VERSUM MATERIALS

Installation / Operation / Maintenance Manual

GASGUARD®

Source System TE11

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Corporate address:

Versum Materials, Inc.
1919 Vultee Street
Allentown, PA 18101, U.S.A

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Chapter 1 – Safety Warnings	Rev-2	MNL000294.doc
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Chapter 2 – Dimensions and Mounting	Rev-2	MNL000295.doc
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Chapter 3 – Tubing Connections	Rev-2	MNL000297.doc
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Chapter 4 – Electrical Connections	Rev-2	MNL000298.doc
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Chapter 11 – System Specific Information

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- Updated touch screen part number

Appendix A

Rev-2 MNL000138.doc

- Updated company name and logo

Appendix B – Nitrogen Material Safety Data Sheet

Rev-3 MNL000139.doc

- Updated company name and logo

TABLE OF CONTENTS

Introduction

Important Safety Information

Read and understand the safety warnings section in this manual before installing the equipment. Failure to do so can result in *personal injury or death.*

Warnings:

Warnings, like the sample shown below are found throughout the manual to point out hazards which could cause ***personal injury or death*** if proper procedures are not followed:

⚠WARNING

All installation personnel MUST read and understand the safety warnings section before installing the equipment.

SYSTEM HAZARDS:

Possible hazards when **installing** THIS SYSTEM ARE EXPOSURE TO:

- < Pressurized Fluids/Gases
- < Oxygen Deficient Atmospheres
- < Electrical Hazard
- < Falling Equipment Hazard
- < Cylinder Handling Hazard
- < Pinch Hazard

⚠WARNING

Do not make any changes to the equipment independently. Injury or death may result from unauthorized modifications. If equipment needs to be modified, an Versum Materials, Inc.' Representative MUST be contacted.

This manual covers the tasks required to install, operate and maintain a GASGUARD® Gas Equipment System. GASGUARD® Gas Equipment Systems including Source System Gas Cabinets and Racks.

Because of unique installation variables from site to site, it is not intended as a step-by-step installation procedure, but relies on the knowledge of qualified personnel to perform the work properly. This manual should be read thoroughly by the supervising installation engineer before installation is begun.

GASGUARD® Equipment Systems have been designed and built in accordance with the Uniform Fire Code (UFC) and the National Fire Protection Association (NFPA). They must be installed and operated in accordance with the UFC, NFPA and all other applicable industrial, federal, state and local codes.

GASGUARD® is a registered trademark. The GASGUARD® name is officially registered and legally restricted to be used only by Versum Materials, Inc. The information and data contained herein are proprietary to Versum Materials, Inc. and are not to be copied, reproduced, duplicated or disclosed to others, in whole or in part, without prior written consent of Versum Materials, Inc.

This restriction shall not apply to any safety information contained in the manual. The safety information is intended for your use and we encourage you to copy it so that anyone using this equipment knows how to use it safely.

Note: Versum Materials, Inc. recommends that the customer develop a specific "Work Instruction" for each gas cabinet, rack system or distribution system. The work instruction can be used as a step through check list procedure for trained operators.

A standard industrial work instruction would include the following:

- System identification number, gas service, basic description of system, etc.
- Current operating data (pressure, etc.), date, time, operator.
- Tools/supplies required for maintenance (PPE required for the gas, leak testing equipment, gaskets, etc.)
- Step-through procedural check list to include specific customer PPE protocol, communications and customer leak test procedures.

Consult your local Versum Materials, Inc. technical representative if you need assistance in preparation of standard work instruction.

Please refer to the Table of Contents of this manual for a listing of the detailed Chapters and Sections within and what pages they can be found on.

The table below provides a quick reference as to the applicability of the manual's sections.

Manual Section	Supervisory	Maintenance	Operations
1. Safety Warnings	•	•	•
2: Dimensions and Mounting	•	•	•
3: Tubing Connections	•	•	•
4: Electrical Connections	•	•	•
5: Helium Leak Test	•	•	•
6: Distribution System Functional Checklist	•	•	•
7: System Description	•	•	•
8: Operating Procedures	•	•	•
9: Troubleshooting	•	•	
10: Maintenance	•	•	
11: System Specific Information	•	•	•
Appendices	•	•	•

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

⚠ DANGER

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

⚠ WARNING

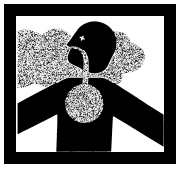
Indicates a potentially hazardous situation, which if not avoided, could result in death or serious injury.

⚠ CAUTION

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.

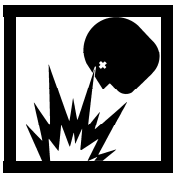
1.1.2 Hazard Types (Symbols)

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.

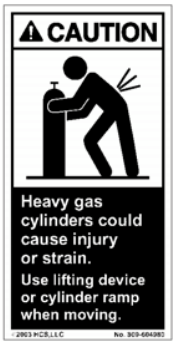
Pyrophoric gases which will ignite spontaneously without the presence of an ignition source when exposed to air.

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.

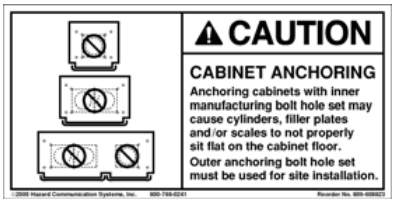


This symbol warns of potential strain or injury when lifting cylinders.

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

This symbol warns of the possibility of the source 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 cabinets.

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.

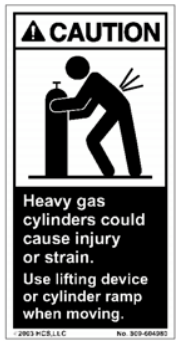
The control circuits for the system use 115/220 VAC, 50/60 Hz. Do not attempt to work on the system without first turning the power off and tagging out and locking out the electrical supply disconnect switch per plant lock out procedures. ***Follow the Typical Minimal Lockout or Tagout System Procedures 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 cabinet 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 gas cabinet) 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, DO NOT 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 Chapter 1 Section 12 using the warning sign with POISON GAS on the left and FLAMMABLE GAS on the right REQUIRE 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 <u>MUST</u> 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.

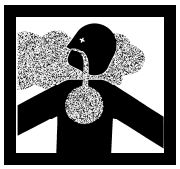
⚠WARNING

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, and shortness of breath) to alert personnel of exposure to toxic levels.

Personal protective equipment required for use with toxic gases is detailed in Chapter 1 Section 9 of this manual.

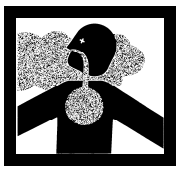
A list of most of the toxic gases used in the GASGUARD® system follows:

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***.

Chapter 1 Section 9 of this manual lists the personal protective equipment required for use with corrosive gases.

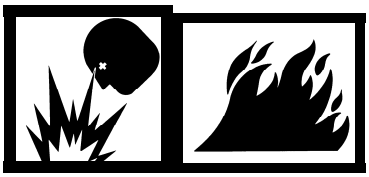
A list of most of the corrosive gases used in the GASGUARD® system follows:

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 Chapter 3 Section 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 recommend 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 Chapter 1 Section 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 VERSUM MATERIALS, INC. 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 Chapter 1 Section 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.

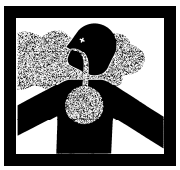
When entering a confined area or area which may contain high inert gas concentrations, a **"Buddy System"** must be used. One person should remain outside the suspect area, but within view of the other person. This method ensures that the other person can respond in the event of an emergency.

Personal protective equipment required for use with inerts is listed in Chapter 1 Section 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**

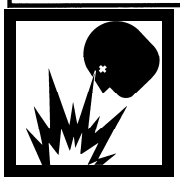
⚠WARNING



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 Chapter 1 Section 1.10.7 and the safety literature on cylinder handling in Chapter 1 Section 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 Chapter 8 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 source system with another type of gas cylinder. 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 source 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

⚠WARNING

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 Chapter 1 Section 11 of this manual.***

1.10.9 Purge Gas Backstream Hazard

⚠WARNING

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 a 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 are 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

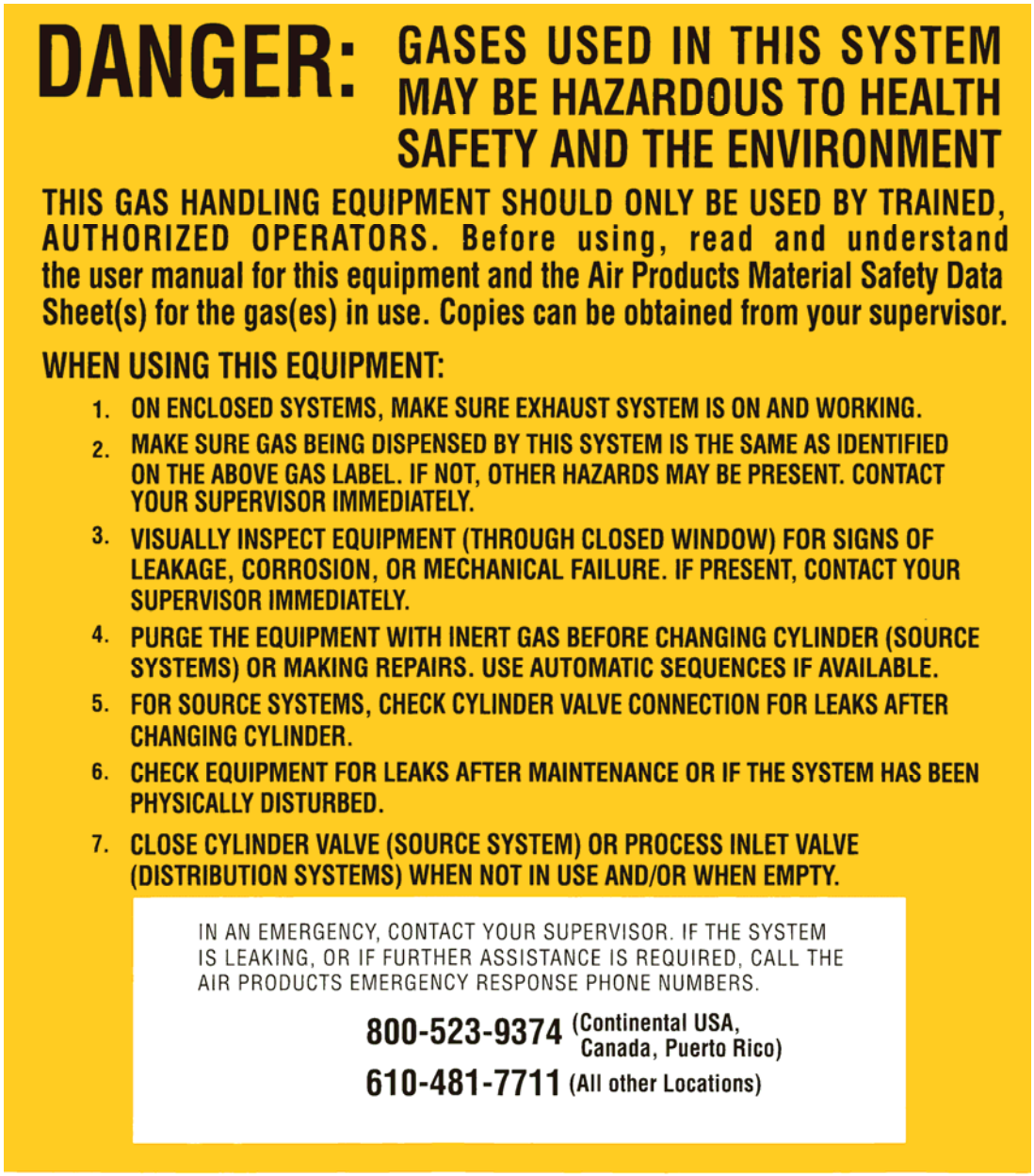
All equipment shall be locked or tagged out to protect against accidental or inadvertent operating when such operation could cause injury to personnel. Do not attempt to operate any switch, valve or other energy isolating device where it is locked or tagged.

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® cabinet.



DANGER: GASES USED IN THIS SYSTEM MAY BE HAZARDOUS TO HEALTH SAFETY AND THE ENVIRONMENT

THIS GAS HANDLING EQUIPMENT SHOULD ONLY BE USED BY TRAINED, AUTHORIZED OPERATORS. Before using, read and understand the user manual for this equipment and the Air Products Material Safety Data Sheet(s) for the gas(es) 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 GAS BEING DISPENSED BY THIS SYSTEM IS THE SAME AS IDENTIFIED ON THE ABOVE GAS LABEL. IF NOT, OTHER HAZARDS MAY BE PRESENT. CONTACT YOUR SUPERVISOR IMMEDIATELY.
3. VISUALLY INSPECT EQUIPMENT (THROUGH CLOSED WINDOW) FOR SIGNS OF LEAKAGE, CORROSION, OR MECHANICAL FAILURE. IF PRESENT, CONTACT YOUR SUPERVISOR IMMEDIATELY.
4. PURGE THE EQUIPMENT WITH INERT GAS BEFORE CHANGING CYLINDER (SOURCE SYSTEMS) OR MAKING REPAIRS. USE AUTOMATIC SEQUENCES IF AVAILABLE.
5. FOR SOURCE SYSTEMS, CHECK CYLINDER VALVE CONNECTION FOR LEAKS AFTER CHANGING CYLINDER.
6. CHECK EQUIPMENT FOR LEAKS AFTER MAINTENANCE OR IF THE SYSTEM HAS BEEN PHYSICALLY DISTURBED.
7. CLOSE CYLINDER VALVE (SOURCE SYSTEM) OR PROCESS INLET VALVE (DISTRIBUTION SYSTEMS) WHEN NOT IN USE AND/OR WHEN EMPTY.

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

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

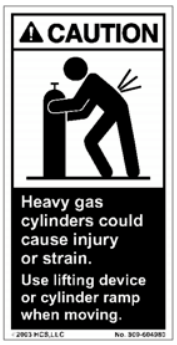
610-481-7711 (All other Locations)

The following sign is located on the GASGUARD® controller. This label is required if the GASGUARD® Source System is located in certain hazardous areas (i.e., Class I, Division II locations in the United States).

ENCLOSURE SHALL NOT BE OPENED UNLESS AREA IS KNOWN TO BE NON-HAZARDOUS OR UNLESS THE POWER HAS BEEN REMOVED FROM ALL DEVICES WITHIN THE ENCLOSURE.

POWER SHALL NOT BE RESTORED AFTER ENCLOSURE HAS BEEN OPENED UNTIL ENCLOSURE HAS BEEN PURGED FOR 10 MIN.

The following label appears inside cabinets containing cylinders. It is located on the inside door, approximately at eye level. It is also located on the cylinder strap on both cabinets and racks.



The following label appears inside doors of cabinets.

The following label appears on cabinets. It is located on the back of the cabinet, 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® cabinet. 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:

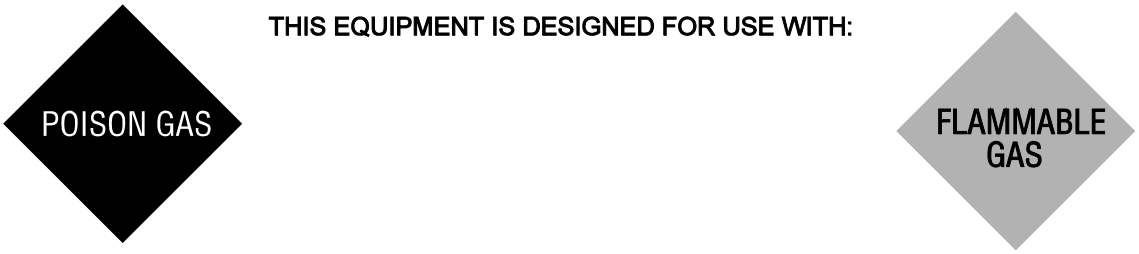
Fluorine
Fluorine mixtures

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

THIS EQUIPMENT IS DESIGNED FOR USE WITH:

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

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 cabinet (see Chapter 1 Section 12).
- The gas cabinet has a self-closing cabinet door with locking mechanism.
- A sprinkler head is installed in the source system, unless water is a hazard with the specific gas used in the source system.
- Cabinet doors have self-closing 1/4" thick wire reinforced safety glass windows.
- 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 cabinet.
- 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.
- A flow restricting orifice may be installed in the cylinder valve. This flow restricting orifice significantly reduces the flow of gas in the event of a failure in the downstream equipment.
- An ultraviolet infrared (UVIR) detector may be installed for pyrophoric gas systems. A temperature switch is required in lieu of a UVIR detector for pyrophoric gas systems.
- A temperature switch is required for flammable 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.

1.14 Safety Literature for Handling and Use of Gas Cylinders

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

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

Material Safety Data Sheets for all gases used in system (Please contact your gas supplier to obtain the appropriate MSDS documents).

1.15 Safety Literature for Handling and Use of Instrument Nitrogen Supply

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

VERSUM MATERIALS, INC. Safetygram 2	Gaseous Nitrogen
VERSUM MATERIALS, INC. Safetygram 17	Dangers of Oxygen Deficient Atmospheres

Nitrogen Material Safety Data Sheet (Included as Appendix B)

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.

Section 2.1.1 contains the 2 Cylinder Source System figures
Section 2.1.2 contains the 3 Cylinder Source system figures
Section 2.1.3 contains the 1x1 Cylinder Source System figures
Section 2.1.4 contains the 1x2 Cylinder Source System figures

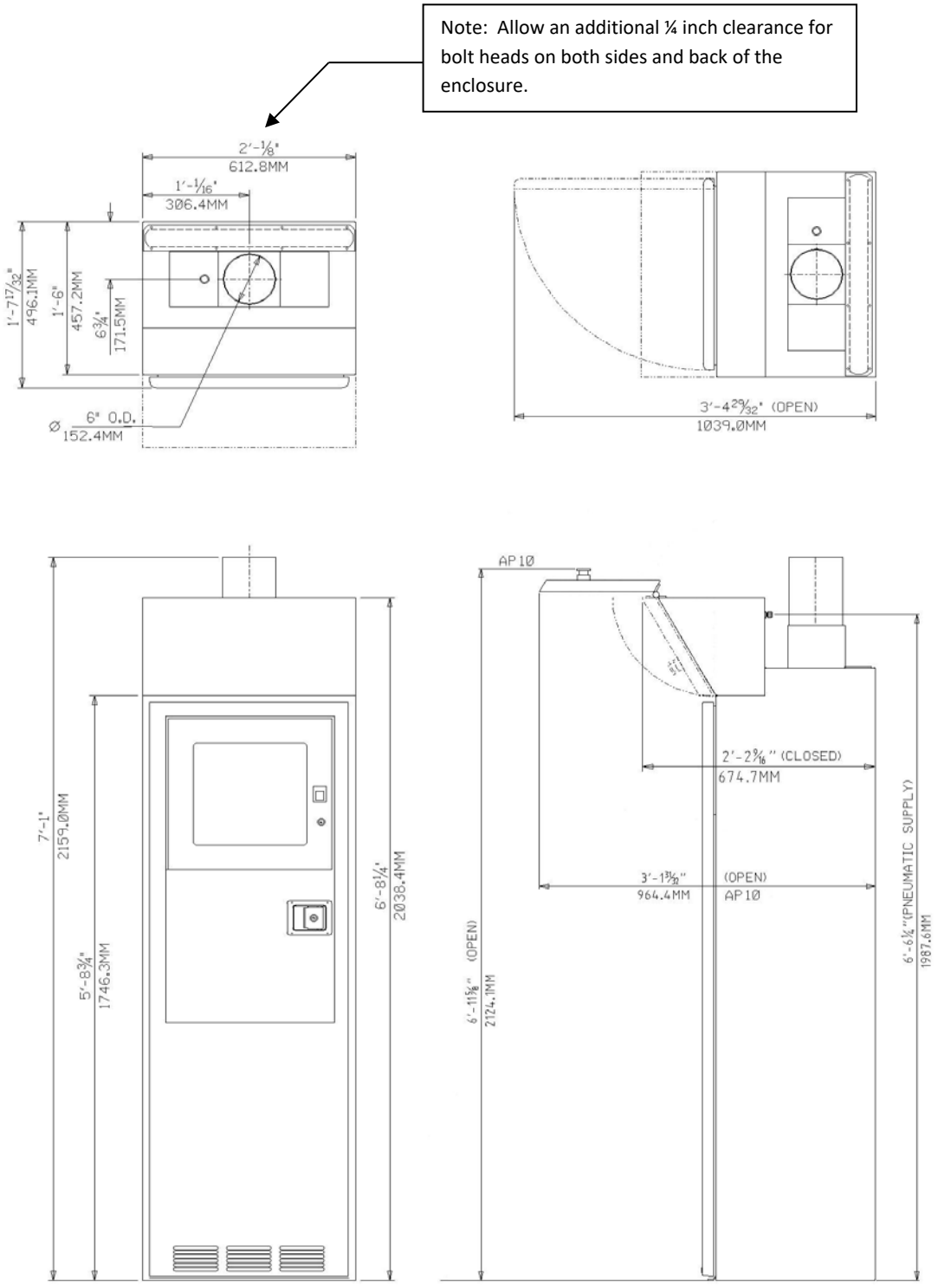
2.1.1 Outline Dimension Figures for 2 Cylinder Source Systems

2.1.1.1 - 2 Cylinder Enclosure

2.1.1.2 - 2 Cylinder Euro (XH-Extra High) Enclosure

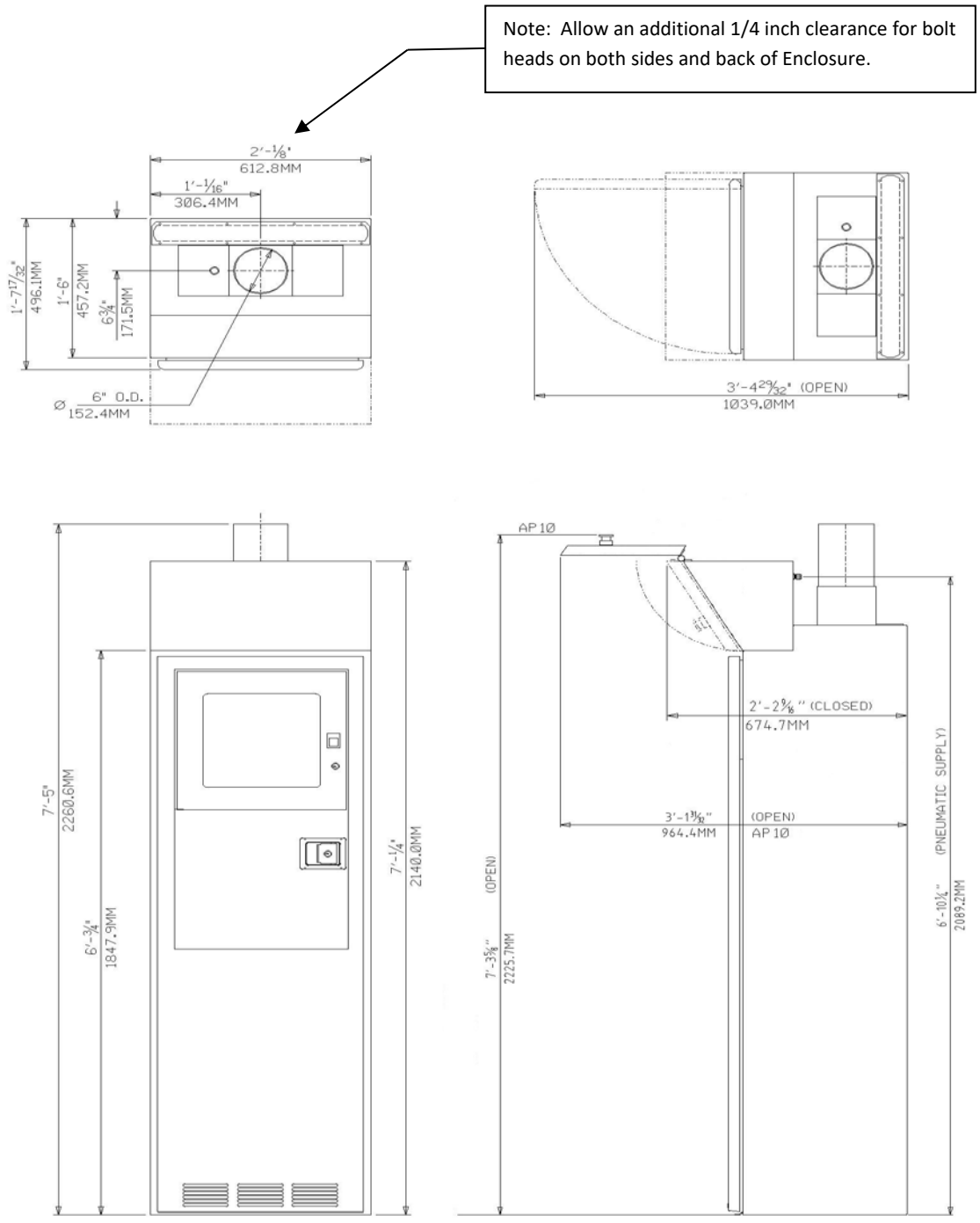
2.1.1.3 - 2 Cylinder Rack

2.1.1.4 - 2 Cylinder Euro (XH-Extra High) Rack



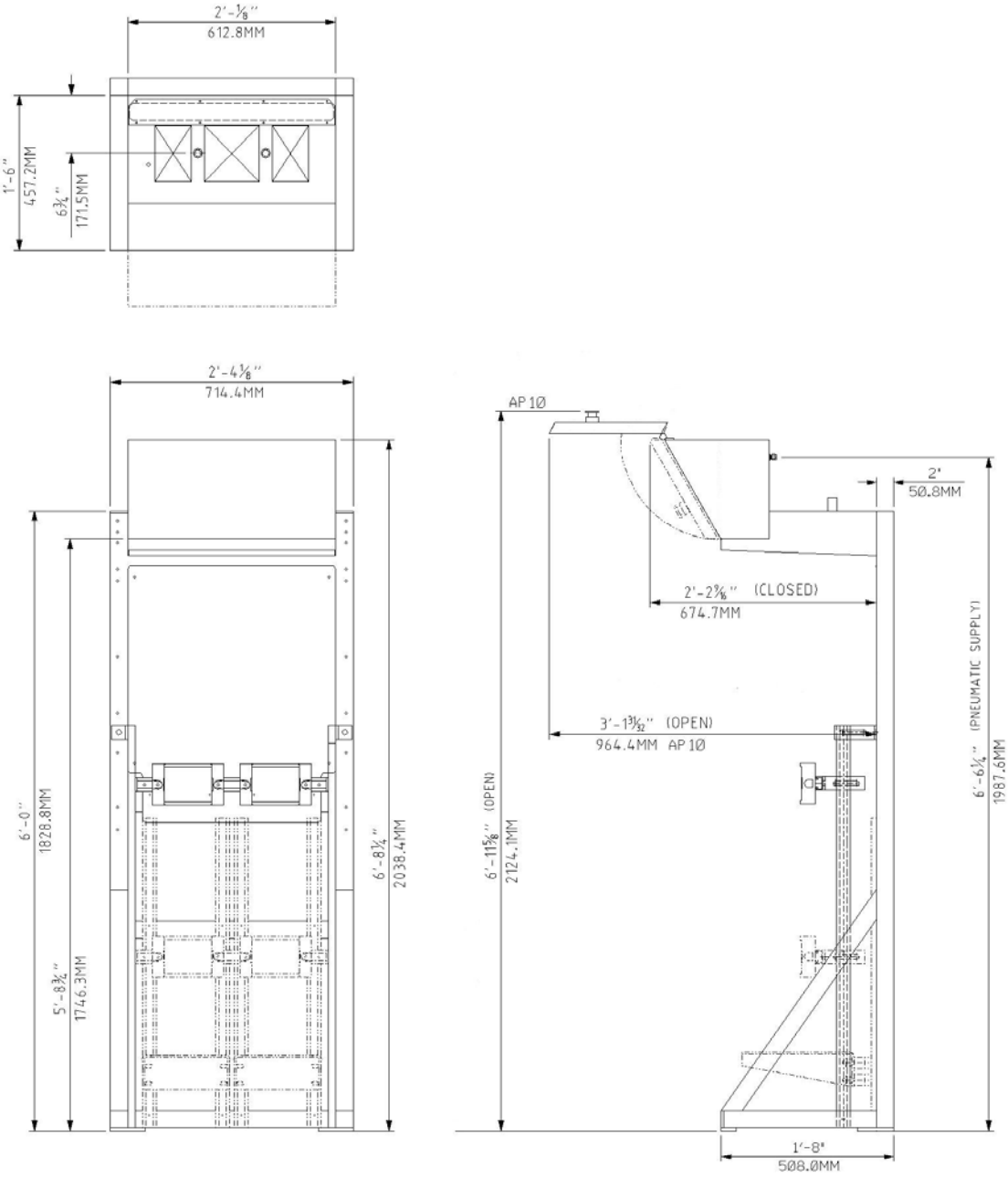
Approximate Weight = 500 pounds (226.24 Kilograms)

Figure 2.1.1.1: Outline Dimensions
2 Cylinder Enclosure



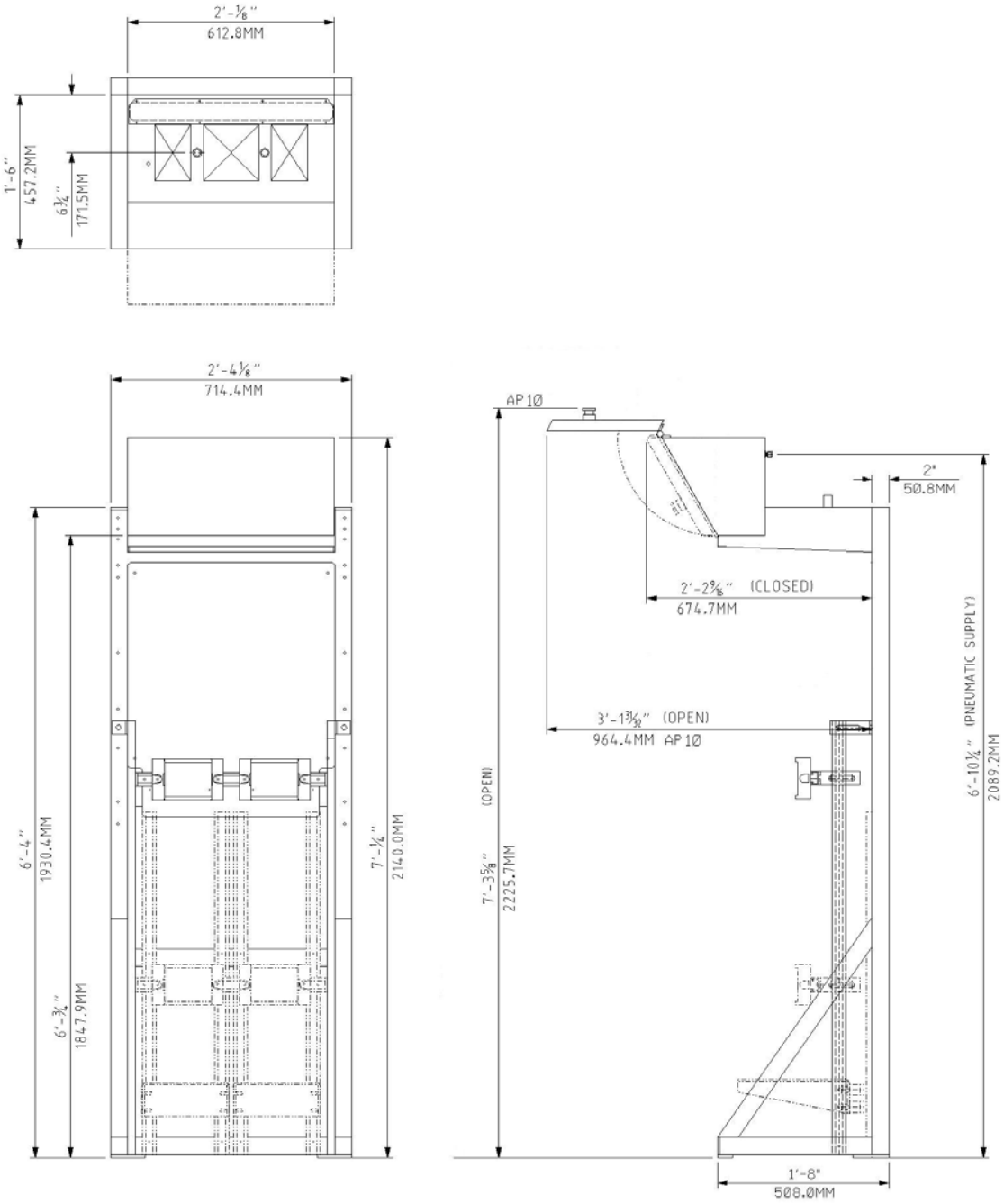
Approximate Weight = 500 pounds (226.24 Kilograms)

Figure 2.1.1.2: Outline Dimensions
2 Cylinder Euro (XH) Enclosure



Approximate Weight = 360 pounds (163.29 Kilograms)

Figure 2.1.1.3: Outline Dimensions
2 Cylinder Rack



Approximate Weight = 360 pounds (163.29 Kilograms)

Figure 2.1.1.4: Outline Dimensions

2 Cylinder Euro (XH) Rack

2.1.2 Outline Dimension Figures for 3 Cylinder Source Systems

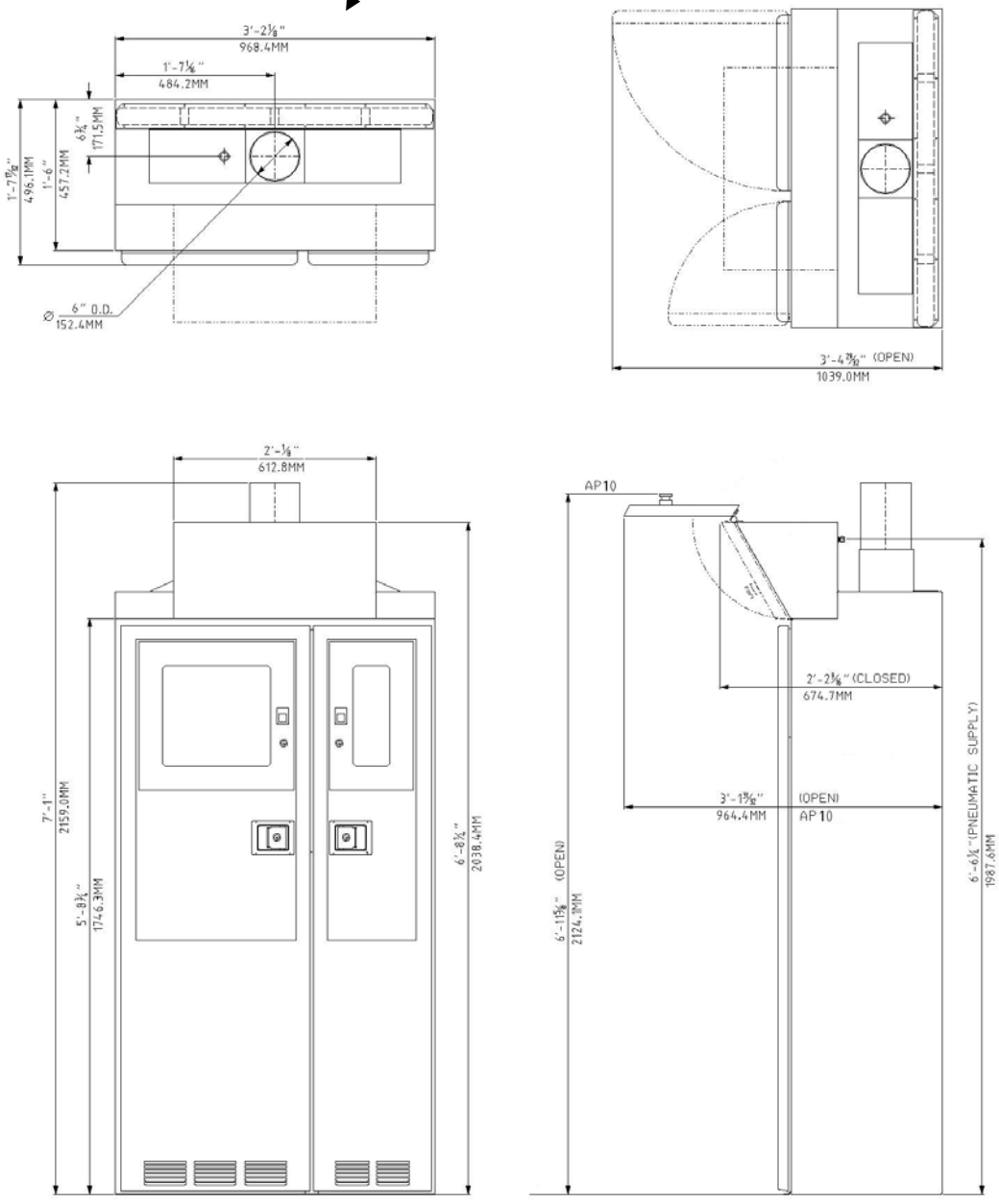
2.1.2.1 - 3 Cylinder Enclosure

2.1.2.2 - 3 Cylinder Euro (XH-Extra High) Enclosure

2.1.2.3 - 3 Cylinder Rack

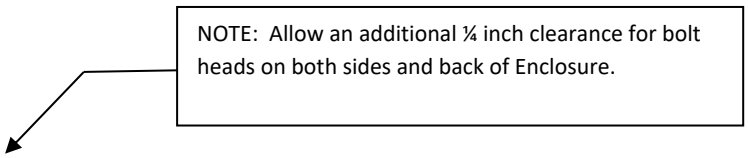
2.1.2.4 - 3 Cylinder Euro (XH-Extra High) Rack

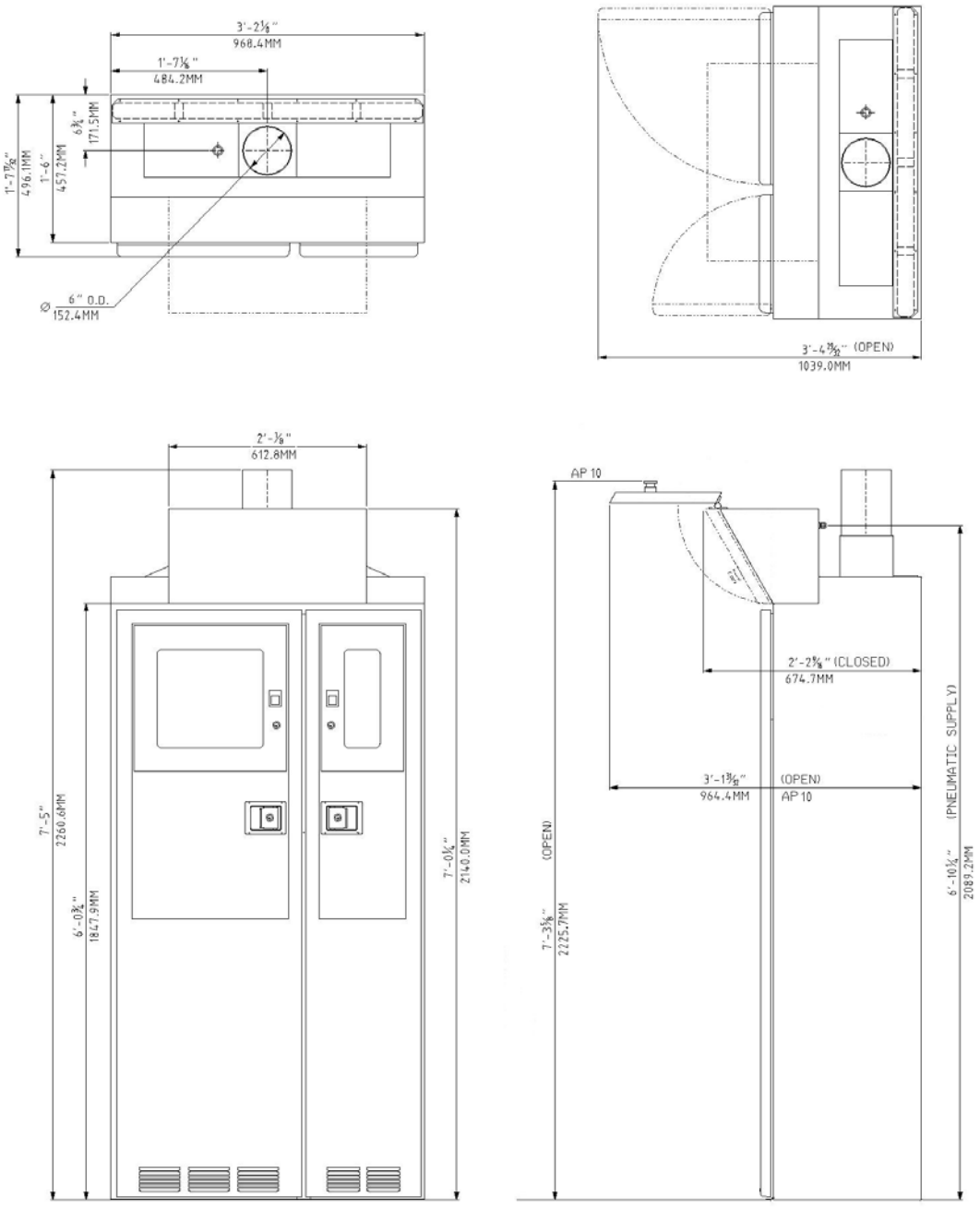
NOTE: Allow an additional ¼ inch clearance for bolt heads on both side and back of Enclosure.



Approximate Weight = 600 pounds (271.49 Kilograms)

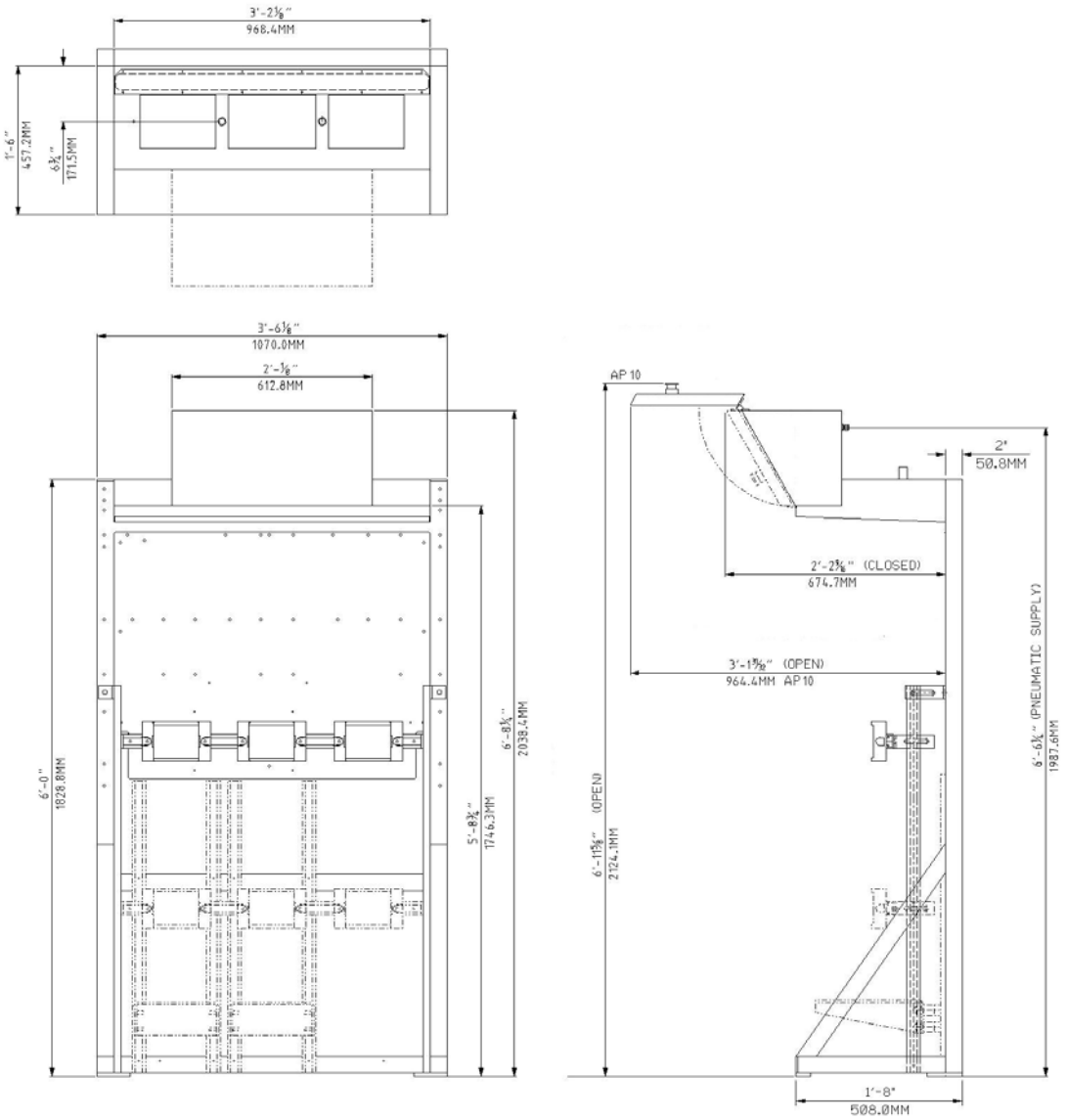
Figure 2.1.2.1: Outline Dimensions
3 Cylinder Enclosure





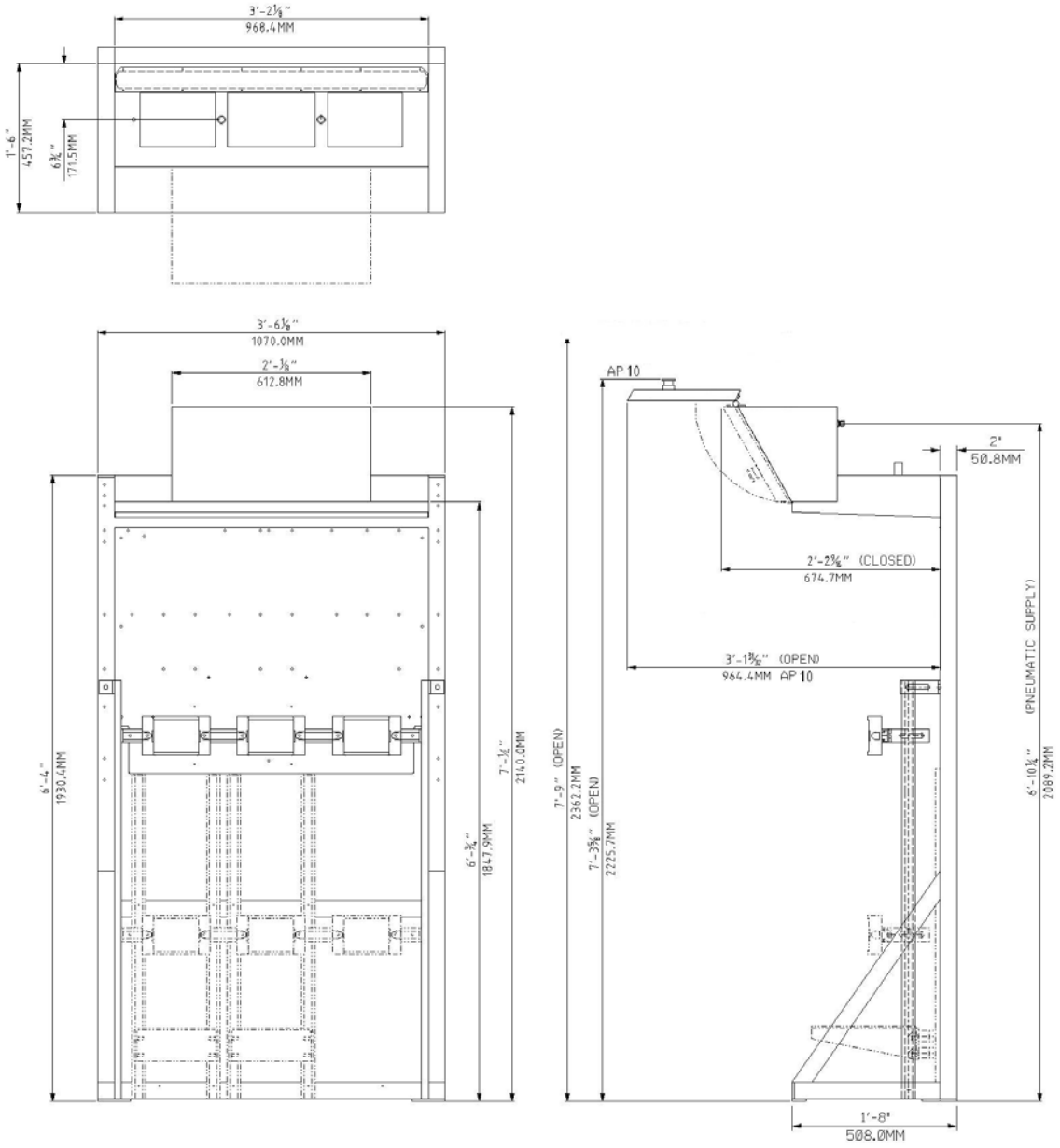
Approximate Weight = 600 pounds (271.49 Kilograms)

Figure 2.1.2.2: Outline Dimensions
3 Cylinder Euro (XH) Enclosure



Approximate Weight = 425 pounds (192.77 Kilograms)

Figure 2.1.2.3: Outline Dimensions
3 Cylinder Rack



Approximate Weight = 425 pounds (192.77 Kilograms)

Figure 2.1.3.4: Outline Dimensions
3 Cylinder Euro (XH) Rack

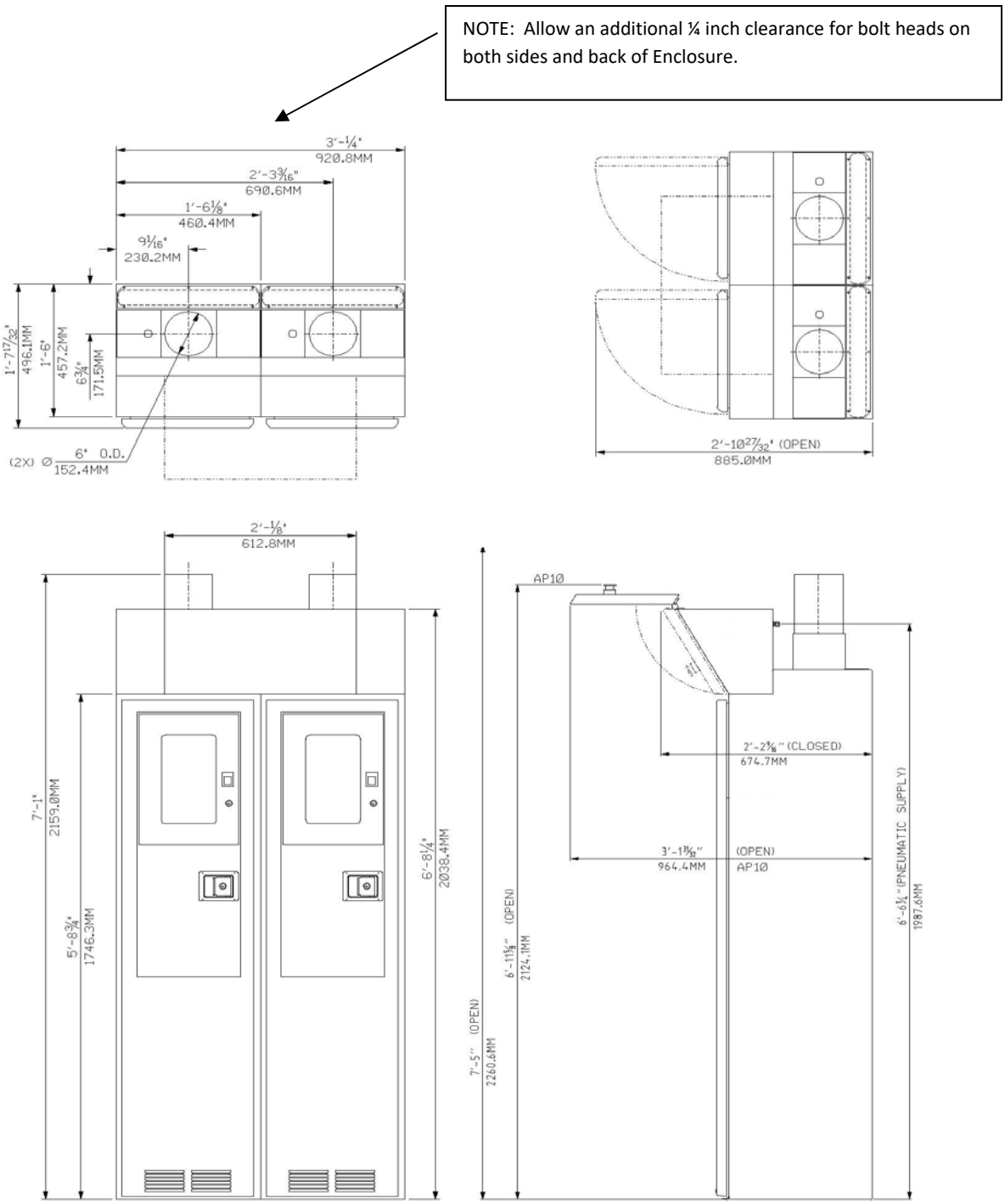
2.1.3 Outline Dimension Figures for 1x1 Cylinder Source Systems

2.1.3.1 - 1x1 Cylinder Enclosure

2.1.3.2 - 1x1 Cylinder Euro (XH-Extra High) Enclosure

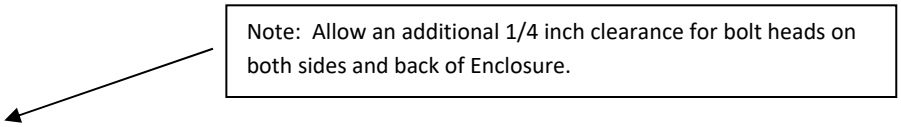
2.1.3.3 - 1x1 Cylinder Rack

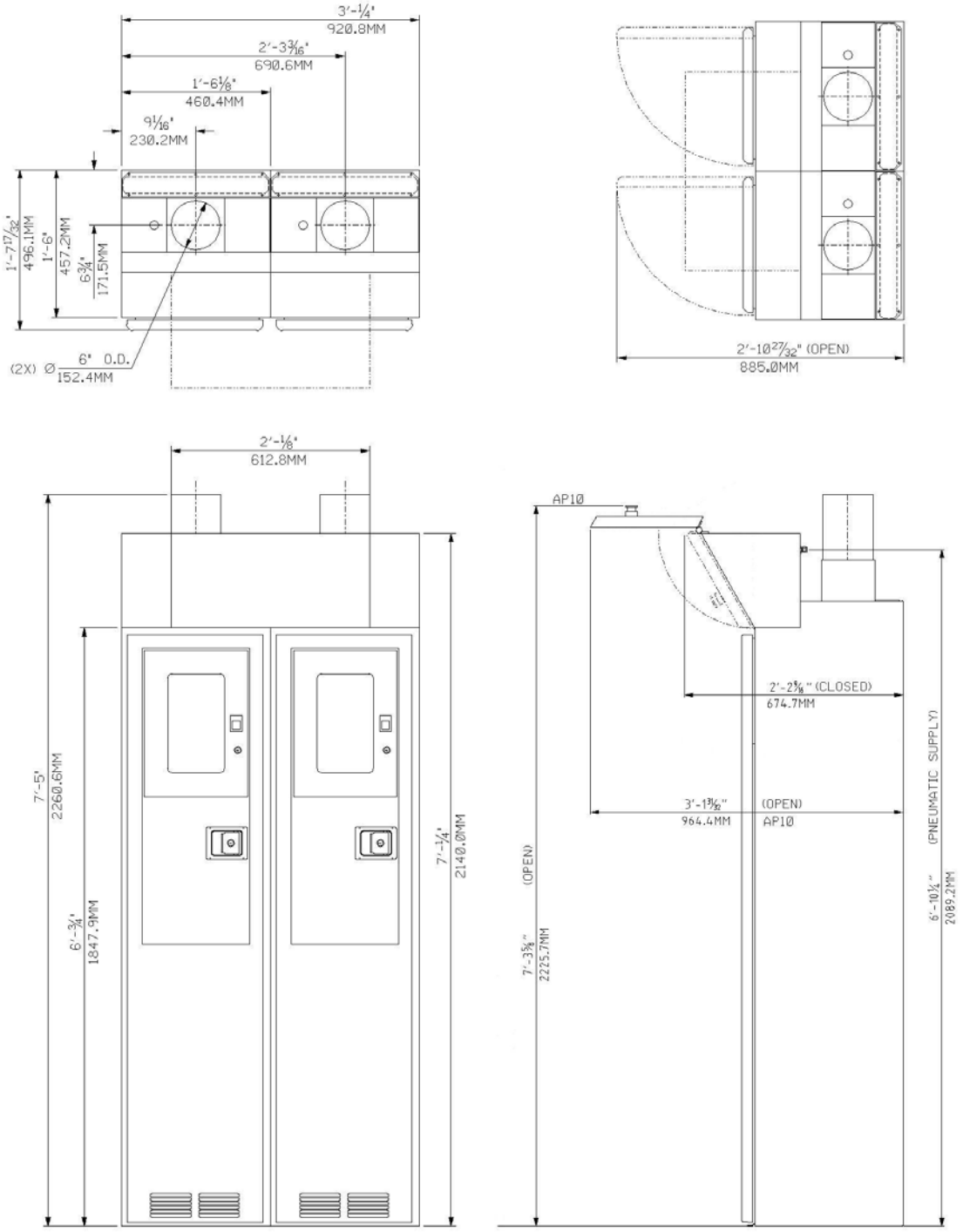
2.1.3.4 - 1x1 Cylinder Euro (XH-Extra High) Rack



Approximate Weight = 600 pounds (271.49 Kilograms)

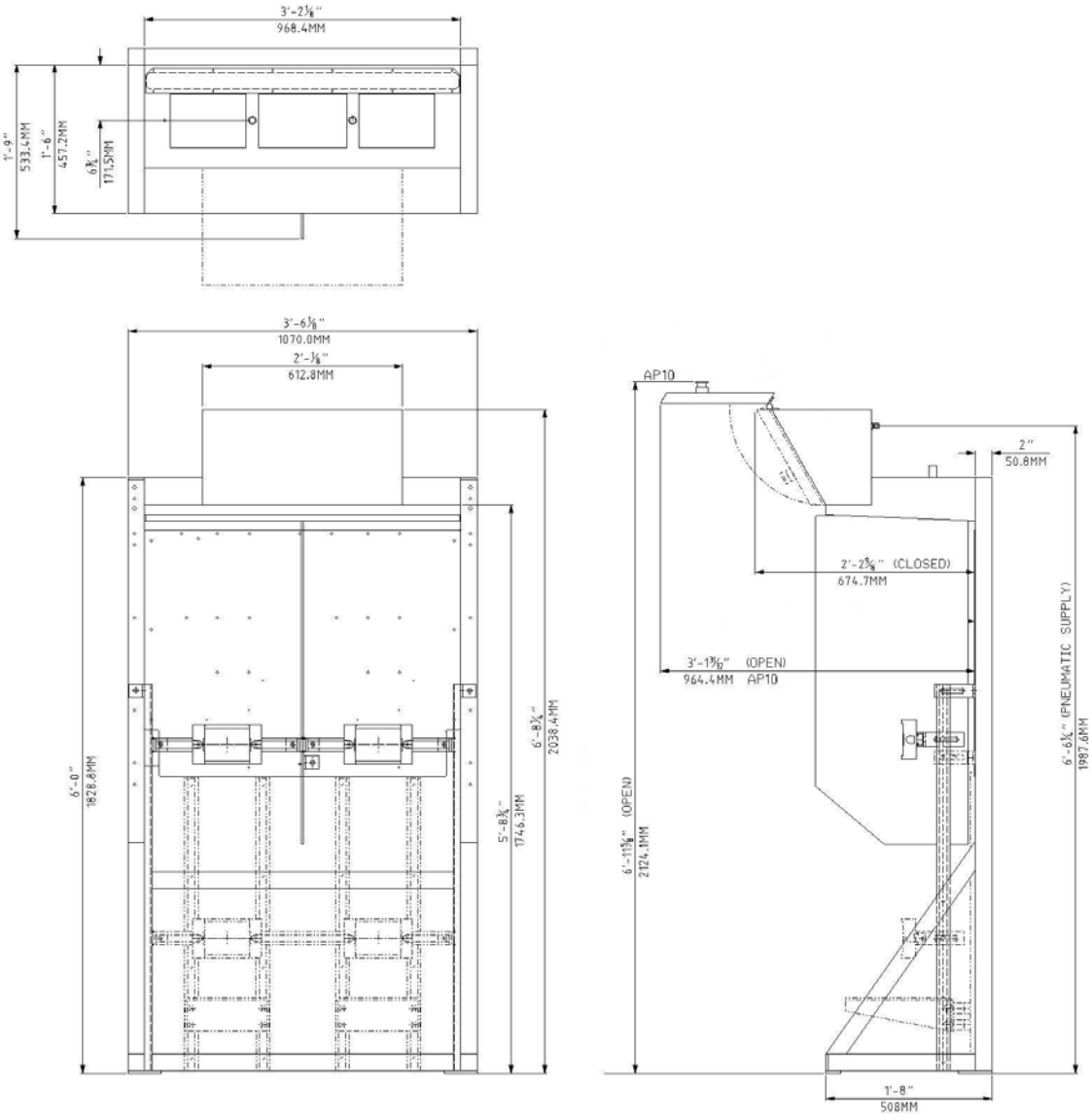
Figure 2.1.3.1: Outline Dimensions
1x1 Cylinder Enclosure





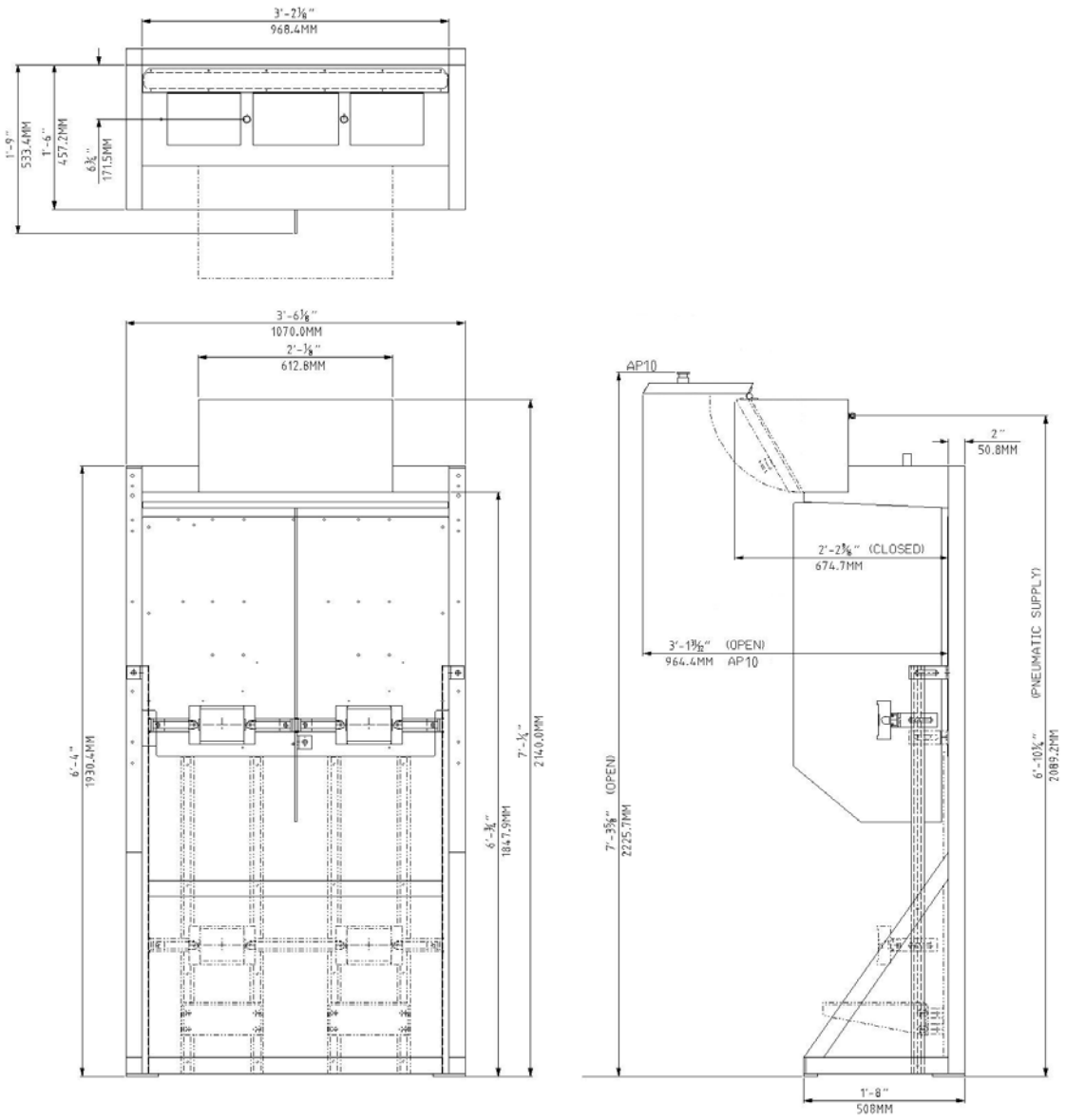
Approximate Weight = 600 pounds (271.49 Kilograms)

Figure 2.1.3.2: Outline Dimensions
1x1 Cylinder Euro (XH) Enclosure



Approximate Weight = 425 pounds (192.77 Kilograms)

Figure 2.1.3.3: Outline Dimensions
1x1 Cylinder Rack



Approximate Weight = 425 pounds (192.77 Kilograms)

Figure 2.1.3.4: Outline Dimensions
1x1 Cylinder Euro (XH) Rack

2.1.4 Outline Dimension Figures for 1x2 Cylinder Source Systems

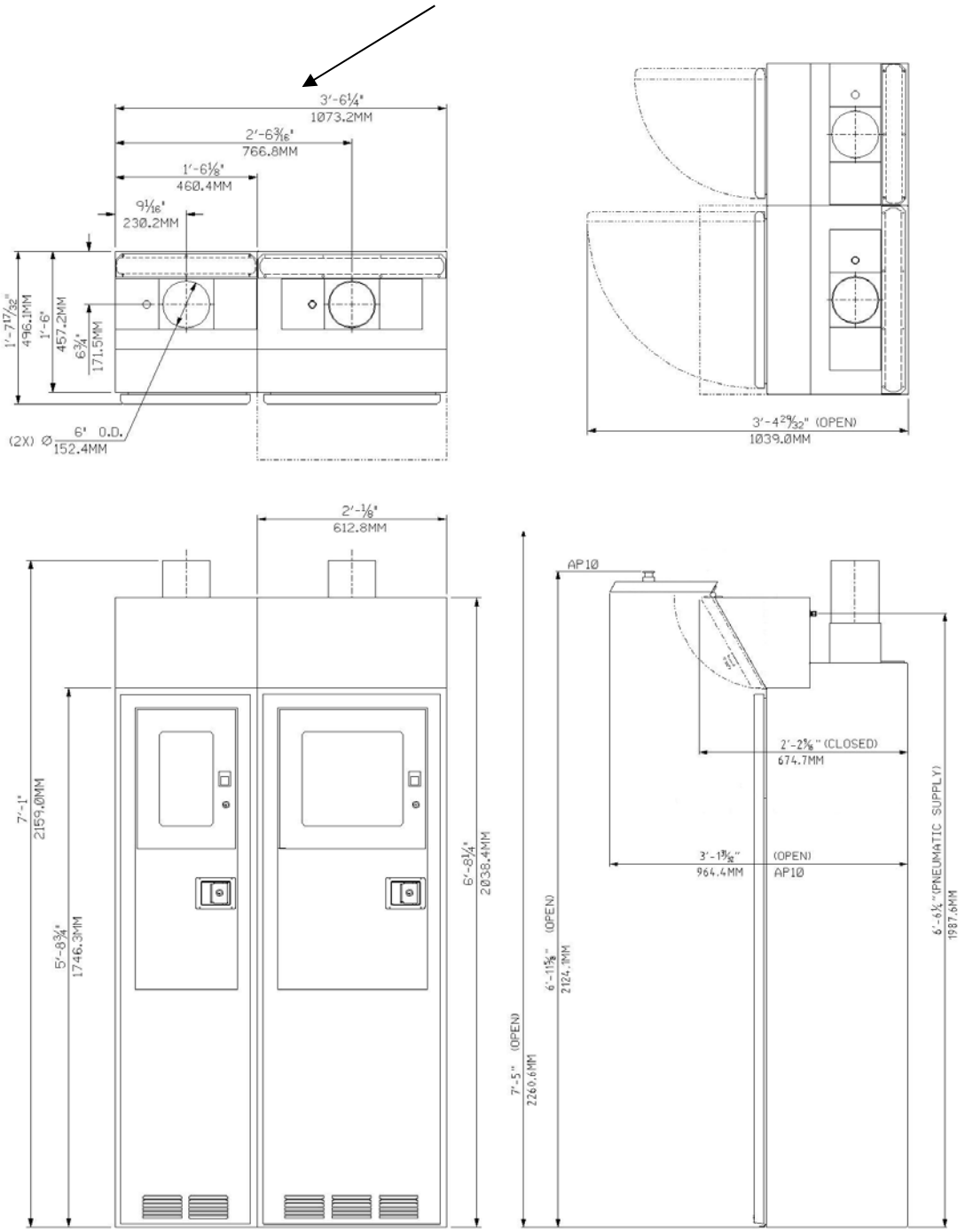
2.1.4.1 - 1x2 Cylinder Enclosure

2.1.4.2 - 1x2 Cylinder Euro (XH-Extra High) Enclosure

2.1.4.3 - 1x2 Cylinder Rack

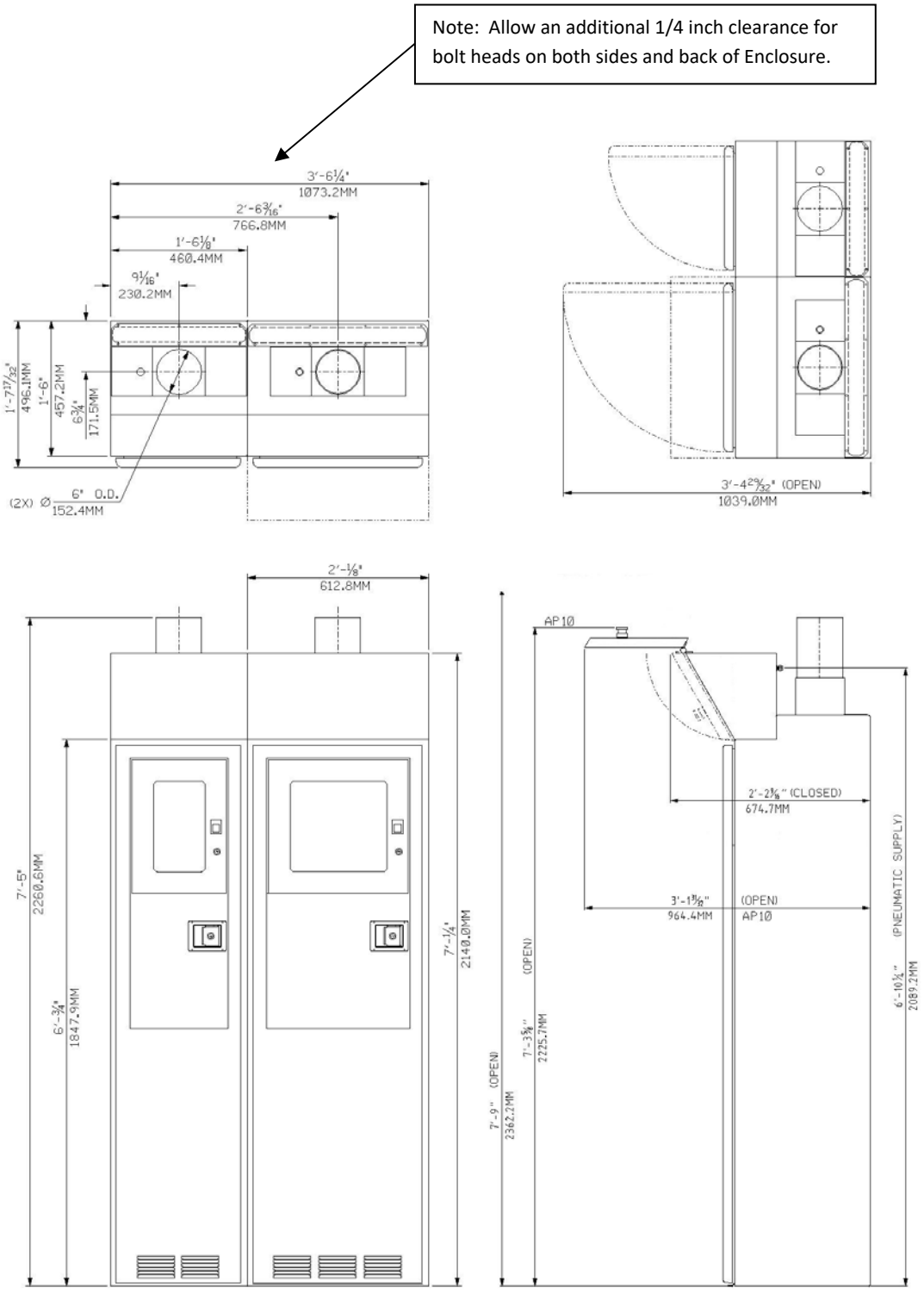
2.1.4.4 - 1x2 Cylinder Euro (XH-Extra High) Rack

Note: Allow an additional 1/4 inch clearance for bolt heads on both sides and back of Enclosure.



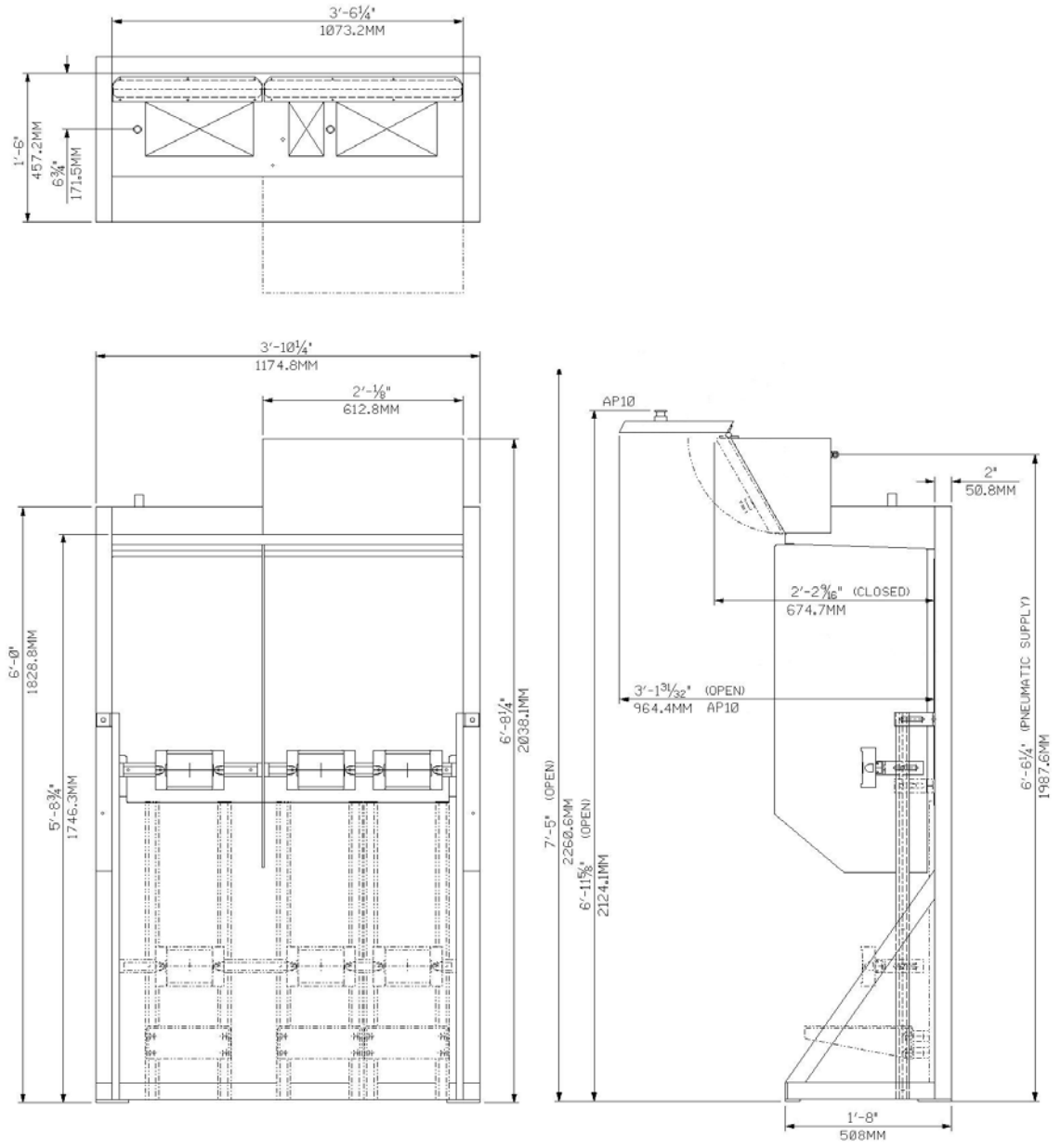
Approximate Weight = 650 pounds (294.84 Kilograms)

Figure 2.1.4.1: Outline Dimensions
1x2 Cylinder Enclosure



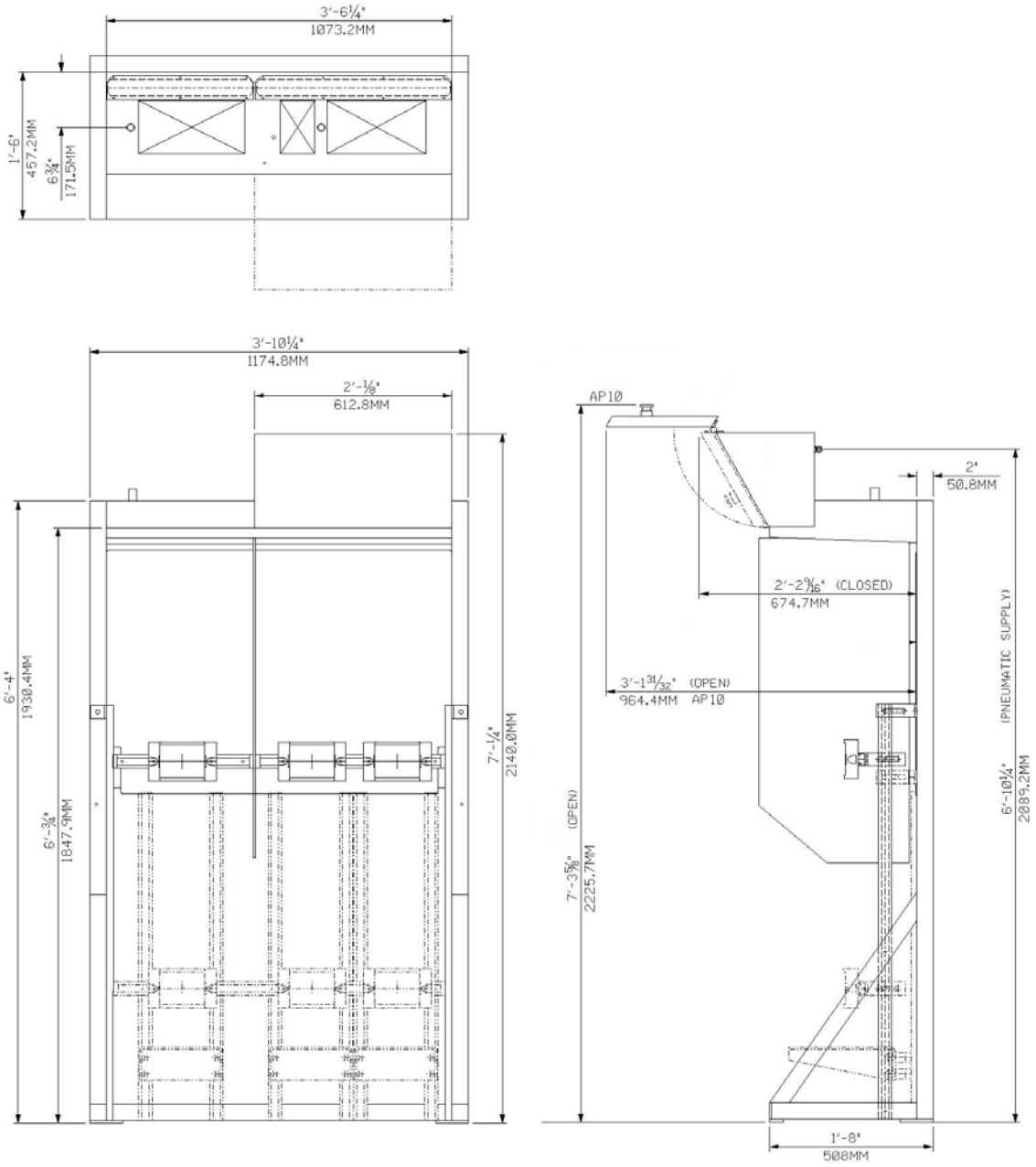
Approximate Weight = 650 pounds (294.84 Kilograms)

Figure 2.1.4.2: Outline Dimensions
1x2 Cylinder Euro (XH) Enclosure



Approximate Weight = 450 pounds (204.12 Kilograms)

Figure 2.1.4.3: Outline Dimensions
1x2 Cylinder Rack



Approximate Weight = 450 pounds (204.12 Kilograms)

Figure 2.1.4.4: Outline Dimensions
1x2 Cylinder Euro (XH) Rack

2.2 Mounting Hole Locations

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

Highest tension load when resisting tipover 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.

For Enclosure anchoring figures see Section 2.2.1. For rack anchoring figures see section 2.2.2.

2.2.1 Enclosure Anchoring

For Enclosure anchoring see the following Mounting Hole Location Figures for proper floor location of four (4) 7/16" (11.1 mm) diameter holes in Enclosure floor. *Do not use inner manufacturing bolt hole set in cabinet base*. Using the inner manufacturing bolt hole set may interfere with gas cylinder and/or cylinder weight scale placement within the Enclosure.

2.2.1.1 - 2 Cylinder Enclosure or 2 Cylinder Euro (XH-Extra High) Enclosure

2.2.1.2 - 3 Cylinder Enclosure or 3 Cylinder Euro (XH-Extra High) Enclosure

2.2.1.3 - 1x1 Cylinder Enclosure or 1x1 Cylinder Euro (XH-Extra High) Enclosure

2.2.1.4 - 1x2 Cylinder Enclosure or 1x2 Cylinder Euro (XH-Extra High) Enclosure

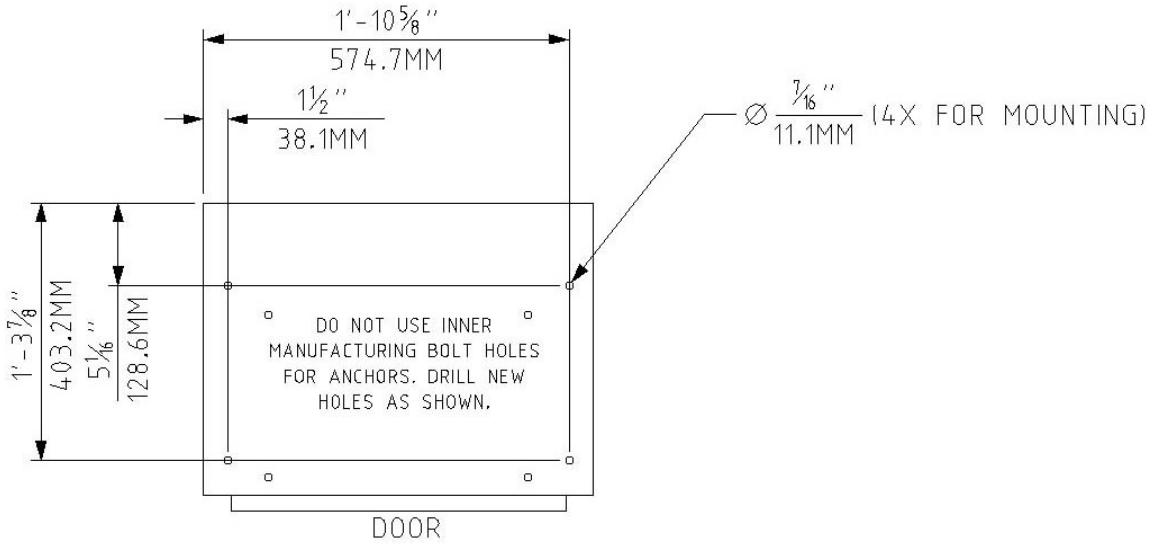


Figure 2.2.1.1: Mounting Hole Locations
2 Cylinder Enclosure or 2 Cylinder Euro (XH) Enclosure

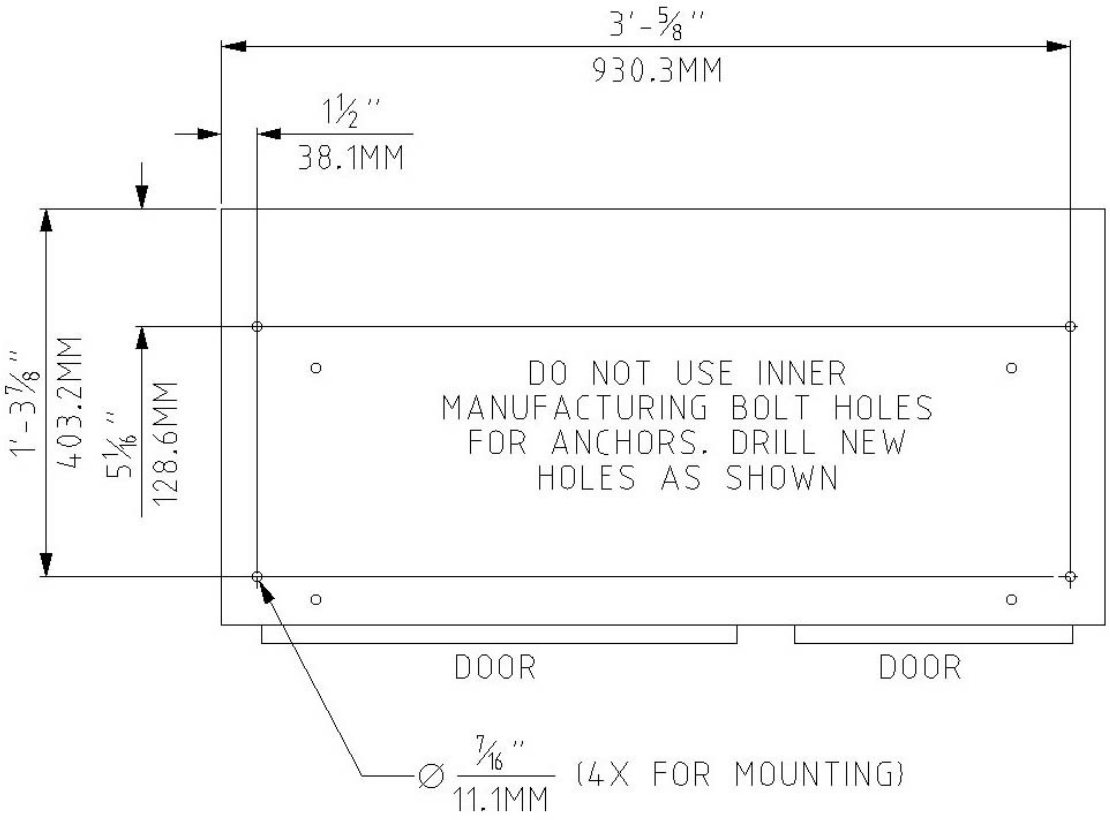


Figure 2.2.1.2: Mounting Hole Locations
3 Cylinder Enclosure or 3 Cylinder Euro (XH) Enclosure

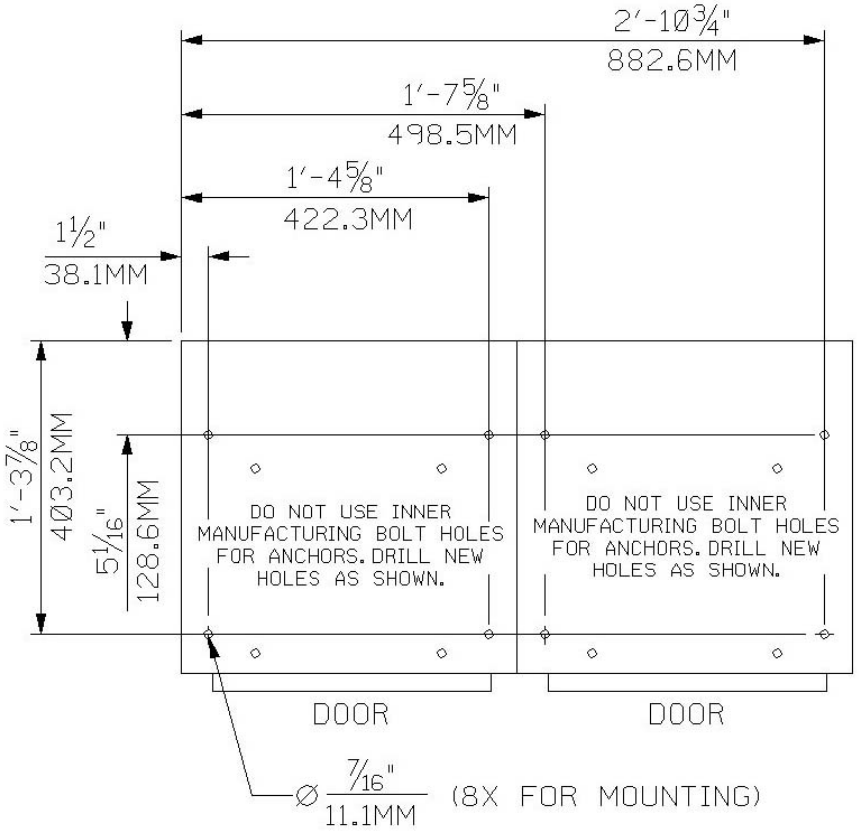


Figure 2.2.1.3: Mounting Hole Locations
1x1 Cylinder Enclosure or 1x1 Cylinder Euro (XH) Enclosure

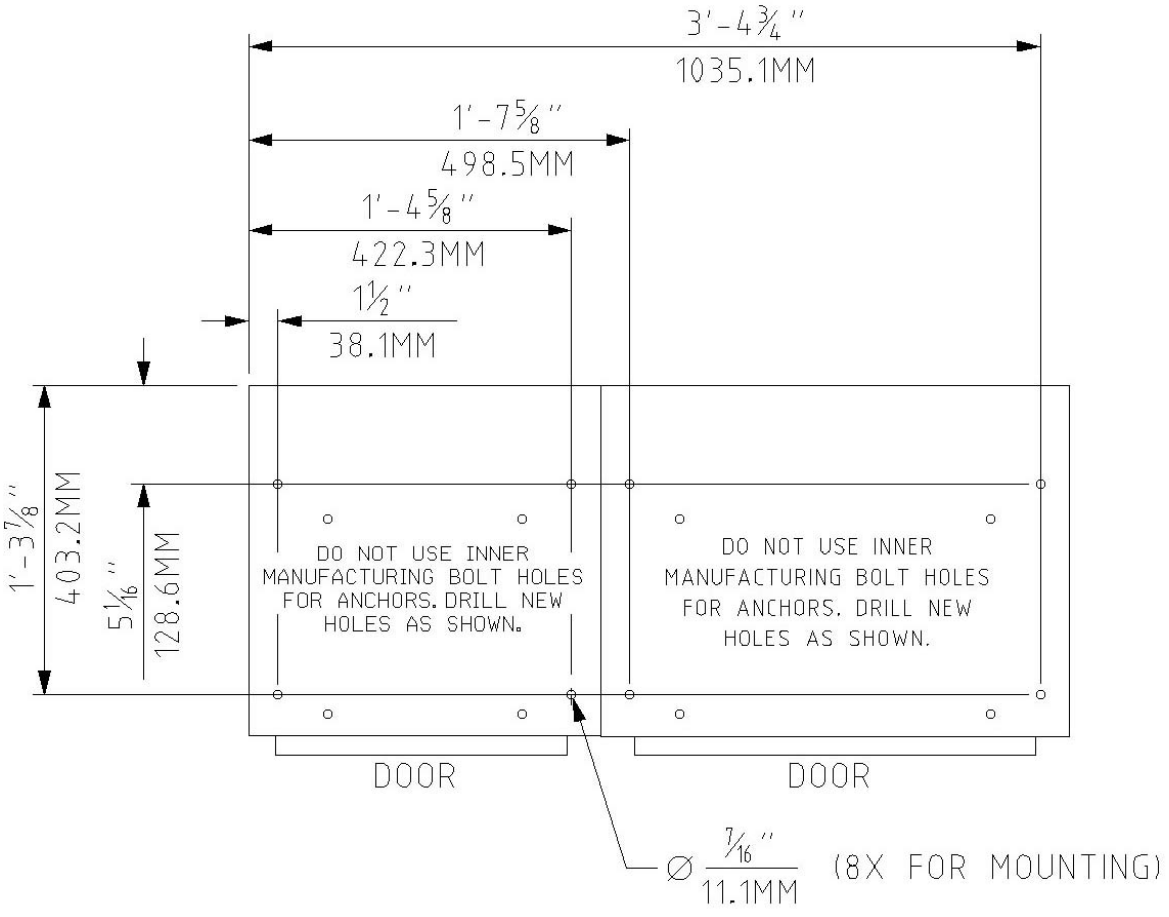


Figure 2.2.1.4: Mounting Hole Locations
1x2 Cylinder Enclosure or 1x2 Cylinder Euro (XH) Enclosure

2.2.2 Rack Anchoring

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

2.2.2.1 - 2 Cylinder Rack or 2 Cylinder Euro (XH-Extra High) Rack

2.2.2.2 - 3 Cylinder Rack or 3 Cylinder Euro (XH-Extra High) Rack

2.2.2.3 - 1x1 Cylinder Rack or 1x1 Cylinder Euro (XH-Extra High) Rack

2.2.2.4 - 1x2 Cylinder Rack or 1x2 Cylinder Euro (XH-Extra High) Rack

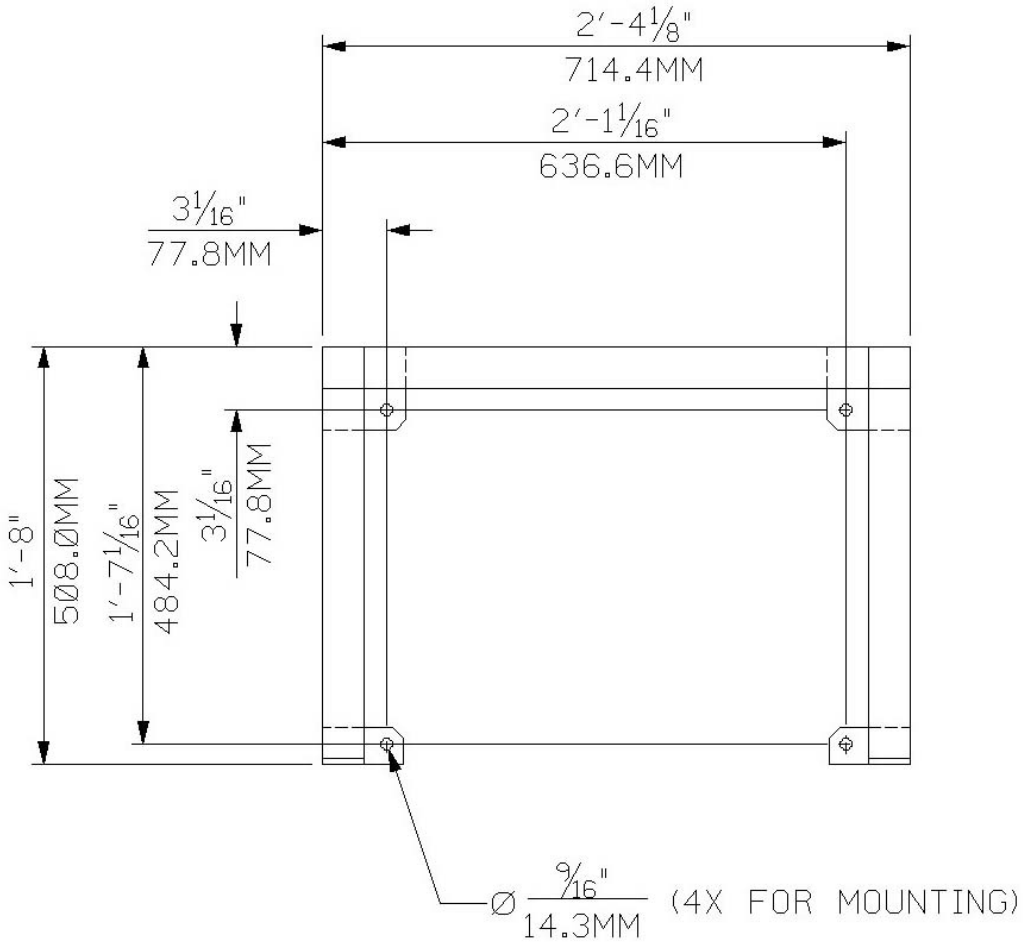


Figure 2.2.2.1: Mounting Hole Locations
2 Cylinder Rack or 2 Cylinder Euro (XH) Rack

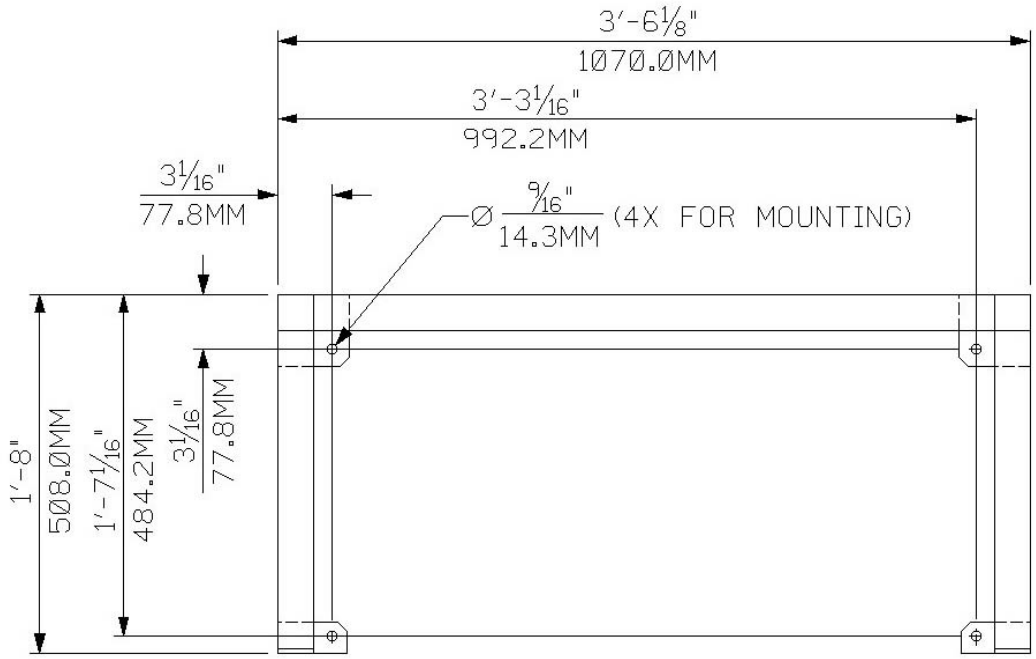


Figure 2.2.2.2: Mounting Hole Locations
3 Cylinder Rack or 3 Cylinder Euro (XH) Rack

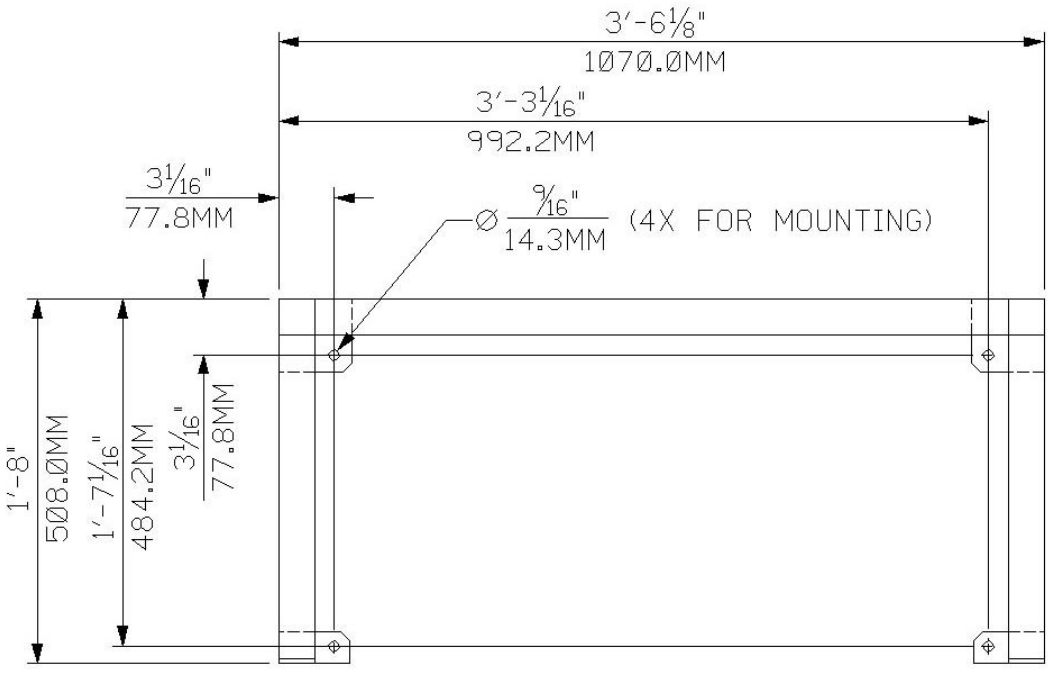


Figure 2.2.2.3: Mounting Hole Locations
1x1 Cylinder Rack or 1x1 Cylinder Euro (XH) Rack

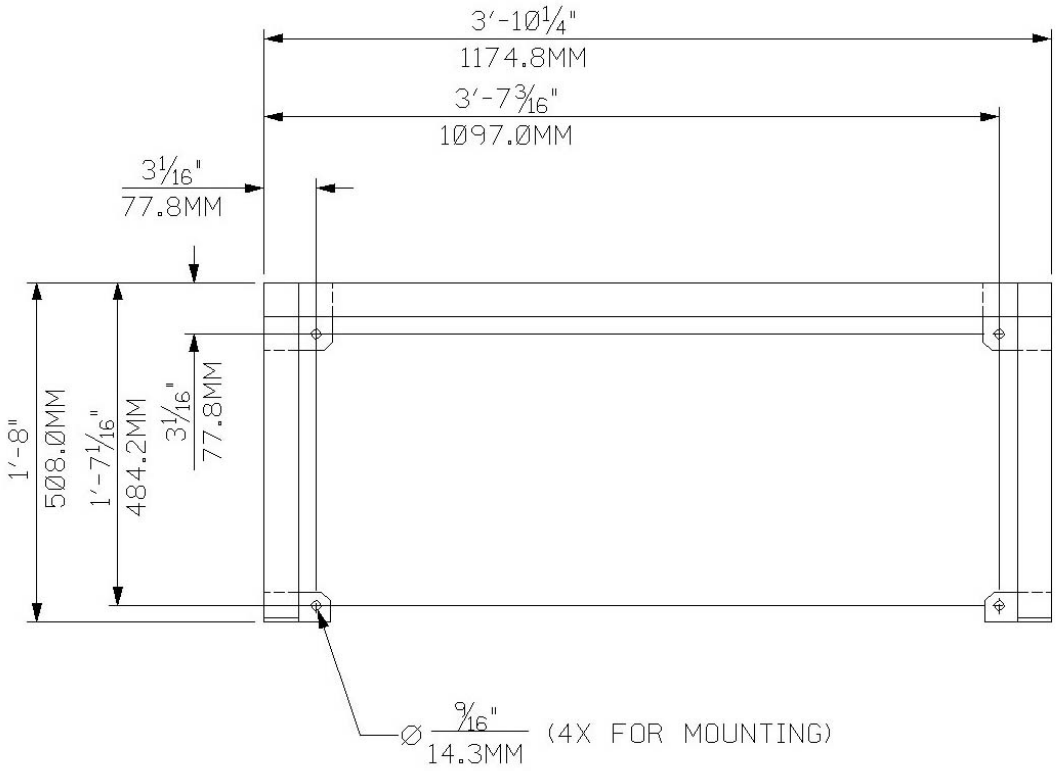


Figure 2.2.2.4: Mounting Hole Locations
1x2 Cylinder Rack or 1x2 Cylinder Euro (XH) Rack

Chapter 3

Tubing Connections

Section 13 Cylinder Cooling (Diborane Mixes)

Section 14 Hazardous Area / Potentially Flammable Atmosphere Requirements for Racks and Wallmounts

All tubing connections to the GASGUARD® Source System should be designed and installed following the 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 (Nickel-Chromium-Molybdenum Alloy) is sometimes specified by the customer for corrosive gases. Verify the tubing material type on the Specification Sheet that is supplied with the order.

All tubing connections are made at the top rear of the source 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

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
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
Optional vent:	1/4" (6.4 mm) diameter, 0.035" (0.9 mm) wall thickness

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

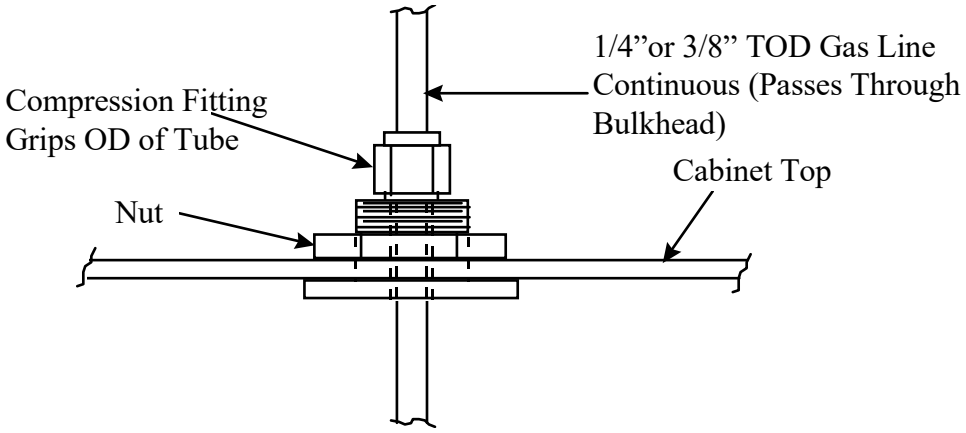


Figure 3.1: Standard Bulkhead

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.

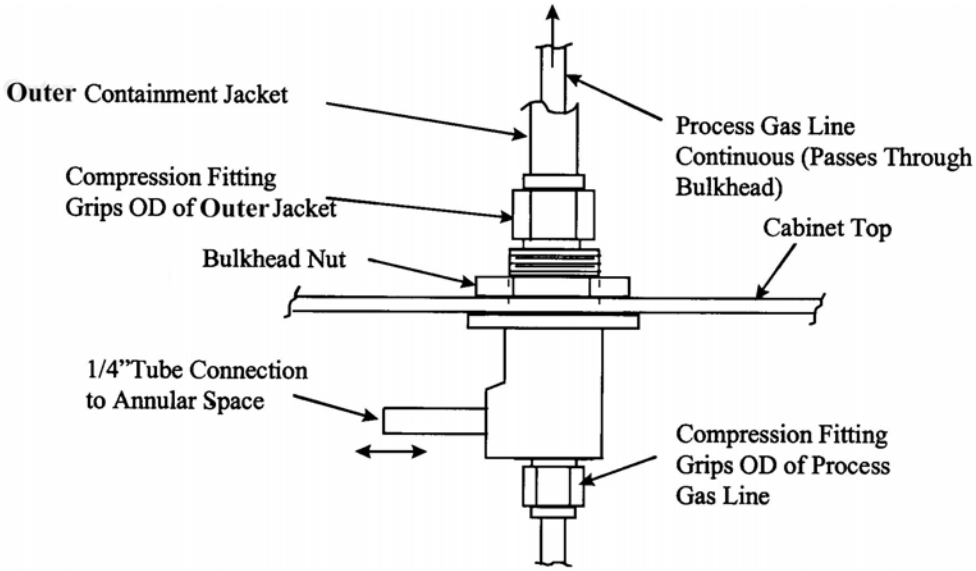


Figure 3.2: Coax Bulkhead

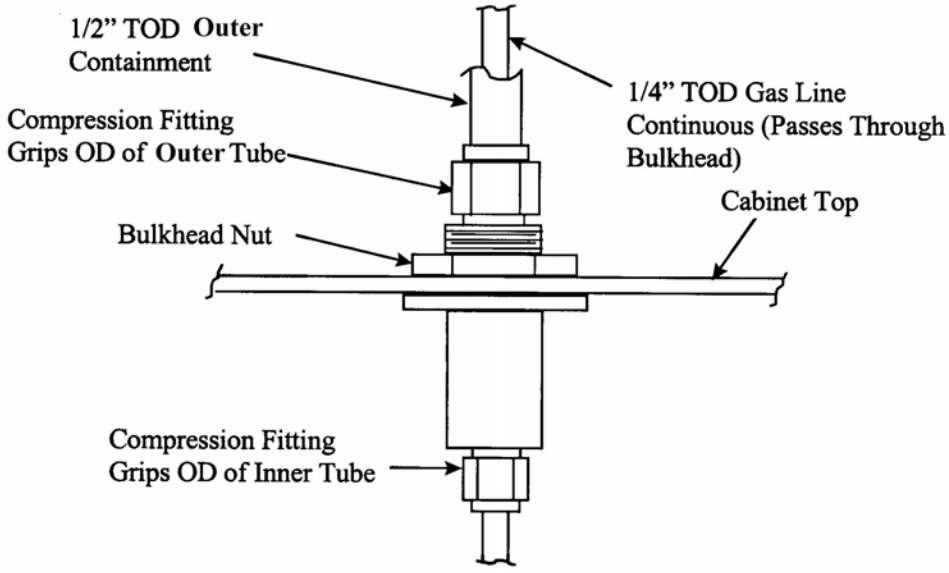
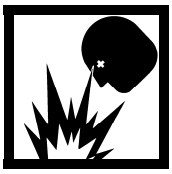


Figure 3.3: Dead End Coax Bulkhead

3.3 Vent Line

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 "Pre-Purge" purging cycle, when the process gas panel is being purged prior to process gas cylinder removal. At this time, 50-60 LPM (106-127 CFH) of nitrogen is also being sent into the line through the vacuum venturi loop. The purging sequences run approximately 30-45 minutes.

⚠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 an 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.

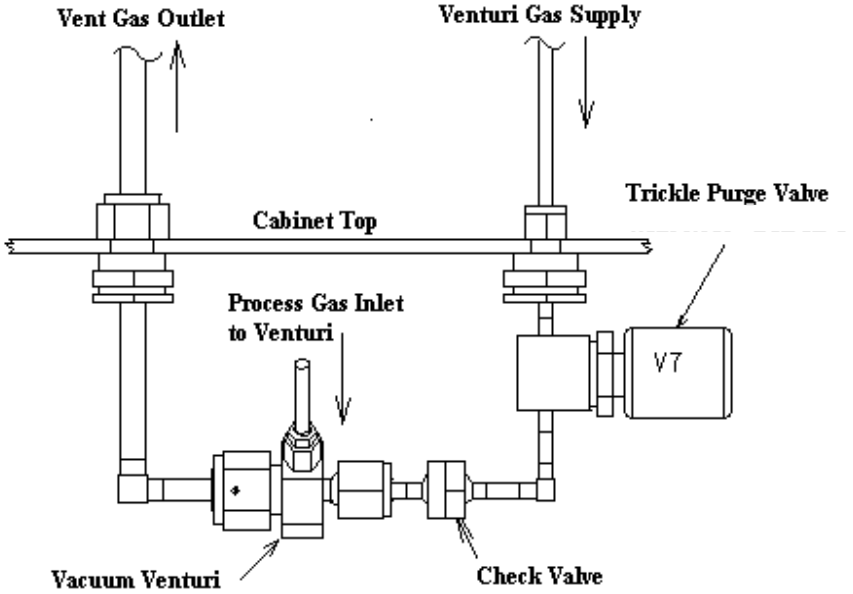


Figure 3.4: Typical Trickle Purge Assembly

3.4 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.

3.5 Purge Line

A purge line may be provided when the nitrogen purge cylinder is not included in the source system. This purge line must be connected to a designated purge source for the source system. The pressure required during cylinder purging is typically 80-90 psig (5.5-6.2 barg). If an external purge source is used, sufficient over pressure protection must be provided. Versum Materials, Inc. recommends a safety relief valve set at 125 psig (maximum) for the purge supply. Do not exceed the source system component maximum allowable working pressure (MAWP) in the event of purge source regulator failure. If an internal purge cylinder is included in the source system the purge line connection does not apply.

⚠CAUTION

The purge gas source for the GASGUARD® Source 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 nitrogen (or compressed clean dry air) source is required for this system for pneumatic valve operation. 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 ***source system*** disconnect.

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). This is in accordance with Article 496 of the National Fire Protection Agency (NFPA) regulations. 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.

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.

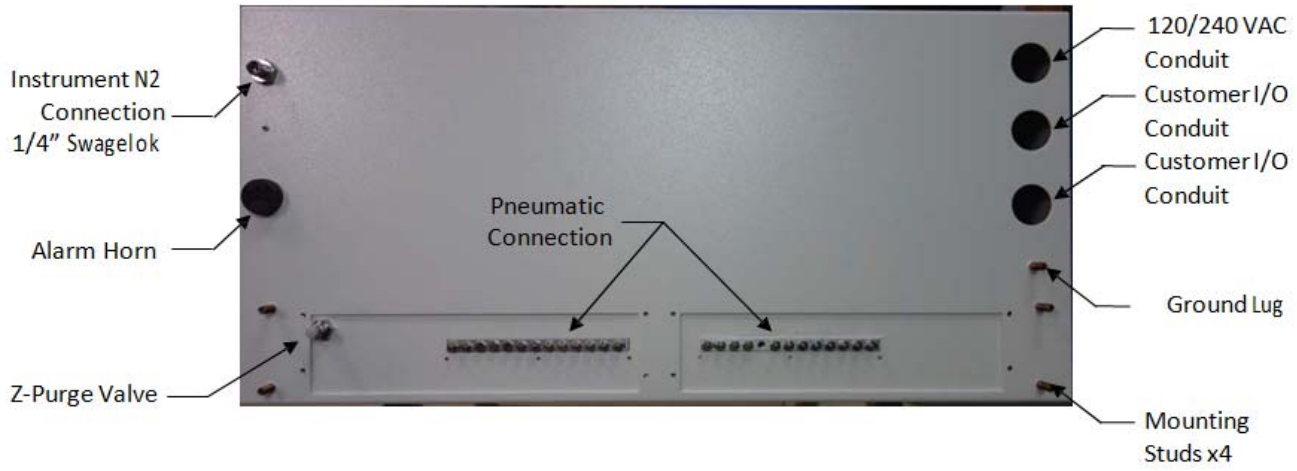


Figure 3.5: Rear View of GASGUARD® TE11 Controller

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 UFC (Uniform Fire Code) criteria (U.S.A. only) in HPM gas service, air velocity across the opened access hatch 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).

3. In order to meet UFC criteria (U.S.A. only) in Silane gas service, air velocity across all unwedded fittings and connections must meet the following velocity requirements to minimize potential pocketing of Silane gas: 200 feet per minute (61 meters per minute).

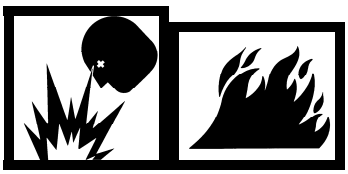
⚠WARNING

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

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

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

⚠WARNING



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 UFC and NFPA code requirements (U.S.A. only).

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

The features described below can be used to identify the enclosure type. ***The specific enclosure type (Standard or High Flow) can be verified on the Specification Sheet supplied with your order.***

Table 1

Minimum Exhaust Requirements for GASGUARD® High Flow Enclosures Containing Silane

	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)
1 CYLINDER	325	0.31	0.17	9.2	77	42	350	0.198	9.9	49
2 CYLINDER	475	0.54	0.37	13.5	134	92	490	0.390	13.9	97

Notes:
[1] All vent stack duct sizes are 6 inch (154 mm) diameter.
[2] "Access Hatch Closed" values have been measured at the exhaust stack duct and provide a minimum air velocity of 200 feet per minute (61 meters per minute) across cylinder connections and panel fittings.
[3] "Access Hatch Open" values have been measured while observing a minimum velocity of 200 feet per minute (61 meters per minute) across the access hatch opening.
[4] These recommended values assume that a 0.25 mm [0.010 inch] diameter restrictive flow orifice (RFO) is installed in the Silane source cylinder valve per US Code requirement.

Table 2

Exhaust Recommendations for GASGUARD® Equipment Containing Gases with a TLV ≥ 0.20 ppm (25% TLV ≥ 0.050 ppm)

	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 all GASGUARD® standard flow enclosures.

[4] All standard GAGGUARD® enclosures are sized for a 6 inch outer diameter (OD) duct connection to the vent stack. Refer to the system's Specification Sheet to determine the type of enclosure.

[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 taken from experimental results. Balancing to Tables 2 and 3 will meet or exceed UFC 80 face velocity requirements.

Table 3

Exhaust Recommendations for GASGUARD® Equipment Containing Gases with a TLV between 0.050 and 0.20 ppm (25% TLV: 0.0125 - 0.050 ppm) [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 all GASGUARD®standard flow enclosures.

[4] All standard GASGUARD® enclosures are sized for a 6 inch outer diameter (OD) duct connection to the vent stack. Refer to the system's Specification Sheet to determine the type of enclosure.

[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 taken from experimental results. Balancing to Tables 2 and 3 will meet or exceed UFC 80 face velocity requirements.

3.8 Sprinkler Installation

GASGUARD® Source System Cabinets, Wall Mounts and Racks can contain optional coated sprinkler head(s) with a trip point of 165° F (74° C). The sprinkler head is capable of flowing 32 GPM @ 31 psig (145 LPM @ 2.1 barg). The connection is a ½" FNPT. It is located on the ceiling of the enclosures and on racks the optional sprinkler is located on the controller shelf.

Figure 3.7 shows the sprinkler connection location for a 2 cylinder cabinet.

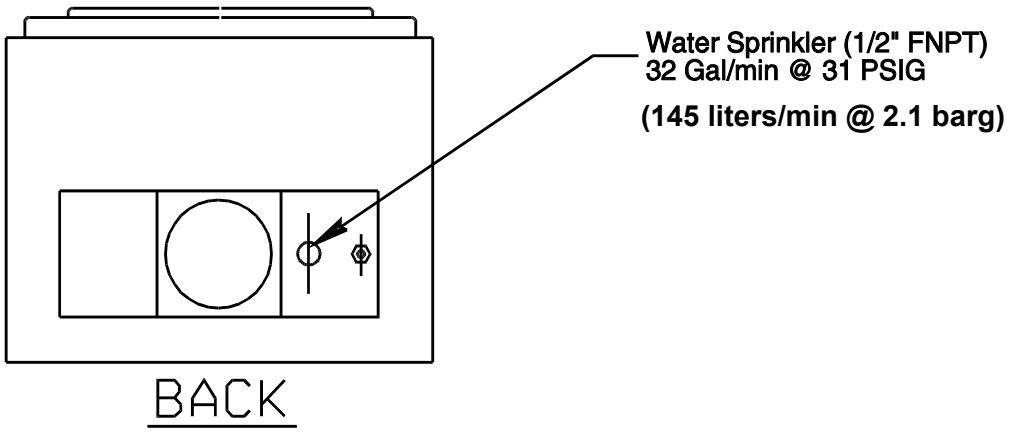


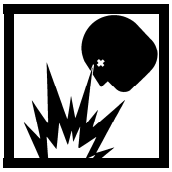
Figure 3.7: Sprinkler Connection Location

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. A manual valve, MV22, isolates the downstream vent system in order to achieve vacuums required for in-board leak testing upstream. When leak testing is complete, the VCR port must be capped and manual valve
MV22 should be opened and left open during normal operation of the GASGUARD® Source System.

⚠WARNING

The helium leak test 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 GASGUARD® cabinet. The detection points must include the interior of the gas cabinet. If a leak is detected, the system must provide signals that will shutdown the gas cabinet. See specific I/O field wiring drawings provided in the document envelope.

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.

3.11 Restrictive Flow Orifice (RFO) for Cylinder Valve (Customer Requirement)

A restrictive flow orifice (RFO) must be installed in the outlet valve of any cylinder containing a highly toxic gas or gas mix.

An RFO with a maximum orifice diameter of 0.010 inch (.254mm) must be installed in the outlet valve of any cylinder containing pure silane or mixes containing 2% or more of Silane.

In addition to the above requirements, systems that do not have an excess flow switch installed in the process piping line must have an RFO installed in the outlet valve of the cylinder, if the cylinder contains a toxic gas, flammable gas, toxic gas mix or flammable gas mix that is dispensed at pressure greater than 15 psi (1 bar).

Note: An EFS may be required by local code.

A restrictive flow orifice (RFO) may be used (at the customer's discretion) to reduce the hazardous exhaust treatment requirements, as an RFO will decrease the maximum potential leak rate from a full cylinder.

Do not operate equipment without a properly sized RFO installed in the cylinder valve.

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) 1993, 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.

Range of Environmental Conditions:

- 0 to 60° Interior Operating Temperature Range (Under Roof)

  -20 to 60° C Optional Outdoor Temperature Range

- 95% Maximum Relative Humidity, no Condensation

- 2000 Meters Above Sea Level, Maximum

- 100 to 240 VAC Nominal Voltage Range, 50 to 60 Hertz

- ± 10% Fluctuation of Nominal Voltage Range

4.1 Grounding Method

The equipment must be grounded in accordance with Article 250 – Grounding in the National Electrical Code 1993, if installed in the United States. The customer is responsible for connections to earth ground. A ground lug is supplied on the controller as well as the plenum of the gas cabinet for customer 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.

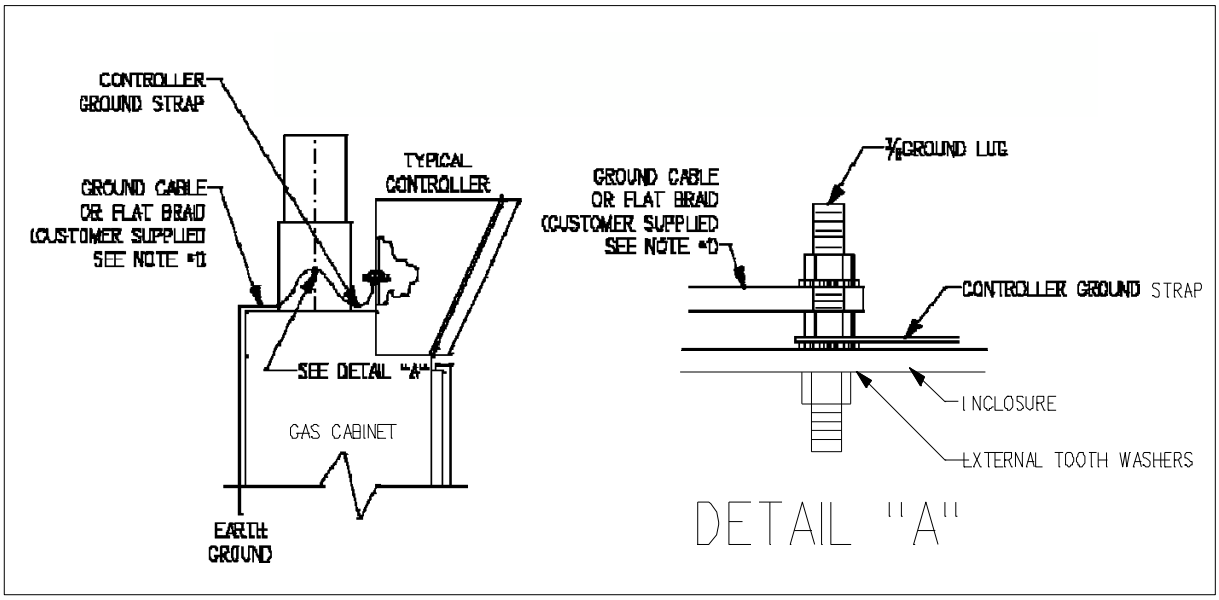


Figure 4.1: Suggested Grounding Method

Use #4 AWG ground wire for non EMI/FRI protected systems, installed in the United States. Use Alpha #1239, 1-3/8" flat braid or equivalent for EMI/FRI protected and CE marked systems. The total length is not to exceed 10 feet (3 meters).

After grounding the overall resistance must be measured. This resistance for the equipment ground to the grounding electrode cannot exceed one ohm (1Ω). Check the effectiveness of the grounding by attaching a wire to the nearest grounding electrode and connect an ohmmeter in between the reference ground wire and the enclosure.

For 1x1 and 1x2 cabinet configurations each cabinet requires grounding to the earth ground.

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 cabinet, and must have the on/off position clearly marked for the operator.

The power input must be wired to the terminals shown below. For additional detail on the power connection, see Figure 4.3.

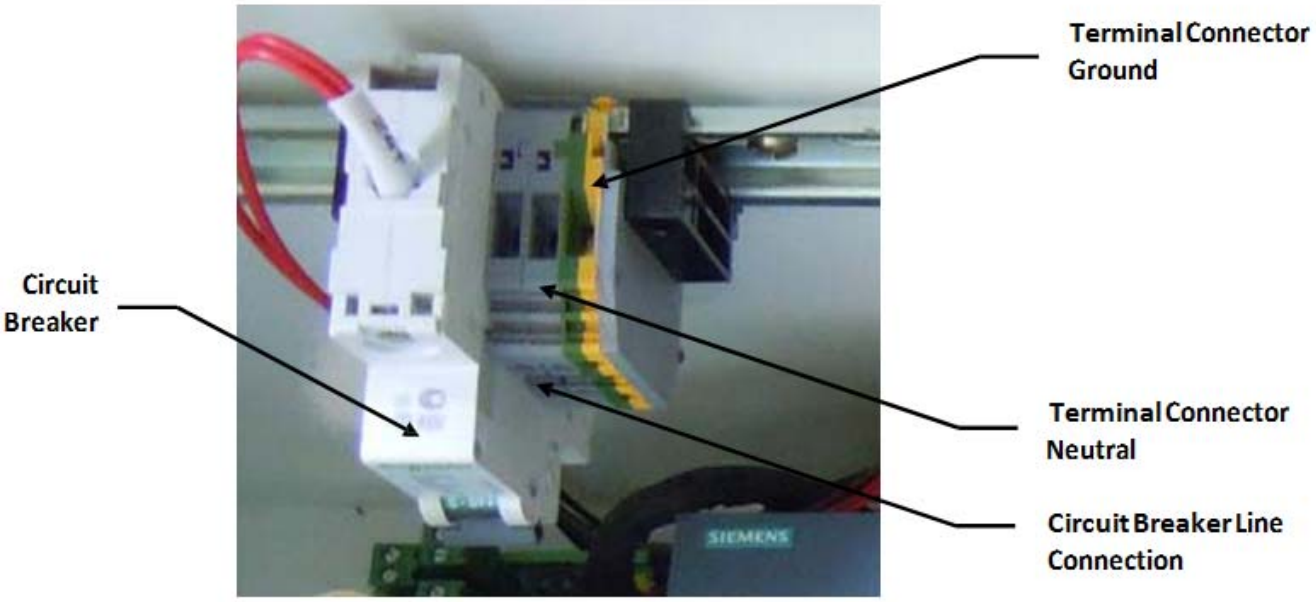


Figure 4.2: Inside View of GASGUARD® TE11 Controller

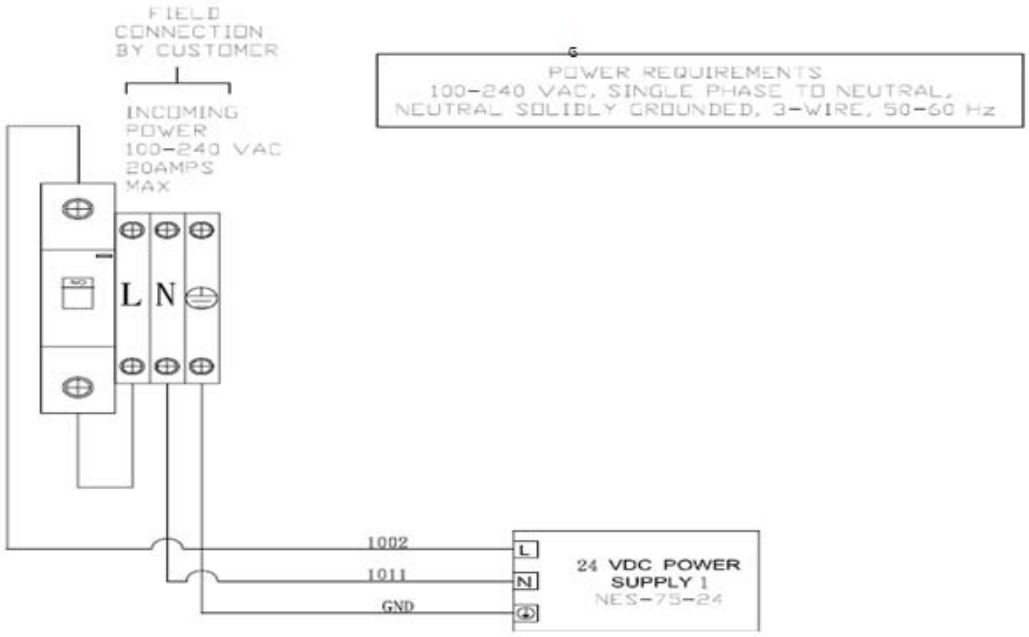


Figure 4.3: Power Supply Terminal Connector

The power requirements are as follows:

100-240 VAC @ 150 VA maximum.

Overvoltage protection: Recommended; may be required be local code

Sizing: 25% (minimum) over required load (add all cabinet loads and divide by 0.75)

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.***

4.3 Field Connections

In NEC Class 1, 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 cabinet and the electrical source. Liquid tight flexible conduit can be installed between the GASGUARD® TE11 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 cabinet connector. All conduits shall be sealed in accordance to Sections 501-5, 502-5 or 504-70 of the National Electric Code. See Figures 4.4 and 4.5 for details.

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

A 1-1/8” (28.6 mm) diameter hole for ¾” 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. See Figure 4.4 below.

Figure 4.4: Rear View of GASGUARD® TE11 Controller

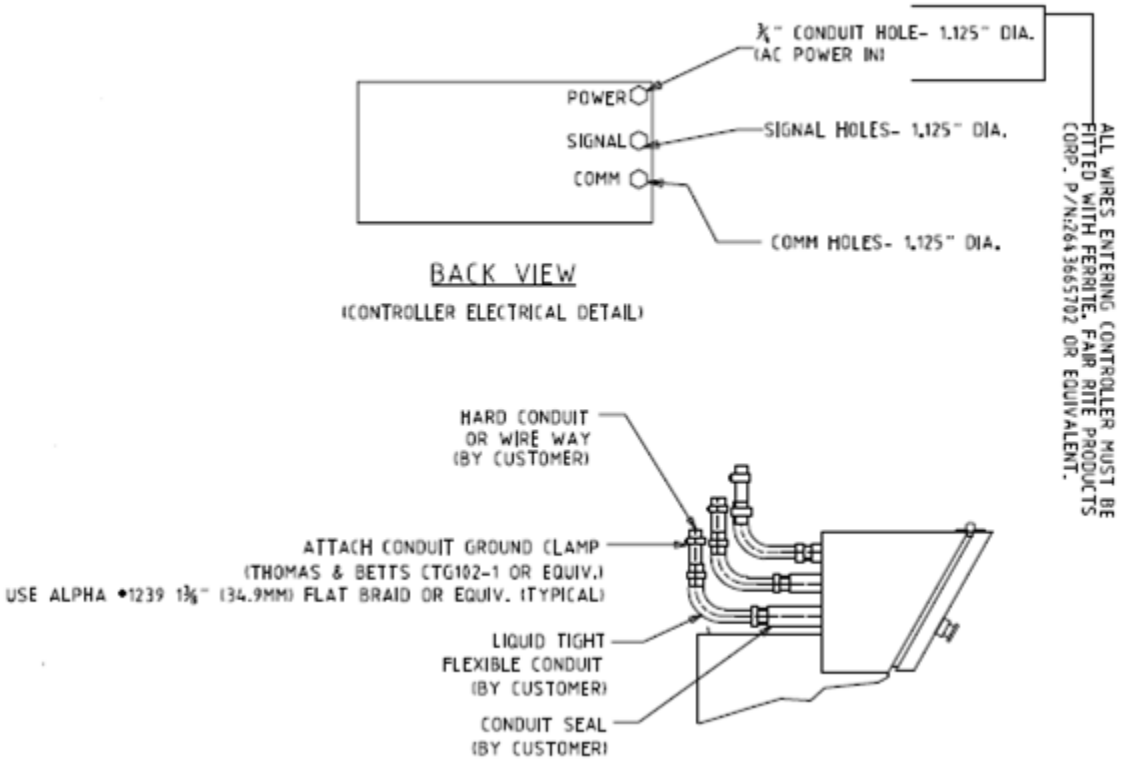


Figure 4.5: Conduit and Conduit Seals

4.4 External I/O Communication

Connections between the GASGUARD® TE11 controller and external I/O devices are made at the terminal blocks located inside the controller, on the back wall, left side. See Figure 4.6 for details on the location of the connections.

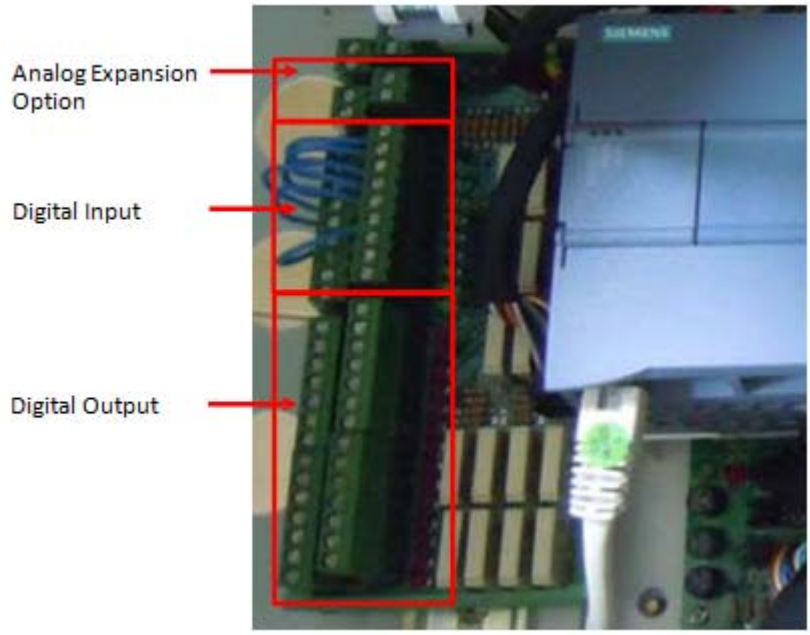


Figure 4.6: I/O Terminal Blocks

The tables on the following 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 Available External I/O Communications

Digital Outputs	Response
Gas unavailable	Notify process tool that gas is unavailable

Digital Inputs	Response
Process tool down	Prevent GASGUARD® System from flowing Process gas
Process gas leak	Shut down GASGUARD® System
Remote Shutdown	Shut down GASGUARD® System
Vent system unavailable	Prevents purge modes from starting
Emergency Stop	Hardwired Shutdown of GASGUARD® System; local reset required
Master Solenoid Permissive	Hardwired permissive for Master Solenoid; allows remote inhibit of master solenoid

Supervised Inputs	Response
Remote Shutdown	Shut Down 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-function vent system.

Digital Outputs Dry

CON3 24 VDC @ 1 Amp maximum

Relay Output #	Common CON3	NO CON3
K101 – Gas Avail Left	1	2
K102 – Gas Avail Right	3	4
K103 – Shutdown Alarm	5	6
K104 – Fault Alarm	7	8
K105 – UVIR Shutdown L	13	14
K106 – UVIR Shutdown R	15	16
K107 – UVIR Fault L	9	10
K108 – UVIR Fault R	11	12
K109 – BARCODE REP1	17	18

Digital Inputs

CON2

Digital Input #	Source CON2	Signal CON2
Remote Shutdown	1	2
Life Safety L	3	4
Life Safety R	5	6
Pre Purge	7	8
Change Cylinder	9	10

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® Source 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 TE11controller uses:

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

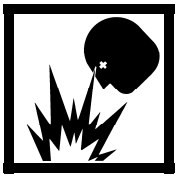
NOTE: It is recommended that the internal GASGUARD® Source System tubing, which was helium leak tested at the factory, be rechecked at this time to ensure no leaks have developed during installation or shipment. Consult Versum Materials, Inc. for proper helium leak detection procedures.

In order to adequately leak test the GASGUARD® Source System internal and external piping, the pneumatic emergency shutoff and auto-crossover 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® Source 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 (see Chapter 3 Section 6) and the Electrical Power Supply Connection (see Chapter 4 Section 2) installation must be completed.

How to Perform Helium Leak Checking in Manual Mode

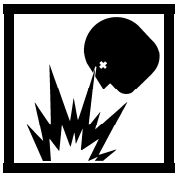
⚠WARNING



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 process gas cylinders should be connected at this time. If one is or was connected, do not continue, 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® Source 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: Some shutdown alarms (indicated by the red SHUTDOWN INDICATOR on the top left of the screen being lit) will not allow you to access and open valves in manual mode, therefore making a leak test invalid. Manual mode availability is shown in the mode menu. If a shutdown alarm is present, contact an 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:

   Press touch screen.

   The LCD screen will prompt: “PASSWORD”

   Type in the password.

   Press “OK”

   It the password is correct, the Main Menu will be displayed. If the password is incorrect, “**The password window will display “BLUE” color and Invalid Password at bottom of window **” will be displayed.

2. From the Mode Menu screen, highlight “MANUAL MODE” by pressing Manual Mode button (if the button is red and displays N/A a shutdown has occurred that prevents manual operation)

   2.1 A legend, located on the graphics panel indicates:

   TE11 Color controller: Green – valve closed (Default)

   Red - valve open (Default)

3. Follow the procedures below to open and close valves. (Valves that can be controlled manually are shown highlighted with a square box around them).

   To open a valve:

   3.1 Select the valve by touching the screen.

   3.2 The valve state menu will appear asking you to confirm that you want to open the Valve by pressing “Open Valve”. Pressing “Secure Mode” will close the menu leaving the valve closed.

   To close a valve:

   3.3 Touch the valve you wish to close.

   3.4 The valve state will toggle from open to close.

⚠CAUTION

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

4. When leak testing is complete, press Cancel to return to the Mode Menu.

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

⚠CAUTION

Source System must not be left unattended in Manual Mode, as access to the system in Manual Mode is open to anyone. See Chapter 8 Section 5 on information on securing manual mode before leaving your gas cabinet.

Chapter 6

Functional Checklist

Section 1 **Source System Utility Checklist**

Section 2 **Source System Field Start-Up Checklist**

After all connections have been made and installation of the gas source system is complete, the appropriate Versum Materials, Inc. Representative should be contacted to schedule the final on-site gas source system 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 gas source systems are functioning properly and all programmed sequences are operational.

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

6.1 Source System Utility Checklist

_____ 1. Cabinet located and mounted to floor (see Chapter 2).

_____ 2. Cabinet exhaust duct installed, functioning and monitored for loss of exhaust (see Chapter 3 Section 7).

_____ 3. Sprinkler line installed (if applicable) and pressurized (see Chapter 3 Section 8).

_____ 4. Grounding wire installed (cabinet and controller) and checked for less than 1 ohm resistance (see Chapter 4 Section 1).

_____ 5. Electrical power (120/240 VAC, 50/60 Hz) connected (see Chapter 4 Section 2).

_____ 6. Remote I/O wiring installed and checked (see Chapter 4 Section 4).

_____ 7. GASGUARD® Network wiring installed (if applicable) and configured on the host (see Chapter 4 Sections 5 and 6).

_____ 8. Process line installed and helium leak tested (see Chapter 3 Section 2).

_____ 9. Vent line installed and helium leak tested (see Chapter 3 Section 3).

_____ 10. Venturi line installed, leak tested and 75-95 psig (5.2-6.6 barg) of nitrogen available (see Chapter 3 Section 4).

_____ 11. Purge line installed and helium leak tested (see Chapter 3 Section 5). (If external purge cylinder utilized.)

_____ 12. Pneumatic supply connected to controller and 85-95 psig max. (5.9-6.6 barg) of nitrogen available (see Chapter 3 Section 6).

_____ 13. Source System internal piping helium leak tested (see Chapter 5).

_____ 14. Purge cylinder available.

_____ 15. Hazardous gas monitor installed and operating.

_____ 16. Properly sized RFO installed in process cylinder valve (see Chapter 3 Section 11).

Inspection Sign-Offs

Electrical

Mechanical

Quality

Safety

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

6.2 VERSUM MATERIALS, INC. TE11 SOURCE SYSTEM FIELD START-UP CHECKLIST page 1 of 9

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**	
	Left side or single	**Right side**
Perform visual inspection to verify all mechanical and electrical connections have been made.		
System labeled correctly per Specification Sheet.		
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 gas bottle to P.O.U. complete		
Verify corrosive or toxic scrubber and incinerator operational and running		
Pitot tube installed with correct 90° orientation		
Sprinkler line installed (except ClF3)		
Tel tails installed		
Verify cabinet exhaust is functioning		
Panel under pressure 20 psig $\geq \leq$ 25 psig (1.4 barg $\geq \leq$ 1.7 barg)		
Correct process purifier installed per gas service		

Cylinder conn. seating surface condition acceptable		
Verify and record cylinder orifice size (see Chapter 3 Section 11 and warnings Chapter 8 Section 3)		

VERSUM MATERIALS, INC. TE11 SOURCE SYSTEM FIELD START-UP CHECKLIST page 2 of 9

PIPING/MECHANICAL (cont.) **Check off line item when completed** **Sign and date when section completed**		
	Left side or single	**Right side**
Shelf kit installed and adjusted		
Cyl. Chains / Cyl. Straps (circle)		
Trickle purge gasket installed		
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		
Gas detection system operational		
Secondary containment installed		
Process Gas cylinder has proper size RFO installed		
Pneumatics for cylinder valve operator, Or CGA Cylinder Indicator installed		
Verify and record flow switch rating	See Quality Inspection and Test Sheet	
High pressure flow switch rating		
Low pressure flow switch rating		

SECTION COMPLETED SIGNATURE_____ DATE _____

Notes: _____

VERSUM MATERIALS, INC. TE11 SOURCE SYSTEM FIELD START-UP CHECKLIST page 3 of 9

ELECTRICAL	**Check off line item when completed** **Sign and date when section is completed**	
	Left side or single	**Right side**
Earth ground installed		
120v/220v/24v electrical complete (circle)		
Graphics panel condition satisfactory		
Elect. sealoffs poured		
I/O wired per DWG # EE-_____		
VERSUM MATERIALS, INC. supplied temperature		
Verify temperature control power		
Verify heat tape power		
	Jacket temp._____	Jacket temp._____
	Set point _____	Set point _____

SECTION COMPLETED SIGNATURE_____ DATE _____

Notes: _____

VERSUM MATERIALS, INC. TE11 SOURCE SYSTEM FIELD START-UP CHECKLIST page 4 of 9

CONTROLLER	Left side or single	Right side
Seat all cable connections and verify mounting of components on DIN rails.		
E-stop guard in place		
Remove pneumatic bulkheads from the back of the controller.		
Do all valves operate		
Manual mode operation		
No audible solenoid leaks		
Re-install pneumatic bulkheads from the back of the controller.		
Firmware Versions:		
PLC		
HMI		
Network		
Configuration File Rev.		
External Shutdown wired		
Supervisory circuit utilized		
Correct program loaded / version		
Program name and date		
Life safety system utilized (yes / no)		
Verify device addressing indicated on the controller		
Source system name		
Profibus Address		
IP Address (Ethernet Only)		
IP subnet Mask (Ethernet Only)		
Default Gateway (Ethernet Only)		
Source system communicating with network		
Controller door adjustment		
Z-purge set @ ≧0.1" H20 (24.9 Pa)		

SECTION COMPLETED SIGNATURE_____DATE _____

VERSUM MATERIALS, INC. TE11 SOURCE SYSTEM FIELD START-UP CHECKLIST page 5 of 9

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	**Left side or single**					**Right side**				
	(Left/right)	Zero	Zero	Span	Span	Completed	Zero	Zero	Span	Span	Complete
		before	after	before	after		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. TE11 SOURCE SYSTEM FIELD START-UP CHECKLIST page 6 of 9

FUNCTIONAL TEST - DIGITAL ALARMS			
Record label from software documentation. Record, verify and test the digital alarms and the hardwire shutdowns.			
Digital In #	Label	Hardwire SD loc.	Checked
I0.0	Remote Shutdown L	X	
I0.1	Remote Shutdown R		
I0.2	Emergency Stop	X	
I0,3	Control Box Z-Purge		
I0,4	Low Pneumatics		
I0.5	Excess Flow LP L		
I0.6	Excess Flow LP R		
I0.7	Low Exhaust L		
I1.0	UVIR Fault L		
I1.1	High Temperature L		
I1.2	Flame Detect L	X	
I1.3	Flame Verify L		
I1.4	Life Safety L		
I1.5	UVIR Fault R		
I8.0	High Temperature R		
I8.1	Low Exhaust R		
I8.2	Flame Detect R	X	
I8.3	Flame Verify R		
I8.4	Life Safety R		
I8.5	Pre Purge (Option)		
I8.6	Change Cylinder (Option)		
I8.7	Barcode-1		
I9.0	Barcode-2		
I9.1	Barcode-3		
I9.2	MV9 DI L		
I9.3	MV9 DI R		
I9.4	Spare		
I9.5	Spare		
I9.6	Spare		
I9.7	Spare		

CONTINUED ON NEXT PAGE:

VERSUM MATERIALS, INC. TE11 SOURCE SYSTEM FIELD START-UP CHECKLIST page 7 of 9

FUNCTIONAL TEST - RELAY OUTPUTS		**Check off line item when completed** **Sign and date when section is completed**
Q0.0	HRDW MSTR RES	
Q0.1	FAULT LED	
Q0.2	SHUTDOWN LED	
Q0.3	GAS FLOW LED	
Q0.4	HORN	
Q0.5	MSTRSOL PERM	
Q0.6	GAS UNAVAIL L	
Q0.7	GAS UNAVAIL R	
Q1.0	SHUTDOWN ALARM	
Q1.1	FAULT ALARM	

SECTION COMPLETED SIGNATURE_____**DATE** _____

NOTES: _____

_____

FUNCTIONAL TEST-USER SET POINTS (cont.)			**Check off line item when completed** **Sign and date when section is completed**			
			Left side or single		**Right side**	
User Alarm set points listed and verified						
	Left side or single			**Right side**		
List changes in this column	Alarm #	Label	Setpoint	Alarm #	Label	Setpoint

SECTION COMPLETED SIGNATURE_____DATE _____

NOTES: _____

VERSUM MATERIALS, INC. TE11 SOURCE SYSTEM FIELD START-UP CHECKLIST page 8 of 9

FUNCTIONAL TEST- PROGRAM MODES	**Check off line item when completed Sign and date when section is completed**	
	Left side or single	**Right side**
Source system programs		
Process		
Pre-purge		
Change cylinder		
Post purge		
After post purge, verify low pressure portion of the panel is in vacuum state from the decay		
Crossover signal tested		
Crossover line purge lockout tested		
Low process delivery		
Process response for very low purge		
Test shutdowns for process line and aux purge while other side is in gas to tool		

SECTION COMPLETED SIGNATURE_____DATE _____

Notes:

_____

FUNCTIONAL TEST - FILE VERIFICATION	**Check off line item when completed Sign and date when section is completed**	
	Left side or single	**Right side**
Verify purge parameters per software documentation		
Verify alarm conditions per software documentation		
Verify VERSUM MATERIALS, INC. set points per		
Source 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 _____

VERSUM MATERIALS, INC. TE11 SOURCE SYSTEM FIELD START-UP CHECKLIST page 9 of 9

Comments_____

I have received and understood training on the operation of this Source System on the date given below.

_____ _____

Name Date

Gas service to CGA and DISS fitting cross-reference			
Appendix A			
Gas	**Gas abbreviation**	**CGA fitting**	**DISS fitting**
AMMONIA	NH3	660	720
ARGON	AR	580	718
ARSINE	ASH3	350	632
BORON TRICHLORIDE	BCL3	660	634
BORON TRIFLUORIDE	B11F3	330	642
CARBON DIOXIDE	CO2	320	716
CHLORINE	CL2	660	634/724
DIBORANE MIXES	B2H6	350	632
DICHLOROSILANE	DCS	678	636
DISILANE	SI2H6	350	632
HALOCARBON-116	C2F6	660	716
HALOCARBON-12	CCL2F2	660	716
HALOCARBON-14	CF4	580	716
HALOCARBON-23	CHF3	660	716
HELIUM	HE	580	718
HYDROGEN	H2	350	724
HYDROGEN BROMIDE	HBR	330	634
HYDROGEN CHLORIDE	HCL	330	634
HYDROGEN SULFIDE	H2S	330	722
NITROGEN	N2	580	718
NITROGEN TRIFLUORIDE	NF3	330	640
NITROUS OXIDE	N20	326	712
OXYGEN	O2	540	714
PERFLUOROPROPANE	C3F8	660	716
PHOSPHINE	PH3	350	632
SILANE	SIH4	350	632

SILICON TETRACHLORIDE	SICL4		636
SILICON TETRAFLUORIDE	SIF4	330	642
SULFUR HEXAFLUORIDE	SF6	580	716
TUNGSTEN HEXAFLUORIDE	WF6	670	638

Chapter 7

System Description

The GASGUARD® Source Systems typically consist of a gas cabinet (except for wall-mounted or rack-mounted systems), a controller, a process gas panel, and an inert purge gas panel.

Some GASGUARD® systems can be configured to provide continuous gas service, without interruption from a depleted cylinder. These systems are called auto switch-over, because process gas is automatically switched from a panel supplying gas from a depleted cylinder, to a panel that can supply gas from a full cylinder. The minimum hardware requirements to operate in auto switchover mode are:

- One dual controller, and
- Two process gas panels sharing process outlet piping

GASGUARD® Systems are designed and built for the safe storage and handling of high purity toxic, flammable, pyrophoric, corrosive, oxidizing, and reactive cylinder gases. GASGUARD® 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 Gas Cabinet

The function of the GASGUARD® Cabinet is to ensure a safe environment for personnel during cylinder changes or in the unlikely event of a hazardous gas leak. The cabinet must be connected to a properly designed exhaust system that is continuously operated in order to provide a safe environment.

The cabinet provides the secondary containment for any leak from the hazardous gas cylinder, cylinder connection and pigtail, and the process panel. The exhaust system continuously removes any leaking hazardous gas from the cabinet to a safe disposal system.

The GASGUARD® enclosure is constructed of 12 gage (0.004 mm) steel with fully welded seams and protected with corrosion resistant polyurethane paint. Enclosure sizes are available to hold from one to three cylinders. One or more exhaust stacks are provided for connection to the customer's exhaust system.

The Enclosure has 12 gage (0.004 mm) steel doors with windows constructed of 1/4" thick (6.4 mm) wire reinforced safety glass. A temperature activated (165°F / 74°C) sprinkler head is provided, in accordance with Article 51 of the UFC. Formed brackets are mounted inside of the cabinet to securely hold each cylinder. There is a weight scale option for use with cylinders containing liquefied gases.

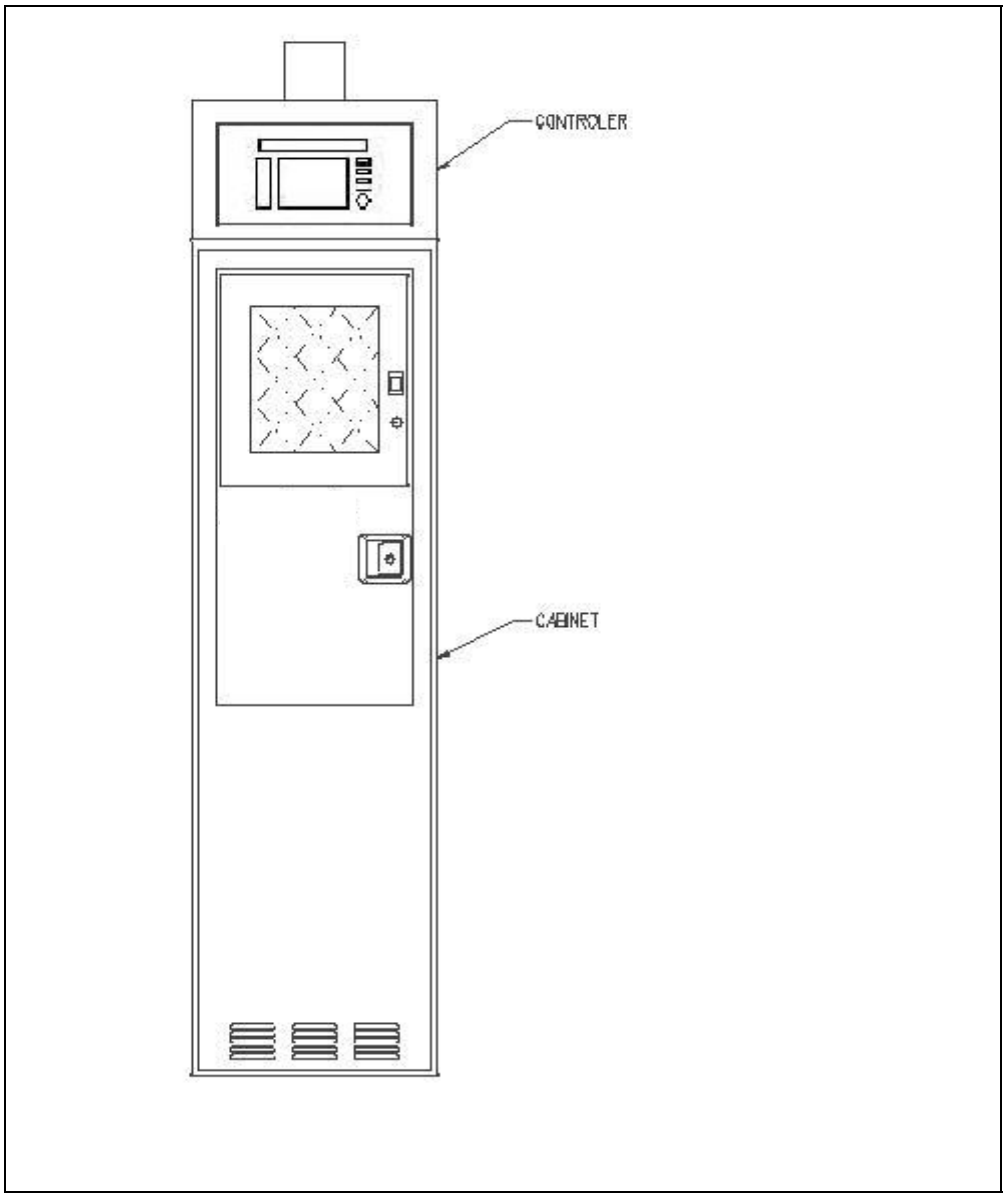


Figure 7.1: GASGUARD® cabinet

7.2 Rack System

A Rack System is a free-standing open platform for inert and Silane gas handling systems. Its design will accommodate process and purge panels, gas cylinders and a controller. No exhaust hook-up is required.

The use of a rack system for Silane distribution is the preferred alternative to gas cabinets that minimizes the potential for Silane pocketing and subsequent explosion.

NFPA 318 and UFC 80-1 lend insight into open rack design. In addition any local building codes need to be followed when considering the use of a rack system.

A typical rack system is shown in Figure 7.2.

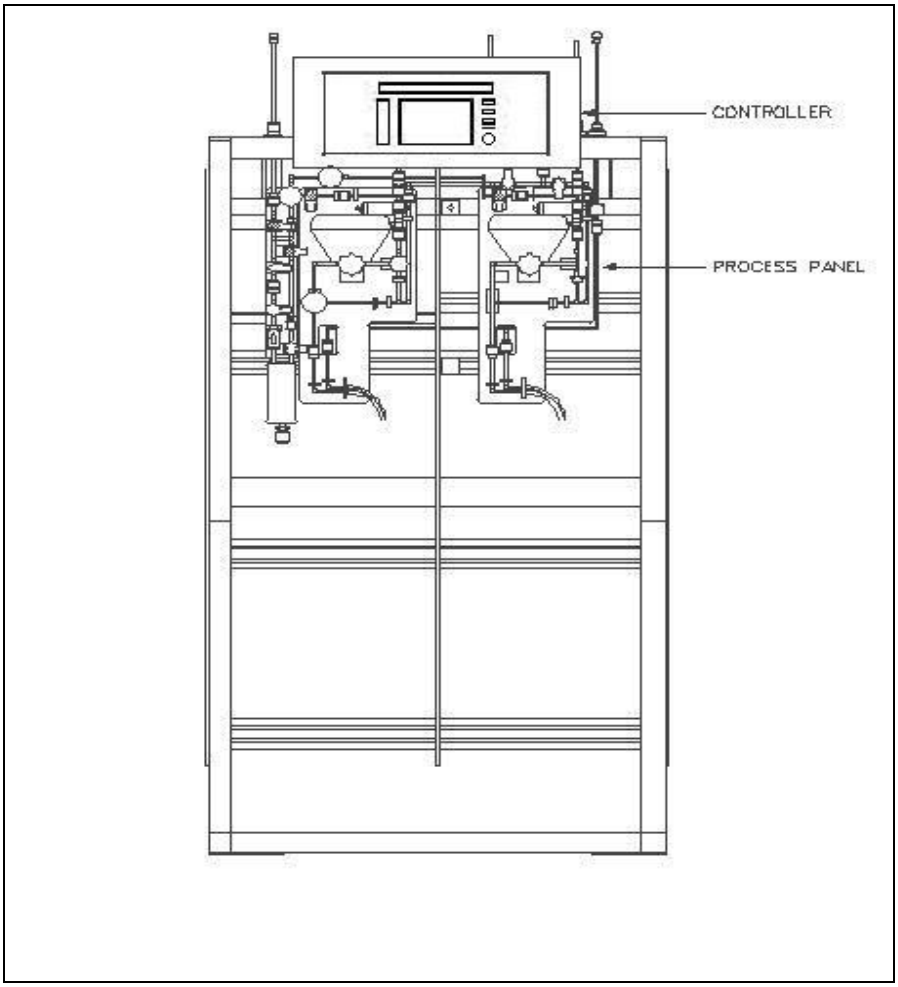


Figure 7.2: Typical Rack System

7.3 Auto Switchover System

For automatic switchover to occur, both cylinders must be placed into a "PROCESS GAS FLOW" mode. Whichever cylinder is started first will begin flow, the other cylinder will wait in a "standby" state until the cylinder flowing gas is stopped by a “VERY LOW DELIVERY PRESSURE”, “VERY LOW CYLINDER PRESSURE”, or “VERY LOW CYLINDER WEIGHT” alarm. If a global related shutdown alarm arises, both cylinders will return to the "IDLE" mode and all pneumatic valves will close.

Minimum hardware requirements for the automatic switchover system is one dual GASGUARD® TE11 controller, and two process gas panels sharing the process out piping. Chapter 7 Section 2 on page 7-4 depicts a two cylinder low pressure auto switchover system. Process gas switchover between right and left cylinders is initiated by a very low delivery pressure, a very low process gas cylinder pressure or weight (on liquid cylinders). This switchover set point is set and entered by the customer.

After an automatic switchover has occurred, the low process cylinder can be purged for a cylinder change while the other cylinder is flowing gas. This cycle is called "PRE-PURGE". When the automated pre-purge cycles are completed, the "CHANGE CYLINDER" mode must be selected. The cylinder can physically be removed and replaced during this time. During a cylinder change-out procedure, sufficient Personal Protective Equipment (PPE) must be worn assuming hazardous process gas is still present in the pigtail line. See Chapter 1 Section 9 for details on PPE.

With a new cylinder in place, the next step would be "POST-PURGE". Any air which may have entered the pigtail and valve connection during change out is removed during these purging cycles. When post-purge is complete, the cylinder can be put into the "PROCESS GAS FLOW" mode again, which will now place it into standby until the other cylinder is stopped.

7.4 Hazardous Gas Panel

The Gas Panel consists of pneumatic valves, manual valves, pressure transducers, pressure regulators, check valves, relief valves and various safety/purity components that perform the following functions:

- Regulate cylinder pressure to the process tool working pressure.
- Remove hazardous material, if present, from the panel prior to changing the process cylinder.
- Provide immediate shut-off in a hazardous situation using fail-safe pneumatic valves.
- Maintain process tubing purity during process cylinder change.

Pneumatic valves are 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. Check 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.

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 use Cajon VCR fittings or equivalent. The panels are connected to the gas cylinder by a stainless steel pigtail and a CGA, DISS, or keyed VCR fitting, in the United States, (BS, DIN, AFNOR, INI in Europe, JIS in Asia) that is defined specifically for each type of gas. A flow restricting orifice is sometimes installed in the cylinder valve to minimize hazardous gas flow. Excess flow sensors may be installed on certain systems.

7.5 Inert Gas Purge Panel

This panel controls the pressure and flow of purge gas to the hazardous gas panel during the purge sequence and cylinder change-out procedure. The panel is constructed using similar materials and techniques as the hazardous gas panel. In addition, a safety relief valve located on the purge panel is used to prevent overpressure of the inert gas purge system, and the process panel.

7.6 Panel Schematic and Component Descriptions

Figure 7.3 is a flow schematic of a typical GASGUARD® TE11 Process/Process/Purge Auto Crossover Source System.

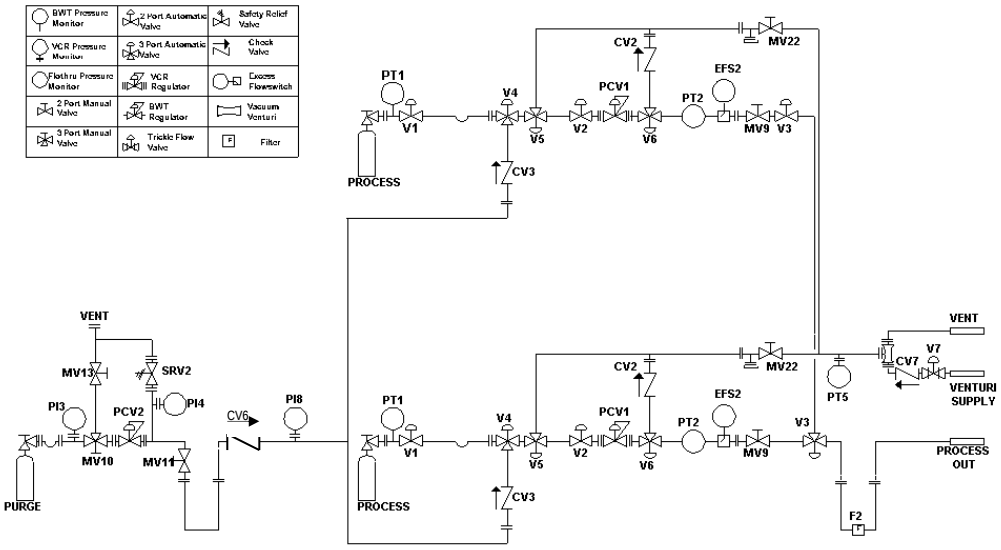


Figure 7.3: Process/Process/Purge Auto Crossover Source System Schematic

The function of each component is described in the table.

V0 **Process Cylinder Valve (Customer Supplied)**
This valve located on the process cylinder controls process gas flow from the cylinder to the pigtail. If the valve is pneumatically operated, it will automatically close on shutdown alarms. Solenoid valve, V8, in the controller is used to supply the pneumatic cylinder valve (if present).

V2 **Automatic Shutoff Valve (On Pigtail)**
This pneumatic valve is located on the pigtail, close to the process gas cylinder. Its primary function is to stop the flow of process gas when a shutdown alarm occurs or the E-Stop button is pressed.

V2 **High-Pressure Process Isolation Valve**
This pneumatic vale isolates the pressure regulator and downstream components from the high pressure process gas.

V3 **Low-Pressure Process Isolation Valve**
This pneumatic valve isolates the gas cabinet piping from the facility process piping.

V4 **Purge Gas Inlet Valve**
This pneumatic valve controls the on/off flow of purge gas to the high pressure side of the process panel and pigtail.

V4-1 **Purge Gas Inlet Double Isolation Valve**
This pneumatic valve provides double isolation function for V-4.

V5 **High Pressure Vent Valve**
This pneumatic valve controls flow from the high pressure side of the panel to vent/vacuum system.

V6 **Low-Pressure Vent Valve**
This pneumatic valve controls flow from the low pressure side of the panel to vent/vacuum system.

V7 **Vacuum Venturi Supply Valve**

This pneumatic valve controls house nitrogen flow to the vacuum venturi, where vacuum is created and used to evacuate the process piping during purge sequences.

PT1 **Process Cylinder Pressure Transducer**
This transducer monitors process gas pressure at the cylinder outlet. It is also used to check pressures during purge cycles.

PT2 **Process Delivery Pressure Transducer**
This transducer monitors process gas delivery pressure at the outlet side of the process regulator.

PT3 **Purge Cylinder Pressure Transducer**
This transducer monitors pressure of the purge gas at the cylinder outlet.

PT4 **Purge Delivery Pressure Transducer**
This transducer monitors purge gas delivery pressure at the outlet side of the purge regulator.

PT5 **Vent Line Pressure Transducer**
This transducer monitors vacuum pressure in the vent piping created by the vacuum venturi.

PT8 **Purge Line Pressure Transducer (Optional)**
This transducer monitors pressure in the purge header downstream of the purge purifier.

PT9 **House Line Pressure Transducer (Optional)**

PT11 **Monitoring V4 Valve Leakage Pressure Transducer (Optional)**
This transducer monitors pressure for the V4 pneumatic valve downstream of the purge line.

MV9 **Process Line Isolation Valve (Optional)**
This manual valve isolates the facility process piping and downstream equipment from the low pressure process gas supply. When closed, along with V3, it provides double block isolation of the process panel from the facility process piping.

MV11 **Low Pressure Purge Gas Isolation Valve (Optional)**

This manual valve isolates the purge gas pressure regulator from components.

MV12 **Purge Gas Purifier Isolation Valve (Optional)**
This manual valve isolates the purge gas purifier from the process panel piping.

MV13 **Purge Gas Vent Valve**
This manual valve is used to remove air from the high pressure purge piping after purge cylinder installation.

MV14 **Process Purifier Isolation Valve (Optional)**
This manual valve isolates the process purifier inlet from process gas.

MV15 **Process Purifier Bypass Valve (Optional)**
This manual valve allows process, purge or test gases to bypass the process purifier when open. It is used in conjunction with MV14 and MV16. It should be closed during normal process gas flow.

MV16 **Process Purifier Isolation Valve (Optional)**
This manual valve isolates the process purifier outlet from process gas.

MV17 **Process Purifier Inlet Valve (Optional)**
This manual valve isolates the process purifier when removed from the system.

MV18 **Process Purifier Outlet Valve (Optional)**
This manual valve isolates the process purifier when removed from the system.

MV19 **Purge Purifier Inlet Valve (Optional)**
This manual valve isolates the purge gas purifier when removed from the system.

MV22 **Vent Isolation Valve**
This manual valve isolates the vacuum venturi piping from the vent piping on each process panel, in a dual process panel system. It is also used to isolate the vacuum venture piping from an optional helium leak test port in the high pressure vent downstream of V5. The valve should be left open except when performing a helium leak test.

MV29 **Process Outlet Isolation Valve (Optional)**
When a system has more than one process outlet, this manual valve(s) isolates the process outlet gas line from the facility process piping.

⚠CAUTION

Prior to initiating a Main Menu sequence, ensure these valves are in the proper configuration for the task to be performed.

MV30 **Leak Test Isolation Valve (Optional)**
This manual valve isolates a leak test port (typically a VCR connection) from the process panel.

MV33 **Weld Gas Inlet Valve (Optional)**
This manual valve is used to supply weld gas to the process line during installation.

PCV1 **Process Gas Pressure Regulator**
This regulator controls process gas delivery pressure.

PCV2 **Purge Gas Pressure Regulator**
This regulator controls purge gas delivery pressure.

CV1 **High Pressure Process Vent Check Valve**
This check valve prevents back-flow of vent gases is V5 is improperly opened.

CV2 **Low Pressure Process Vent Check Valve**
This check valve prevents bypass of high pressure process gas around PCV1. CV2 also prevents back-flow of vent gases if V6 is improperly opened.

CV3 **Purge Gas Supply Check Valve**
This check valve prevents back-flow of process gas into the purge gas line.

CV4 **Purge Gas Supply Check Valve (Optional)**
This check valve is installed to protect the purge gas purifier. It must also be installed in conjunction with PT8.

CV5 **Vacuum Venturi Check Valve**

This check valve prevents back-flow of process gas from the vent piping into the house nitrogen system. CV5 provides redundancy to CV7.

CV6 **Purge Panel Vent Check Valve**
This check valve prevents back-flow of purge gas from SRV2.

CV7 **Vacuum Venturi Check Valve**
This check valve prevents back-flow of process gas from the vent piping into the house nitrogen system.

SRV2 **Purge Gas Delivery Pressure Safety Valve**
This pressure safety valve prevents over pressurization of the purge gas delivery piping.

7.7 GASGUARD® TE11 Controller

The GASGUARD® TE11 controller is a Siemens S7-1215 PLC 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. Closed valves are indicated in green (default), open valves are indicated in red (default). The controller status is displayed at the top of the screen. Shutdown status is shown on the top left hand corner of the screen. Fault status is shown on the top right hand corner of the screen. Pressing either the Fault or Shutdown box will display the relevant alarms for each category.

Figure 7.4: GASGUARD® TE11 Controller

7.7.1 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 process gas piping, shutdown and fault alarm boxes, a controller status box and the selection window. The screen that is displayed when the system is powered up for a single controller is shown below.

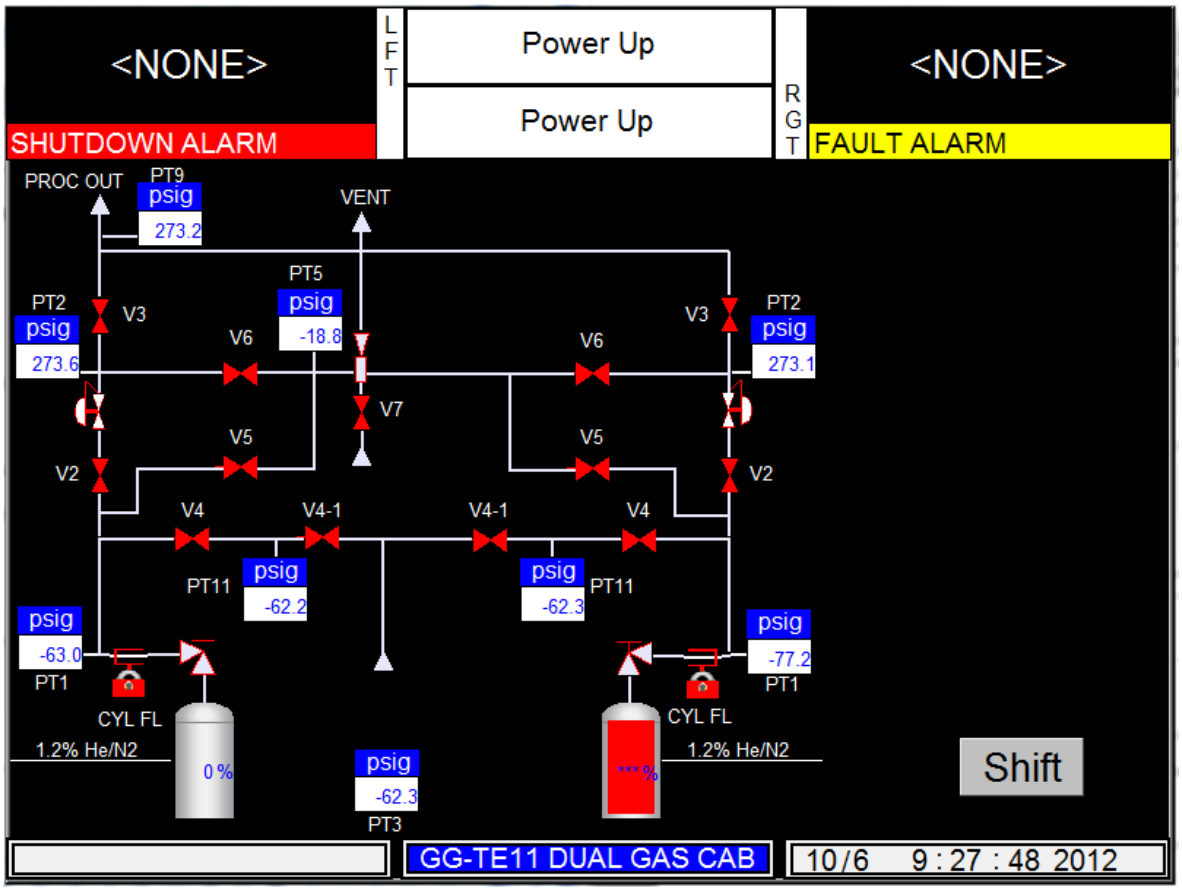


Figure 7.5: GASGUARD® TE11 Screen
(Valve color is optional)

The Main Menu, Control Mode and Cabinet Configuration Selection Window

The Main menu is selected by pressing Main Screen anywhere and key in appropriate password, The Main Menu is shown in Figure 7.6. The Main Menu will remain displayed for a configurable amount of time or until the Logout key is pressed.

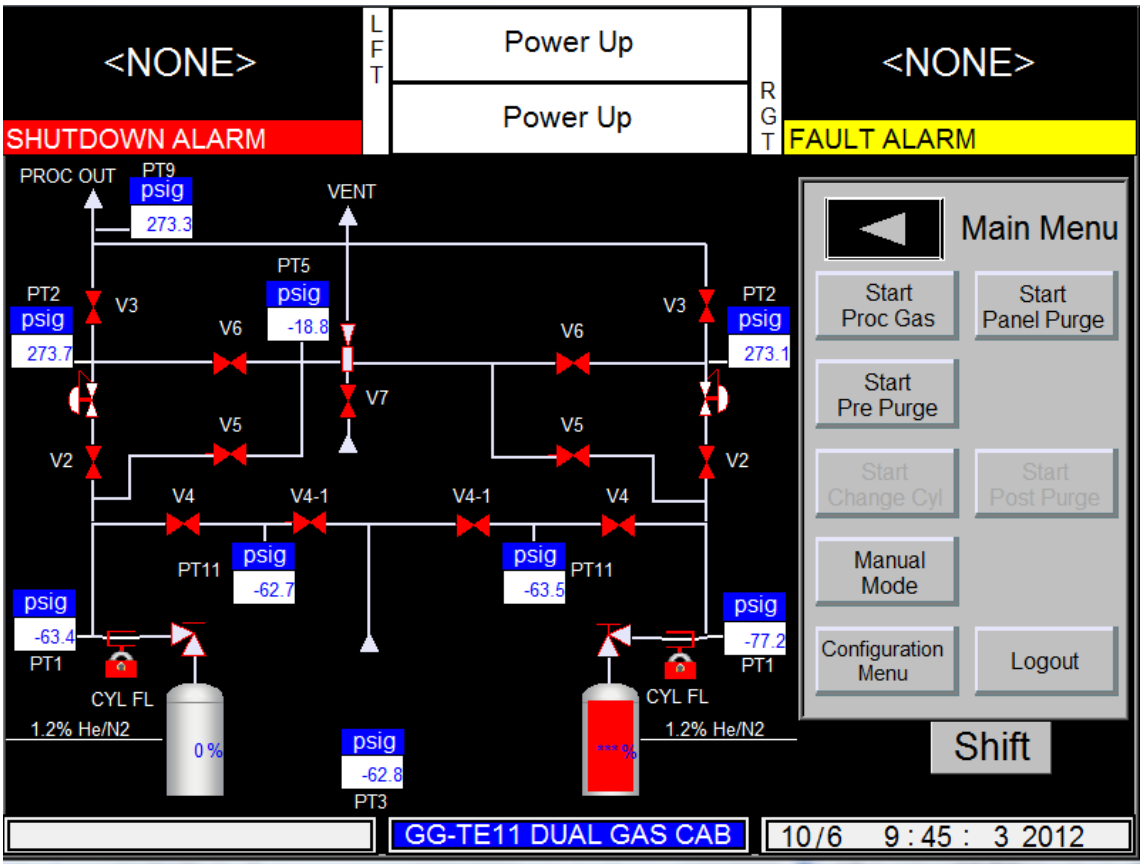


Figure 7.6: GASGUARD® TE11 Controller Main Menu

Alarm and Controller Status Boxes

Shutdown alarms will appear on the ACTIVE ALARM box, selected by pressing the SHUTDOWN Alarm indicator on the top left corner of the Main screen. Fault alarms will appear on the ACTIVE ALARM box, this is selected by pressing the FAULT Alarm indicator on the top

right corner of the Main screen. A time stamp of when the alarm occurred will be displayed with each alarm.

The CONTROLLER STATUS box is located in the top center of the screen and displays the current status of the process panel. Refer to Figure 7.7.

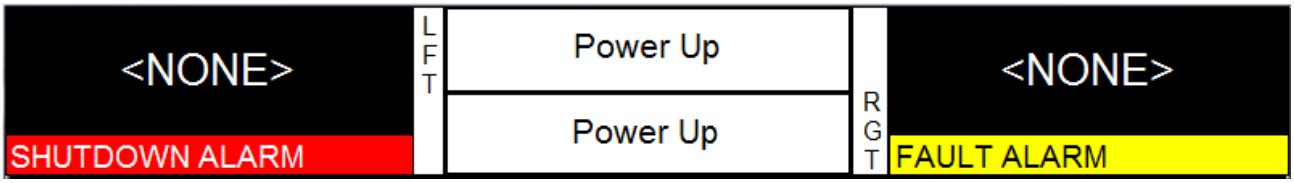


Figure 7.7: Alarm and Controller Status Boxes

TFT LCD Display

The 10" TFT LCD display provides, through a lighted display, visual indication of pneumatic valve positions. On a color screen, open valves are shown in red (default) and closed valves are shown in green (default). The valve condition colors conform to ISA standards. TE11 also provides the optional valve condition color to meet customers' requirement.

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 Chapter 8 Section1, Figure 8.1 for details on the Emergency Stop pushbutton.

7.8 Main Menu Options

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

The main menu provides access to Source Mode Menu and the Configuration Menu. It is password-protected. Contact your Versum Materials, Inc. Representative for your system passwords.

7.8.1 Source Mode Menu Options

The source mode menu provides access to the controllers' sequences. It is password-protected. Contact your Versum Materials, Inc. Representative for your system password. Section 8.2 explains how to enter a password. Some options are only available after completing another sequence. For example, a cylinder change must be preceded by pre purge.

The following options are available from the main menu:

Process Gas Flow

This option starts and stops the process gas flow.
The start sequence tests the process panel for adequate process pressures.
If problems are found, process gas flow is not started and an alarm is displayed. Details of these alarms are located in Chapter 11 (System Specific Information) of this manual.
If no problems are found, the process gas flow is started. Flow continues until a process stop, or until an alarm condition causes a shutdown.

Pre Purge

This option starts the pre purge sequence prior to cylinder change.
It tests for a gross leak at the cylinder valve. The primary purpose of this test is to provide operator safety and protect purity of the system.
The pre purge sequence tests for adequate vacuum, then initiates a series of purges of the process piping to remove all process gas before changing the process gas cylinder.
The number of purge cycles depends on the type of process gas. Minimum values are built into the sequence. Cycles may be increased (see TE11 Source System Configuration in Chapter 8 Section 6 of this manual), but not reduced below the minimum.

Change Cylinder

This option only appears on the Main Menu after a Pre Purge has been completed.
This option is used when changing the process cylinder. It must be preceded by a pre purge sequence.
This sequence tests for high pressure, which is an indication of a process cylinder valve leak, and then establishes a trickle purge flow through the pigtail for cylinder removal and replacement.
If a safe condition is detected, you are prompted to remove the spent cylinder and replace it.

⚠CAUTION

Cylinder change procedures are located in Chapter 8 Section 3. Do not attempt to change a cylinder without following appropriate procedures.

Post Purge

This option only appears on the Main Menu after a Change Cylinder has been completed.

This option starts the post cylinder change purge sequence.

The post cylinder change purge sequence purges the process panel after a process cylinder change. It tests for gross leaks at the pigtail cylinder connection.

As with the pre purge, the number of purge cycles is determined by the process gas type. Cycles may be increased (See TE11 Source System Configuration in Chapter 8 Section 6 of this manual), but not reduced below the minimum.

Rough Line Evac (Optional)

This option starts the rough line evacuation sequence.

The rough line evacuation sequence purges the process line between the gas cabinet and the tool. It is used to remove process gas before maintenance on a component, such as a mass flowmeter, located between the cabinet and the tool. It is also used to remove contaminants after maintenance is complete.

This sequence alone does not remove the process gas from the process line to an acceptable threshold limit value (TLV).
It is Versum Materials, Inc.' recommendation to follow the Rough Line Evac sequence with an inert flow (flush) from the gas cabinet to the tool.
This can be established with the use of Manual Mode operation as described in Chapter 8 Section 5.

Panel Purge (Optional)

This option starts the panel purge sequence. The panel purge sequence evacuates the entire process panel, including both the high pressure and low pressure sides, and then purges the low pressure side of the panel up to V3. It is used to remove process gas before any maintenance is performed on the panel or if the entire panel is to be removed.

7.8.2 Active Alarms

The active alarm screen shows the current status of the system alarms. Pressing Esc will return to the Main Menu

7.8.3 Configuration Menu

The configuration menu provides access to the controllers' configuration menu. It is password-protected. Contact your Versum Materials, Inc. Representative for your system password. Chapter 8 Section 2 explains how to enter a password. Chapter 8 Section 6 describes the functionality of the Configuration Menu in detail.

The following options are available from the Configuration Menu:

Net Product Alarm Setpoints
Subcycle Parameters Leak
Test Parameters Digital
Inputs
Digital Outputs Analog
Inputs Analog Setup
Alarm Conditions Helium
Leak Check Password List
Historical Alarms Service
Functions System Setup

7.9 High Pressure Leak Test (HPLT)

HPLT is an optional piping configuration. The following section describes functionality of HPLT for systems designed with the HPLT piping configuration.

7.9.1 Definitions

HPLT - High Pressure Leak Test. This is the term used to describe the leak test function performed at an elevated pressure on the CGA connection between a pigtail and cylinder. The control system utilizes a pressure transducer to monitor for pressure decay and will indicate the presence of a leak.

Standard leak test - this is the leak test function supplied with standard cabinets. It can be configured as either inboard or outboard. Inboard is done with a helium spray at the CGA connection and a leak detector pulling a vacuum through the leak test port. Outboard is done with a sniffer probe sensing at the pressurized CGA connection.

RFO - Restrictive Flow Orifice. Installed in a line to limit flow rate or provide surge suppression. There is an RFO on the HPLT supply line to provide surge suppression (0.007 inch).

7.9.2 Valve And Transducer Numbers And Nomenclature

V10 = HPLT supply valve (pneumatic).

V11 = low pressure purge inlet valve (pneumatic). This is also a high pressure valve, and is installed opposite to the purge flow direction allowing HPLT gas pressure to seat against the inlet side of the valve body.

PT1 = cylinder pressure transducer.

PT8 = purge back pressure transducer. Not required on all systems. Senses process gas back flow and contamination of purge line/cylinder. PT8 is supplied for certain hazardous gases where the cylinder pressure is high enough to back contaminate the purge gas. PT8 is typically a 250 PSI transducer, however 1000 PSI transducers are supplied on HPLT systems where PT8 is needed (so a higher leak test pressure can be used without damaging the transducer).

7.9.3 Description of Operation

HPLT is supplied in order to more effectively verify the leak integrity of the pigtail-to-cylinder CGA connection after a cylinder is changed. It is an improvement on the standard leak testing. Leak testing done at a higher pressure will indicate leaks faster and of a lesser magnitude than leak testing done at a lower pressure.

The maximum value of the leak test pressure is dependent upon several factors;

- the service pressure of the fittings and valves that will be exposed to it.
- the pressure rating of PT1
- the pressure rating of PT8
- the pressure available from the leak test gas supply.

If PT1 is a 1000 psi transducer, the recommended HPLT supply pressure is 950 psig, but shall not exceed 970 psig. If PT1 is a 250 psi transducer, the recommended HPLT supply pressure is 220 psig, but shall not exceed 230 psig.

HPLT is automatically initiated as part of the cylinder change sequence following cylinder change out. Upon initiation of the cylinder change sequence, a prompt will appear to close MV4 on the opposite side. Upon completion of the cylinder change out portion of the cylinder change sequence, the HPLT will open V10 and V4 allowing the system to pressurize with leak test gas between V10 and V2. When the HPLT is initiated**,** the high purge back pressure alarm associated with PT8 is disabled. A period of 3 minutes is allowed for the system to stabilize, after which time V10 and V4 are closed. After stabilization, the pressure is monitored by PT1 for 10 minutes. During the test, the message “HP LEAK L (or R)” is displayed, and the 10 minute period is counted down on the screen.

If the actual pressure decay was less than the preset limit, the system has passed. Post purge can now be initiated (refer to appropriate section in operation manual). If the pressure decay was equal to or greater than the limit, the test will abort and the system will alarm indicating that the test has failed. The connection must be remade and the cylinder change sequence performed again. Note, prior to re-running the cylinder change sequence, the operator must ensure a vacuum condition at PT1 and PT2. If not at a vacuum, the operator must manually achieve vacuum at PT1 and PT2 before change cylinder mode can be started. If the HPLT fails, the controller will not allow post purge and process gas sequences to start. HPLT must be successfully completed before any further operations are permitted.

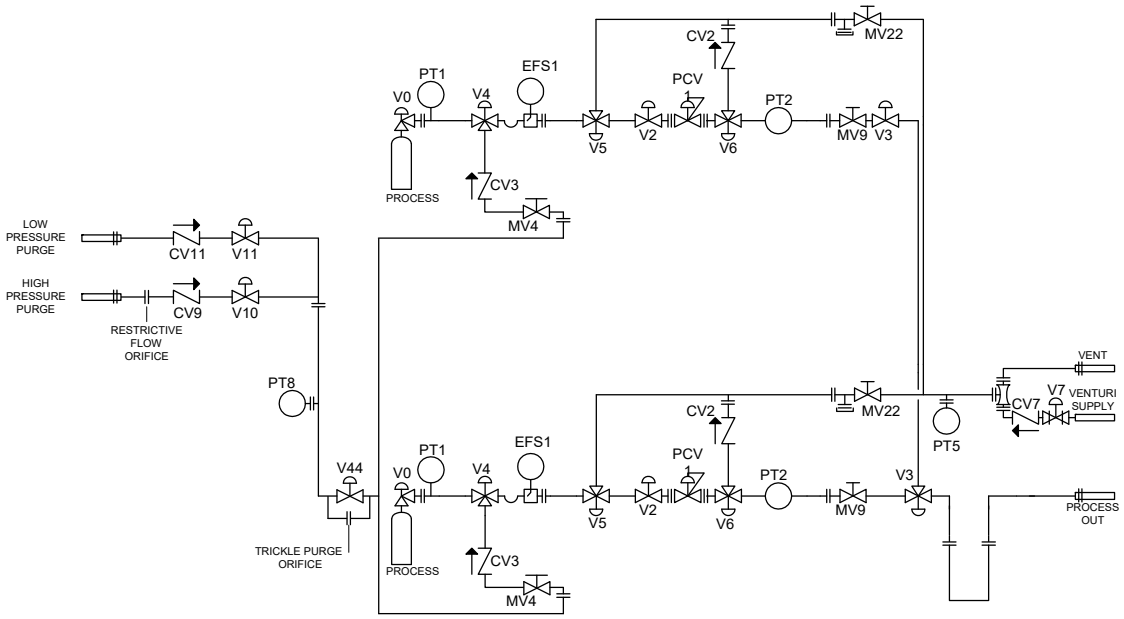


Figure 7.8: Example HPLT Piping Schematic

7.9.4 Alarm Conditions And Responses

The following table summarizes the alarms associated with HPLT. Other alarms exist (not listed in the table) which control the operation of the system.

INPUT ALARM	RESPONSE	CONDITION	DELAY	SETPOINT (950 psig supply pressure)	SETPOINT (220 psig supply pressure)
HIGH HP PURGE PT1	Fault	HI	0	980	233
LOW HP PURGE PT1	Shutdown	LO	0	900	200
LOW HP PURGE PT8	Shutdown	LO	0	900	200

HPLT - Alarm Conditions & Responses

7.10 Multiple Process Outlets

Multiple Process Outlets are optional piping configurations available for auto crossover configurations that can extend the flexibility and application of a single GASGUARD® Source System. Each additional process outlet is furnished with a manual isolation valve and a process line connection with the option of either a standard bulkhead or a coaxial bulkhead. The VCR connection downstream of the valve is terminated and capped with a VCR plug at the factory. The additional outlet piping spools are faced, ready for welding and are shipped loose with the cabinet. Verify all tubing connections with the flow schematic, or INS drawing (if requested), prior to welding.

Additional process outlet piping spools shall not be installed until the facility delivery line is complete and ready to be terminated.

Multiple process outlets offer a convenient method for providing gas to multiple use points:

- to another source cabinet(s) for emergency manual supply.
- to valve manifold box(es) or process tool(s).
- for future expansion.

Prior to initiating a Main Menu sequence, ensure these valves are in the proper configuration for the task to be performed.

Before attempting to service a Multiple Process Out system, tag out and lock out (see Chapter 1 section 11) all Process Outlet Isolation Valves (MV-29) to prevent opening while service is being performed.

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 Chapter 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 Chapters 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.

⚠CAUTION

Versum Materials, Inc. require the handling of any toxic gas cylinders be performed by <u>two</u> trained operators utilizing self contained breathing apparatus.

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***.

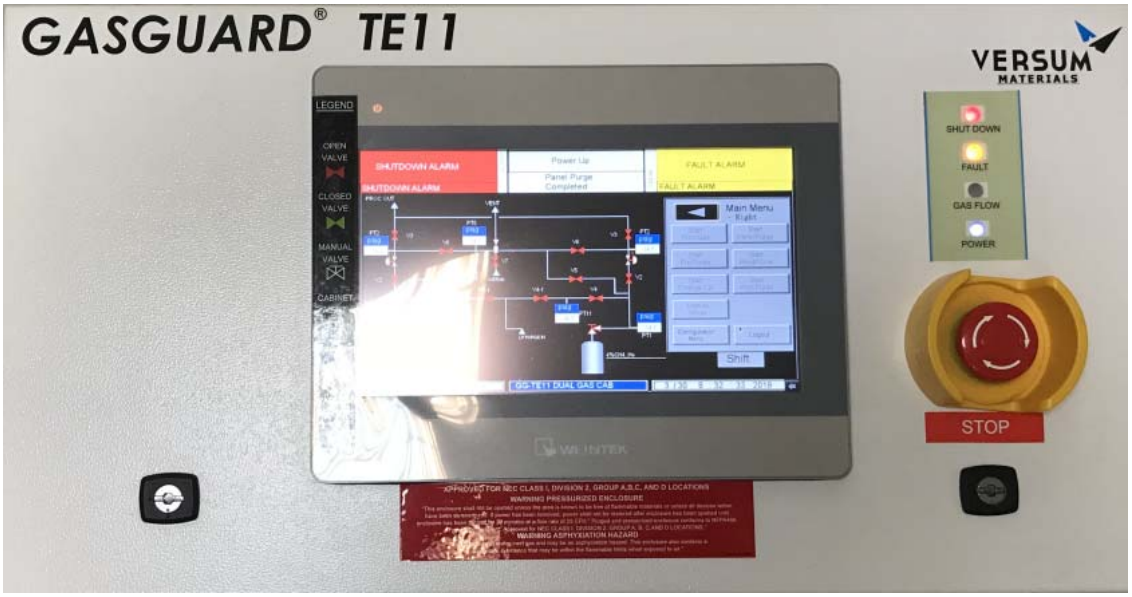


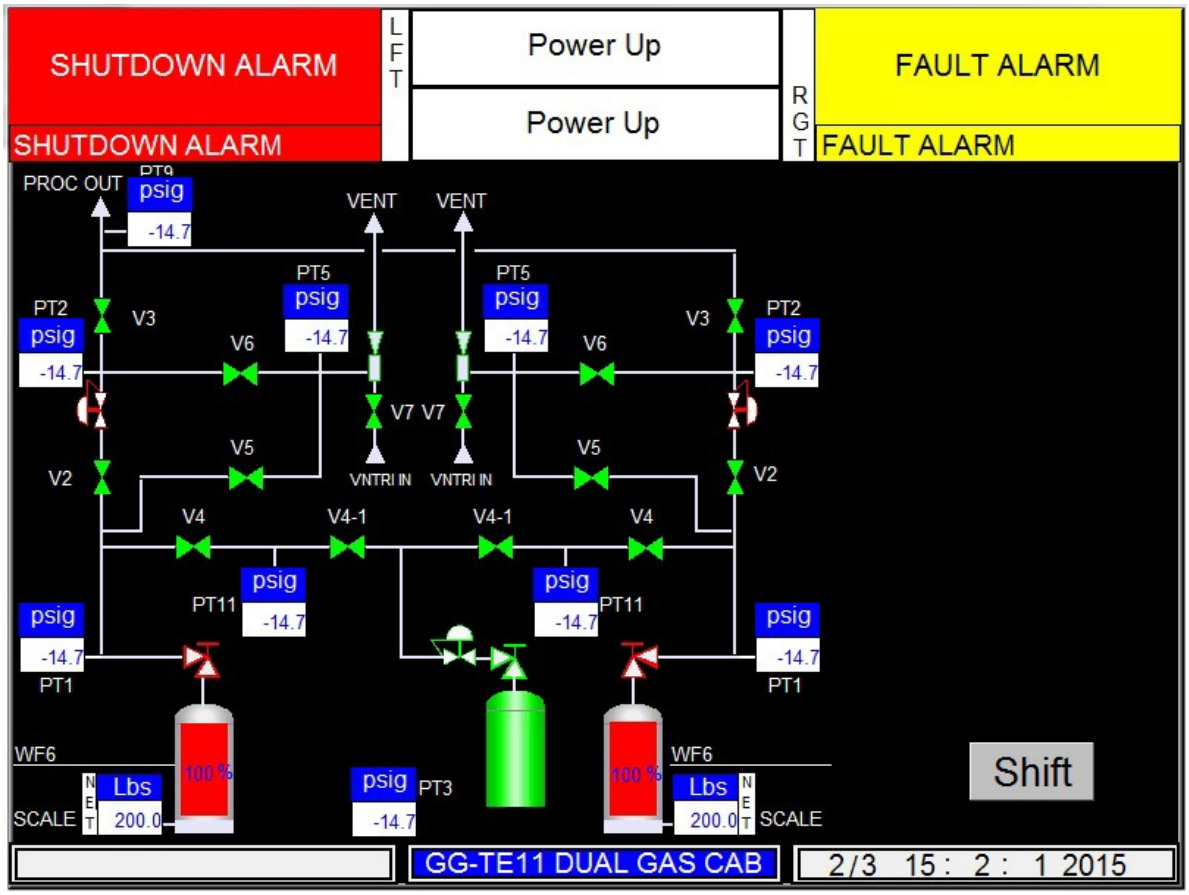
Figure 8.1: Emergency Stop Pushbutton Location

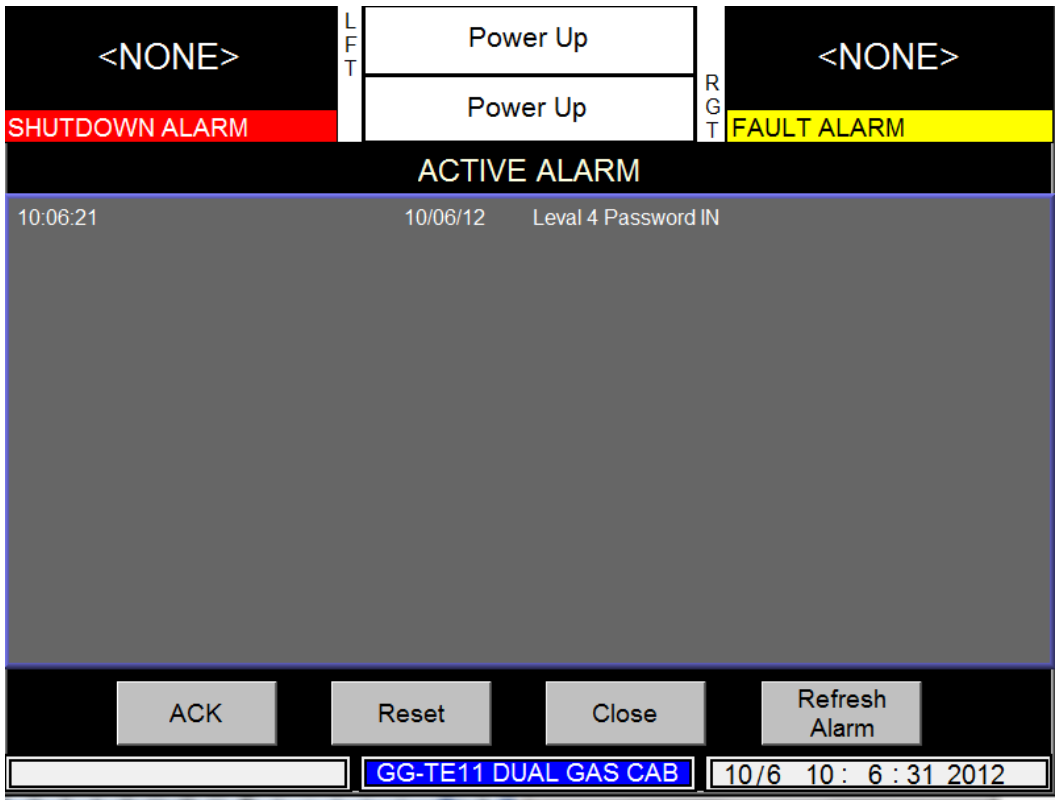
Pressing the "Emergency Stop" button does not disconnect power to the controller. The 120 VAC/240 VAC power is still active within the controller. Do not perform maintenance on the controller without disconnecting or switching of power externally and following the required Lockout or Tagout procedures.

If it is necessary to reenter the area while a hazardous atmosphere is suspected, the proper Personal Protective Equipment (PPE) must be worn. See Chapter 1 Section 9 of this manual for the proper PPE.

8.2 Operation of the Source System Controller

This is the screen that is displayed upon power up.





Button Functions:

ACK Silences alarms Reset Resets and clears alarms. If an alarm condition still exists it will re-alarm, Refresh Alarm clean alarm history.

Close Will close this window and take you to the Main Menu.

Once the system is powered up a power up alarm will exist. To silence this alarm press the ACK button. Pressing Reset will then clear this and any other alarm. If an alarm condition still exists it will re-alarm after the reset is pressed. You can press ACK to clear it.

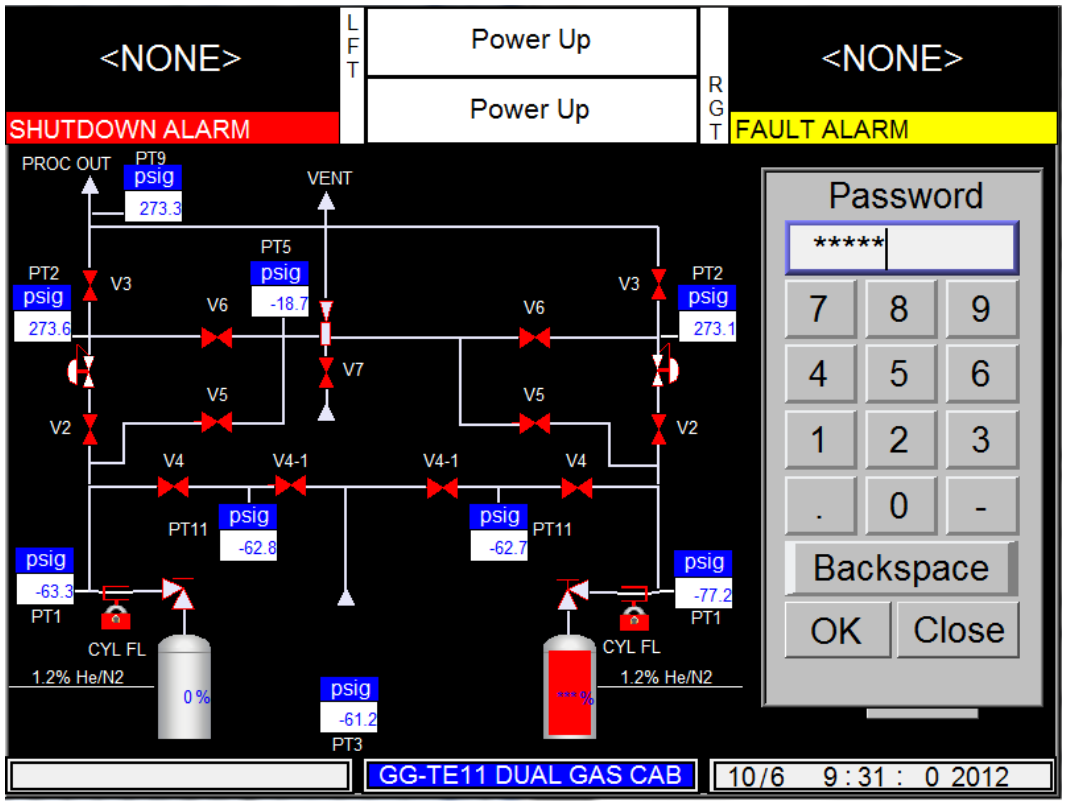
After silencing and resetting the power up alarm you may enter the Main Menu by pressing the Close key. This will prompt you for a password with this screen.

Enter the password using the keypad that appears on the screen. Press the anywhere on the TFT touch screen, then the OK key on the Login window to enter the password.

Example:

To enter the password "12345": where the level of access precedes the password. Press the OK key on the Login window.
If an improper password is entered, it will appear a color cover " * " in password window.

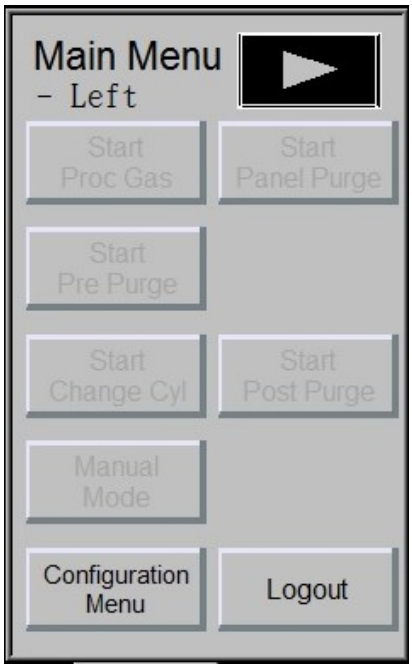
Once you are in the Main Menu you can pick a function by pressing the touch screen. The main Menu is shown below.

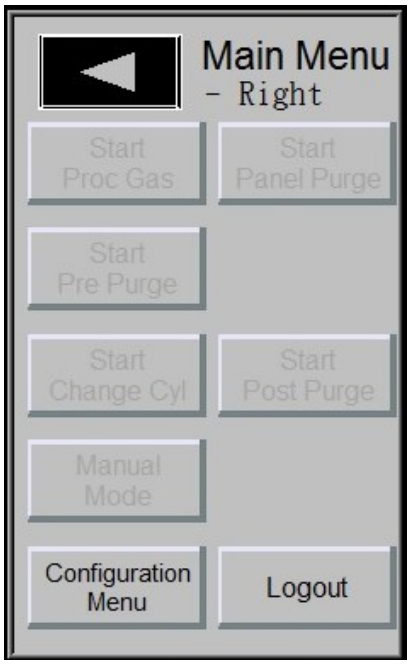


Note: Selections that appear red are not selectable at this point of the controller sequence. All sequences require the operator to follow an executable order.

8.2.1 Source Mode Menu (Left or Right side)

Selecting the ◄ for Left or ► for Right from the Main Menu will display the following screen for the side that is selected.





This screen will allow the user to purge, start process gas, change cylinders, rough lines, and enter manual modes. The following sections 8.3 thru 8.5 will explain the operation of these modes.

8.3 Process and Purge Cylinder Procedures

⚠CAUTION

Only operators trained in the following procedures and the hazardous gas system are allowed to change cylinders.

⚠WARNING

High pressure gas cylinders can be extremely hazardous when not handled properly. Follow the procedures in this section to prevent personal injury or death.

⚠CAUTION

The procedures listed in this section are intended to be used in conjunction with the purge and cylinder change functions of the cabinet controller. Do not use these procedures independently.

⚠WARNING

All high pressure gas cylinders containing highly toxic or pyrophoric gases must have an RFO installed in the cylinder. Do not operate equipment without a properly sized RFO in place

⚠WARNING

Any HPM container > 15psig must have an RFO installed in the cylinder valve if there is no Excess Flow Switch installed in the system. Do not operate equipment without a properly sized RFO in place

⚠WARNING

All silane cylinders and silane mix cylinders containing 2% or more silane must have an RFO installed in the cylinder valve with a maximum orifice diameter of 0.010 inch. Do not operate equipment without a properly sized RFO in place.

8.3.1 Inert Purge Gas Cylinder Change Procedure

This procedure will normally be done after "PRE-PURGE CYCLES" in conjunction with a process gas cylinder change.

Before approaching a hazardous gas cabinet for a cylinder change, verify that there are no alarm labels displayed on the screen and that the exhaust system is functioning correctly. Only operators trained in these procedures and the hazardous gas system are allowed to change cylinders.

Process gas back-stream hazard can exist if the purge cylinder pressure drops below 200 psig (13.78 barg).

8.3.1.1 Empty Purge Gas Cylinder Removal

1. Check and record the required information on the Process Gas Cylinder Change Checklist (found at the end of Section 8.3) each time a cylinder is changed.

Do not proceed if there are any alarm labels displayed on the screen, the exhaust system is not working or pressures appear abnormal.

2. Open access window.
3. Close purge gas cylinder valve (fully clockwise).
4. Close manual valve MV10.
5. Slowly open manual valve MV13, to vent purge gas within pigtail. Close MV13.
6. Through the access window, loosen the pigtail cylinder connection from the cylinder valve using the proper wrench. Be sure to support the connection and pigtail tubing.
7. Close access window.
8. Don the required Personal Protective Equipment (PPE) prior to opening cabinet door.
9. Re-verify that exhaust system is working.
10. Open gas cabinet door.
11. Recheck that cylinder valve and manual valve MV10 are closed.
12. Fully remove pigtail cylinder connection from cylinder valve.
13. Install cylinder valve protection cap.
14. Install pigtail cylinder cap/plug onto pigtail connection.
15. Unbuckle cylinder strap and remove cylinder from source system.
16. Place cylinder in appropriate cart and strap in place. Place "EMPTY" tag on cylinder and return cylinder to the appropriate cylinder storage area.

8.3.1.2 Full Purge Gas Cylinder Installation

1. Verify that the replacement cylinder is identical to the purge gas cylinder that was removed.

Never attempt to replace specified gas with another gas without consulting equipment supplier. Incompatible gases could cause fires, explosions or extremely corrosive or toxic compounds.

2. Position full cylinder in gas cabinet, and strap loosely. Remove valve protection cap.

If a 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. 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.

3. Check that the cylinder valve is tightly closed.

4. Check valve outlet area for contamination or damage. Do not attempt to use gas cylinder with damaged or contaminated valve outlet. Replace the cylinder and tag the defective cylinder indicating the problem.

5. Position valve outlet so that it lines up properly with the pigtail cylinder connection and tighten cylinder strap.

Do not rotate cylinder by holding cylinder valve handle. This may open the cylinder valve and cause a high pressure gas leak which could result in personal injury or death.

6. Remove pigtail cap/plug from pigtail cylinder connection.

7. Thread cylinder nut hand tight into/onto clean undamaged cylinder valve outlet. Be careful not to cross thread connections.

8. Tighten nut using appropriate tools to support pigtail. Do not apply excessive torque. Refer to CGA Pamphlets in Appendix for recommended torque of cylinder connection.

9. Close enclosure door.

8.3.1.3 Cylinder Connection Leak Check (Purge Cylinder)

1. Open access window.

2. Slowly open purge cylinder valve to fill pigtail panel with purge gas.

3. Close cylinder valve.

4. Slowly open MV13 to vent purge gas from pigtail.

5. Close MV13.

6. Repeat steps 3-5 a minimum of 10 times to purge the pigtail of any contaminants that may have entered during purge gas cylinder installation.

7. Open MV10.

8. Slowly open purge cylinder valve to fill pigtail and purge panel with purge gas. PI3 should indicate full cylinder pressure.

9. Close cylinder valve.

10. Observe PI3 for any pressure decay for five (5) minutes.

11. If there is no decay, the cylinder connection is not leaking at a detectable level. Proceed to step 13.

12. If there is a pressure drop, a leak is indicated.
    a. Slowly open manual valve MV13 to completely vent purge gas pressure in pigtail.
    b. Close valve, MV13.
    c. Close valve, MV10.
    d. Remove purge cylinder from the pigtail.
    e. Reinstall the purge cylinder (reference Section 8.3.1.2 "Full Purge Gas Cylinder Installation.)
    f. Retest following steps 1 through 11 in Section 8.3.1.3.
    g. If leak persists, remove cylinder (reference Section 8.3.1.1 "Empty Purge Gas Cylinder Removal Procedure".)

h. Remember to mark the cylinder "FAULTY, BAD CYLINDER CONNECTION."

13. With suitable means (helium mass spectrometer, thermal conductivity detector, or liquid leak detector - as specified for area), inspect the cylinder connection and pigtail connection for leakage. Pay particular attention to the point where the nipple passes through the nut.

8.3.1.4 Putting Purge Gas Cylinder On-Stream

1. Open access window and open purge cylinder valve.
2. Slowly open manual valve MV13 for approximately 15 seconds to remove air from pigtail, then close.
3. Slowly open manual isolation valve, MV10, to regulator.
4. Adjust the purge gas regulator, PCV2, to 80-90 psig (5.51-6.20 barg) delivery pressure.
5. Close access window.
6. The inert purge gas system is now ready for use.

8.3.2 Process Gas Cylinder Procedures

8.3.2.1 Empty Process Gas Cylinder Removal (Prior to Removal)

This procedure assumes that a process gas cylinder and an inert purge gas cylinder are in place and operating.

Before approaching a hazardous gas cabinet for a cylinder change, verify that there are no alarm labels displayed on the screen and that the exhaust system is functioning correctly Only operators trained in these procedures and the GASGUARD® hazardous gas system are permitted to change cylinders. The appropriate Personal Protective Equipment (PPE) must be worn when performing any Process Cylinder Procedures. See Chapter 1 Section 9 of this manual for the appropriate PPE.

1. Confirm with operating personnel that the process gas can be shut off before initiating stop process gas.
2. On the Main Menu window, press the "STOP PROCESS GAS" pushbutton
3. Check and record the following information on the Process Gas Cylinder Change Checklist (found at the end of Section 8.3.2.5) each time a cylinder is changed.

   Pressure readings on:
   "PROCESS CYL PRESS" and
   "PROCESS DEL PRESS"

   Process cylinder weight (if scale is present)
4. Note the valve color coding key on the graphics:

   Color screen:

   Red = valve open (default)

   Green = valve closed (default)

Proceed to the troubleshooting section for corrective action if any shutdown or warning conditions occur. Notify your supervisor immediately or contact your Versum Materials, Inc. representative for assistance.

5. On the Main Menu for the side to be purged window, highlight "—START—PRE PURGE".
6. Follow prompted manual steps on the screen.

The following valves will sequence on the display during the high pressure purge cycles.

- First the tubing between the high pressure valve (V2) and the process cylinder valve is evacuated.
- The high pressure tubing will then be "flush" purged.
- The tubing will then be pressurized with purge gas.
- This sequence of evacuation and pressurization will be repeated until the configured number of cycles is completed.

8.3.2.2 Empty Process Gas Cylinder Removal

1. Verify that "PRE-PURGE COMPLETE" is displayed in the controller status box.

2. On the Main Menu screen, for the side you are changing, select "—START—CHANGE CYLINDER".

3. Follow prompted information on the screen.

While the system is waiting for you to replace a cylinder, a trickle purge of the high pressure tubing may begin and continue until you press OK, acknowledging the prompt "Remove and Replace Cylinder", indicating the cylinder change is complete.

4. ***Don the self-contained breathing apparatus and all other Personal Protective Equipment (PPE) if required, if not done already. See Chapter 1 Section 9 for details on the required PPE.***
5. Verify that exhaust system is working.

6. Open access window.

7. Recheck that process cylinder valve is closed.

⚠CAUTION

Do not use a wrench or other devices to close diaphragm type cylinder valves. This could cause valve failure. The maximum torque on diaphragm type cylinder valves is 12 foot/pounds (16.3 Nm). Certain gases are supplied with cylinder valves without hand wheels. Use the proper tool from your gas supplier to operate these valves.

8. Loosen and remove the pigtail cylinder connection from the gas cylinder using appropriate tools to support the connection and pigtail tubing. Note proper direction of rotation. Fittings with left-hand threads have notched hex corners. Observe and listen for any sound of gas leakage. Close door immediately if the process gas cylinder valve is leaking and evacuate the area.

9. Install cylinder valve outlet plug/cap securely into/onto process cylinder valve outlet.

⚠CAUTION

This valve outlet cap must be used on all toxic, corrosive and pyrophoric gases. Consult your supplier if there is no cap on these gas cylinders.

10. Install pigtail cap/plug onto pigtail cylinder connection.

11. Open the enclosure door.

12. Loosen cylinder holding strap but do not unbuckle.

13. Install cylinder valve protection cap. If necessary, tilt cylinder toward door slightly.

14. Unbuckle cylinder strap and remove cylinder from cabinet.

15. Place cylinder in appropriate cart and strap in place. Place "EMPTY" tag on cylinder and return cylinder to the appropriate cylinder storage area.

8.3.2.3 Full Process Gas Cylinder Installation

The required Personal Protective Equipment (PPE) must be worn when performing any process cylinder procedures. Refer to Chapter 1 Section 9 of this manual for the required PPE.

1. Verify that the cylinder contains the same gas as the label on the gas cabinet and process panel.

Never attempt to replace a specified gas with another gas without consulting equipment supplier. Incompatible gases could cause fires, explosions or extremely corrosive or toxic compounds.

2. Position full cylinder in gas cabinet, and strap loosely. Remove valve protection cap.

⚠WARNING

If a 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. 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.

3. Check that the cylinder valve is tightly closed.

4. Slowly remove valve outlet plug/cap on the cylinder. Listen and observe for any sign of leakage. If you notice leakage, immediately retighten cap, close the cabinet door and evacuate the area. Follow established emergency response procedures. Cylinders with valve leaks are defective and should be returned to supplier.

5. Check valve outlet area for contamination and damage. Do not attempt to use a gas cylinder with a damaged or contaminated valve outlet. Tag the cylinder as "FAULTY", and obtain another cylinder.

6. Position cylinder so that the valve outlet lines up with the pigtail cylinder connection and tighten cylinder strap.

⚠WARNING

Do not rotate cylinder by holding cylinder valve handle. This may open the cylinder valve and cause a high pressure gas leak which could result in personal injury or death.

7. Remove pigtail cap/plug from pigtail connection.

8. Install new washer on those cylinder connections that require washers.

9. Thread pigtail cylinder nut hand tight into/onto clean undamaged cylinder valve outlet noting proper direction of rotation. Be careful not to cross thread connections.

10. Tighten nut using proper wrench. Be sure to support pigtail. Do not apply excessive torque. Refer to CGA Technical Bulletins located in Appendix for recommended torque of cylinder connection.

11. Close encloure door.

12. The system is now ready for post purge cycles.

Do not open the process cylinder at this time. The post purge procedure must be completed first.

8.3.2.4 Full Process Cylinder Purge (After Installation)

1. On the Main Menu for the side you are changing window, highlight "—START—POST PURGE".

2. Follow any steps that may be prompted on the screen.

The following valves will sequence on the display during the high pressure purge cycles.

V1L, V4L will open to pressurize the pigtail.

- A leak check will be preformed.
- The high pressure tubing will then be evacuated and "flush" purged by opening V1, V4, V5 and V7.
- The tubing will then be pressurized with purge gas by opening V1, V4, and V1 and then evacuated using V1, V5 and V7. This sequence of evacuation and pressurization will be repeated until the configured number of cycles is completed.
- At the end of the Post purge sequence V 6 will open to allow evacuation of the lines between PCV1 and V3. After this the status bar will display POST PURGE COMPLETE.

8.3.2.5 Process Gas Flow

1. On the Main Menu =screen, highlight"-- START-- PROCESS GAS".

2. Follow the steps prompted on the screen.

3. Process gas is now flowing to the process equipment.

PROCESS GAS CYLINDER CHANGE CHECKLIST

Customer Cabinet No. _____

Gas Service _____

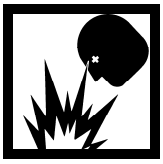
⚠CAUTION

CLOSE CYLINDER VALVE BEFORE STARTING PURGE SEQUENCE.

⚠WARNING

WEAR APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT AS DETAILED IN SECTION 1.9 OF THIS MANUAL WHEN CHANGING OR INSTALLING A TOXIC GAS CYLINDER.

⚠WARNING



RECHECK THAT CYLINDER VALVE IS TIGHTLY CLOSED BEFORE LOOSENING CGA CONNECTION FROM CYLINDER VALVE.

Date	Time	Cabinet Interior OK (Leakage Corrosion)	Cabinet Exhaust Working	Cylinder Valve Closed	Proper RFO Installed		Process Gas Pressure		Purge Gas Pressure		Cylinder Weight	Operator Initials
							PI1	PI2	PI3	PI4		
						Start						
						Finish						
						Start						
						Finish						
						Start						
						Finish						

8.4 New System Startup Procedure

In NEC Class I, Division II hazardous locations (applies only in the U.S.A) do not apply power to the cabinet controller until the controller enclosure has been purged for at least 10 minutes at a pressure at or above 0.1" H2O (.025 milli-barg) as monitored by the internal Z purge pressure switch (hazardous locations only). Refer to steps 3 and 4 below. This complies with NFPA 496 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, to be sure, that the GASGUARD® 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® system has been functionally checked after installation.

2. Check that the cabinet 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. For locations that require Z-purge, turn on and adjust the 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.

5. After purging the controller for at least 20 minutes, turn on electrical power to the controller.

   NOTE: The GASGUARD® TE11 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. Type Z purge <u>does not</u> meet Class I, Division I NEC requirements.

6. Press ACK then Reset 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 Chapter 9. If needed, contact you Versum Materials, Inc. factory representative for assistance.

7. Check that all automatic valves indicate closed position (default is green).

8. Check that regulators are closed (knob rotated fully counterclockwise).

9. Ensure the process pigtail connection cap/plug is installed and tight.

10. For systems with internal purge, install an inert purge gas cylinder in the cabinet. Refer to Section 8.3.1.2 Full Purge Gas cylinder Installation. For systems with external purge, verify that purge gas is available.

11. Select Close and goto Main Menu to enter the password.

12. Select the Main menu for a side you wish to purge.

13. On the Main Menu screen, highlight "—START PRE PURGE—".

14. Follow the prompts on the screen.

15. When the controller status box indicates "—PRE PURGE COMPLETE—", select "—START CYL CHANGE—".

16. Follow the prompts on the screen.

17. Refer to Section 8.3.2.3 Full Process Gas Cylinder Installation.

18. When the controller status box indicates "—CYL CHANGE COMPLETE—" select "—START
POST PURGE—".

19. Follow any prompts that may be on the screen.

⚠CAUTION

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

20. When the controller status box indicates "—POST PURGE COMPLETE—", select "—START
PROCESS GAS—".

21. Adjust the process gas regulator, through the access window, to the desired delivery pressure.

22. Process gas is now flowing to the process equipment.

8.5 Manual Mode Operation

⚠CAUTION

Only experienced operators should operate the cabinet 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.

NOTE: Opening high pressure vent valves when high pressure gas is present could cause damage to the vent line pressure transducer, if installed.

Manual mode provides a means of flowing purge gas through the purge and process gas panels during cabinet installation and pre-start-up procedures. It also provides a means of flowing purge gas while maintenance or repairs are being performed.

8.5.1 How to Operate in Manual Mode

⚠WARNING

Operating in Manual Mode could 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 gas could be vented.***
- ***Opening vent valves when high pressure process gas is present.***

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

1. Enter second level (or higher) security code (check with appropriate Air Products representative for proper password) as follows:

   Press TFT touch screen

   The LCD screen will prompt: "
   PASSWORD" Type in the password.
   Press "OK"

   If the password is correct, the Main Menu will be displayed. If the password is incorrect, It will be display a color at " * " in Password window.

2. Press "OK"

3. From the Main Menu screen, select source menu for either the left or right side.

4. From the Mode Menu screen, highlight "--MANUAL MODE--" by pressing Manual Mode button (if the button is Grayscale and displays N/A a shutdown is has occurred that prevents manual operation.)

The MANUAL MODE window will display

5. Operate valves referring to Section 8.5.2 below.

6. To exit MANUAL MODE, press Cancel

NOTE: Pressing Cancel will automatically close any valves which were left open unless the secure mode feature is used as seen below in section 8.5.2.

8.5.2 How to Open and Close Valves

To open a valve:

1. Select the valve by touching the screen.

2. The valve state menu will appear asking you to 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:

1. Touch the valve you wish to close.

2. The valve will close.

To SECURE Manual Mode:

1. The Secure option will allow an operator to exit the Manual Mode menu while remaining in the Manual Mode with the valves open. The Secure option will not be selectable if no valves are open.
   When the operator chooses Secure Mode from the Manual Mode menu, the controller will leave the side in manual and will allow you to go to other screens. Any open valves will remain open and the Mode Status Box will continue to indicate Manual Mode. The Manual Mode will remain active or “secured” until an operator reenters the Manual Mode menu. While Manual Mode is “secured”, Manual Mode will be the only selectable option on the Main Menu.

⚠CAUTION

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

8.5.3 General Principles of Manual Operation

Open valves in sequence from cylinder to outlet for pressure or from vacuum to cylinder or line for vacuum.

Close valves in reverse order.

Monitor pressures on the screen frequently.

Consider all possible results before opening or closing a valve.

8.6 Source System Configuration

Certain GASGUARD® TE11 controller files may be modified using a second or third level security code. These modifications are referred to as the source system configuration.

The source 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.

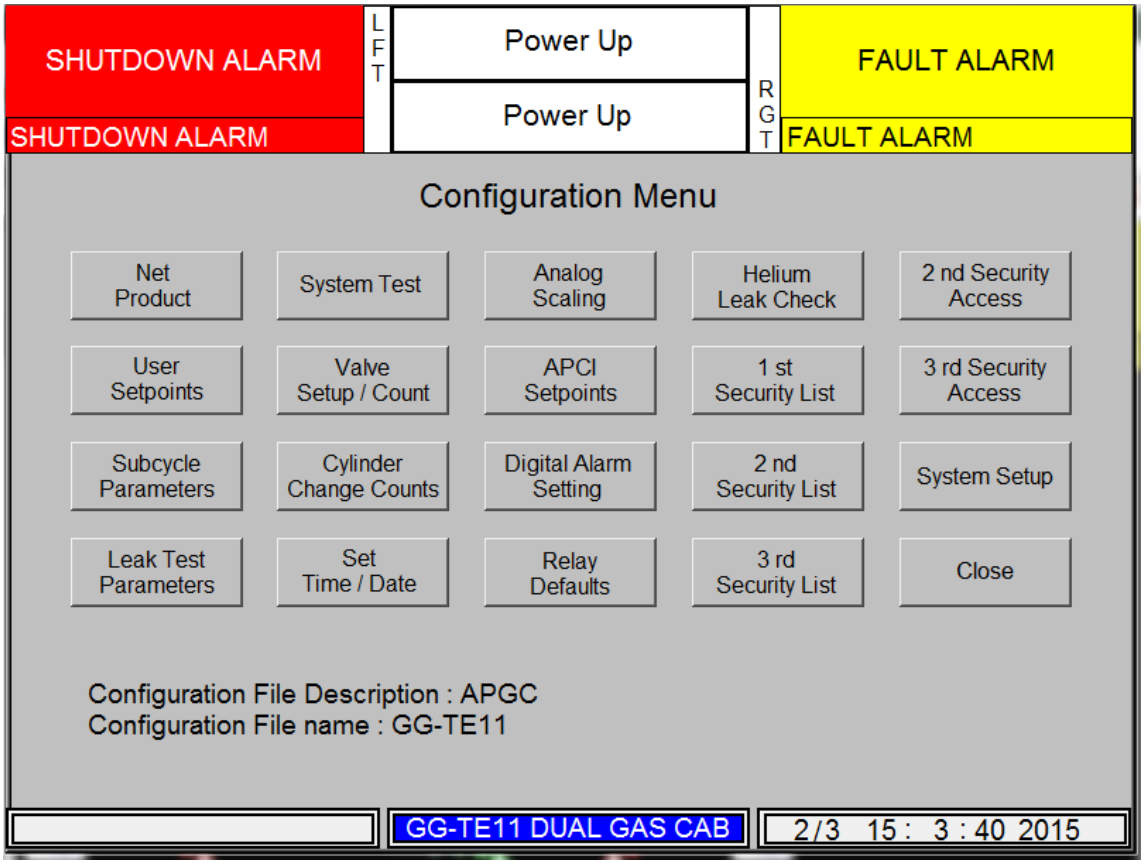


Figure 8.2: Configuration Menu

To select a menu option, simply press the touch screen button of the configuration parameter you would like..

Table 8.3 defines the preset permissions assigned to each security level and configuration parameter. First level security password users are limited to basic controller operations and do not have access to any Configuration menu items. In Table 8.3 below, "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 8.3 - Source System Permissions

		Security Level Permissions	
Section	**Configuration Menu Options**	**Level 2**	**Level 3**
8.6.1	Net Product	W	W
8.6.2	Alarm Setpoints	R	W
8.6.3	Subcycle Parameters	R	W
8.6.4	Leak Test Parameters	R	W
8.6.5	Digital Inputs	R	R
8.6.6	Digital Outputs	R	W
8.6.7	Analog Inputs	R	R
8.6.8	Analog Setup	R	R
8.6.9	Alarm Conditions	R	R
8.6.10	Helium Leak Check		W
8.6.11	Password List		W
8.6.12	Historical Alarms	R	R
8.6.13	Service Functions		
8.6.14	System Setup		W

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

8.6.1 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.

This window is also used to enter the full cylinder pressure of the process and purge cylinders installed in the system. The analogs configured for displaying cylinder pressures will prompt for the "max cyl press" instead of a "net product". This will not occur however if a process cylinder scale is utilized, in which case the process cylinder analogs will function as standard analogs.

8.6.2 Alarm Setpoints

This option allows the operator to choose an analog or exit the window. When the operator chooses an analog, a window will be displayed to allow the operator to enter a new user analog setpoint value. The User Analog Setpoints window will display 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 VERSUM MATERIALS, INC. 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 Process Cyl.
- Very Low Process Cyl
- Regulator Creeping (may also serve as a high pressure delivery alarm)
- Low Process Del.
- Low Cyl. Weight
- Very Low Cyl. Weight

To change a setpoint, first select the analog input, by touching the value you wish to change. A key pad will appear on the screen allowing you to enter a number.

Pressing the enter key ENT will change the value.

Depending upon the security level you are assigned to, you may only be able to view certain setpoints that you have permission to change. These values are identified by a white box around them. Setpoints shown with a Red box are VERSUM MATERIALS, INC. specific setpoints.

8.6.3 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. The purge parameters and their Versum Materials, Inc. minimum values follow:

- High Pressure Cycles = 20
- Low Pressure Cycles = 20
- Helium Leak Inboard = 1
- Helium Leak Outboard = 1

To change a setpoint, first select the analog input, by touching the value you wish to change. A key pad will appear on the screen allowing you to enter a number. Pressing the enter ENT key will change the value.

8.6.4 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. The leak parameters and their Versum Materials, Inc. minimum values follow:

- Cylinder Leak Test Min. of Testing = 5 Press. Differ. = 5psi (.344 barg)
- Decay Test Min. of Testing = 5 Press. Differ. = -5psi (-.344 barg)
- V-3 Leak Test Min. of Testing = 5 Press. Differ.= 5 psi (.344 barg)
- HP Leak Test Min. of Testing = 10 Press. Differ. = 5 psi (.344 barg)
-

To change a setpoint, first select the analog input, by touching the value you wish to change. A key pad will appear on the screen allowing you to enter a number. Pressing the enter ENT key will change the value.

⚠CAUTION

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

8.6.5 Digital Inputs

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.

To scroll through the digital input values, use the <PREV key or the NEXT>.

8.6.6 Digital Outputs

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 8.5. It is the customer's responsibility to adhere to all operational warnings in Section 8.5 when performing the Digital Out Test.

To scroll through the digital input values, use the <PREV or the NEXT>. Touch the State block to toggle the output state.

⚠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.

8.6.7 Analog Inputs

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).

To Scroll through the digital input values, use the <PREV key or the NEXT>.

8.6.8 Analog Setup

The Analog Setup allows you to enable and change the scaling of analogs. This window will display all analogs used in the system. The operator will be allowed to choose an analog or exit the window. Then the operator chooses an analog, a window will be displayed to allow the operator to enter a new maximum or minimum analog scaling value. The Analog Scaling window will display the analog number, analog label, 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.

8.6.9 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 closed, open, or not used and the alarm condition for analog alarms to high, low, or not used. The window will allow the operator to change one or more alarms or to exit the window without changes. The Alarm Delays show the 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 99 seconds.

The Alarm Types have the possible alarm types of Fault, Shutdown, Sequence Controlled, and Non-Latching. The alarm type is not editable.

8.6.10 Helium Leak Check

The Helium Leak Check Menu window will display the leak check options and will indicate the currently selected leak check options. The options will be Outboard He Leak Check, and No Leak Check. The operator will be allowed to exit the window or change the leak check option.

8.6.11 Password List

The Password List selection from the Configuration Menu manages user levels and passwords. There are two security access levels with permissions as given in Table 8.2.

8.6.12 System Setup

The System Setup window will allow the user to choose Language Option, Edit Date or Edit Time.

8.6.13 Edit Date/Edit Time

The Edit Date/Time 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 for the system.

Chapter 9

Troubleshooting

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

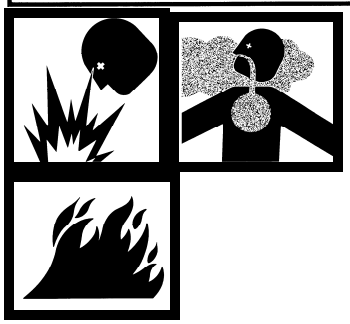
⚠CAUTION

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

⚠WARNING

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.

⚠WARNING



Before attempting to service the system components, close the cylinder valve(s), vent all pressure in the system, and purge all lines that have contained process gas. Tag out and lock out the cylinder valve(s) following the procedure in Safety Chapter 1 Section 11 of this manual to prevent opening while service is being performed. Once the repairs have been made, follow the start-up procedure, in Chapter 8 Section 4 of this manual.

⚠WARNING

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 Troubleshooting the Controller

9.1.1 System Off, No Display 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.
	Verify 24 VDC power supply to PLC and Display	Replace faulty power supply, or controller equipment.

9.1.2 Incorrect Analog Value on Display

Possible Source of Problem	Test	Solution
No Signal or incorrect signal from field device	Verify the field device is connected to the proper input receptacle.	Connect field device to the proper receptacle o the interface box.
	Check the field device for proper operation and calibration.	Repair, or replace as necessary.
Analog input not scaled properly	Verify the input scaling range in the controller configuration.	Set the scaling values to the proper range of the field device.
Input circuit fault	Check for blown fuse on Input circuit.	Replace fuse.
	Follow “Troubleshooting Analog Inputs” procedure To determine location of Fault.	Repair, or replace faulty component as necessary.

9.1.3 Digital Input Not Working

Possible Source of Problem	Test	Solution
No Signal or incorrect signal from field device	Verify the field device is connected to the proper input receptacle.	Connect field device to the proper receptacle o the interface box.
	Check the field device for proper operation and calibration.	Repair, or replace as necessary.
Input circuit fault	Check for blown fuse on input circuit.	Replace fuse.
	Follow “Troubleshooting Digital Inputs” procedure to determine location of fault.	Repair, or replace faulty component as Necessary.

9.1.4 Valve Does Not Open

Possible Source of Problem

	Test	Solution
Instrument nitrogen supply not adequate	Check instrument nitrogen pressure.	Adjust instrument supply pressure to 85-95 psig (5.9-6.6 barg).
No signal to solenoid valve	Check the solenoid valve for proper operation.	Repair, or replace as necessary.
Output circuit fault	Check for blown fuse on output circuit.	Replace fuse.
	Follow "Troubleshooting Digital Inputs" procedure to determine location of fault.	Repair, or replace faulty component as Necessary.

9.2 No or Low Purge Gas Pressure

Possible Source of Problem

	Test	Solution
Closed purge gas cylinder valve	Check position of cylinder valve.	Open cylinder valve, pressure should indicate the current purge cylinder pressure.
Low purge gas cylinder pressure	Check cylinder pressure.	Change cylinder following Cylinder Change Out Procedures found Chapter 8 Section 3 of this manual.
Instrument nitrogen supply not adequate	Check instrument nitrogen pressure.	Adjust instrument supply Pressure 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 Flow

Possible Source of Problem	Test	Solution
No or low purge gas pressure	See Section 9.2 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 process gas cylinder valve	Check position of process gas cylinder valve.	Open cylinder valve, pressure should indicate process cylinder pressure.
Low process gas cylinder pressure	Check process gas cylinder pressure.	Change cylinder following Cylinder Change Out Procedures found in Chapter 8 Section 3 of this manual.
Instrument nitrogen supply not adequate	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 Flow

Possible Source of Problem	Test	Solution
No or low process gas pressure	See Section 9.4 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 the Safety section and read the warnings at the beginning of this Chapter. 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.

9.6.2 Low Pneumatic 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).

PT1 (Process Cylinder Transducer) Alarms
The following are possible process cylinder transducer alarms.

9.6.3 Low Process Cylinder Pressure or Very Low Process Cylinder Pressure

Probable Cause	Corrective Action
Process cylinder is below the low and/or very low setpoint. OR Cylinder valve is not open.	Follow the process cylinder change-out procedure found in Chapter 8 Section 3 of this manual. Ensure cylinder valve is open.

9.6.4 Low Vacuum at PT1

Probable Cause	Corrective Action
Vacuum at PT1 < -5 psig (0.67 barg) due to Vacuum Venturi supply pressure or flow requirement is insufficient. OR PT1 path to vent is isolated either from a closed manual valve or an air operated valve in this path not actuating.	Verify Venturi supply is 75-95 psig (5.2-6.6 barg) and that a flow rate of 50-60 slpm (105-127 cfh) can be achieved. Visually inspect the panel for a closed manual valve in the path to vent and verify 85-95 psig (5.9-6.6 barg) of pneumatic supply pressure is being supplied to the controller.

9.6.5 Low Purge Pressure at PT1

Probable Cause	Corrective Action
Purge pressure at PT1 is less than 70 psig (4.8 barg) due to low purge delivery pressure.	Increase purge delivery to 80-90 psig (5.5-6.2 barg).

9.6.6 High Pressure at Cylinder Connection (Diss, CGA, Keyed VCR, etc.)

Probable Cause	Corrective Action
Process cylinder valve was accidentally opened prior to starting the change cylinder sequence or the post purge sequence.	Ensure the process cylinder valve is closed and enter the Manual Mode (according to the steps in Section 8 of this manual) and evacuate by opening V7, V5 and V1 until PT1 is less than -5 psig (0.67 barg), reinitiate the sequence.

9.6.7 Standby Leak Detected

Probable Cause	Corrective Action
Used on Auto Crossover Systems Only. This alarm monitors process gas retention while a panel is on "Stand-by." Probable causes are V3, V5 or V6 are leaking across the seat.	Remove pneumatic line hoses from these valves and verify absence of pressure. If pressure is present, this indicates a solenoid failure. Contact your Versum Materials, Inc. Technical Representative. Perform a pre-purge sequence with the purpose of removing any debris that may be on the seat of the valves.

9.6.8 Cylinder Connection Leaking

Probable Cause	Corrective Action
Process gas cylinder connection not properly tightened.	***Personal protective equipment (PPE) MUST be worn when a leak is suspected.*** Appropriate PPE is detailed in Chapter 1 Section 9 of this manual. Tighten pigtail cylinder connection to the value specified in the CGA Bulletins found in the Appendix. If leak persists, advise supervisor or contact Versum Materials, Inc.

9.6.9 Cylinder Leaking

Probable Cause	Corrective Action
Process cylinder valve not completely closed.	Close cylinder valve. (Do not overtorque.) Reinitiate program sequence. If failed, assume cylinder valve is leaking and take appropriate emergency response.

PT2 (Process Delivery Transducer) Alarms
The following are possible process delivery transducer alarms.

9.6.10 Low Vacuum at PT2

Probable Cause	Corrective Action
Vacuum at PT2 is < -10 psig (0.7 barg) due to Vacuum Venturi supply pressure or flow requirement is insufficient.	Verify Venturi supply is 70-90 psig (4.8-6.2 barg) at a deliverable flow rate of 50-60 slpm (105-127 cfh).
OR	
An air operated valve in the PT2 path to vent is not actuating.	Ensure that 85-95 psig (5.9-6.6 barg) of pneumatic supply pressure is being supplied to the controller.

9.6.11 Low Purge Pressure at PT2

Probable Cause	Corrective Action
Purge pressure at PT2 is < 10 psig (0.7 barg) due to low purge delivery pressure.	Increase purge delivery to 80-90 psig (5.5-6.2 barg).
OR	
Process regulator set to deliver less than 10 psig (0.7 barg).	Increase process regulator to deliver more than 10 psig (0.7 barg).

9.6.12 Low Process Delivery or Very Low Process Delivery

Probable Cause	Corrective Action

Process delivery pressure is below the low and/or very low setpoint.	Adjust process pressure regulator to the desired delivery pressure.

9.6.13 High Process Delivery Pressure or Very High Pressure

Probable Cause	Corrective Action
Process delivery pressure exceeded the high and very high setpoints	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.

PT3 (Purge Cylinder Transducer) Alarms
The following is a possible purge cylinder transducer alarm.

9.6.14 Low Purge Cylinder Pressure or Very Low Purge Cylinder Pressure

Probable Cause	Corrective Action
Purge cylinder pressure is below user setpoint.	Change purge cylinder following purge gas cylinder procedures in Chapter 8 Section 3 of this manual.

PT4 (Purge Delivery Transducer) Alarms
The following are possible purge delivery transducer alarms.

9.6.15 Low Purge Delivery Pressure

Probable Cause	Corrective Action
Purge delivery pressure is below user setpoint.	Adjust purge gas pressure regulator to the desired pressure. Change purge cylinder as required following procedures in Chapter 8 Section 3

9.6.16 High Purge Delivery Pressure

Probable Cause	Corrective Action
Purge gas delivery pressure is too high.	Adjust purge pressure regulator to the desired pressure. Observe regulator for proper operation. Advise supervisor or contact Versum Materials, Inc. if regulator will not maintain setpoint.

PT5 (Vent Line Transducer) Alarms
The following are possible vent line transducer alarms.

9.6.17 High Vent Pressure

Probable Cause	Corrective Action
Vent line pressure is above user setpoint	Check pollution abatement equipment for obstruction.

9.6.18 Low Vacuum Generated PT5

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

PT8 (Purge Header Transducer) Alarms
The following are possible purge header transducer alarms. This transducer is located downstream of the purge panel and purge purifier (if installed).

9.6.19 High Purge Delivery PT8 or Very High Purge Delivery PT8

Probable Cause	Corrective Action
V4 (Purge Gas Inlet Valve) and check valve failure resulting in process gas entering the common purge header.	Verify alarm was not caused by high purge gas delivery pressure. If not, assume V4 is leaking and purge panel, purge purifier and purge cylinder are contaminated with process gas. Take appropriate action. Contact an Versum Materials, Inc. Representative for assistance.

If V4 is leaking and purge panel, purge purifier and purge cylinder are contaminated with process gas. Take appropriate action. Contact an Versum Materials, Inc. Representative for assistance.

9.6.20 Low Purge Delivery Pressure

Probable Cause	Corrective Action
Purge Delivery pressure is below user setpoint	Adjust purge gas pressure regulator to the desired pressure. Change purge cylinder as required following procedures in Chapter 8 Section 3.

9.6.21 High Purge Delivery Pressure

Probable Cause	Corrective Action
Purge gas delivery pressure is too high	Adjust purge pressure regulator to the desired pressure. Observe regulator for proper operation. Advise supervisor or contact Versum Materials, Inc. if regulator will not maintain setpoint.

Scale Alarms
The following is a possible scale alarm.

9.6.22 Low Cylinder Weight or Very Low Cylinder Weight

Probable Cause	Corrective Action
Process cylinder weight is below setpoint.	Change cylinder following procedure found in process cylinder change procedures in Chapter 8 Section 3.

9.7 Troubleshooting Procedures

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.

Before performing troubleshooting, review the Safety section and read the warnings at the beginning of this chapter. If at any time during troubleshooting, you are unsure what to do next, DO NOT CONTINUE, contact Versum Materials, Inc..

9.7.1 Troubleshooting Analog Inputs

9.7.1.1 Blown fuse

1. The analog input circuits are grouped 4 to a fuse. Determine which fuse is blown by identifying the four analog inputs that are faulted.

2. Turn off power to the system.

3. Remove the blown fuse from the fuse holder and use an ohm meter to verify that the fuse is bad.

4. Check each of the associated analog circuits for a short circuit by performing an ohm test between points JAIx-1 and JAIx-3 (x = analog input number).
    a. If a short circuit is detected then disconnect the associated field device from the interface box and perform the ohm test again. If the short circuit goes away then field device is probably defective. Replace the field device. Continue to next step.
    b. If the short circuit remains after the field device is disconnected then the fault exists in the cables, connectors, or other internal circuitry of the controller. Replace the cables, or connectors, one at a time, as necessary until the short circuit is eliminated. Continue to next step.

5. Replace the blown fuse with a new fuse.

6. Re-establish power to the system.
    a. If the fuse blows again then more advanced troubleshooting skills may be required to isolate the fault.

9.7.2 Troubleshooting Digital Inputs

9.7.2.1 Blown fuse

1. Determine which fuse has blown and remove it from the fuse holder.

2. Turn off power to the system.

3. The digital input circuits are grouped 16 to a fuse. Determine which digital circuits are associated with the blown fuse and check each one for a short circuit by performing an ohm test from the fuse output to 24vdc common.
    a. If a short circuit exists then disconnect each associated field device, one at a time, from the interface box, or customer terminal until the short circuit goes away.
    b. If the short circuit goes away then the fault exists in the field device, or field circuitry. Replace, or repair as necessary. Continue to next step.
    c. If the short circuit remains after the field devices are disconnected then the fault exists in the cables, or connectors somewhere between the PLC Interface Board and the Interface Box. Replace the cables, or connectors, one at a time, as necessary until the short circuit is eliminated. Continue to next step.

4. Replace the blown fuse with a new fuse.

5. Re-establish power to the system.
    a. If the fuse blows again then more advanced troubleshooting skills may be required to isolate the fault.

9.7.3 Troubleshooting Digital Outputs

9.7.3.1 Blown fuse

1. Determine which fuse has blown and remove it.

2. The digital output circuits are grouped 16 to a fuse. Determine which digital output circuits are associated with the blown fuse. Disconnect all associated devices (unplug the solenoid connector, and unplug any other connections at the interface box).

3. From the HMI display, manually close all valves associated with the blown fuse.

4. Replace the blown fuse with a new one.
    a. If the fuse blows immediately then the short circuit is somewhere within the PLC I/O, interface board, or cables. Replace the associated components, one at a time, as necessary until the short circuit is eliminated. Continue to next step.

5. Turn off instrument air to the solenoids to prevent opening process valves during troubleshooting.

6. Test each valve output by cycling the valve on and off from the HMI display. Verify that the LED on the PLC output card turns on.
    a. If the fuse blows at any time during this test then the short circuit is somewhere within the PLC I/O, interface board, or cables. Replace the associated components, one at a time, as necessary until the short circuit is eliminated. Continue to next step.

7. Reconnect the solenoid connector and cycle each of the valves from the HMI display again. Also, reconnect any other devices and power those outputs as well.
    a. If the fuse blows when any of the devices is tested then that may be the faulty device. Replace as necessary. Continue to next step.

8. Replace the blown fuse with a new fuse.

9. Turn instrument air back on.

Chapter 10

Maintenance

Section 1 **Warranty**

Section 2 **Routine Maintenance**

Section 3 **Component Expected Life**

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 system components, all pressure in the system should be relieved and electrical power to the system turned off. Close the cylinder valve(s) and then vent all pressure in the system. Purge out all process gas lines and seal them. The process gas cylinder must be removed from the gas source system following the process cylinder procedures in Chapter 8 Section 3 of this manual. Tag out and lock out the cylinder valve(s) (see Chapter 1 Section 11) to prevent opening while service is being performed. Once the maintenance is complete, helium leak test the system using a mass spectrometer. Follow the start-up procedure, in Chapter 8 Section 4.

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 Gas Guard 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: Every cylinder change and at the start of an extended shutdown. It is recommended that panels in corrosive service (including standby side) be purged at least once every 3 months.
		All other process gases: Every cylinder change
Cylinder Connection Gasket/Filter	Replace gasket each time the cylinder connection is broken. Do not reuse.	As required
Process/Purge Pigtail	Examine cylinder connection face seal for scratches, plugging, or corrosion. Replace the pigtail if there is evidence of damage.	Every cylinder change
	Check flex-hoses for signs of wear.	Every cylinder change or every 3 months (whichever comes first)
	Replace as recommended.	See Section 10.3
Cylinder Connection Gasket/Filter	Replace gasket each time the cylinder connection is broken. Do not reuse.	As required
Process/Purge 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 Section 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 cylinder change or Every 3 months (whichever comes first)

Cabinets 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 source 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.
Cabinet 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
Cylinder Restraints	Visually inspect for wear. Verify cylinder is properly secured.	Every cylinder change or every year (whichever comes first)
Pressure Monitors (Transducer, Switch, Transmitter, Gauge)	Check pressure readings against the cylinder change checklist pressure readings. If process gas pressure must be adjusted, monitor the delivery pressure for a smooth increase or decrease.	Every cylinder change
	Verify zero.	Yearly
	*Function Test Pressure Switches for safety critical alarms. Where applicable, verify: • High pressure cylinder 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
Safety Relief Valves	* Test safety relief valves (or replace with new) to ensure they relieve at manufacturer's specified pressure setting. Replace any defective safety relief valves. Caution: Shut down piping circuit and remove SRV before performing test. Never intentionally overpressurize the system components.	Corrosives: Every 3 years or as dictated by local code (whichever comes first)

		All others: Every 4 years or as dictated by local code (whichever comes first)
Purifiers	Replace as recommended.	See Engineering Specification 4WEQ-9509
Vacuum Venturi	Verify vacuum readings.	Every cylinder change
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
UV Source for auto self-check	Replace as recommended.	See Section 10.3
Temperature Switch	* Test temperature switch.	Every 2 years
Scales	Verify zero or calibrate to known weight.	Yearly or at every cylinder change if cylinder life exceeds 1 year.
Sprinklers	Inspect for corrosion or damage. Verify that wax coating is intact. Verify that discharge path to cylinder is clear.	Yearly
VCR Gaskets	Replace each time a connection is broken. Do not reuse.	As required
Cylinder Heaters (TCU, Temperature Control Units)	Test over-temperature interlocks.	2 years
Power Supply	Replace as recommended.	See Section 10.3
	Verify power supply voltage is between 5.1 and 5.2 VCD. Adjust as necessary following proper Versum Materials, Inc. operational procedures.	Yearly
Instrument Air Pressure Transmitter	Check that pressure transmitter is in working condition.	Yearly
TFT Touch Screen	Check for readability and brightness. Adjust contrast as	Yearly

	necessary. Replace backlight as necessary.	
E-Stop	* Test E-Stop.	Yearly
Keypad Membrane	Check each dome button. Look for mis-keying and multiple stroking. Check for proper sealing of adhesive around edge of graphic.	Yearly
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
Door Locking Prop	Check that prop locks and stays in place until locking button is depressed	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 Section 4.1 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 Chapter 10 Section 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
Cylinder Connection Gasket	Every cylinder change
Process Pigtail	Corrosives/Diborane/Pyrophorics: 3 years
	SST tubing for Noncorrosives: 5 years
	Flexhose for inert service: 6 years
	Flexhose for flammable service: 3 years
Conical Filter (downstream of pigtail)	Corrosives/Diborane/Pyrophorics: 3 years
	Noncorrosives: 5 years
Pressure Transducers	10 years
Process Regulator	Diborane: 2 years
	Corrosives: 5 years
	All others: 10 years
Purge Regulator	10 years
Excess Flow Switch	10 years
Valves	10 years
Purifiers	See 4WEQ-9509
Purge Pigtail	SST Tubing: 10 years Flex-hose: 6 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
Scales	10 years

Electrical Components Expected Life

Component	**Expected Life / Recommended Minimum Changeout Frequency**
Power Supply	3 years
HMI TFT Touch Panel	Change out as necessary. Expected Life is 5–10 years
Gasket	Indoor: 10 years
	Outdoor: 10 years
System Controller	10 years

Chapter 11

System Specific Information

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 TE11 Recommended Spare Parts

11.2.1 TE11 Controller Spare Parts

NOTE: Data is from document BAJ001TCHMAN004; Rev-4

Item	Category	Critical Spare Part (Qty)	Recommended Spare Part (Qty)	Manufacturer	VERSUM MATERIAL	Description
1	CPU	1	0	Siemens	6ES7 215-1AG40-0XB0	Simatic S7-1200, CPU1215C, Compact CPU, DC/DC/DC, 2 Profinet Port, Onboard I/O: 14 DI 24V DC; 10 DO 24VDC 0.5A 2 AI 0-10V DC, 2 AO 0-20mA DC, Power Supply: DC20,4 - 28.8 V DC, Program/Data Memory: 100KB, Siemens part # 6ES7 215-1AG40-0XB0
2	Analog	1	0	Siemens	6ES7 231-4HF32-0XB0	Analog Input Card, 8 Channel, 12 bit, Siemens part # 6ES7 231-4HF32-0XB0
3	Expansion I/O	1	0	Siemens	6ES7 223-1BL32-0XB0	Discrete I/O Card, 16 DI / 16 DO, 24VDC, Siemens part # 6ES7 223-1BL32-0XB0
4	Expansion I/O	1	0	Siemens	6ES7 222-1BH32-0XB0	Discrete I/O Card, 16DO Relay, 24VDC, Siemens part # 6ES7 222-1BH32-0XB0
5	TFT Touch Screen	1	0	Weintek Labs	MT8102iE	EasyView- Display, 10.1", 1024x768 TFT LCD Touch Weintek Part # MT8102iE
6	Fuse	2	0	Glorytech	1712050044	MicroFuse, 125 VAC, 500mA, 0,17LG Leads
7	Fuse	3	0	Glorytech	1712020044	MicroFuse, 125 VAC, 200mA, 0,17LG Leads
8	Power Supply	1	0	MEAN WELL	RS-75-24	24VDC, 3.2A
9	Circuit Breaker	1	0	SCHNEIDER	C60N	2A Miniature Circuit Breaker
10	Pressure Gauge With Switch	1	0	SMC	GP46-10-01M-C	Pneumatic Pressure Gauge With Switch
11	Air Filter	0	1	SMC	AF10-M5-Z	Air Filter

Item	Category	Critical Spare Part (Qty)	Recommended Spare Part (Qty)	Manufacturer	VERSUM MATERIAL	Description
12	Pneumatic	0	1	SMC	VQZ115K-5L1-M5-PR	Hardware Valve
13	Pneumatic	0	1	SMC	VQ110Y-5L	Pneumatic Valve
14	Pneumatic	0	1	SMC	VQZ100-FB	13 Valve Pneumatic Manifold Base
15	Pneumatic	0	1	SMC	M-5P	Pneumatic Manifold Plug
16	Needle Valve	0	1	SMC	AS2001F-07-03	Z-Purge meeting valve
17	Circuit board	0	1	VERSUM MATERIALS, INC.	ATMI-L	Gasguard TEx Left Interface Board Circuit Diagram
18	Circuit board	0	1	VERSUM MATERIALS, INC.	ATMI-R	Gasguard TEx Right Interface Board Circuit Diagram
19	Circuit board	0	1	VERSUM MATERIALS, INC.	ATMI-P	Gasguard TEx Lamp Board Circuit Diagram
20	Circuit board	0	1	VERSUM MATERIALS, INC.	ATMI-T	Gasguard TEx Terminal Block Board Circuit Diagram(Green Terminal Option)
21	Circuit board	0	1	VERSUM MATERIALS, INC.	ATMI-D	Gasguard TEx D Connector Interface Board Circuit Diagram (D-Sub Connector Option)
22	Miscellaneous	0	1	IDEC	AVW411ERP	Push Button – Mushroom Head - Red
23	Miscellaneous	0	1	IDEC	LW1Z-1X4	Alarm Horn

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

11.2.2 Source Recommended Mechanical Spare Parts

Process Panel

Process Pigtail

Purge Pigtail

Purge Panel

Purge Purifier (if used)

Process Purifier (if used)

Process Out Spool

Process Crossover Spool (if used)

Purge Crossover Spool

Vacuum Venturi Spool

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, cylinder rack frame or cylinder wall mount frame.

Figure 1: Equipment Commodity Code Number on a TE11 Gas Cabinet

11.3 Program Logic Chart

The program logic chart for the system follows this page.

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.

*S*emiconductor *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)	:	1-800-424-9300 (CHEMTREC) and (+1) 703-741-5970 (CHEMTREC)

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 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 : Wear self contained breathing apparatus for fire fighting if necessary.

for fire-fighters

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 a Versum Materials 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.