/O PCB hardware (AP1563) and software program with alarm circuits enabled.**

VERSUM MATERIALS, INC. AP11 DISTRIBUTION SYSTEM FIELD START-UP CHECKLIST

FUNCTIONAL TEST - DIGITAL ALARMS (cont.)			
19	Left Terminal Box Switch 11	---	
20	Left Terminal Box Switch 12	---	
21	Right Terminal Box Switch 1	---	
22	Right Terminal Box Switch 2	---	
23	Right Terminal Box Switch 3	---	
24	Right Terminal Box Switch 4	---	
25	Right Terminal Box Switch 5	---	
26	Right Terminal Box Switch 6	---	
27	Right Terminal Box Switch 7	---	
28	Right Terminal Box Switch 8	---	
29	Right Terminal Box Switch 9	---	
30	Right Terminal Box Switch 10	---	
31	Right Terminal Box Switch 11	---	
32	Right Terminal Box Switch 12	---	

VERSUM MATERIALS, INC. AP11 DISTRIBUTION SYSTEM FIELD START-UP CHECKLIST

FUNCTIONAL TEST - DIGITAL ALARMS (cont.)			
33**	Customer Digital Input 1		
34**	Customer Digital Input 2		
35**	Customer Digital Input 3		
36**	Customer Digital Input 4		
37**	Customer Digital Input 5		
38**	Customer Digital Input 6		
39*	Customer Digital Input 7		
40*	Customer Digital Input 8		
41*	Customer Digital Input 9		
42*	Customer Digital Input 10		
43*	Customer Digital Input 11		
44*	Customer Digital Input 12		

*** These Digital input alarm circuits require optional Customer I/O PCB hardware (AP1563) and software program with alarm circuits enabled.**

**** These Digital input alarm circuits require optional Customer I/O PCB hardware (AP1563 or AP1573) and software program with alarm circuits enabled.**

SECTION COMPLETED SIGNATURE_____ DATE _____

Notes: _____

VERSUM MATERIALS, INC. AP11 DISTRIBUTION SYSTEM FIELD START-UP CHECKLIST

FUNCTIONAL TEST - RELAY OUTPUTS Check off line item when completed **Sign and date when section is completed**	
Customer Board #1	
Relay outputs (digital outputs) tested	
Relay # 1**	
Relay # 2**	
Relay # 3**	
Relay # 4**	
Relay # 5*	
Relay # 6*	
Relay # 7*	
Relay # 8*	
Relay # 9*	
Relay #10*	
Relay #11*	
Relay #12*	

*** These Digital input alarm circuits require optional Customer I/O PCB hardware (AP1563) and software program with alarm circuits enabled.**

**** These Digital input alarm circuits require optional Customer I/O PCB hardware (AP1563 or AP1573) and software program with alarm circuits enabled.**

SECTION COMPLETED SIGNATURE_____ DATE _____

NOTES: _____

VERSUM MATERIALS, INC. AP11 DISTRIBUTION SYSTEM FIELD START-UP CHECKLIST

FUNCTIONAL TEST-USER SETPOINTS Check off line item when completed **Sign and date when section is completed**			
User Alarm set points listed and verified			
List changes in this column	Alarm #	Label	Setpoint

SECTION COMPLETED SIGNATURE_____ DATE _____

NOTES: _____

VERSUM MATERIALS, INC. AP11 DISTRIBUTION SYSTEM FIELD START-UP CHECKLIST

FUNCTIONAL TEST- PROGRAM MODES **Check off line item when completed** **Sign and date when section is completed**		
	Branch 1-4 (A-D)	**Branch 5-8 (E-H)**
AP11 Distribution system programs		
Enable ARS Fault Alarms (ARS only)		
Process Gas Flow		
Stick Purge		
Rough Line Evacuation		
Manual Mode		
Lamp test		
ARS Functional Test (Recovery)		
ARS Shutdown Test (EMO, LSS, Timeout, HW)		
Low process delivery		
Process response for very low purge		

SECTION COMPLETED SIGNATURE_____ DATE _____

Notes: _____

VERSUM MATERIALS, INC. AP11 DISTRIBUTION SYSTEM FIELD START-UP CHECKLIST

FUNCTIONAL TEST - FILE VERIFICATION **Check off line item when completed** **Sign and date when section is completed**		
	Branch 1-4 (A-D)	**Branch 5-8 (E-H)**
Verify purge parameters per software documentation		
Verify alarm conditions per software documentation		
Verify VERSUM MATERIALS, INC. set points per software documentation		
AP11 Distribution system cleaned inside and out		
Suggested Customer Signoff (Optional)	**Date**	**Signature**
Section: Required / Not required (Circle one)		
Exhaust signed off		
Electrical Signed off		
Safety signed off		
Environmental documentation submitted		
Plumbing signed off		
Environmental sign off		

SECTION COMPLETED SIGNATURE_____ DATE _____

Comments_____

_____

_____

_____

_____

_____

I have received and understood training on the operation of this Distribution system on the date given below.

_____ _____

Name Date

Chapter 7

System Description

The GASGUARD® Distribution System typically consists of a valve manifold enclosure, a process gas manifold panel and a controller. The systems may also be supplied with a free standing rack or a wall mounting frame.

GASGUARD® Distribution Systems are designed and built for the safe handling of high purity toxic, flammable, pyrophoric, corrosive, oxidizing, reactive, and non-reactive gases. The systems have been designed in accordance with the applicable requirements of the National Fire Protection Agency (NFPA), Uniform Fire Code (UFC), Toxic Gas Ordinance (TGO), and Semiconductor and Equipment and Materials International (SEMI).

7.1 Valve Manifold Enclosure

The function of the GASGUARD® Valve Manifold enclosure is to ensure a safe environment for personnel during operation and maintenance, or in the unlikely event of a leak of hazardous gas. For certain areas and gases, regulations may require that the enclosure must be connected to a properly designed exhaust system that is ***continuously*** operated in order to ensure a safe environment outside the enclosure.

The enclosure provides the secondary containment for any leak from the process gas manifold panel. The exhaust system quickly carries any leaking hazardous gas to a safe disposal system preventing its escape from the enclosure.

The GASGUARD® Valve Manifold enclosure is constructed of 12 gage steel and protected with corrosion resistant polyurethane paint or polyester powder coat finish. Two enclosure sizes are available to hold up to four or eight manifold Branches. An exhaust stack is provided for connection to the customer's exhaust system.

The enclosure has a 12 gage steel door with a window constructed of 1/4" thick wire reinforced safety glass.

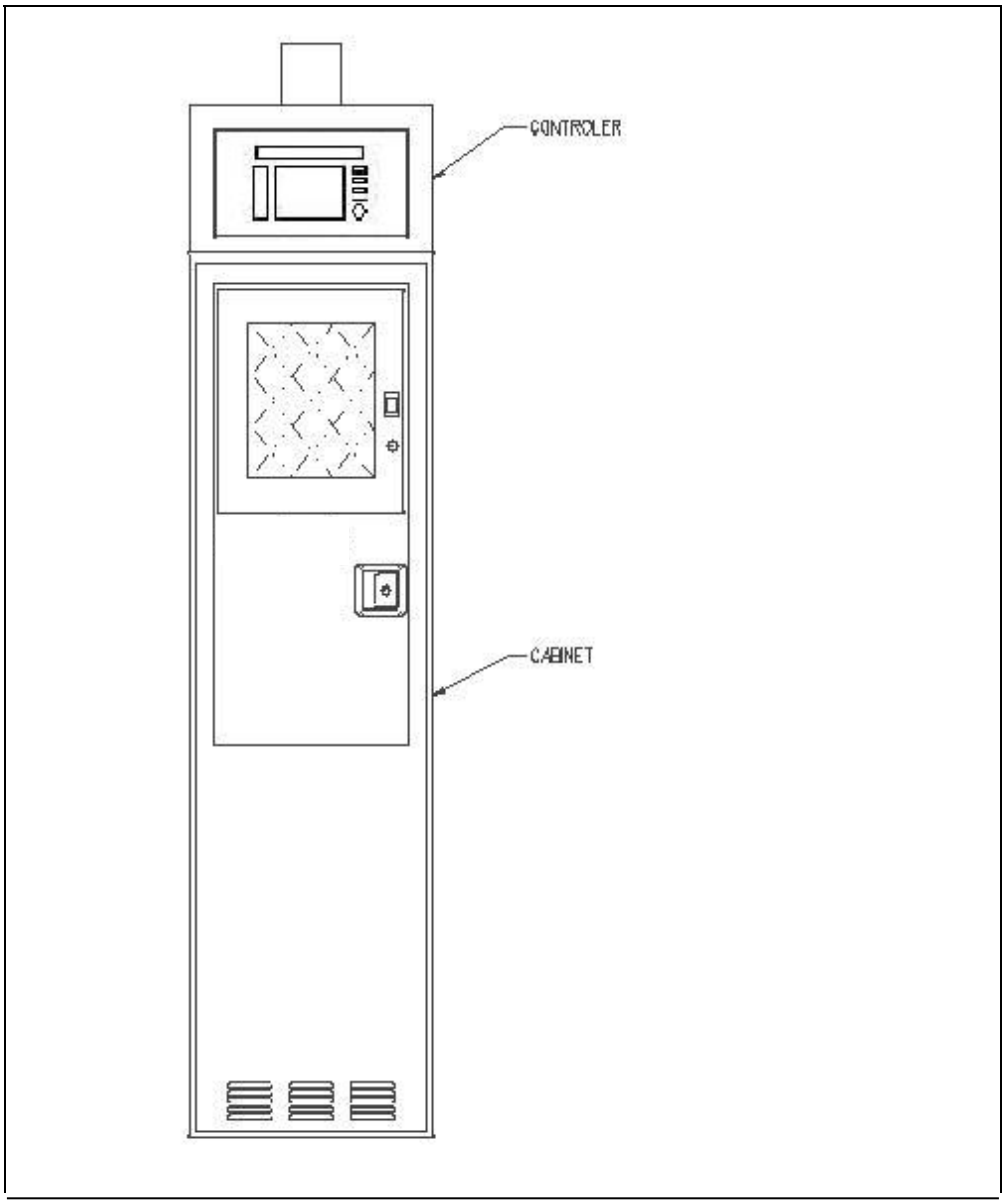


Figure 7.1: Typical GASGUARD® Distribution System

7.2 Hazardous Gas Manifold Panel

The Gas Panel may consist of pneumatic control valves, * manual valves, pressure monitors, pressure regulators, check valves and various safety/purity components that are capable of performing the following functions:

- Distributes gas supplied by an upstream source to one to eight process tool use points.
- Regulates inlet pressure to the process tool working pressure.
- Removes hazardous material, if present, from the valve manifold Branches and downstream piping prior to maintenance.
- Provides immediate shut-off in a hazardous situation using fail-safe pneumatic control valves.

Pneumatic control valves can be used to shut off process gas flow, to control purge gas flow into the process panel, to vent process gas and purge gas from the panel and to feed inert gas to the vacuum venturi system. Excess flow sensors are used on individual Branches to initiate a Branch shutdown if a downstream excess flow condition exists. Manual valves are used as backup to prevent process gas flow into the inert gas panel and to prevent contamination of the panel from the exhaust system. Optional check valves can be used in place of manual valves.

All components and tubing are type 316L stainless steel. Hastelloy C-22 trim is used in corrosive gas regulators. All components handling the process gas or purge gas are welded into the system or connected by face seal fittings where mechanical junctions are necessary.

Note: Asterisk (*) indicates manual valve type supplied is not equipped with optional Lock-Out/Tag-Out hardware, but maybe available. Contact an Versum Materials, Inc. representative for more information related to this optional manual valve hardware.

7.3 Panel Schematic and Component Descriptions

7.3.1 Panel Components

Figure 7.2 is a flow schematic for a typical four branch Distribution System. The function of each component on the schematic is described in the table.

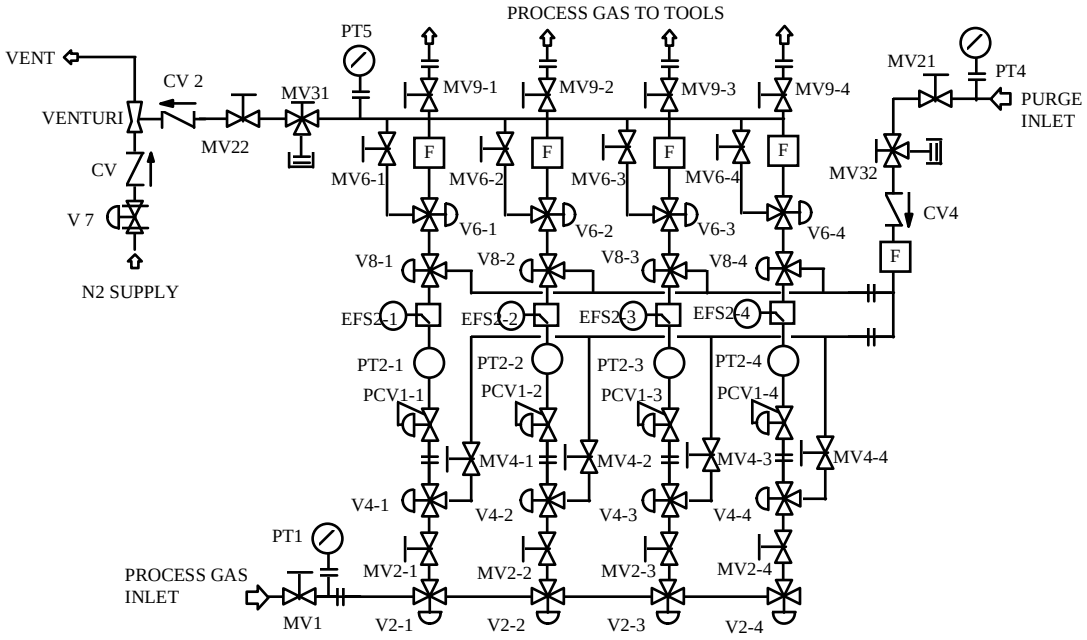


Figure 7.2: Typical Four Branch Distribution System Flow Schematic

NOTE: Some components shown here are optional. Not all systems contain all components. Most valves have the option of being either pneumatically or manually controlled. In certain cases, the pressure transducers may be replaced with another type of pressure monitor (i.e. switch, gage, transmitter). Valve numbering is repeated for Branch 5 and 6 of a six branch Distribution System or Branch 5 through 8 of an eight branch Distribution System.

V1 **Process In Emergency Shutoff Valve** Optional pneumatic control valve isolates process gas supply from cabinet to the Distribution System.

V2 **High Pressure Process Valve [branch 1-4 (A-D)]**

Pneumatic control valve permits flow from Branch 1 through 4 piping.

V4 Purge In Gas Valve [branch 1-4 (A-D)]

Pneumatic control valve isolates each individual process gas branch from purge gas on the upstream side of pressure control valve.

V6 Low Pressure Vent Valve [branch 1-4 (A-D)]

This pneumatic control valve isolates process gas flow stream of each branch from waste gas vent system.

V7 Venturi Supply Valve

This pneumatic control valve controls Nitrogen Supply for vacuum venturi operation.

V8 Opposing Purge In Gas Valve [branch 1-4 (A-D)]

This optional pneumatic control valve isolates purge gas to each process gas branch downstream of pressure control valve

MV1 Process In Isolation Valve

This manual valve isolates the Distribution System and downstream equipment from the process gas supply (provides dual isolation with V1).

MV2 High Pressure Process Valve [branch 1-4 (A-D)]

This manual valve isolates each individual branch or process gas flow stream from the common upstream process piping (Provides dual isolation with V2).

MV4 Manual valve provides isolation between each individual branch process flow stream and purge gas supply on the upstream side of the pressure control valve (Provides dual isolation with V4).

MV6 Low Pressure Vent Valve [branch 1-4 (A-D)]

This manual valve isolates process gas flow for each individual branch from the waste gas vent system. (Provides dual isolation with V6).

MV9 Process Isolation Valve [branch 1-4 (A-D)]

These manual valves isolates each individual process gas branch line from their respective house delivery line.

MV21 Purge In Isolation Valve

Manual valve isolates purge gas supply from the Distribution System panel.

MV22 Vent Isolation Valve

Manual valve isolates waste vent gas system from Distribution System panel upstream of the vacuum venturi. Used in conjunction with MV31 for leak testing Distribution System panel vent piping.

MV31 Leak Test Isolation Valve

This valve permits Helium leak testing of panel vent gas header when used in conjunction with valve MV22.

MV32 Weld Gas Inlet Valve

This manual valve permits a source of welding gas to enter the Distribution System panel through the purge gas supply line when used in conjunction with valve MV21.

PCV1 Pressure Control Valve [branch 1-4 (A-D)]

This regulator controls the pressure of each individual process gas flow stream.

PT1 Pressure Transducer for Process Gas Supply

This device measures the process gas source pressure at the inlet to the Distribution System panel.

PT2 Pressure Transducer for Process Gas Delivery [branch 1-4 (A-D)]

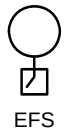
This transducer measures the delivery gas pressure for the individual process gas flow streams.

PT4 Pressure Transducer for Purge Gas Supply

This transducer measures purge gas pressure at the inlet to the Distribution System panel.

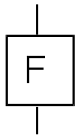
PT5 Pressure Transducer for Waste Gas Vent System

This transducer measures vent gas pressure upstream of the vacuum venturi.



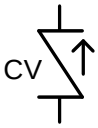
Flow Switch (Optional)

This device senses an excess flow of process gas caused by downstream system failure (tubing or component leak, valve or regulator failure, etc.) and sends a switch signal to the controller to shutdown the system.



Filter (Optional)

This device removes particles from the gas stream



Check Valve

This safety device is used to prevent backflow of gas into another section of the system.

Vacuum Venturi

This device is used to pull a vacuum on the process panel during purge cycles. It uses a flow of nitrogen past an orifice to create a vacuum as low as 26" Hg.

NOTE: Reference the specific system drawings and inserts in the document envelope for additional component descriptions included in custom systems.

7.4 GASGUARD® AP11 Controller

The GASGUARD® AP11 controller is a microprocessor-based unit housed in a custom designed metal enclosure. It continuously monitors system inputs and automatically performs purging operations by sequencing valve actuation. Adequate purging is ensured by checking pressure and vacuum at each step within the purge cycles. The controller also has the capability of shutting down the system if an unsafe condition arises.

The controller screen allows the operator to easily understand the operation and to quickly identify operating problems. The color scheme for open and closed valves can be found on the legend of the controller face. The path of gas flow is indicated by an animated dashed line and controller status is displayed in the middle of the top of the screen. Any shutdown alarms are displayed in the SHUTDOWN ALARM box in the top left hand corner of the screen. Fault alarms are displayed in the FAULT ALARM box in the top right hand corner of the screen.

Figure 7.3: GASGUARD® AP11 Controller

7.4.1 Controller Components

The Display Screen

Located on the front face of the controller, the display screen is an LCD that contains a graphical display of the distribution system gas panel, shutdown and fault alarm boxes, a branch status box and the selection window. The screen that is displayed when the system is powered up for an 8 stick Distribution System is shown below.

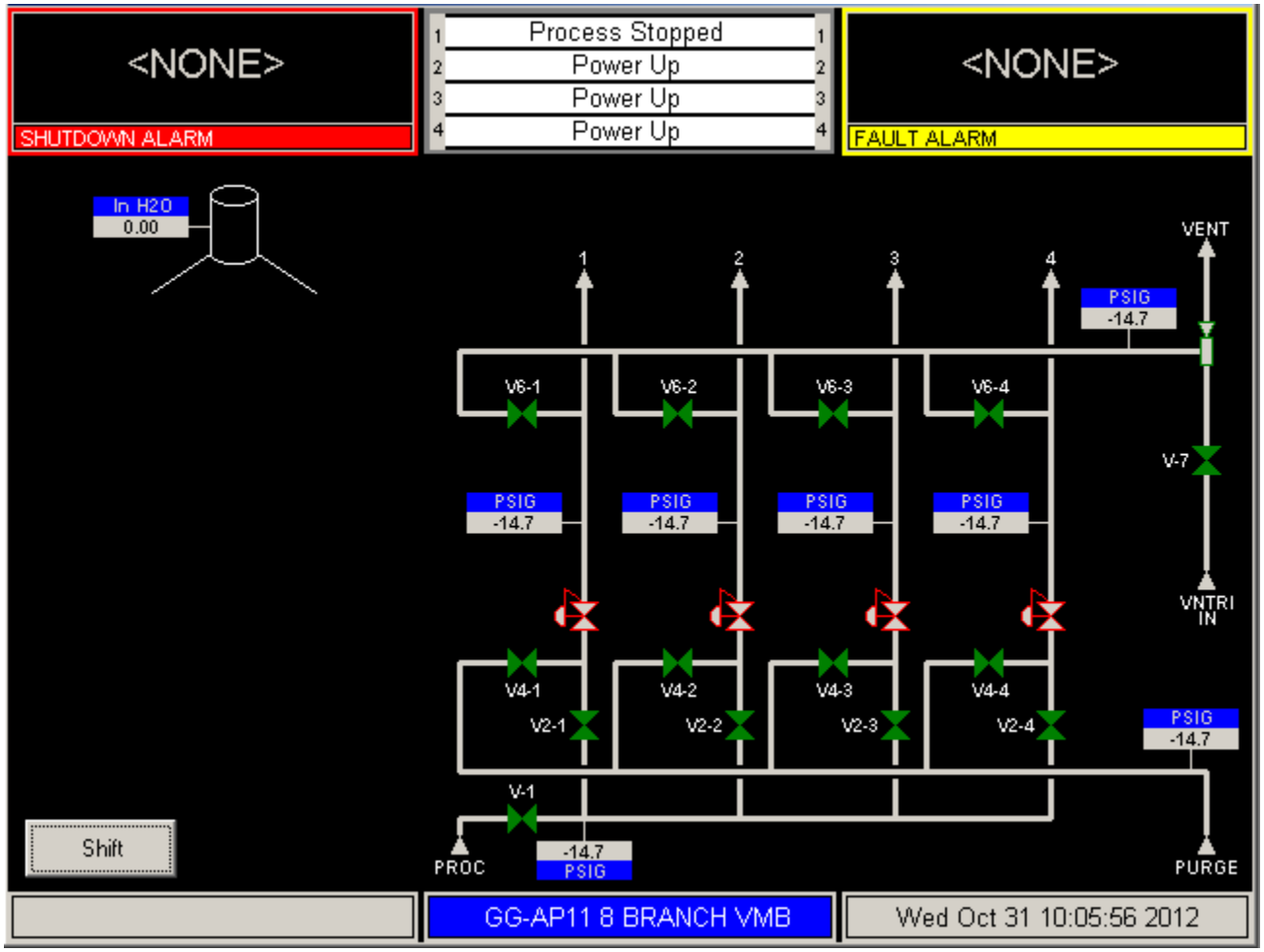


Figure 7.4a: GASGUARD® AP11 Power Up Screen Sticks 1-4

Pressing the Shift button in the lower left side of the display screen will display sticks 5 thru 8 as shown below. If your system is a 4 stick VMB, sticks 1 thru 4 will be displayed and there will not be the Shift button.

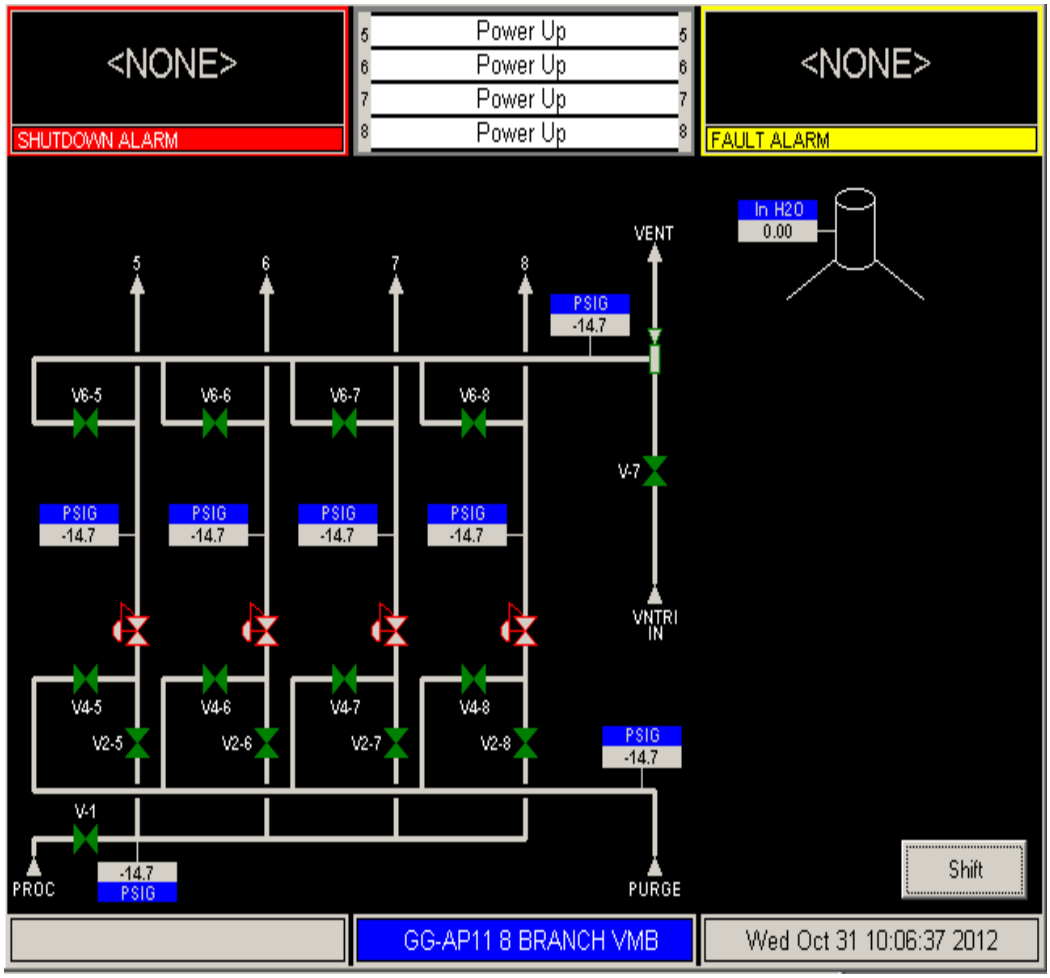


Figure 7.4b: GASGUARD® AP11 Power Up Screen Sticks 5-8

The Main Menu and Cabinet Configuration Selection Window

The selection window is located to either the left or right side of the screen after successfully entering the password. It presents prompts and menu selections. The Main Menu is shown in Figure 7.5. The Main Menu will remain displayed for a configurable amount of time or until the Logout key is pressed.

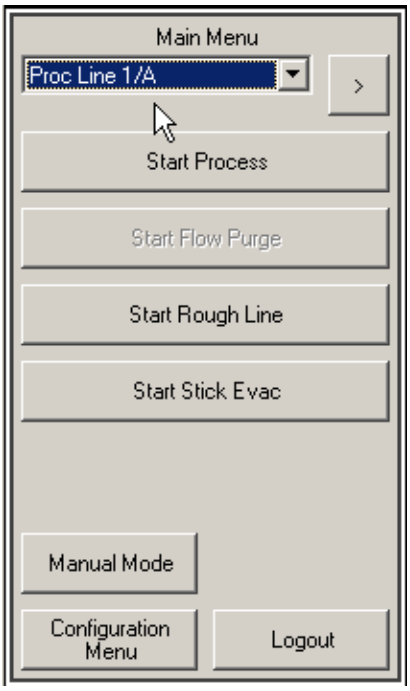
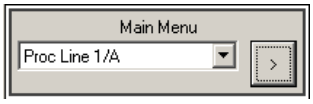


Figure 7.5: GASGUARD® AP11 Distribution System Main Menu

It is possible to resize the Main Menu to get a full screen view. To resize the Main Menu, touch the words, "Main Menu," at the top of the window.

The Main Menu will appear like the illustration to the right.



To return the Main Menu to its full size, simply touch the words, "Main Menu," at the top of the window again.

Alarm and Branch Status Boxes

Shutdown alarms will appear on the SHUTDOWN ALARM box, located in the top left hand corner of the screen. Fault alarms will appear on the FAULT ALARM box, located in the top right hand corner of the screen. If <NONE> is displayed, no alarm conditions are present. A time stamp of when the alarm occurred will be displayed with each alarm. Touch either box to acknowledge alarms and touch again to reset alarms.

The BRANCH STATUS box is located in the top center of the screen and displays the current status of the process panel. Refer to Figure 7.6.

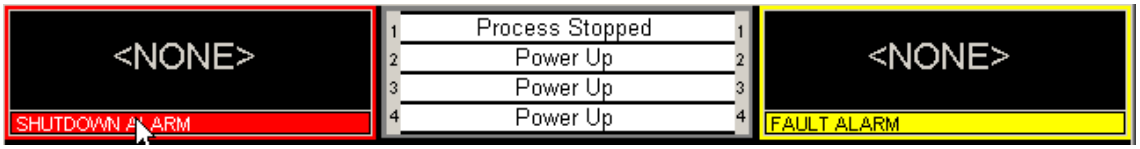


Figure 7.6: Alarm and Controller Status Boxes

System Information

The System Information window can be reached by touching the blue title button at the bottom of the screen. This window displays the firmware, network, and configuration information. The user also has the option of testing the shutdown and/or fault alarms as well as cleaning the touch screen.

VGA LCD Display

The VGA LCD display, located on front of the controller, provides, through a lighted display, visual indication of pneumatic valve positions. The color scheme for open and closed valves can be found on the legend of the controller face.

Controller LEDs

Additionally, LEDs which display system functions are located to the right of the LCD display. The table below describes these LEDs and their functions.

LED	Function
SHUTDOWN ALARM	This LED flashes red on power up and for an un-acknowledged shutdown alarm. Once acknowledged, the LED stops flashing but remains red until it is reset.
FAULT ALARM	This LED flashes yellow on power-up and for a fault alarm. Once acknowledged, the LED stops flashing but remains yellow until it is reset.
PROCESS	This LED lights green when process gas is flowing.
ARS	This LED lights blue; steady on when ARS is enabled, flashing when ARS is active.
POWER	This LED indicates that there is +5 VDC power to the unit.

Emergency Stop

The red, mushroom head push-pull emergency stop button, located on the right side of the cabinet controller, shuts off power to the pilot solenoids, closing all of the pneumatic valves. Power is maintained to the controller, but it cannot open the valves until the button is pulled out to its normal position. Refer to Figure 8.1 for details on the Emergency Stop pushbutton.

Screen Saver

For all display types, the screen saver will blank the screen and a randomly moving mode indicator box will appear on the screen. The screen saver function will become active when the programmed amount of time has elapsed since the last operator touch screen action. If the operator presses the touch screen, a new alarm appears, or a sequence prompt appears while the screen saver is active, the screen saver function will become inactive and the key pressed will be ignored.

USB Devices

The GASGUARD® AP11 Controller is furnished with four USB ports; 3 available on the Carrier board, 1 available at the front of the controller.

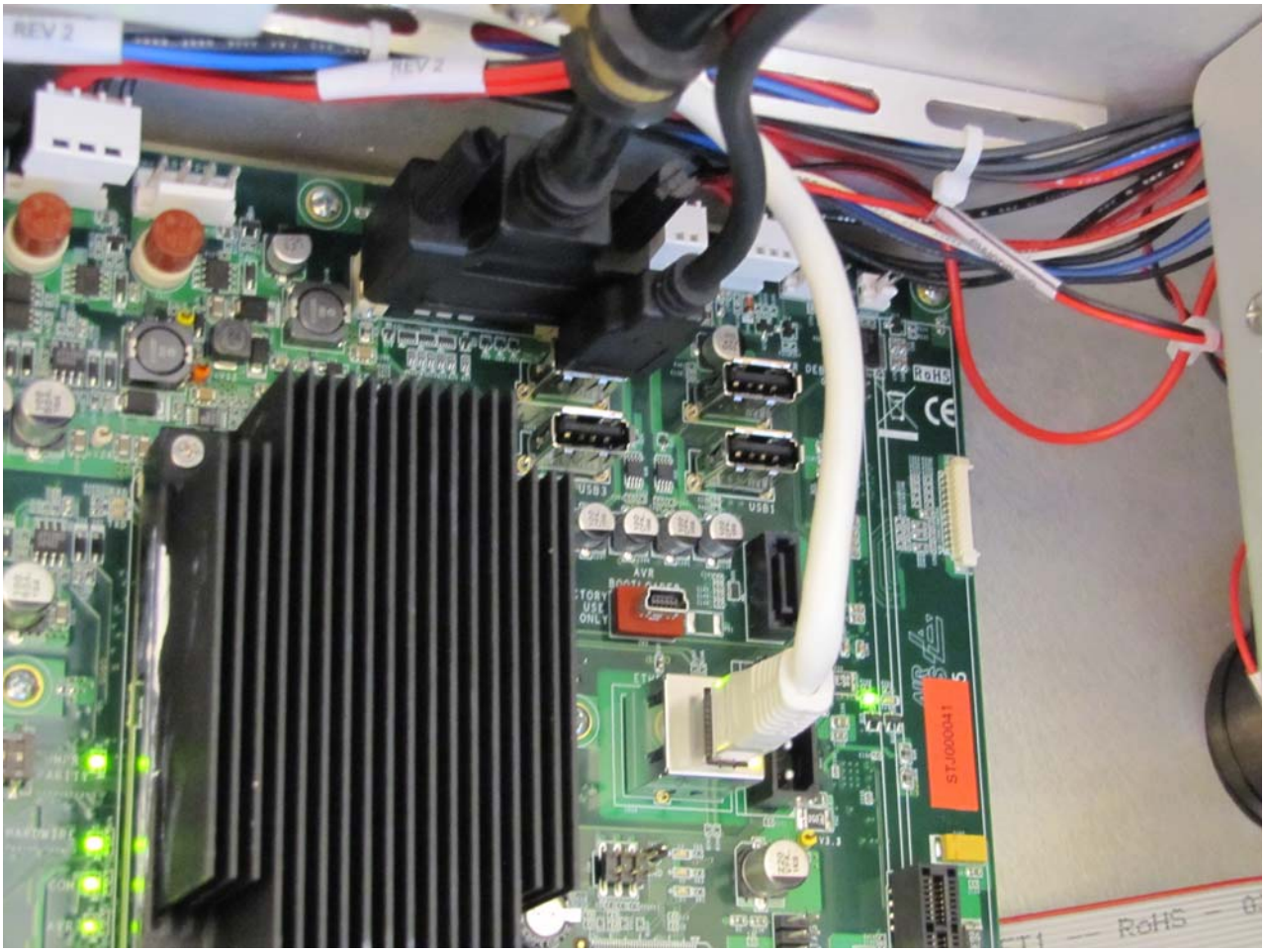


Figure 7.7: USB Ports

Any USB compatible device may be connected to either of the USB ports. For instance, a memory device may be used to transfer Firmware from the device to the Controller. Likewise, information can also be transferred from the Controller to the memory device. As another example, a USB compatible mouse can be used to navigate the Controller screens rather than using the touch screen capabilities. An option available for the GASGUARD® AP11 controller is a USB port that is located on the face of the controller, just to the right of the fault alarm light. Refer to Section 4 for further information about this USB port and proper operation.

Mouse Usage

The GASGUARD® AP11 Controller is setup for mouse usage. All actions performed using the touch screen can also be achieved using a mouse. This may become necessary in the event of a touch screen failure. For the mouse icon to appear, move the mouse at a 45 degree angle to the upper left-hand corner and right click. This will enable the cursor.

Notes On Highlighting Text

In the Controller Configuration menu, it is possible modify setpoint, password, and other numerical data. Rather than hitting the BACKSPACE key to eliminate the exiting data, it is possible to highlight the data by simply dragging your finger across the field and then entering the new data using the on-screen keypad.

Flow Valve (Z-Purge)

The flow valve is located on the right rear of the controller and can be adjusted via the penetration into the gas cabinet between the pneumatic control bulkheads.

> The flow valve controls the flow of the house nitrogen to the controller interior. Its use may be required in certain areas (i.e. Class I, Division II designated areas in the U.S.A. or Group II, Category 3 areas in the European Community.)

A pressure switch is installed inside the controller to ensure adequate pressure ($\geq$ 0.1" H_2O) during the Z-purging. A "low Z-purge" alarm will be triggered if pressure falls below the setpoint. The nitrogen flow must be increased until the alarm can be reset.

7.5 Basic GASGUARD® AP11 Controller Operation

7.5.1 Security Code Protection

A password security system is built into the GASGUARD® AP11 controller operation to prevent operation by untrained and unauthorized personnel. The controller will not respond to keypad operation unless an operator correctly enters his assigned 5-8 character password when requested. Four levels of password security provide added protection to assure safe operation of AP11 systems:

- 1st level for trained operators to initiate basic programmed controller operations.
- 2nd level for trained supervisory personnel to enter certain operating files in the Configuration Menu - to change some operating parameters and view others.
- 3rd level allows access to additional operating files for highly trained supervisory personnel.
- 4th level is restricted to Versum Materials, Inc. personnel.

Details of the password security system and how to enter security codes are provided in Section 8.2.

7.5.2 Menu Operation

All AP11 controller operations are initiated from menus that appear on the LCD screen. The Main Menu appears on the screen after a password has been entered and accepted by the controller. A specific Branch Action Menu can then be selected from the Main Menu.

7.5.2.1 Menu Time-Out Feature

The **Menu Time-Out Feature** causes the controller to drop out of the Main Menu automatically if a menu option is not selected within the configured time period. This safeguard prevents unauthorized operation if an operator leaves the equipment before selecting a menu option.

7.5.2.2 User Entry Time-Out Feature

Operator Prompts may appear on the LCD display during some operating sequences. After completing the specified task, the operator must press OK. The controller will go to the next step. There is a **User Entry Time Out** feature on Operator Prompts. If the task is not completed within the time limit, the controller initiates a shutdown alarm and drops out of the selected sequence. The sequence must be repeated from the beginning.

7.5.3 Branch Menu Operations

> ***Note: The following descriptions of system sequences are not intended as a guide to operation. Use specific operating procedures, provided in Section 8, to operate the system.***

The following sections provide a brief description of what occurs during each of the operations in the Branch Menu.

Process Gas Flow

This operation is highlighted when the desired Branch menu is selected. It starts process gas flow to the process tool for the selected Branch, or stops flow if the Branch is currently flowing gas.

The start sequence enables all Branch specific process alarms and checks for adequate process gas pressure.

If problems are found, an alarm is displayed. Details of these alarms are located in Section 11 System Specific Information of this manual.

If no problems are found, flow is started and continues until a process stop is selected, or an alarm condition causes a shutdown. The excess flow alarm is disabled for a brief variable time at the start of flow to prevent false trips during initial filling of the process line.

Line Purge

> ***NOTE: Line refers to the component assembly within the Branch that can be removed for maintenance or replacement. The Branch outlet manual valve is closed during the Line purge sequence.***

This option starts the Line purge sequence for the selected Branch. This operation is used to reduce the amount of hazardous process gas in the Line to safe levels prior to maintenance or other activities.

The purge sequence tests for adequate purge pressure and vacuum, and then initiates a series of purge cycles of the Line process piping to reduce process gas concentration to safe levels.

The number of purge cycles depends on the type of process gas. Minimum values are built into the sequence. Cycles may be increased (See System Configuration in Section 8.8 of this manual), but not reduced below the minimum.

Flow Purge (Optional Process Line Purge)

This purge sequence consists of flowing purge gas continuously through the Line and downstream process line. The gas is vented through a vent valve at the tool or through the tool itself. This purge process is used to reduce the concentration of hazardous gas to safe levels to allow maintenance to be performed on the process line.

The customer must establish a purge time to reach a safe level that is based on the flow rate, line length and type of gas. The vented gas should be monitored for residual hazardous gas concentration before maintenance is performed.

Line purging can also be performed using Manual Mode.

Rough Line Evacuation (Optional Process Line Purge)

This option starts a purge and evacuation sequence for both the selected Branch and the process line to the tool isolation valves. The purpose of this sequence is to remove the **major portion** of the hazardous process gas from the Distribution System Branch ***and downstream process line*** through the vent system of the Distribution System. It does not reduce the concentration of hazardous gas to safe levels for maintenance activities.

This sequence does not remove hazardous gases to a low enough concentration to permit operator maintenance or other activity on the process line or downstream components. The customer must develop purge and evacuation procedures for the process line and components downstream of the Distribution System to assure acceptable low concentrations of hazardous gas to permit maintenance of this equipment.

NOTE: Either the Flow Purge or the Rough Line Evacuation sequence will be installed in the AP11 controller per the original order. See the System Specific Information provided with the equipment to determine which process line purging sequence is installed for this system.

7.6 Configuration Menu

The configuration menu contains a collection of files that are used to define the operation of the GASGUARD® AP11 controller. The files establish operating sequences for valves during various operating modes, define digital alarm responses, and establish setpoints for analog devices.
Access to the Configuration Menu requires a second or higher level password. Access to individual files in the menu is further restricted by password security level based on the content of the files. Many of the files are only accessible by VERSUM MATERIALS, INC. personnel with 4th level security. This is to prevent changes to the operation of the system that may cause unsafe conditions. See Section 8.8 for more details of the configuration menu and descriptions of the files that the customer may access for changing parameters such as non-critical setpoints or number of purge cycles, or for viewing only.

7.7 Manual Mode Operation

The Manual Mode file in the Configuration Menu permits authorized personnel to open and close any pneumatic control valves individually. Manual Mode provides a means of flowing purge gas, weld shield gas and certification gas during system installation and start-up procedures. It also provides a means of flowing purge gas while maintenance or repairs are being performed.
Access to Manual Mode operation is restricted to 2nd or higher level supervisory personnel. See Section 8.6 for detailed instructions for Manual Mode operation.

⚠CAUTION

Only experienced operators should operate the Distribution System in Manual Mode. Operating valves out of their proper sequence could potentially cause damage to the product by interrupting or providing insufficient gas flow. Manual operation should not be used for process gas flow as critical shutdown alarms may be disabled in Manual Mode.

Chapter 8

Operating Procedures

This section will describe the operating procedures. The following procedures are included.

⚠CAUTION

Be sure you have read and understood the safety information located in Section 1 of this manual before operating the system. You should also be familiar with the location and function of all components.

⚠CAUTION

Prior to operating the system, the proper installation procedures need to be completed. This information is found in the Sections 1 through 6.

⚠CAUTION

The gases being used in this equipment may be extremely hazardous. It is the customer's responsibility to assure that only experienced, trained operators, thoroughly familiar with this manual, the equipment and operating procedures, the hazards and the safety procedures are permitted to operate this system.

8.1 Emergency Shutdown Procedures

In the event of an emergency, press the "EMERGENCY STOP" pushbutton on the controller panel. See Figure 8.1 below. This will close all valves, any process or purge program is aborted, the alarm horn will sound and the shutdown alarm light will flash. ***Evacuate the area***.

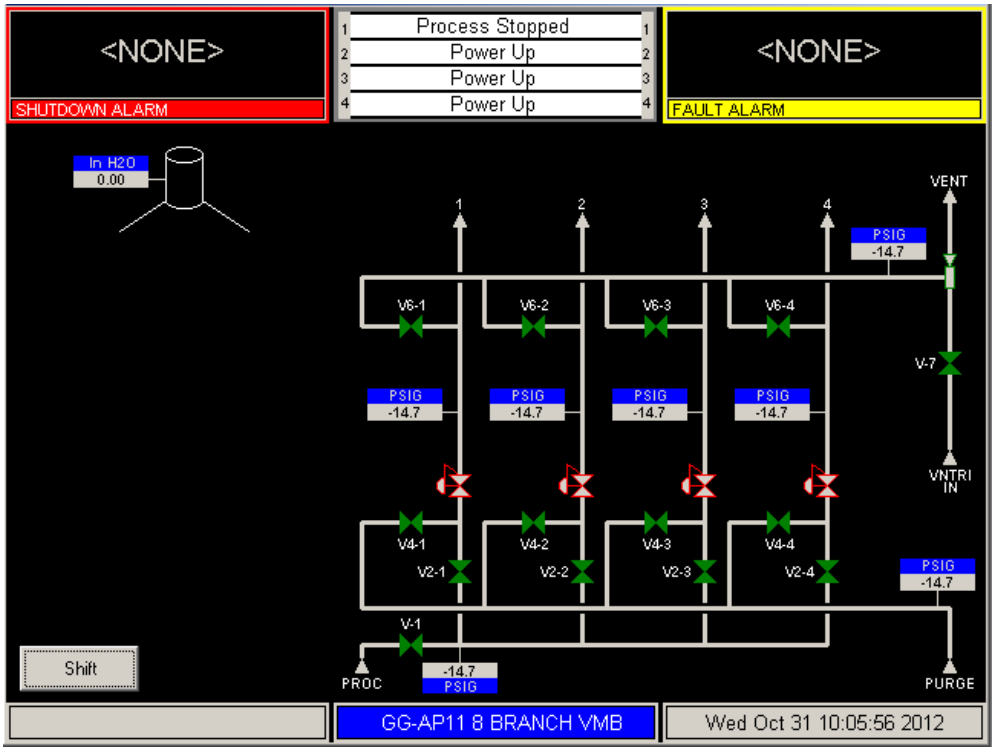
Figure 8.1: Emergency Stop Pushbutton Location

Pressing the "Emergency Stop" button does not disconnect power to the controller. The 120 VAC/240 VAC power is still active within the controller. Do not perform maintenance on the controller without disconnecting or switching of power externally and following the required Lockout or Tagout procedures.

If it is necessary to reenter the area while a hazardous atmosphere is suspected, the proper Personal Protective Equipment (PPE) must be worn. See Section 1.9 of this manual for the proper PPE.

8.2 Using the Controller

This is the screen that is displayed upon power up.



To begin operation, press the Shutdown Alarm Status window once to acknowledge any alarms. Press the Shutdown Alarm Status window again to reset any alarms.

Touch anywhere on the graphics portion of the screen.

A window like the one on the right will open on the screen.

Enter the password using the numbers on the keypad.

Example:

To enter the password "11234": where the level of access precedes the password.

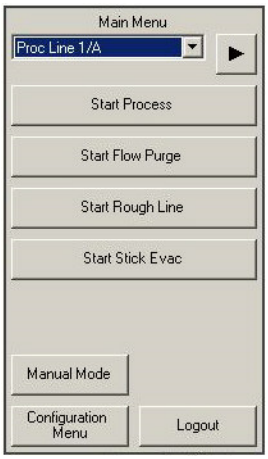
Press OK

If an improper password is entered, the password window will look like the one to the right.

"Invalid Password" will appear at the bottom of window.

If using a dual controller the screen will default to display the left side.

Use the  and  keys or the drop down menu to select the left (sticks 1-4) or right (sticks 5-8) panel.

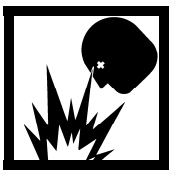


Use the drop down menu to select a process line.

Note: Selections that appear dimmed are not selectable at this point of the controller sequence. All sequences require the operator to follow an executable order.

8.3 New System Startup Procedure

WARNING



In NEC Class I, Division II hazardous locations (applies only in the U.S.A.) or Explosive Atmospheres (applies only in the European Community), do not apply power to the Distribution System controller until the controller enclosure has been purged for at least 20 minutes at a pressure at or above 0.1" H_2O as monitored by the internal Z purge pressure switch (hazardous locations only). Refer to steps 3 and 4 below. This complies with NFPA 496 and ATEX regulations regarding electrical equipment enclosures. Failure to do so could result in the ignition of any flammable gas which may be present.

1. Verify that the system is ready for startup by completing the startup checklist in the installation manual. Check that the GASGUARD® Distribution System and all plant piping have been leak checked with a helium mass spectrometer in accordance with the customer's specified procedure. Check that the GASGUARD® Distribution System has been functionally checked after installation.
2. Check that the Distribution System exhaust system and hazardous gas disposal system (pollution abatement) are operating.
3. Verify that house nitrogen pressure is between 85-95 psig (5.9-6.6 barg).
4. In Class I, Division II (US) or Group II, Category 3 (Europe) hazardous locations, turn on and adjust Z-purge gas flow to the cabinet controller. The controller is equipped with a Z-purge pressure switch. The absence of this alarm during Z-purging indicates that the Z-purge is adequate. If a "Low Z-purge" alarm is present, increase the flow rate until the alarm can be reset (hazardous locations only).
5. After purging the controller for at least 20 minutes, turn on electrical power to the controller.

NOTE: The GASGUARD® AP11 system is supplied with an internal controller purging means that meets NFPA 496, Type Z purging requirements for use in NEC Class I, Division II hazardous location (applicable only in the U.S.A). The internal Z-purge also meets the requirements of the Explosive Atmospheres Directive (ATEX) (applicable in the European Community). Type Z purge <u>does not</u> meet Class I, Division I NEC requirements.

6. Press the shutdown alarm status window to initialize the controller on power up. No alarms should be present. If alarms are present, ***do not continue***. Follow the troubleshooting procedures found in Section 9. If needed, contact your Versum Materials, Inc. factory representative for assistance

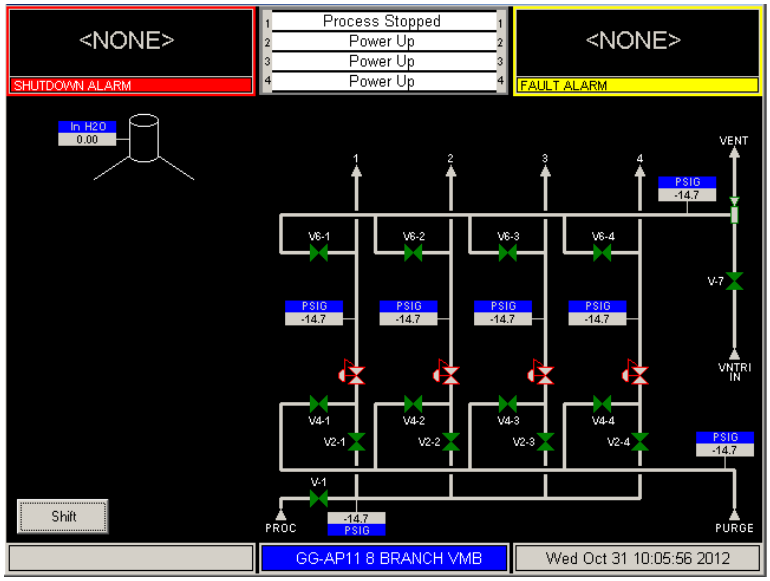
7. When requested by the customer, partially populated VMB/VMPs may be supplied with software to support a fully populated system. This is done so that build outs do not require a new software reload. When this is the case, please note the following:

    1) Unused sticks must be kept in idle mode
    2) The controller screen will show sticks that are not physically there.
    3) The Pressure Transducer readings will show 0.00 on unused sticks.
    4) Where used, the Branch shutdown alarms for unpopulated sticks must be disabled. The alarms can re-enabled and /or disabled with a 4th level password.
    5) It is strongly recommended to physically lock out the manual process isolation valves for any unused stick prior to start-up. The pneumatic tubing for any unused air-op valve should be properly labeled and disconnected from the valve.

8. Check that all automatic valves indicate closed position (green). They should appear as illustrated to the right.

9. Begin by closing the regulators (knob rotated fully counter clockwise). Adjust each regulator clockwise 6 turns. This will ensure an adequate purge pressure downstream of the regulators when purging is initiated in step 14.

10. Check that the purge source is connected and delivering 80-90 psig of purge gas (PT4).

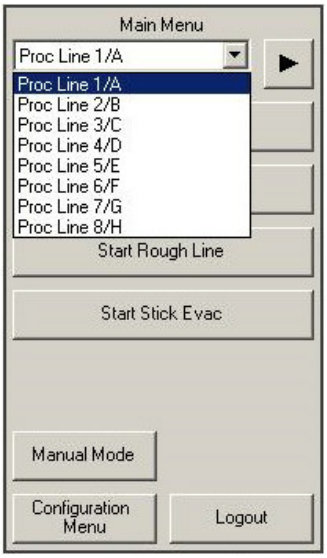


⚠CAUTION

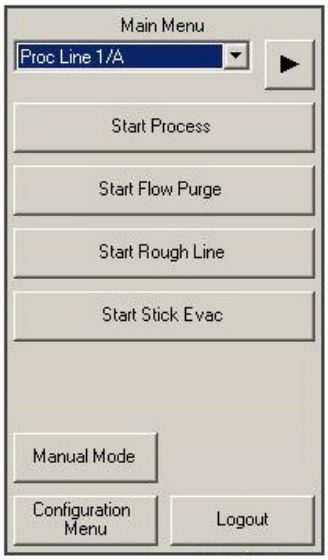
Process gas back-stream hazard can exist if the purge supply drops below 200 psig.

11. Ensure MV4-1, purge gas inlet valve, is open.

12. Touch anywhere on the graphics portion of the screen and enter the password. Press OK
13. Using the dropdown menu on the Main Menu screen, highlight the Line you want to operate.



14. From the Main Menu, select "START ROUGH LINE".
15. When prompted by the Confirm Sequence Start Window, hit “CONFIRM”.



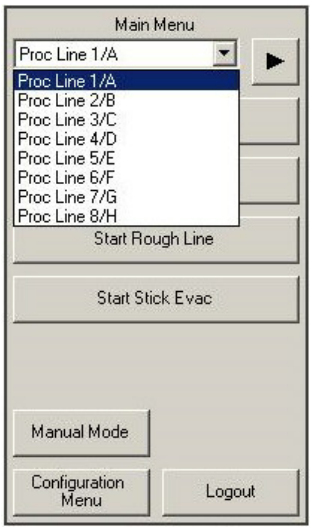
Note: If manual valves must be opened or closed or their position verified, an operator prompt will appear. The operator must push OK ***when done, to continue with the program.***

⚠CAUTION

All manual valves on the Line purge inlets (MV4-1, MV4-2, MV4-3, MV4-4) and vent outlets (MV6-1, MV6-2, MV6-3, MV6-4) should be closed during process flow and idle modes. The specific valves should be opened only during purging cycles and manual mode operations.

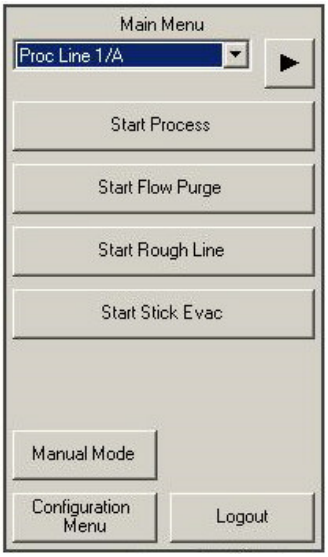
16. At the end of the purge cycle, the Line status box at the top of the screen will indicate "ROUGH LINE COMPLETE."

17. Verify the process gas source is on-line and set at the desired delivery pressure, PT1 (process gas inlet maximum 90 PSIG.)
18. Ensure MV1, process gas inlet manual valve, is open.
19. Touch anywhere on the graphics portion of the screen and enter the password.
20. Select the same Line from the Main Menu that the purge was performed in step 13.



⚠CAUTION ***Before proceeding further, verify that process equipment and facility piping is ready to receive process gas.***

21. From the Main Menu, select "START PROCESS."
22. The controller will open the process gas inlet isolation valve on the selected Line.
23. Adjust the Line regulator, through the access window, to the desired delivery pressure.
24. Process gas is now flowing to the process equipment.

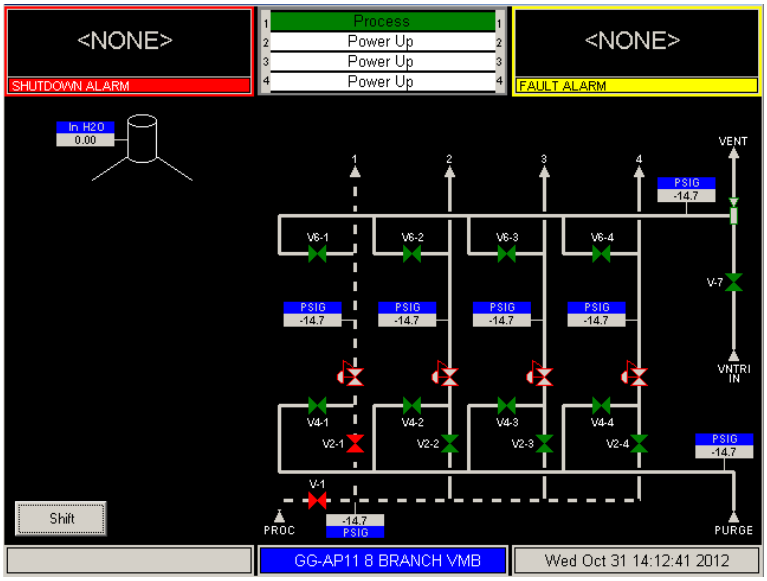


With process gas flowing through Line 1, the valves on the graphic display will appear as illustrated to the right.

25. Note the color coding key on the graphic:

Color screen:

Red - valve open
Green - valve closed



CAUTION

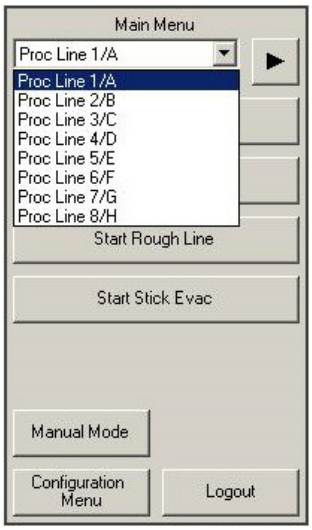
Isolate downstream process equipment from the valve manifold box when process gas is not required to prevent back contamination.

8.4 Line Purge and Process Line Purging Procedures

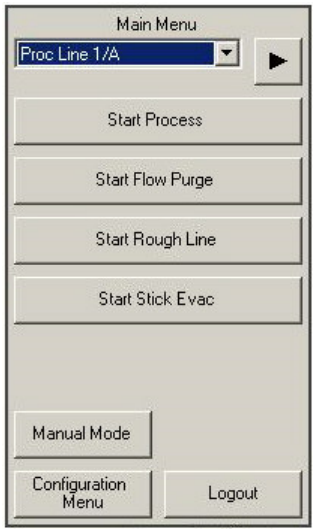
8.4.1 Line Purge Procedure

This procedure purges hazardous gas from the selected Line prior to maintenance or other operations on the Line that require removal of hazardous gas to safe levels.

> ***NOTE: A process line purging procedure (rough line evac or flow purge) must be performed on the Line before the Line purge can be initiated. This reduces the concentration and pressure (< 0 psig) of hazardous gas in the Line downstream of the manual Line outlet valve (MV9-1, 9-2, 9-3, 9-4) so that maintenance can be performed safely on the upstream Line.***

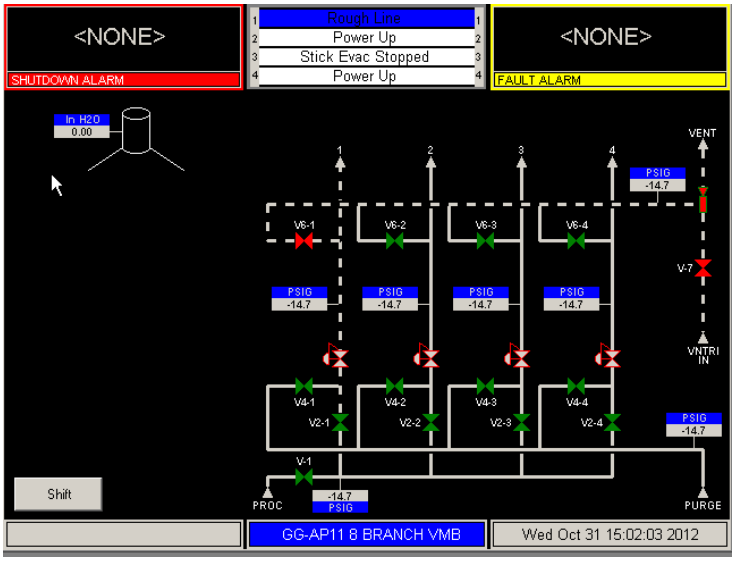


1. Touch anywhere on the graphics portion of the screen and enter the password.
2. Using the dropdown menu on the Main Menu screen, highlight the Line you want to operate.

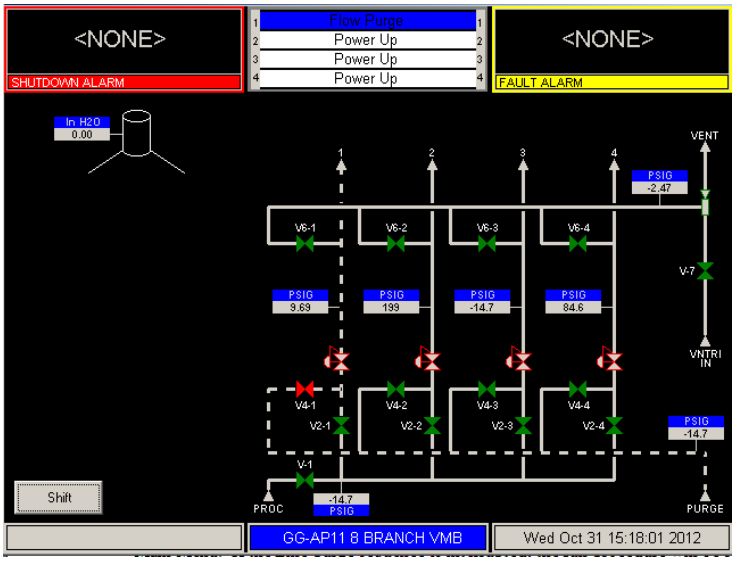


3. From the Main Menu, select "START ROUGH LINE".
4. Went prompted by the Confirm Sequence Start Window, hit “CONFIRM”.
5. “ROUGH LINE" will appear in the appropriate Line status box at the top of the screen.
6. Follow prompted manual steps on the screen.
7. The controller will make several checks for adequate purge pressure and vacuum and proper closure of the manual process isolation valve for the Line. Any fault will stop the process and alarm.
8. The controller will initiate a sequence of evacuation and pressurization steps until the configured number of cycles are completed.

9. During evacuation, venturi supply valve, V7, and the Line vent valve (for Line 1, valve 6-1) open to evacuate process gas in the Line. The screen at the right shows the evacuation step of Line 1. V7 and V6-1 are open (red) and the dashed line indicates the gas flow path.



10. During pressurization, valves 6-1 and 7 will close (green) and the purge valve (for Line 1, valve 4-1) will open (red). The screen to the right displays this portion of the purge sequence for Line 1.



11. To stop the purge sequence before completion, press the "STOP ROUGH LINE" button on the Main Menu. If the Line purge sequence is interrupted, the full procedure will be repeated when restarted.

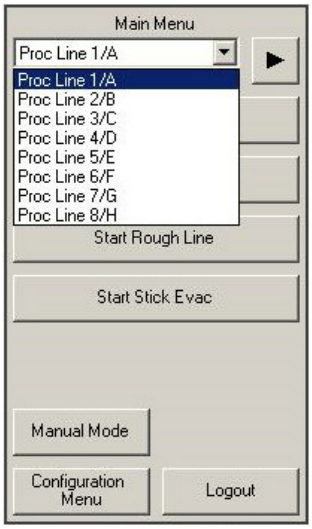
12. Upon completion, maintenance may be performed on the Line by following the maintenance procedures in Section 5.

8.4.2 Rough Line Evacuation Procedure

This procedure purges hazardous gas from the selected Line 1 and the process line to the tool. Its purpose is to remove the major portion of the hazardous gas in the process line through the vent system of the Distribution System.

The Rough Line Evacuation Procedure <u>does not</u> remove hazardous gas from the process line to non-hazardous levels required for maintenance operations. A manual purge of the Line 1 and process line through the tool must be completed prior to any maintenance operations.

1. Verify that the appropriate valves at the process tool have been closed to isolate the process line from the process tool gas panel.
2. Touch anywhere on the graphics portion of the screen and enter the password.
3. Using the dropdown menu on the Main Menu screen, highlight the Line you want to operate.



4 From the Main Menu, select "START ROUGH LINE".
5. Went prompted by the Confirm Sequence Start Window, hit “CONFIRM”.
6. “ROUGH LINE" will appear in the appropriate Line status box at the top of the screen.
7. Follow prompted manual steps on the screen.
8. The controller will make several checks for adequate purge pressure and vacuum and proper closure of the manual process isolation valve for the Line. Any fault will stop the process and alarm.
9. The controller will initiate a sequence of evacuation and pressurization steps until the configured number of cycles are completed.
10. To stop the purge sequence before completion, press the "STOP ROUGH LINE" button on the Main Menu.
11. When completed, the major portion of the hazardous process gas in the process line has been removed.
12. Do not perform maintenance unless the line is purged with an inert gas through the process tool. This must be performed using Manual Operation detailed in Section 8.6.

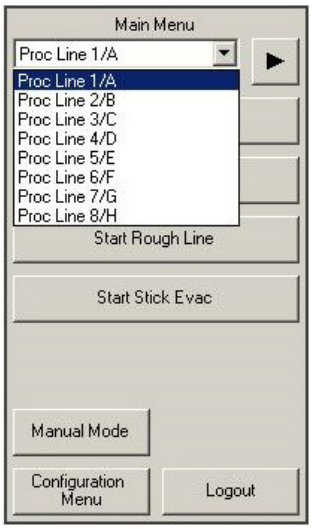
8.4.3 Flow Purge Procedure

This procedure purges hazardous gas from the selected Line 1and process line to the tool by flowing purge gas continuously through the Line 1 and venting at the tool. This purge technique can be used to reduce the concentration of hazardous gas to safe levels to allow maintenance to be performed on the process Line 1 and downstream components.

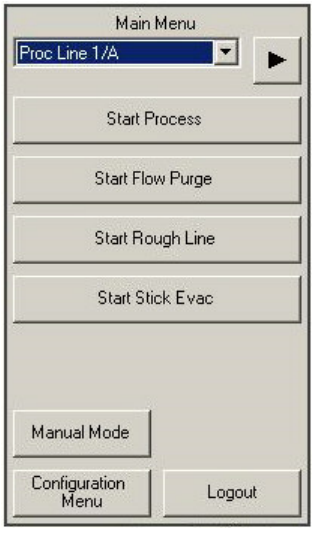
It is the ***customer's responsibility*** to establish a purge time to reach safe levels based on line length, purge flow rate and type of process gas. The vented gas should be monitored for residual gas concentration before maintenance is performed.

Flow purging can also be performed using Manual Mode.

1. Verify that the appropriate valves at the process tool have been opened to allow flow through purging.
2. Touch anywhere on the graphics portion of the screen and enter the password.
3. Using the dropdown menu on the Main Menu screen, highlight the process line you want to operate.



4. From the Main Menu, select "START FLOW PURGE".
5. "FLOW PURGE" will appear in the appropriate Line status box at the top of the screen.
6. Follow any prompted manual steps on the screen.
7. The flow through purge will continue until the operator initiates "STOP FLOW PURGE".



8. Touch anywhere on the graphics portion of the screen and enter the password to obtain the Main Menu.
9. Select appropriate process line using the dropdown menu.
10. Select "STOP FLOW PURGE".

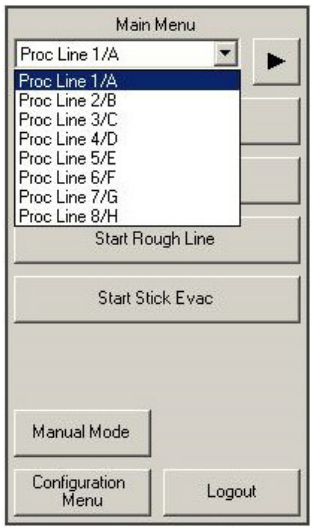
11. When the Flow Purge has been completed for the customer's required time duration, the concentration of hazardous gas has been reduced to safe levels for maintenance activities.
12. Monitor residual gas concentration before starting maintenance activities.

8.5 Process Gas Flow Procedure

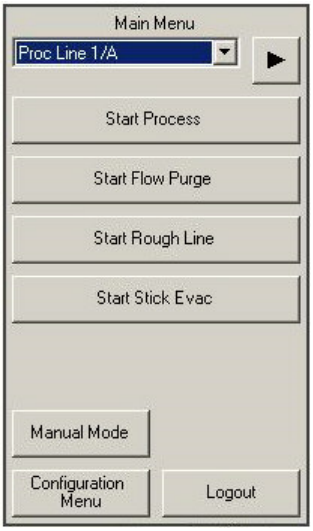
8.5.1 Start Process Gas Flow

Verify that the source for the valve manifold box is prepared to supply process gas. Verify that the downstream equipment is prepared to receive process gas.

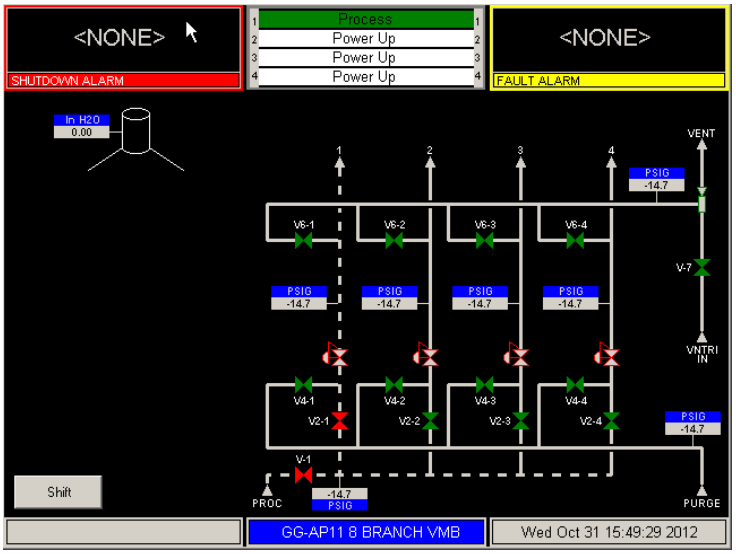
1. Touch anywhere on the graphics portion of the screen and enter the password.
2. Using the dropdown menu on the Main Menu screen, highlight the process line you want to operate.



3. From the Main Menu, select "START PROCESS".
4. Follow any prompted manual steps on the screen.

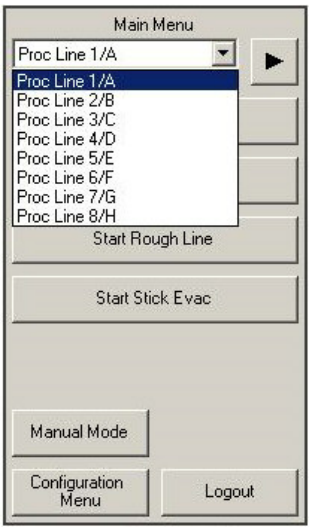


5. The appropriate valve will open (valve 2-1 for Line 1), dashed line will show the path of gas flow and the Line status box will display "PROCESS". See the screen to the right for an example of process gas flow through Line 1.



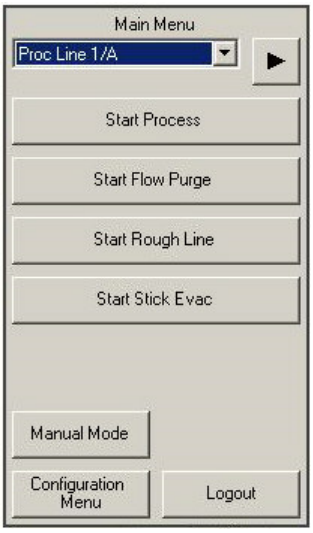
8.5.2 Stop Process Gas Flow

1. Touch anywhere on the graphics portion of the screen and enter the password.
2. Using the dropdown menu on the Main Menu screen, highlight the process line you want to operate.



3. From the Main Menu, select "STOP PROC GAS".

4. The appropriate process inlet valve will close (valve 2-1 for Line 1).



8.6 Manual Mode Operation

CAUTION

Only experienced operators should operate the Distribution System in manual mode. Operating valves out of their proper sequence could potentially cause damage to the product by interrupting or providing insufficient gas flow. Manual operation should not be used for normal, daily operation.

Manual mode provides a means of flowing purge gas through the valve manifold panel lines during Distribution System installation and pre-start-up procedures. It also provides a means of flowing purge gas while maintenance or repairs are being performed. Manual mode should not be used for process gas flow as critical shutdown alarms may be disabled.

NOTE: Access to Manual Mode is not permitted when a digital Shutdown alarm condition is present.

8.6.1 How to Operate in Manual Mode

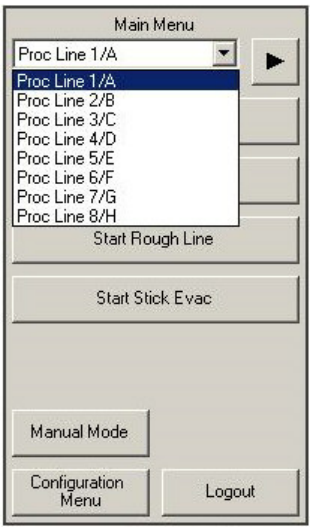
WARNING

Operating in Manual Mode can cause the following hazards which can result in PERSONAL INJURY OR DEATH.

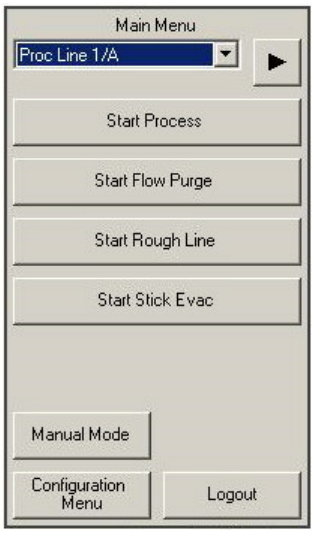
- ***Process gas could be forced into the purge piping and source.***
- ***Opening purge valves when process gas is present.***
- ***Process gas could be unintentionally vented.***
- ***Opening vent valves when high pressure process gas is present.***
- ***Alarms associated with normal process flow (excess flow, process pressure) are disabled in Manual Mode.***

NOTE: Due to the potential hazards listed above, Manual Mode operation requires a second level or greater security code.

1. Touch anywhere on the graphics portion of the screen and enter the password.
2. Using the dropdown menu on the Main Menu screen, highlight the process line you want to operate.



3. From the Main Menu, select "MANUAL MODE".



4. The MANUAL MODE window will display

5. Operate valves referring to Section 8.6.2 below.
6. To exit MANUAL MODE, press Cancel

NOTE: Pressing Cancel ***will close all the valves unless the Secure valve feature is used. This feature will not allow anyone with a low level password access to enter the controller while this feature is active.***

⚠CAUTION

Distribution System must not be left unattended in Manual Mode, as access to the system in Manual Mode is open to anyone.

8.6.2 How to Open and Close Valves

To open a valve:

1. Select the valve by touching the screen. The valves that can be operated from the screen will be highlighted with a yellow box.

2. The valve confirmation window will appear, asking you to confirm that you want to open the valve by pressing the Open Valve key.

Pressing Cancel will close the window, leaving the valve closed.

To close a valve:

1. Simply select the valve by touching the screen.

If hazardous process gas has been introduced to the Distribution System panel, the operator should open venturi supply valve, V7, and confirm adequate vacuum on PT5 before opening any vent valve in Manual Mode.

Specific manual valves may have to be opened during Manual Mode operations. The operator must understand the consequence of opening a valve before performing this step. All Line manual purge and vent valves must be returned to closed positions after completion of Manual Mode operations.

To SECURE Manual Mode:

1. The Secure option will allow an operator to exit the Manual Mode menu while remaining in manual mode with valves open. The Secure option will not be selectable if no valves are open. When the operator chooses Secure Mode from the Manual Mode window, the controller will leave the bank in manual and allow the operator to go to other screens. Any open valves will remain open, and the

Mode Status Box will continue to indicate manual mode. Manual mode will remain active or 'secured' until an operator reenters the Manual Mode window. While manual mode is 'secured', Manual Mode will be the only selectable option on the Main Menu.

⚠CAUTION

Distribution System must not be left unattended in Manual Mode, as access to the system in Manual Mode is open to anyone.

8.6.3 General Principles of Manual Operation

Open valves in sequence starting at the first valve downstream of the pressure source and continuing to the next valve in sequence.

For vacuum operation, open the valve closest to the vacuum source and continue to open the next valve in sequence.

Close valves in reverse order.

Monitor pressures on the touch screen display frequently.

Consider all possible consequences before opening or closing a valve.

8.7 Password Security

Multiple levels of password security are used in the controller to prevent unauthorized operation by untrained personnel.

The first security level allows normal sequence selection, start and stop process flow, and purge procedures. Access to Manual Mode and the Configuration Menu is not permitted.

The second security level allows access to Manual Mode and the Configuration Menu. It permits the user to change certain operating parameters, to view other menu selections and restricts access to others' files.

The third security level allows access to additional files for changing parameters or viewing only.

8.8 Distribution System Configuration

Certain GASGUARD® AP controller files may be modified using a second or third level security code. These modifications are referred to as the system configuration.

The system configuration may be accessed from the CONFIGURATION MENU option on the Main Menu. From the CONFIGURATION MENU, you may display some configurable parameters and change user configurable parameters. The CONFIGURATION MENU will appear as illustrated below.

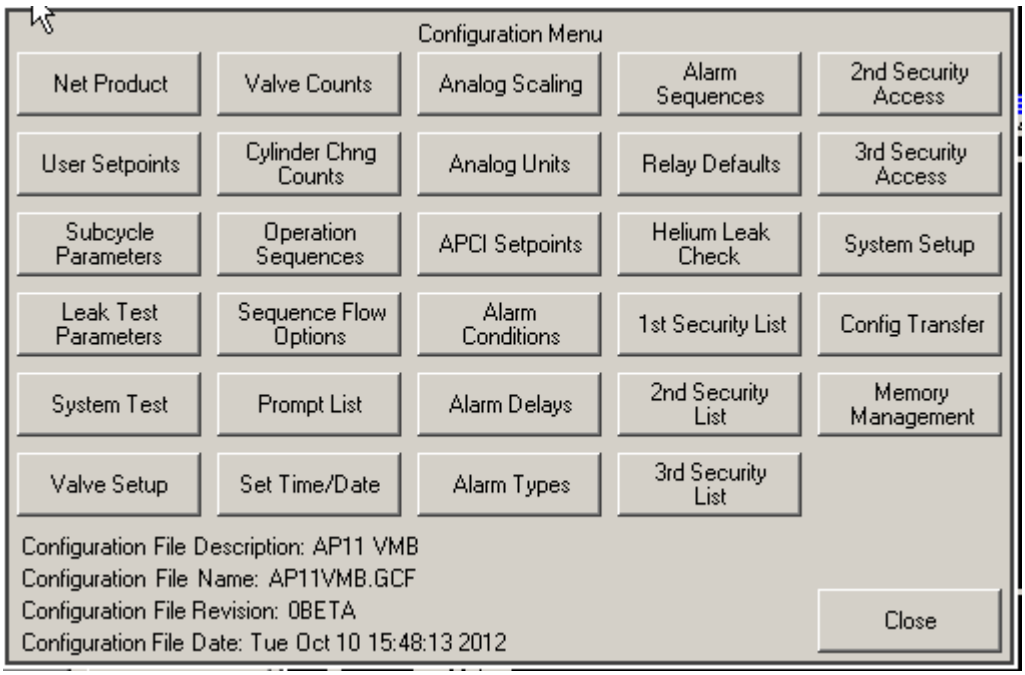


Figure 8.8: Configuration Menu

To select a menu option, simply press the corresponding menu option button.

Table 8.2 defines the preset permissions assigned to each security level and configuration parameter. In the table, “W” defines a Write access level of security and “R” defines Read access level. A blank means no access is allowed for the user. For safety considerations, most configuration parameters may be changed only by Versum Materials, Inc. technical personnel.

Table 8.2 – Configuration System Permissions

Section	Configuration Menu Options	Sub-Menu Options	Level 2	Level 3
8.8.1	Net Product		W	W
8.8.2	User (Analog) Setpoints		R	W
8.8.3	Subcycle Parameters		R	W
8.8.4	Leak Test Parameters		R	W
8.8.5	System Test		W	W
8.8.5.1		Test Digital In	W	W
8.8.5.2		Test Digital Out	W	W
8.8.5.3		Test Analog In	W	W
8.8.5.4		Test Internal Flag	W	W
8.8.5.5		Test Remote In	W	W
8.8.6	Valve Setup			R
8.8.7	Valve Counts		R	W
8.8.8	Operation Sequences			R
8.8.9	Sequence Flow Options			R
8.8.10	Prompt List			R
8.8.11	Set Time/Date		R	W
8.8.12	Analog Scaling		R	R
8.8.13	Analog Units		R	R
8.8.14	APCI Analog Setpoints		R	R
8.8.15	Alarm Conditions		R	R
8.8.16	Alarm Delays		R	W
8.8.17	Alarm Types			R

Section	Configuration Menu Options	Sub-Menu Options	Level 2	Level 3
8.8.18	Alarm Sequences			R
8.8.19	Relay Defaults			R
8.8.20	Helium Leak Check			W
8.8.21	1st Security List			W
8.8.22	2nd Security List			W
8.8.23	3rd Security List			R
8.8.24	2nd Security Access		R	W
8.8.25	3rd Security Access		R	R
8.8.26	System Setup			R
8.8.26.1		Local Setup		R
		Change Exhaust Stack Size		R
		Password Protected Reset		R
		Screen Saver delay		R
		Key Press Feedback		R
		Auto recovery System		R
		Simulation		R
8.8.26.2		Network Setup		R
		Network Control		R
		RS-485 Channel Number		R
		Ethernet Channel Number		R
		Network Comm Type		R
8.8.26.3		IP Settings		R
8.8.26.4		Peer-to-Peer IP Settings		R
8.8.26.5		Set Product Code		R
		Calibrate Touch Screen		R
		Alarm History		R
		Relay Config		R
		Enable Z purge		R
		Completed timers		R
8.8.27	Config Transfer			W
8.8.27.1		Controller to USB Transfer		W
8.8.27.2		USB to Controller Transfer		W

Section	Configuration Menu Options	Sub-Menu Options	Level 2	Level 3
8.8.28	Memory Management			

The following paragraphs describe the parameters that you may view and/or change.

8.8.1 Net Product

This option allows the operator to display either a gross or net value on any analog. The gross value will display the normal analog reading with no adjustment. The net value will display a "net" reading based on the value input by the operator. If a value other than zero is entered in this window, the "net" value will be calculated and displayed for this analog. A "net" tag will also appear at the analog display box. If zero is entered, the gross or unadjusted value will display with no additional tag.

8.8.2 User Analog Setpoints (User Setpoints)

This option allows the operator to choose an analog input device from a drop down menu or exit the window. When the operator chooses an analog input device, the corresponding setpoints will be displayed. The operator has the ability to select and change any of the setpoints. The User Analog Setpoints window displays the customer/user defined analog alarm data. The window will display the alarm number, alarm label, and current alarm setpoint for each user defined alarm. A total of ten setpoints will exist per analog input. The number of user setpoints will be equal to ten minus the number of factory controlled setpoints. This window will allow the operator to enter a new setpoint value for one or more chosen alarms or exit the window without changes. These setpoints may include one or more of the following:

- Low Branch Del.
- High Branch Del.
- Low Process Inlet
- Low Purge Inlet

To change a setpoint, first select the analog input device from the drop down menu. Then highlight the setpoint of your choice, by touching the screen. Type in a numeric value using the keypad. Press Apply to accept the changes. Press the OK pushbutton to exit the window.

8.8.3 Subcycle Parameters

This option displays the current values for the purge parameters. You may increase these values, but may not decrease them below their pre-programmed minimum.

To change a value, select the parameter of your choice by touching the screen. Use the keypad to type in a numeric value. Press Apply to accept the changes. Press the OK pushbutton to exit the window.

8.8.4 Leak Test Parameters

This option displays the current values for the leak parameters. You may increase these values, but may not decrease them below their pre-programmed minimum.

To change a value, select the parameter of your choice by touching the screen. Then select either the Delta or the Duration by again touching the screen. Use the key pad to type in a numeric value. Press Apply to accept the changes. Press the OK pushbutton to exit the window.

⚠CAUTION

All Decay Test parameters must have a negative value for the pressure difference in order to detect a leak and alarm.

8.8.5 System Test

8.8.5.1 Test Digital In

This option displays a list of the digital inputs and their current state. The state may be used to determine if the digital device is operating properly.
Use the scroll bar to view all the digital input values.

8.8.5.2 Test Digital Out

This option displays a list of the digital outputs and their current values. Outputs may be forced "on" (energized) or "off" (de-energized) to determine if the output is operating properly.
This file operates in a similar manner to manual operation as described in Section 8.8. It is the customer's responsibility to adhere to all operational warnings in Section 8.8 when performing the Digital Out Test.
Use the scroll bar to view all the digital output values.

⚠CAUTION

Extreme care must be taken when forcing a digital output either on or off as there is no confirmation in Digital Out Test, as a reminder, like that which is used in manual operation for critical valve operation.

8.8.5.3 Test Analog In

This option displays a list of the analog inputs and their current values. The current value may be used to determine if the analog device is providing accurate output (controller input).
Use the scroll bar to view all the analog input values.

8.8.5.4 Test Internal Flag

The Test Internal Flags window will display the internal flag number, label, and state (Set or Clear) for all internal flags in the system. This window will allow the operator to exit the window or change one or more internal flag states to SET or CLEAR. To change an internal flag state, the operator will highlight the desired internal flag to change and select SET or CLEAR at the bottom of the window. Then press the APPLY pushbutton. Upon exiting the Test Internal Flags window, any changes made to internal flag states will be ignored and the internal flag states will return to their original state.

⚠CAUTION

Extreme care must be taken when changing the state of an internal flag. The operator must fully understand the use of the flag prior to any edits.

8.8.5.5 Test Remote In

The Test Remote In window will display the controller number, controller name, controller input, controller input type, controller input value, and controller comm status for different controllers on the network. Changes to parameters in the Test Remote In window are not allowed.

8.8.6 Valve Setup

The Valve Setup window will display the solenoid number, valve label, and valve confirmation for each valve in the system. This window will allow the operator to change the valve confirmation mode for one or more valves or exit the window without changes. The valve confirmation mode will be set to CONFIRM or NO CONFIRM.

8.8.7 Valve Counts

The Valve Counts window will display each valve in the system and the count for each valve. The valve count will represent the number of times a pneumatic valve has cycled (opened and closed). This window will allow the operator to change the valve count for one or more valves or exit the window. New valve counts will be written to the NV Data File upon exiting and saving the Configuration Menu. To change the valve counts, select the solenoid of your choice by touching the screen. Use the keypad to type in a numeric value. Press Apply to accept the changes. Press the OK pushbutton to exit the window.

8.8.8 Operation Sequences

The Operation Sequences window will display a menu, listing the following for each operational sequence defined in the Configuration File: process line number, an indication of whether the sequence is a main menu sequence, sequence type, sequence number, and sequence label. This menu will allow the operator to exit the window or view an operational sequence by choosing the desired sequence. Changes to operational sequences will not be allowed.

8.8.9 Sequence Flow Options

The Sequence Flow Options window will display a list of all Main Menu Sequences in the system. The operator will be allowed to choose one of these sequences. When the operator chooses a sequence, a window will appear with the sequence label as the title. The window will display the end, stop, and fail options lists defined in the Configuration File for the chosen sequence. The end, stop, and fail options lists will contain the sequence label of each main menu sequence that is permitted to be selected from the main menu after an end, stop, or fail of the chosen sequence. Changes to sequence flow options will not be allowed.

8.8.10 Prompt List

The Prompt List window will display the prompt number and prompt label for each of the prompts in the system. The window will allow the operator to view the prompt list or exit the window. Changes to the prompt list will not be allowed.

8.8.11 Set Time/Date

The Set Time/Date window will display the current time and date for the system. The window will allow the operator to exit the window or enter a new time and/or date by selecting to the appropriate prompt.

8.8.12 Analog Scaling

The Analog Scaling window will display all the analogs used in the system. The operator will be allowed to choose an analog or exit the window. After selecting an analog, the operator can change the maximum and minimum scaling values using the keypad. The Analog Scaling window will display the analog number, analog label, device type (milliamps or volts), minimum analog value, and maximum analog value for each analog point. This window will allow the operator to exit the window or enter a new analog range minimum and/or analog range maximum for one or more analog points. To change the analog scaling values, select the input of your choice by touching the screen. Select either the minimum or maximum. Use the keypad to type in a numeric value. Press 

to accept the changes. Press the 

pushbutton to exit the window.

8.8.13 4th level (APCI) Analog Setpoints

The APCI Setpoints window will display all analogs used in the system. The operator will be allowed to choose an analog from the drop down menu or exit the window. When the operator chooses an analog, the corresponding setpoints for that analog will be displayed. The Setpoints window will display the APCI. defined analog alarm data. The window will display the alarm number, alarm label, and current alarm setpoint for each APCI. alarm. A total of ten setpoint will exist per analog input. This window will allow the operator to enter a new setpoint value for one or more chosen alarms or exit the window without changes. The APCI. Setpoints window will only be accessible with a 4th level password.

8.8.14 Alarm Conditions

The Alarm Conditions window will display the alarm input type, alarm number, alarm label, and alarm condition for each system alarm. This window will allow the operator to change the alarm condition for digital alarms to either closed, open, or not used and the alarm condition for analog alarms to either high, low, or not used. The window will allow the operator to change one or more alarms or to exit the window without changes.

8.8.15 Alarm Delays

The Alarm Delays window will display the alarm input type, alarm number, alarm label, and current alarm time delay (in seconds) for each alarm in the system. The window will allow the operator to enter a new time delay value for one or more alarms or exit the window. A delay entry of ‘ 0’ equates to no delay. The range of values is from 0 to 255 seconds.

8.8.16 Alarm Types

The Alarm Types window will display the alarm input, alarm number, alarm label, and alarm type for each alarm in the system. The possible alarm types are Fault, Shutdown, Sequence Controlled, and Non-Latching. The window will allow the operator to exit the window or change the alarm type of one or more alarms. An alarm having an alarm type of Sequence Controlled cannot be changed to a different type. All other alarm types can be changed; however, the alarm type cannot be changed to Sequence Controlled.

8.8.17 Alarm Sequences

The Alarm Sequences window will display the alarm number and alarm label for each alarm in the system. The window will also display the alarm response sequence and alarm response sequence label for those alarms that have an alarm response associated with them. The window will allow the operator to exit the window or select one or more alarms to view the alarm response sequence. Changes to alarm response sequences will not be allowed.

8.8.18 Relay Defaults

The Relay Defaults window will display the relay number, relay label, and relay default state for each relay in the system. The window will allow the operator to exit the window or change the relay default state of one or more relays. Each relay default state will be set to either No Default, Energize, or Deenergize.

8.8.19 Helium Leak Check

The Helium Leak Check Menu window will display the leak check options and will indicate the currently selected leak check option. The options will be Inboard He Leak Check, Outboard He Leak Check, and None. The operator will be allowed to exit the window or change the leak check option.

8.8.20 1st Security List

The 1st Security List window will display the password number and password for each first level password. The 1st level security list will be accessible to 2nd level security users and higher. This window will allow the operator to exit the window or change, add, or delete one or more 1st level passwords. To change a password, 1) select the password by touching the screen, 2) highlight the entire password by dragging your finger across the password field at the bottom of the window, and 3) use the keypad to enter the new password. Only numeric characters are permitted in 1st level passwords and the first character will always be the number one.

8.8.21 2nd Security List

The 2nd Security List window will display the password number and password for each second level password. The 2nd level security list will be accessible to 3rd level security users and higher. This window will allow the operator to change, add, or delete one or more 2nd level passwords or exit the window without changes. To change a password, 1) select the password by touching the screen, 2) highlight the entire password by dragging your finger across the password field at the bottom of the window, and 3) use the keypad to enter the new password. Only numeric characters are permitted in 2nd level passwords and the first character will always be the number two.

8.8.22 3rd Security List

The 3rd Security List window will display the password number and password for each third level password. The third level security list will be accessible to 3rd level security users and higher. This window will allow the operator to exit the window or change, add, or delete one or more third level passwords. To change a password, 1) select the password by touching the screen, 2) highlight the entire password by dragging your finger across the password field at the bottom of the window, and 3) use the keypad to enter the new password. Only numeric characters are permitted in 3rd level passwords and the first character will always be the number three.

8.8.23 2nd Security Access

The 2nd Security Access window will display all available user functions. For each function, the window will display the current operator's degree of access at the 2nd level of security. The degrees of access will be No Access, Read Only, or Write. The operator will be allowed to view the access list or exit the window. Operators at 3rd level of security and higher that have Write access to the 2nd Security Access window will be allowed to change one or more degrees of access. Changes to the degree of access cannot allow a 2nd level operator greater access than a higher level operator.

8.8.24 3rd Security Access

The 3rd Security Access window will display all available user functions. For each function, the window will display the current operator's degree of access at the 3rd level of security. The degrees of access will be No Access, Read Only, or Write. The operator will be allowed to view the access list or exit the window. Only users with the VERSUM MATERIALS, INC. password will be allowed to change the 3rd security access.

8.8.25 System Setup

The System Setup window will display the option to change either local or network options. It also allows the change of the IP settings.

8.8.25.1 Local Setup

The Local Setup selection will display the Local Setup window. This window will display the menu timeout values. The window will allow the operator to exit the window or change one of the following:

Password Protected Reset

The Password Protected Reset option will allow the operator to toggle the password protected reset feature between ENABLED and DISABLED. When this feature is enabled, the operator will be required to enter a valid password when resetting alarms.

Screen Saver

The Screen Saver option will allow the operator to change the screen saver time delay. The box will accept the values 0 or 31–99. A time delay of zero will disable the screen saver.

Key Press Feedback

Key Press Feedback enables or disables the "beep" noise associated with pressing a touch screen key or button.

Simulation

Permits the user to enable or disable simulation capabilities.

8.8.25.2 Network Setup

The Network Setup option will display the Network Setup window. The Network Setup window will display the network port number, the network device type, the Network Control state, the RS-485 channel numbers, the Ethernet channel numbers, and the network comm. type. The window will allow the operator to exit the window or change one or more of the network parameters.

Enable/Disable Network Control

The Enable/Disable option will allow the operator to change the Network Control state to either Enable or Disable

.

RS-485 Channel Number

The RS-485 change channel option will allow the operator to change the left and right RS-485 channel numbers. The numbers may be changed within the range of 0 to 63. Changes to the channel number will be written to the NV data file.

Ethernet Channel Number

The Ethernet change channel option will allow the operator to change the left and right channel numbers. The numbers may be changed within the range of 0 to 63. Changes to the channel number will be written to the NV data file.

Network Comm. Type

The network comm. type can be set to either RS-485 or Ethernet.

8.8.25.3 IP Settings

The IP settings option allows the user to modify the IP address, subnet mask, and default gateway.

8.8.25.4 Peer-to-Peer IP Settings

The Peer-to-Peer IP Settings option displays the controller number, controller name, controller IP address, controller port, and controller comm. information for different controllers on the network. It also displays the peer-to-peer communication status as well as the network communication timeout values. The user has the ability to modify the controller IP address and controller port.

8.8.25.5 Set Product Code

The set product code option allows the user to modify the product code.

8.8.26 Config Transfer

The Configuration Transfer window will display the Configuration File transfer options listed below. The operator will be allowed to choose an option or exit the window.

8.8.26.1 Controller to USB

The controller to USB transfer option will begin the file transfer of the Configuration File from the controller to the target device connected to the controller USB port.

8.8.26.2 USB to Controller Transfer

The USB to controller transfer option will begin the file transfer of the configuration file from the source device connected to the controller USB port. This option will only be accessible by users with the VERSUM MATERIALS, INC. level password.

8.8.27 Memory Management

The Memory Management window is not accessible to the customer. Only Versum Materials, Inc. authorized personnel has access. It will display the options listed below. The operator will be allowed to choose an option or exit the window.

8.8.27.1 UBS to Controller Firmware

This option will begin the Firmware file transfer from the source device attached to the controller USB port.

8.8.27.2 Controller to USB Memory Contents

This option will begin the file transfer of the firmware executable files, Configuration File, and NV Data File from the memory of the Controller to the attached USB Device.

8.8.27.3 Delete Nonvolatile Data File And Reboot

The Delete Nonvolatile Data File option will delete the nonvolatile (NV) data file from the memory. The controller will reboot after completing deleting the NV data file from memory.

8.8.27.4 Other Options

Return to Power Up Mode – Returns the Controller to Power Up Mode.

Reboot – Reboots the Controller.

Reboot to OS – Reboots the Controller to the Operating System.

Disable/Enable OS Access – Permits Access to the Operating System Task Bar.

Calibrate Touch Screen – Allows the User to Calibrate the Touch Screen.

Chapter 9

Troubleshooting

This section explains how you can identify malfunctions present in the system.

Troubleshooting is only to be performed by trained people who understand the hazards of the system.

Personal injury or death may result if proper personal protective equipment (PPE) is not worn when performing troubleshooting.
See Chapter 1 Section 9 for the proper PPE.

Before attempting to service the Distribution System components, all pressure in the system needs to be vented.
Close the gas inlet supply valve(s) to the Distribution System and then vent all pressure in the system.
Purge out all lines that have contained process gas.
Lock out and Tag out the inlet valve(s) to the Distribution System to prevent opening while service is being performed.
Lock out and Tag out the process valves at the tool gas panel to prevent back flow of another hazardous gas to the Distribution System.
See Chapter 1 Section 11 for Lock out/Tag out system procedures.
Once the repairs have been made, follow the start-up procedure in Chapter 8 Section 3 of this manual.

Turn off electrical power to the system before performing service.

This section explains how you can identify malfunctions present in the system. The format of this section is the presentation of a problem, possible cause and possible solutions.

⚠CAUTION

Before performing troubleshooting, review the Safety section and read the warnings in following section. If at any time during troubleshooting, you are unsure what to do next, DO NOT CONTINUE. Contact Versum Materials, Inc..

9.1 System Shut Down, No Lights on Controller

Possible Source of Problem	Test	Solution
Electrical power failure	Check the power being supplied to the system.	Restore specified power to electrical control panel.
	Verify internal circuit breaker is in the "ON" position.	Place in "ON" position.

9.2 No or Low Purge Gas Pressure

Possible Source of Problem	Test	Solution
Closed purge gas supply valve	Check position of supply valve.	Open supply valve.
Low purge gas cylinder pressure	Check cylinder pressure.	Change cylinder.
Instrument nitrogen supply not adequate	Check instrument nitrogen pressure.	Adjust instrument nitrogen to 85-95 psig (5.9-6.6 barg).
Purge gas pressure regulator set incorrectly	Check setting on pressure regulator.	Set pressure regulator to correct delivery pressure 80-90 psig (5.5-6.2 barg).
Purge gas pressure transducer(s) malfunctioning	Check input to controller, Check connections and signal from pressure transducers.	Repair connections, repair or replace transducer(s) as necessary.

9.3 No or Low Purge Gas Inlet Flow

Possible Source of Problem	Test	Solution
No or low purge gas pressure	See Section 2 above.	
Purge gas manual isolation valve(s) closed or partially closed	Check position of purge gas manual isolation valve(s).	Open fully.
Are any purge vent valves open?	Check position of all purge vent valves.	Close any purge vent valves if open.
Are purge gas pneumatic valves receiving sufficient pressure to open?	Check if instrument supply is adequate.	Adjust to 85-95 psig (5.9-6.6 barg) if necessary.

9.4 No or Low Process Gas Pressure

Possible Source of Problem	Test	Solution
Closed manual process gas inlet valve to Distribution System	Check position of manual process gas inlet valve.	Open manual process gas inlet valve, pressure should indicate source delivery pressure.
Low process gas inlet pressure	Check process gas inlet pressure.	Increase process gas inlet pressure from source.
Instrument nitrogen supply not adequate to open process pneumatic valves.	Check instrument nitrogen pressure.	Adjust instrument nitrogen to 85-95 psig (5.9-6.6 barg).
Process gas pressure regulator set incorrectly	Check setting on pressure regulator.	Set pressure regulator to correct metering pressure.
Process gas pressure transducer(s) malfunctioning	Check input to controller, Check connections and signal from pressure transducers.	Repair connections, repair or replace transducer(s) as necessary.

9.5 No or Low Process Gas Inlet Flow

Possible Source of Problem	Test	Solution
No or low process gas pressure	See Section 4 above.	
Process gas manual isolation valve(s) closed or partially closed	Check position of process gas isolation valve(s).	Open fully.
Are any vent valves open?	Check position of all vent valves.	Close any vent valves if open.
Are process gas pneumatic valves receiving sufficient pressure to open?	Check if instrument supply is adequate.	Adjust to 85-95 psig (5.9-6.6 barg) if necessary.

9.6 Typical Alarms

This section assumes that all devices are calibrated and functioning according to the manufacturer's specification. Contact your Versum Materials, Inc. Technical Representative or the manufacturer should you need to obtain this information.

⚠CAUTION

Before performing troubleshooting, review Chapter 1 on Safety and also read the warnings in beginning of this Chapter 9. If at any time during troubleshooting, you are unsure what to do next, DO NOT CONTINUE. Contact Versum Materials, Inc..

NOTE: Contact Versum Materials, Inc. if the alarm displayed on the screen does not appear in this section.

NOTE: Contact Versum Materials, Inc. for the procedure for calibrating the transducers.

9.6.1 Excess Flow

Probable Cause	Corrective Action
High process gas flow due to mechanical failure or product surge.	Examine process gas system to locate cause of signal.
Excess flow switch stuck in the open position due to contamination or corrosion.	Perform branch purge routine according to Chapter 8 Section 4 in an attempt to remove any residual buildup in the excess flow switch.

9.6.2 Low Pneumatic Supply Pressure

Probable Cause	Corrective Action
Pneumatic supply to the controller is less than 65 psig (4.5 barg).	Adjust pneumatic pressure to the controller to 85-95 psig (5.9-6.6 barg).

Pressure Alarms - The following troubleshooting responses assume that pressure transducers are properly calibrated and correct setpoints are installed in the configuration matrix. If corrective action does not alleviate the alarm condition, check setpoints in configuration file and pressure transducer calibration records.

PT2 (Branch 1-4[A-D] or 5-8[E-H] Delivery Pressure) Alarms

The following are possible branch delivery transducer alarms.

9.6.3 Low Branch Delivery Pressure or Very Low Branch Delivery Pressure

Probable Cause	Corrective Action
Branch delivery pressure is set below the low or very low delivery pressure setpoints.	Adjust branch delivery pressure regulator to achieve the desired delivery pressure.
Process gas supply pressure is not adequate.	Adjust process gas supply pressure from source. Ensure process gas manual inlet valve is open.

9.6.4 High Branch Delivery Pressure or Very High Branch Delivery Pressure

Probable Cause	Corrective Action
Branch delivery pressure regulator is set too high.	Decrease the process pressure regulator. Observe regulator for proper operation. If regulator will not maintain the setpoint, it may be "creeping". Contact your Versum Materials, Inc. Technical Representative.

PT1 (Process Inlet Transducer) Alarms

The following are possible process inlet transducer alarms.

9.6.5 Low Process Inlet Pressure or Very Low Process

Inlet Pressure

Probable Cause	Corrective Action
Manual process gas inlet valve in Distribution System or manual process isolation valve at Source Cabinet is closed.	Open manual valve.
Process gas pressure from the source cabinet is below the low or very low set points.	Check delivery pressure from source pressure regulator and adjust to correct delivery pressure.

9.6.6 High Process Inlet Pressure or Very High Process Inlet Pressure

Probable Cause	Corrective Action
Process gas pressure from the respective source is above the high or very high setpoints.	Decrease source delivery pressure to the Distribution System.

PT4 (Purge Inlet Transducer) Alarms

The following are possible purge inlet transducer alarms.

9.6.7 Low Purge Inlet Pressure or Very Low Purge Inlet Pressure

Probable Cause	Corrective Action
Purge gas inlet pressure is below the low or very low setpoints	Increase purge gas inlet pressure to the Distribution System

9.6.8 High Purge Inlet Pressure or Very High Purge Inlet Pressure

Probable Cause	Corrective Action
Purge gas inlet pressure is above the high or very high setpoints	Decrease purge gas inlet pressure to the Distribution System

PT5 (Vent Line Transducer) Alarms

The following are possible vent line transducer alarms

9.6.9 High Vent or Very High Vent Pressure

Probable Cause	Corrective Action
Vent line pressure is above the high or very high setpoints.	Check pollution abatement equipment for obstruction.

9.6.10 Low Vacuum Generated

Probable Cause	Corrective Action
Vacuum Venturi supply pressure or flow is insufficient	. Verify a Venturi supply of 75-95 psig (5.2-6.6 barg) at 50-60 slpm (106-127 cfh) is obtainable.
Vent isolation valve, MV22, is closed	Open fully

SYSTEM FAULTS

If any system/board faults occur, they will be displayed as a "System Fault" fault alarm using the following format:
System Fault BN, DN, DEN, DEP1, DEP2

Where
BN = Board Number
DN = Device Number
DEN = Device error number (Internal for Versum Materials, Inc. Technician Use)
DEP1 = Device error parameter 2 (Internal for Versum Materials, Inc. Technician Use)
DEP2 = Device error parameter 2 (Internal for Versum Materials, Inc. Technician Use)

The board numbers are as follows:

1. Carrier Board
2. Door Board
3. I/O Board 1 - 1st Customer Board (optional hardware)
4. I/O Board 2 - Left Panel Board
5. I/O Board 3 - Right Panel Board
6. I/O Board 4 - 2nd Customer Board (optional hardware)

Chapter 10

Maintenance

10.1 Warranty

Seller warrants the Equipment manufactured by it to be free from defects in material and workmanship at the time of shipment from Seller's factory for a period of twelve (12) months from the date of shipment, (herein referred to as the "warranty period"). If, during the warranty period, any part of such Equipment is found to have been defective or damaged at the time it was shipped, at Seller's option it will either be repaired at Seller's factory, or it will be replaced by a similar part provided that Buyer gives Seller immediate written notice upon the discovery of any defective or damaged items, whereupon Seller shall have the option of requiring the return of the defective material to establish the claim. This warranty is expressly conditioned upon installation of the Equipment in accordance with the Equipment drawings and instructions of the Seller, and upon Buyer availing itself of the services of Seller's installation and startup advisors, to ensure the correct installation and successful operation of the equipment.

As to all apparatus and products not manufactured by Seller which are component parts of the Equipment, furnished by Seller, Seller's only obligation shall be to obtain for Buyer such warranties or guarantees are obtainable from the manufacturers. Such warranties or guarantees shall extend over the longest period of time obtainable in this instance without payment by Seller of additional consideration therefore, and Seller shall use reasonable efforts to require its vendors to fulfill obligations of their warranties of guarantees on such apparatus or products furnished in connection with this quotation or any contract resulting therefore.

The replacement or repair of defective parts, as aforesaid, shall be Buyer's only remedy for breach of the material and workmanship warranties of Seller. As to the Equipment of other manufacturers, resort shall be had against such manufacturers only. No allowance will be made for repairs or alterations made without the written consent of Seller, in which event all Sellers' warranties hereunder shall be void and of no effect. Buyer agrees to assume responsibility and pay for such defects which are attributable to it and for damages which may occur to the Equipment after delivery to it. Seller shall not be responsible for any defects due to or caused by normal wear and tear, corrosion, erosion or disregard of Seller's operating and maintenance instructions, or improper use of equipment.

10.2 Routine Maintenance

The following maintenance needs to be done at the indicated times.

Maintenance is only to be performed by trained personnel who understand the hazards of the system.

Before attempting to service the Distribution System components, all pressure in the system needs to be relieved and the electrical power to the system turned off.
Close the gas inlet supply valve(s) to the Distribution System and then vent all pressure in the system.
Purge out all lines that have contained process gas.
Lock out and Tag out the inlet valve(s) to the Distribution System to prevent opening while service is being performed.
Lock out and Tag out the process valves at the tool gas panel to prevent back flow of another hazardous gas to the Distribution System.
See Chapter 1 Section 11 for Lock out/Tag out system procedures.
Once the maintenance is complete, helium leak test the system using a mass spectrometer. Follow the start-up procedure in Chapter 8 Section 3 of this manual.

Personal injury or death may result if proper personal protective equipment (PPE) is not worn when performing troubleshooting.
See Chapter 1 Section 9 of this manual for the proper PPE.

When piping is added, proper labels must be affixed to critical components. Failure to label correctly could result in inadvertent operation of system, possible resulting in personal injury or death.

When performing maintenance on a GASGUARD® system where piping is replaced or added, assure mounting supports and brackets are installed. Failure to attach this hardware could result in leaks and personal injury or death.

Preventative Maintenance – Mechanical Components

NOTE: Asterisk (*) indicates that Preventative Maintenance task requires a shutdown.

Component	Task	Minimum Frequency
Process Piping & Components	Purge with clean, dry, inert gas to achieve Versum Materials, Inc. recommended purity levels. Refer to Gasguard™ Position Paper on Gas Panel Purging 3EQ95018. Minimum recommended purity level for purge gas is 99.999% and <1ppmv H20 to maintain mechanical integrity. A higher level of purge gas purity may be required to meet customer process specifications.	Corrosives: At the start of an extended shutdown. It is recommended that panels in corrosive service be purged at least once every 3 months. All other process gases: Yearly
Process Panel	Visually inspect for damage, leaks, or malfunctioning components. Check process and purge pressures for readings that are outside of the specification range (found in Chapter 11 of operating manual) or dramatic changes from previous values. Observe the interior of the gas cabinet for any signs of corrosion or gas leakage. Verify that pneumatic tubing is securely connected to valve actuators.	Every 3 months
Enclosures and Frames	Sweep enclosures and racks. Clean all external surfaces with a clean damp cloth. Clean the interior cabinet enclosures and rack frames. **Caution:** Use a damp cloth only on the outside of the controller. Do not clean controller interior. Especially in hazardous areas, DO NOT rub the surface of the screen with a dry cloth. This could generate an electrostatic charge. When cleaning the controller face, take measures to prevent an electrostatic discharge such as earth band, ionic shower, etc. **Caution:** Do not use pressurized water to clean inside or outside of distribution systems as serious damage could occur to the electronic components.	Every 3 months unless the equipment is located in a cleanroom environment. Cleanroom units should be cleaned as necessary.
Enclosure Door/Window	Verify that self-closing mechanism functions properly. Inspect hinges and gaskets for damage or excessive wear. Look for aging, cracks, and peeling of the gaskets. Also check the surface onto which the gaskets seal. Look for oxidation, corrosion, and foreign material that would prevent proper sealing.	Yearly

CONTINUED NEXT PAGE

Preventative Maintenance – Mechanical Components (Continued)

NOTE: Asterisk (*) indicates that Preventative Maintenance task requires a shutdown.

Component	Task	Minimum Frequency
Pressure Monitors (Transducer, Switch, Transmitter, Gauge)	Check pressure readings for any pressures that are outside of the specified pressure readings. If process gas pressure must be adjusted, monitor the delivery pressure for a smooth increase or decrease.	Yearly
	Verify zero.	Yearly
	*Function Test Pressure Switches for safety critical alarms. Where applicable, verify: • High pressure supply shutdown • High pressure delivery shutdown • Co-axial high/low pressure shutdown • Low pressure excess flow alarm	Every 2 years
Regulator	Check downstream pressure.	Daily
	Toxics, Corrosives and Pyrophorics only: Visually examine exterior of the regulator and connections for signs of external leakage.	Annually
Excess Flow Switch	* Test Excess Flow Switch.	Every 2 years
Vacuum Venturi	Verify vacuum readings.	Every evacuation
Exhaust Ventilation Inlet Filter	Check for clogging.	Monthly
	Replace or clean as required.	As necessary
Analog Exhaust Monitor (i.e., Setra)	Verify zero.	Yearly
Exhaust Switch	Replace as recommended.	See Section 10.3
Exhaust Switch Pitot Tube	Visually inspect for damage.	Yearly
Pneumatic Bulkhead	Visually inspect for fatigue, cracking, or other damage.	Yearly
Pneumatic Tubing	Examine for cracking or signs of wear. Replace as required or recommended.	Indoor: Yearly
		Outdoor: Every 6 months
UV/IR Detector	Clean housing glass. Verify that the detector is aimed in the proper direction.	Indoor: Every 6 months
		Outdoor: Monthly
	* Test UV/IR detector.	Yearly

CONTINUED NEXT PAGE

Preventative Maintenance – Mechanical Components (Continued)

NOTE: Asterisk (*) indicates that Preventative Maintenance task requires a shutdown.

UV Source for auto self-check	Replace as recommended.	See Section 10.3
Temperature Switch	* Test temperature switch.	Every 2 years
VCR Gaskets	Replace each time a connection is broken. Do not reuse.	As required
Power Supply	Replace as recommended.	See Section 10.3
	Verify power supply voltage is between 23.8 and 24.2vdc. Contact a Versum Materials, Inc. representative for a copy of the AP11 Power Supply Adjust procedure.	Yearly
Power Board	Replace fuses as necessary.	As required
Instrument Air Pressure Transmitter	Check that pressure transmitter is in working condition.	Yearly
LCD Screen	Check for readability and brightness. Replace backlight as necessary.	Yearly
E-Stop	* Test E-Stop.	Every 2 years
EMI/RFI Gasket	Look for aging, cracks, and peeling of the gaskets. Also check the surface onto which the gaskets seal. Look for oxidation, corrosion, and foreign material that would prevent proper sealing.	Yearly
Door Hinges	Check resistive hinges and replace as necessary.	Yearly
Solenoids	Verify that LED on solenoid lights when component is activated. Gas should flow through the solenoid. Verify that the pressure is off within the required response time. Listen for leaks inside the controller. Check that the pneumatic supply does not exceed the maximum recommended pressure.	Yearly
Z-Purge Switch	* Test switch.	Yearly
Power and signal wiring	Visually inspect for insulation damage, corrosion, shortages.	Yearly
Grounding Connections	Verify that there is minimum resistance in ground line as specified in Chapter 4 Section 1 of the GASGUARD® Operations manual. Tighten connections as needed.	Yearly

10.3 Component Expected Life

This section provides the expected life of several system components. The listed expected life is the length of time during which the component, with proper care and handling as outlined in Section 10.2, is expected to function properly. At the end of the expected life, the component should be replaced to ensure the safe and proper functioning of the system.

Mechanical Components Expected Life

Component	Expected Life / Recommended Minimum Changeout Frequency
Pressure Transducers	10 years
Process Gas Regulator	Diborane: 2 years
	Corrosives: 5 years
	All others: 10 years
Excess Flow Switch	10 years
Valves	10 years
Vacuum Venturi	10 years
Exhaust Ventilation Inlet Filter	10 years
Analog Exhaust Monitor	10 years
Exhaust Switch	2 years
Pneumatic Connectors & Tubing	Outdoor: 2 years
	Indoor: 10 years
UV/IR Detector	10 years
UV source for auto self-check	3 years
Temperature Switch	10 years
Pressure Switch (Coaxial Tubing)	10 years

Electrical Components Expected Life

Component	Expected Life / Recommended Minimum Changeout Frequency
Power Supply	5 years
Power Board	Changeout as necessary. Expected Life is 10 years with no power surge.
LCD Backlight	Changeout as necessary. Expected Life is 5–10 years
EMI/RFI Gasket	Indoor: 10 years
	Outdoor: 10 years
System Controller	10 years

10.4 Decommissioning

Decommissioning is the process by which the equipment is taken out of service. The safe isolation and securing of the process gas lines to and from the equipment is the sole responsibility of the System Owner requiring adequate coordination between gas technicians and the Fab Owner. This section is to provide general guideless for decommissioning of gas distribution equipment. All Fab Tools process lines must be disconnected prior to using this procedure. Before decommissioning the system, ensure the pressure in the system has been relieved.

Procedures are only to be performed by trained personnel who understand the hazards of the system.

Personal injury or death may result if proper personal protective equipment (PPE) is not worn when performing troubleshooting.
See Chapter 1 Section 9 of this manual for the proper PPE.

Before attempting to decommission and to service the Distribution System components, all pressure in the system needs to be relieved and electrical power to the system turned off.
Close the gas inlet supply valve(s) to the Distribution System and then vent all pressure in the system.
Purge out all lines that have contained process gas.
Lock out and Tag out the inlet valve(s) to the Distribution System to prevent opening while service is being performed.
Lock out and Tag out the process valves at the tool gas panel to prevent back flow of another hazardous gas to the Distribution System.
See Chapter 1 Section 11 for Lock out/Tag out system procedures.
Once the maintenance is complete, helium leak test the system using a mass spectrometer. Follow the start-up procedure in Chapter 8 Section 3 of this manual.

Decommissioning Checklist

1. Verify all site paperwork has been completed for Gas Distribution Equipment Shut Off request.
2. Ensure that proper PPE has been obtained and donned. Refer to site documentation for the gas being decommissioned.
3. Gather all required tools. Refer to site documentation.
4. Ensure all electrical power to the system has been turned off (see Chapter 4 Section 2).
5. Ensure process gas inlet valve(s) is closed and purge gas is available.
6. Ensure all pressure in the system has been relieved.
7. Perform required number of manual purges based on the on the gas. Contact a VERSUM MATERIALS, INC. representative for more information.
8. Start system flow through purge on all components in system and all panels of the system (See Chapter 8 Section 4).
9. Complete flow through purge for required number of minutes (contact VERSUM MATERIALS, INC. representative for more information).
10. In conjunction with site coordinators, cut process lines or isolate system from house lines as needed. If it has been longer than 12 hours since the Process Line Purge repeat the manual purge.
11. Remove any Fab Tool ID and Status Tags (such as On-line) from the Gas Cabinet and Process Line and hang a “Prior Use” Tag on the Gas Panel(s) with the Date and Fab Tool Name.
12. Verify the valves positions are correct (all Pneumatic and Manual Valves Closed) and the Controller is in Idle.
13. Notify LSS to stop monitoring for equipment demolition
14. All equipment associated utilities (except exhaust) should be isolated and disconnected from the equipment and OK to DEMO Tag attached.
15. Decommission and decontaminate any support equipment associated with this gas system (heat trace, exhaust scrubbers, etc.) per site protocols. Contact VERSUM MATERIALS, INC. representative for more information.

Chapter 11

System Specific Information

Section 1 **System Specifications**

Section 2 **AP11 Recommended Spare Parts**

This section is provided as a placeholder for information specific to the system. Some information is supplied with the equipment separate from the manual or may be supplied upon request.

11.1 System Specifications

The specifications for the system follow this page.

11.2 AP11 Recommended Spare Parts

11.2.1 AP11 Controller Spare Parts

Item	Category	Critical Spare Part (Qty)	Recommended Spare Part (Qty)	VERSUM MATERIALS, INC. Part #	Description
1	Carrier Board	1	0	**407410**	Carrier Board w/SOM, Heat sink, & firmware. Part # AP1565
2	Carrier Board	0	1	**4414763**	Carrier Board w/ firmware. Part # AP1565
3	Carrier Board	0	1	**414897**	SOM w/Heat sink & firmware. Part # AP1565
4	Panel Board	1	0	**407356**	Panel Board, part # AP1564
5	Customer Board	1	0	**407355**	Customer Board **STD**, board # AP1563 (replacement board only, see item 6 for complete kit)
6	Customer Board Kit	0	0	**400510**	Customer Board **STD** Kit (includes AP1563 board & cables required to add customer input/output alarm function)
7	Customer Board	1	0	**424112**	Customer Board **Lite**, board # AP1573 (replacement board only, see item 8 for complete kit)
8	Customer Board Kit	0	0	**424072**	Customer Board **Lite** Kit (includes AP1573 board & cables required to add customer input/output alarm function)
9	Door Board	1	0	**407726**	Door Board, part # AP1562
10	Display	1	0	**409057**	Display (CCFL BACKLIGHT TYPE)
11	Display	1	0	**436466**	Display (LED BACKLIGHT TYPE)
12	Display	1	0	**409058**	Inverter Board
13	Display	1	0	**436908**	CCFL Replacement Backlight for VERSUM MATERIALS, INC. part # 409057
14	Display	1	0	**439367**	Display Cable
15	Fuse	5	0	**409610**	Fuse 250MA radial
16	Fuse	5	0	**409611**	Fuse 500MA radial
17	Fuse	5	0	**409608**	Fuse 1mA radial
18	Fuse	5	0	**418758**	Fuse 4mA radial
19	Graphics	1	0	**415647**	Graphic Overlay/Touch Screen Assembly
20	Solenoid	1	0	**409865**	AP11 10V Solenoid Bank (SW008631)

Item	Category	Critical Spare Part (Qty)	Recommended Spare Part (Qty)	VERSUM MATERIALS, INC. Part #	Description
21	Solenoid	1	0	**409864**	AP11 13V Solenoid Bank (SW008369)
22	Solenoid	1	0	**420179**	Master Solenoid Valve (L Style, 24V, w/base)
23	Pressure Switch	1	0	**809-418802**	Differential Pressure Switch, For Z-Purge, 0.1" H2O, N.O., 1/16" Barbed Special.
24	Power Supply	1	0	**409506**	Power Supply, 24 VDC
25	Power Board	1	0	**414762**	PCB High Voltage AP11, AP1568
26	Power Board	1	0	**436467**	10Awg Power Wire Modification Kit
27	Misc.	0	1	**409501**	Push Button – Red.
28	Misc.	0	1	**171538**	Mallory Sonalert Horn
29	Graphics	0	1	**199117**	Graphic AP11 Logo with Z Purge Warning
30	Graphics	0	1	**199116**	AP11 Graphic Overlay Optional Valve Legend (Red=closed, Green=open)
31	Misc.	0	1	**415646**	Weather Protection Kit
32	Fuse	4	0	**416974**	Fuse 4A, super quick acting (Schurter 7022.0660 or SIBA 189020.4)
33	Setra Cable	0	0	**400509**	SETRA Exhaust sensor cable (SW008106.SLDDRW)
34	Cooling Fan	1	0	**414764**	AP11 Power Cooling Fan
35	Misc.	0	1	**418571**	Honeywell Pressure-sensor, 150psi, 2%
36	Misc.	0	1	**435058**	USB Type-A Port Blocker

Note: Only spares that meet the manufacturer's specifications should be used.

11.2.2 Distribution System Recommended Mechanical Spare Parts

Process Inlet Spool
Process Header Spool
Process Stick
Vent Header Spool
Process Out Spool
Vacuum Venturi Spool
Purge Gas Spool
Purge Filter (if used)
Setra Kit

Contact Versum Materials, Inc. when ordering spare parts. Your equipment commodity code number will be required when placing your order. The commodity code number can be found on the enclosure door, rack frame or wall mount frame.

Figure 1: Equipment information numbers on an AP11 Distribution System

Model
[ ]
Equipment Number - Serial Number
[ ] - [ ]

Figure 2: Equipment information numbers on an AP11 Distribution Rack

Model
[ ]
Equipment Number - Serial Number
[ ] - [ ]

Figure 3: The AP11 Gas Distribution System Information numbers (circled above) can be found on the enclosure door.

Model
[ ]
Equipment Number - Serial Number
[ ] - [ ]

Appendix A

UHP Tubing and Fitting Specification

The Appendix contains the SEMC-QAF030 "UHP Tubing and Fitting Specification". Compressed Gas Association Technical Bulletins TB-9-1993 “Guidelines for the Proper Handling and use of the CGA 630/710 Series “Ultra High Integrity Service” Connections” and TB-4-1999 “Torque Guidelines for Sealing CGA Outlet Connections” are also included.

Semiconductor ***E***quipment ***M***anufacturing ***C***enter

Quality Assurance Work Instruction:	Document No.: **QAF030**
UHP Tubing and Fitting Specification	Revision: **A**
Responsible Department:	Revision Date: **24 FEB 97**
Quality	Page **1** of **6**

1.0 Purpose:

To establish the minimum requirements for materials, dimensional tolerances, surface finishing, cleaning, testing, inspection, certification, and packaging for stainless steel tube and fittings used in ultra high purity applications.

2.0 Scope:

This specification shall apply to all tubing and fittings purchased for use in all ultra high purity piping installations for the electronics industry.

3.0 Responsibility:

3.1 The Materials Management group of SEMC is responsible for communicating this requirement to its vendors and ensuring their full compliance.

3.2 The vendor shall review and respond to this specification on a line by line basis confirming acceptance or exceptions to each requirement.

3.3 The vendor shall provide any additional steps above and beyond the requirements of this specification for review.

4.0 Definitions: (None)

5.0 References:

5.1 Electronics Engineering Worldwide Standard EES 005, 0.250" and 0.375' UHP and HP Tubing and Fittings.

5.2 ASTM A269 - Specification for seamless and welded austenitic stainless steel tubes for general service.

5.3 ASTM A479 - Specification for general requirements for carbon, ferritic alloy, and austenitic alloy steel bar.

5.4 ASTM A632 - Specification for seamless and welded austenitic stainless steel tubing (small diameter for general service).

5.5 ANSI/ASME B46.1 - 1985 - Specification for surface texture-surface roughness, waviness, and lay.

6.0 Procedure:

6.1 General Requirements

6.1.1 All tube and bar stock shall be produced from ASTM grade TP316L raw material unless specified in the purchase order. Tubing sized smaller than 3" shall be seamless and larger than 3" may be welded.

6.1.2 Stainless steel tubing shall be bright annealed at the producing mill in a dry hydrogen atmosphere (dewpoint <-40°C) or vacuum annealed (10 micron Hg) to a Rockwell Rb 90 maximum hardness.

6.1.3 The sulfur content of fittings and tubing shall be in the range of 0.005-0.017 percent; type 316L VAR and VIM\VAR a maximum of 0.005%. VAR or VIM/VAR will be specified in the purchase order. This range is an actual range and does not allow for rounding of numbers as set forth in ASTM A269.

6.1.4 Tubing shall conform to the requirements of ASTM A269 for sizes one-half inch diameter and larger and ASTM A632 for sizes smaller than one-half inch, except where specified differently within this specification.

6.1.5 Bar stock shall conform to the requirements of ASTM A479, except where specified differently within this specification.

6.2 Dimensional Tolerance Requirements:

6.2.1 End connections on tubing and fittings shall be faced and squared to plus or minus one-half degree for sizes 1/4" through 3/4" inclusive. Squareness of 1" and larger shall be +.006". All ends shall be fully prepped and suitable for installation with automatic orbital welding equipment.

6.2.2 Acceptable dimensional tolerances shall not exceed the limits listed below:

Dimension	Component	Tolerance
Linear	Fittings	+- .015"
Angular	Fittings	+- 1/2 degree
Wall Thickness	Tube and Fittings (including saddle area of tees)	+- 10%

Outside Diameter; Tube and Fittings

1/4" up to not including 1/2", +0.004"/-0.000";
1/2" to not including 1-1/2", +- 0.005";
1-1/2" up to not including 3-1/2", +- 0.010";
3-1/2" up to and including 4"; +- 0.015"

6.3 Interior Surface Finish Requirements:

6.3.1 The interior surface of each tube and fitting shall be electropolished to a microinch surface roughness standard of 7 Ra microinch average (10 Ra maximum).

6.4 Gases and Deionized Water for Drying, Cleaning, Testing:

6.4.1 Argon or nitrogen used for drying and packaging shall be supplied from a liquid source and have the following point of use quality:

Minimum purity:	99.998 percent
Moisture:	Less than 1 ppm
Oxygen:	Less than 3 ppm
Total Hydrocarbons:	Less than 1 ppm

Filtered to no more than 10 particles per scf larger than 0.02 microns at point of use.

6.4.2 Deionized water used for cleaning shall have the following minimum point of use requirements and be verified on a monthly basis by an independent laboratory:

Resistivity: 18 megohm centimeters @ 25°C minimum
Total Organic Carbon: Less than 50 ppb
Viable Bacteria Colonies: Less than or equal to ten/100 milliliters
Filtered to: 0.1 microns at point of use

DI water purity shall conform to the guidelines set forth be SEMI.

6.5 Tube Cleaning:

6.5.1 After electropolishing, tubing shall be final cleaned with deionized water as a final cleaning agent and dried with filtered nitrogen. Freon shall not be used as a cleaning agent.

6.5.2 Final cleaning of tubing shall be performed under Class 100 clean room conditions.

6.5.3 Tube washing shall utilize heated DI water (60^{O}C, minimum). The tube shall be flushed with heated DI water until the resistivity of the effluent measures at least 17.5 Megohm-cm for diameters less than 3 inches and 17.0 megohm-cm for diameters greater than or equal to 3 inches.

6.5.4 The tube shall be blown dry with heated nitrogen gas

6.6 Fittings Cleaning

6.6.1 Final cleaning of fittings shall be performed under Class 100 environment.

6.6.2 Fittings shall be flushed with heated DI water (60^{o}C) minimum.

6.6.3 Fittings shall be blown dry with heated nitrogen gas

6.7 Packaging:

6.7.1 Tubing ends shall be sealed with polyethylene caps pressed over polyamide nylon squares (1.75 mil) after being purged with nitrogen. Polyethylene bags (6 mil) shall then be placed over each end and taped to the tube a minimum of 3" from the end of the tube, using clean room tape. The entire tube shall then be closed in a 6 mil polyethylene bag and heat sealed at both ends.

6.7.2 Fitting ends shall be packaged in a heat sealed nylon bag with a heat sealed polyethylene bag over the nylon bag in a Class 100 environment.

6.7.3 Pack and ship to prevent damage to double bagging, tubing, and fittings.

6.7.4 Finished components shall be mill and heat traceable and permanently marked for correspondence to the applicable mill test reports.

6.8 Inspection and Testing:

6.8.1 All tests and inspections required in this section shall be performed for each order unless otherwise stated in the purchase order. The vendor shall provide a detailed procedure for each test required in Sections 6.9.1.2 - 6.9.1.10 for VERSUM MATERIALS, INC. review and acceptance.

6.8.2 One hundred percent (100%) of components shall be visually inspected to assure that interior surfaces exhibit no macroscopic pitting, staining, or discoloration as can be detected with the unaided eye.

6.8.3 A statistically valid sample of tubes and fittings shall be measured with calipers and/or micrometers or by other repeatable methods to verify conformance to the critical dimensional requirements and monitor process control. Critical dimensions will be identified in the purchase order. Statistical procedures must be submitted to VERSUM MATERIALS, INC. for review and approval prior to receipt of material.

6.8.4 All welded fittings shall be inboard helium leak tested to a 1 x 10^{-9} atm cc/sec gaseous helium with a mass spectrometer leak detector.

6.8.5 Finished tube and fittings in each lot shall be measured for interior surface finish with a stylus type measuring device in accordance with ASME B46.1 - 1985. Surface roughness shall be measured at three locations for each piece tested. Sample quantity for tubing shall be 10% of tube ends and 1% of middle sections. Sample quantity for fittings shall be 10% of fitting ends. The average of the readings shall not exceed 7 microinch Ra with no single reading above 10 microinch Ra. Sampling length cutoff shall be 0.030" and traverse length will be 0.150".

6.8.6 Scanning electron microscopy (SEM) photographs of finished component surfaces shall be analyzed for each machining, honing, polishing, or electropolishing process change or supply of material other than stainless steel. SEM analysis shall verify that no more than 40 defects shall be distinguishable in a 3600X field of view. A sample shall be taken from the middle of the tube or fitting. The test method shall conform to SEMATECH standard 90120401A-STD.

6.8.7 Chemistry analysis (ESCA) of electropolished surfaces shall be performed for each electropolishing process change to verify surface elemental composition. Elemental composition shall be expressed in atomic percent units and shall verify chromium to iron ratio of 1.5:1 and a minimum chromium oxide to iron oxide ratio of 3:1 for stainless steel.

6.8.8 Moisture testing shall be performed on one length of cleaned and packaged tube from each heat for each size (O.D. and nominal wall thickness). Testing shall verify the addition of less than 1 ppm moisture to nitrogen gas as described in Section 8.1 of this specification while flowing N_2 gas at a flow not to exceed 10ÿSCFH/IN2.

6.8.9 Particle testing shall be performed on one length of cleaned and packaged tube from each size (O.D. and nominal wall thickness). Testing shall verify that particle counts be no more than 10 per cubic foot of size greater than or equal to 0.1 microns and zero particles of size 0.3 microns or larger while flowing nitrogen gas at a velocity of 133 ft/sec.

6.8.10 A weld test shall be performed for each heat and lot number of material that is used. Weld tests on fittings can be avoided by completing this requirement on the tube that will be used to make the fitting. The test welds shall be made per Semiconductor Equipment Manufacturer Center specification, QAF020. Weld test shall be deemed acceptable if no internal discoloration of the weld is visible. Samples can be developed between VERSUM MATERIALS, INC. and the tube vendor to judge acceptable welds.

6.8.11 A Rockwell hardness test shall be performed on each mill heat of material to assure a Rockwell Rb 90 maximum hardness. This test shall be performed for each size after "pulling".

6.8.12 VERSUM MATERIALS, INC. reserves the right to source inspect all tubing and fittings and inspect the manufacturer’s facilities upon request.

6.9 Reports and Certifications:

6.9.1 The vendor shall supply the following reports and certifications as follows:

6.9.1.1 One set of reports shall be sent to SEMC QA prior to receipt of material at SEMC. The components will be cross referenced to the received reports for acceptable vendor traceability numbers.

6.9.1.2 Mill Test Reports

6.9.1.3 Certificate of compliance to the specifications within this document. Reference to pre-approved exceptions to this Work Instruction.

Appendix B

N2 MSDS

This Appendix contains the Nitrogen (N2) Material Safety Data Sheet.

Safety Data Sheet

Version 1.10 SDS Number 300000000099

Revision Date 01/26/2015 Print Date 06/24/2016

1. PRODUCT AND COMPANY IDENTIFICATION

Product name	:	
Chemical formula	:	N2
Synonyms	:	Nitrogen, Nitrogen gas, Gaseous Nitrogen, GAN
Product Use Description	:	General Industrial
Manufacturer/Importer/Distributor	:	IDES Holding AG , Postfach 16 05 29, D-60070 Frankfurt/M &ULINE(35)&
Telephone	:	
Emergency telephone number (24h)	:	

2. HAZARDS IDENTIFICATION

GHS classification

Gases under pressure - Compressed gas.
Simple Asphyxiant

GHS label elements

Hazard pictograms/symbols

Signal Word: Warning

Hazard Statements:

H280:Contains gas under pressure; may explode if heated.
May displace oxygen and cause rapid suffocation.

Precautionary Statements:

Storage : P410+P403:Protect from sunlight. Store in a well-ventilated place.

Hazards not otherwise classified

High pressure gas.
Can cause rapid suffocation.
Self contained breathing apparatus (SCBA) may be required.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Components	CAS Number	Concentration (Volume)
Nitrogen	7727-37-9	100 %

Concentration is nominal. For the exact product composition, please refer to Air Products technical specifications.

4. FIRST AID MEASURES

General advice : Remove victim to uncontaminated area wearing self contained breathing apparatus. Keep victim warm and rested. Call a doctor. Apply artificial respiration if breathing stopped.

Eye contact : Not applicable.

Skin contact : Not applicable.

Ingestion : Ingestion is not considered a potential route of exposure.

Inhalation : Remove to fresh air. If breathing has stopped or is labored, give assisted respirations. Supplemental oxygen may be indicated. If the heart has stopped, trained personnel should begin cardiopulmonary resuscitation immediately. In case of shortness of breath, give oxygen.

Most important symptoms/effects - acuate and delayed : Exposure to oxygen deficient atmosphere may cause the following symptoms: Dizziness. Salivation. Nausea. Vomiting. Loss of mobility/consciousness.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media : All known extinguishing media can be used.

Specific hazards : Upon exposure to intense heat or flame, cylinder will vent rapidly and or rupture

violently. Product is nonflammable and does not support combustion. Move away from container and cool with water from a protected position. Keep containers and surroundings cool with water spray. Most cylinders are designed to vent contents when exposed to elevated temperatures.

Special protective equipment for fire-fighters	:	Wear self contained breathing apparatus for fire fighting if necessary.

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions, Protective Equipment, and Emergency Procedures	:	Evacuate personnel to safe areas. Wear self-contained breathing apparatus when entering area unless atmosphere is proved to be safe. Monitor oxygen level. Ventilate the area.
Environmental precautions	:	Do not discharge into any place where its accumulation could be dangerous. Prevent further leakage or spillage if safe to do so.
Methods for cleaning up	:	Ventilate the area.
Additional advice	:	If possible, stop flow of product. Increase ventilation to the release area and monitor oxygen level. If leak is from cylinder or cylinder valve, call the Air Products emergency telephone number. If the leak is in the user's system, close the cylinder valve and safely vent the pressure before attempting repairs.

7. HANDLING AND STORAGE

Handling

Protect cylinders from physical damage; do not drag, roll, slide or drop. Do not allow storage area temperature to exceed 50°C (122°F). Only experienced and properly instructed persons should handle compressed gases/cryogenic liquids. Before using the product, determine its identity by reading the label. Know and understand the properties and hazards of the product before use. When doubt exists as to the correct handling procedure for a particular gas, contact the supplier. Do not remove or deface labels provided by the supplier for the identification of the cylinder contents. When moving cylinders, even for short distances, use a cart (trolley, hand truck, etc.) designed to transport cylinders. Leave valve protection caps in place until the container has been secured against either a wall or bench or placed in a container stand and is ready for use. Use an adjustable strap wrench to remove over-tight or rusted caps. Before connecting the container, check the complete gas system for suitability, particularly for pressure rating and materials. Before connecting the container for use, ensure that back feed from the system into the container is prevented. Ensure the complete gas system is compatible for pressure rating and materials of construction. Ensure the complete gas system has been checked for leaks before use. Employ suitable pressure regulating devices on all containers when the gas is being emitted to systems with lower pressure rating than that of the container. Never insert an object (e.g. wrench, screwdriver, pry bar, etc.) into valve cap openings. Doing so may damage valve, causing a leak to occur. Open valve slowly. If user experiences any difficulty operating cylinder valve discontinue use and contact supplier. Close container valve after each use and when empty, even if still connected to equipment. Never attempt to repair or modify container valves or safety relief devices. Damaged valves should be reported immediately to the supplier. Close valve after each use and when empty. Replace outlet caps or plugs and container caps as soon as container is disconnected from equipment. Do not subject containers to abnormal mechanical shock. Never attempt to lift a cylinder by its valve protection cap or guard. Do not use containers as rollers or supports or for any other purpose than to contain the gas as supplied. Never strike an arc on a compressed gas cylinder or make a cylinder a part of an electrical circuit. Do not smoke while handling product or cylinders. Never re-compress a gas or a gas mixture without first consulting the supplier. Never attempt to transfer gases from one cylinder/container to another. Always use backflow protective device in piping. When

returning cylinder install valve outlet cap or plug leak tight. Never use direct flame or electrical heating devices to raise the pressure of a container. Containers should not be subjected to temperatures above 50°C (122°F).

Storage

Open/close valve slowly. Close when not in use. Wear Safety Eye Protection. Check Safety Data Sheet before use. Use a back flow preventative device in the piping. Use equipment rated for cylinder pressure. Close valve after each use and when empty. Read and follow the Safety Data Sheet (SDS) before use. Full containers should be stored so that oldest s tock is used first. Containers should be stored in a purpose build compound which should be well ventilated, preferably in the open air. Stored containers should be periodically checked for general condition and leakage. Observe all regulations and local requirements regarding storage of containers. Protect containers stored in the open against rusting and extremes of weather. Containers should not be stored in conditions likely to encourage corrosion. Containers should be stored in the vertical position and properly secured to prevent toppling. The container valves should be tightly closed and where appropriate valve outlets should be capped or plugged. Container valve guards or caps should be in place. Keep containers tightly closed in a cool, well-ventilated place. Store containers in location free from fire risk and away from sources of heat and ignition. Full and empty cylinders should be segregated. Do not allow storage temperature to exceed 50°C (122°F). Return empty containers in a timely manner.

Technical measures/Precautions

Containers should be segregated in the storage area according to the various categories (e.g. flammable, toxic, etc.) and in accordance whit local regulations. Keep away from combustible material.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering measures

Provide natural or mechanical ventilation to prevent oxygen deficient atmospheres below 19.5% oxygen.

Personal protective equipment

Respiratory protection	:	Self contained breathing apparatus (SCBA) or positive pressure airline with mask are to be used in oxygen-deficient atmosphere. Air purifying respirators will not provide protection. Users of breathing apparatus must be trained.
Hand protection	:	Wear working gloves when handling gas containers. Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary.
Eye protection	:	Safety glasses recommended when handling cylinders.
Skin and body protection	:	Safety shoes are recommended when handling cylinders.
Special instructions for protection and hygiene	:	Ensure adequate ventilation, especially in confined areas.
Remarks	:	Simple asphyxiant.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	:	Compressed gas. Colorless gas
Odor	:	No odor warning properties.
Odor threshold	:	No data available.
pH	:	Not applicable.
Melting point/range	:	-346 °F (-210 °C)
Boiling point/range	:	-321 °F (-196 °C)
Flash point	:	Not applicable.
Evaporation rate	:	Not applicable.
Flammability (solid, gas)	:	Refer to product classification in Section 2
Upper/lower explosion/flammability limit	:	No data available.
Vapor pressure	:	Not applicable.
Water solubility	:	0.02 g/l
Relative vapor density	:	0.97 (air = 1) Lighter or similar to air.
Relative density	:	No data available.
Partition coefficient (n-octanol/water)	:	Not applicable.
Auto-ignition temperature	:	No data available.
Decomposition temperature	:	No data available.
Viscosity	:	Not applicable.
Molecular Weight	:	28 g/mol
Density	:	0.075 lb/ft3 (0.0012 g/cm3) at 70 °F (21 °C) Note: (as vapor)
Specific Volume	:	13.80 ft3/lb (0.8615 m3/kg) at 70 °F (21 °C)

10. STABILITY AND REACTIVITY

Chemical Stability	:	Stable under normal conditions.

Conditions to avoid	:	No data available.
Materials to avoid	:	No data available.
Hazardous decomposition products	:	No data available.
Possibility of hazardous Reactions/Reactivity	:	No data available.

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Likely routes of exposure

Effects on Eye	:	No adverse effect.
Effects on Skin	:	No adverse effect.
Inhalation Effects	:	In high concentrations may cause asphyxiation. Asphyxiation may bring about unconsciousness without warning and so rapidly that victim may be unable to protect themselves.
Ingestion Effects	:	Ingestion is not considered a potential route of exposure.
Symptoms	:	Exposure to oxygen deficient atmosphere may cause the following symptoms: Dizziness. Salivation. Nausea. Vomiting. Loss of mobility/consciousness.

Acute toxicity

Acute Oral Toxicity	:	No data is available on the product itself.
Inhalation	:	No data is available on the product itself.
Acute Dermal Toxicity	:	No data is available on the product itself.
Skin corrosion/irritation	:	No data available.
Serious eye damage/eye irritation	:	No data available.
Sensitization.	:	No data available.

Chronic toxicity or effects from long term exposures

Carcinogenicity	:	No data available.
Reproductive toxicity	:	No data is available on the product itself.
Germ cell mutagenicity	:	No data is available on the product itself.
Specific target organ systemic toxicity (single exposure)	:	No data available.

Specific target organ systemic toxicity (repeated exposure)	:	No data available.
Aspiration hazard	:	No data available.

Delayed and Immediate Effects and Chronic Effects from Short and Long Term Exposure

Not applicable.

12. ECOLOGICAL INFORMATION

Ecotoxicity effects

Aquatic toxicity	:	No data is available on the product itself.
Toxicity to other organisms	:	No data available.

Persistence and degradability

Biodegradability	:	No data is available on the product itself.
Mobility	:	No data available.
Bioaccumulation	:	No data is available on the product itself.

Further information

No ecological damage caused by this product.

13. DISPOSAL CONSIDERATIONS

Waste from residues / unused products	:	Contact supplier if guidance is required. Return unused product in original cylinder to supplier.
Contaminated packaging	:	Return cylinder to supplier.

14. TRANSPORT INFORMATION

DOT

UN/ID No.	:	UN1066
Proper shipping name	:	Nitrogen, compressed
Class or Division	:	2.2
Label(s)	:	2.2
Marine Pollutant	:	No

IATA

UN/ID No.	:	UN1066
Proper shipping name	:	Nitrogen, compressed
Class or Division	:	2.2
Label(s)	:	2.2
Marine Pollutant	:	No

IMDG

UN/ID No.	:	UN1066
Proper shipping name	:	NITROGEN, COMPRESSED
Class or Division	:	2.2
Label(s)	:	2.2
Marine Pollutant	:	No

TDG

UN/ID No.	:	UN1066
Proper shipping name	:	NITROGEN, COMPRESSED
Class or Division	:	2.2
Label(s)	:	2.2
Marine Pollutant	:	No

Further Information

Avoid transport on vehicles where the load space is not separated from the driver's compartment. Ensure vehicle driver is aware of the potential hazards of the load and knows what to do in the event of an accident or an emergency. The transportation information is not intended to convey all specific regulatory data relating to this material. For complete transportation information, contact an Air Products customer service representative.

15. REGULATORY INFORMATION

Toxic Substance Control Act (TSCA) 12(b) Component(s):

None.

Country	Regulatory list	Notification
USA	TSCA	Included on Inventory.
EU	EINECS	Included on Inventory.
Canada	DSL	Included on Inventory.
Australia	AICS	Included on Inventory.
South Korea	ECL	Included on Inventory.
China	SEPA	Included on Inventory.
Philippines	PICCS	Included on Inventory.
Japan	ENCS	Included on Inventory.

EPA SARA Title III Section 312 (40 CFR 370) Hazard Classification
Sudden Release of Pressure Hazard.

US. California Safe Drinking Water & Toxic Enforcement Act (Proposition 65)

This product does not contain any chemicals known to State of California to cause cancer, birth defects or any other harm.

Appendix C

PED Assessment

PED Assessment

in accordance with the Pressure Equipment Directive 97/23/EC

Versum Materials, Inc., Kanaalweg 15, P.O. Box 3193, 3502 GD Utrecht, Netherlands

Equipment Description: GASGUARD® UHP Delivery Systems

Fluid state:	All
Fluid group:	All
Design Pressure:	All
Piping nominal size (DN):	Less than DN25 [Less than one inch nominal diameter]
Classification according to Table 7:	SEP

This equipment has been classified as SEP in accordance with Article 3, Section 1.3 of the Pressure Equipment Directive 97/23/EC on the basis that all components contained herein are less than DN25. The equipment has been designed and manufactured following 'Sound Engineering Practice' and Versum Materials' Engineering Standards. Instructions for its safe use and installation are documented in the accompanying Operation and Installation Manual.