Installation Manual

for the

Gasguard® 450 Gas Cabinet and Purge Panel Systems

Commodity Number: 809-602775B

Revision B: April 4, 1995

Air Products and Chemicals, Inc.
1919 Vultee Street
Allentown, PA 18103

AIR PRODUCTS

Installation Manual Matrix Sheet for the Gasguard® 450 Gas Cabinet and Purge Panel Systems

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Manual Section	Revision Level	Reason for Revision
Cover and Front	B	General Revision
Introduction	B	General Revision
Section 1: Safety Warnings	B	General Revision
Section 2: Dimensions and Mounting	B	General Revision
Section 3: Tubing Connections	B	General Revision
Section 4: Electrical Connections	B	General Revision
Section 5: Helium Leak Testing	B	General Revision
Section 6: Cabinet Functional Checklist	B	General Revision
Appendix	B	General Revision

Important Safety Information

Read and understand the safety warnings in on pages 1-1 to 1-3 of 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:

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

System Hazards:

Possible hazards when **<u>installing</u>** this system are exposure to:

- **Pressurized Fluids / Gases**
- **Oxygen Deficient Atmospheres**
- **Electrical Hazard**
- **Falling Equipment Hazard**

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

Table of Contents

Introduction

This manual covers the tasks required to install the Gasguard 450 Gas Cabinet and Purge Panel System. 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.

The Gasguard 450 cabinets 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.

Section 1: Safety Warnings

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

1.1 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.

1.2 Pressurized Fluids / Gases

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. The water sprinkler lines contain pressures of 30 psig. 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.***

1.3 Electrical Hazard

Electric shock can cause personnel injury or death.

The control circuits for the system use 115/220 VAC (optional 24 VDC), 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.***

1.4 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 installing the system, extreme care needs to be taken to support it properly. Due to the top heavy nature of the system, if not installed properly, it could tip over, injuring, crushing or possibly killing personnel in the area.

Section 2: Dimensions and Mounting

2.1 Outline Dimensions

Figures 2.1 through 2.4 below, show the outline dimensions for the various cabinets and racks.

Note: These dimensions are typical. See the installation drawings in the Appendix for specific dimensions for this system.

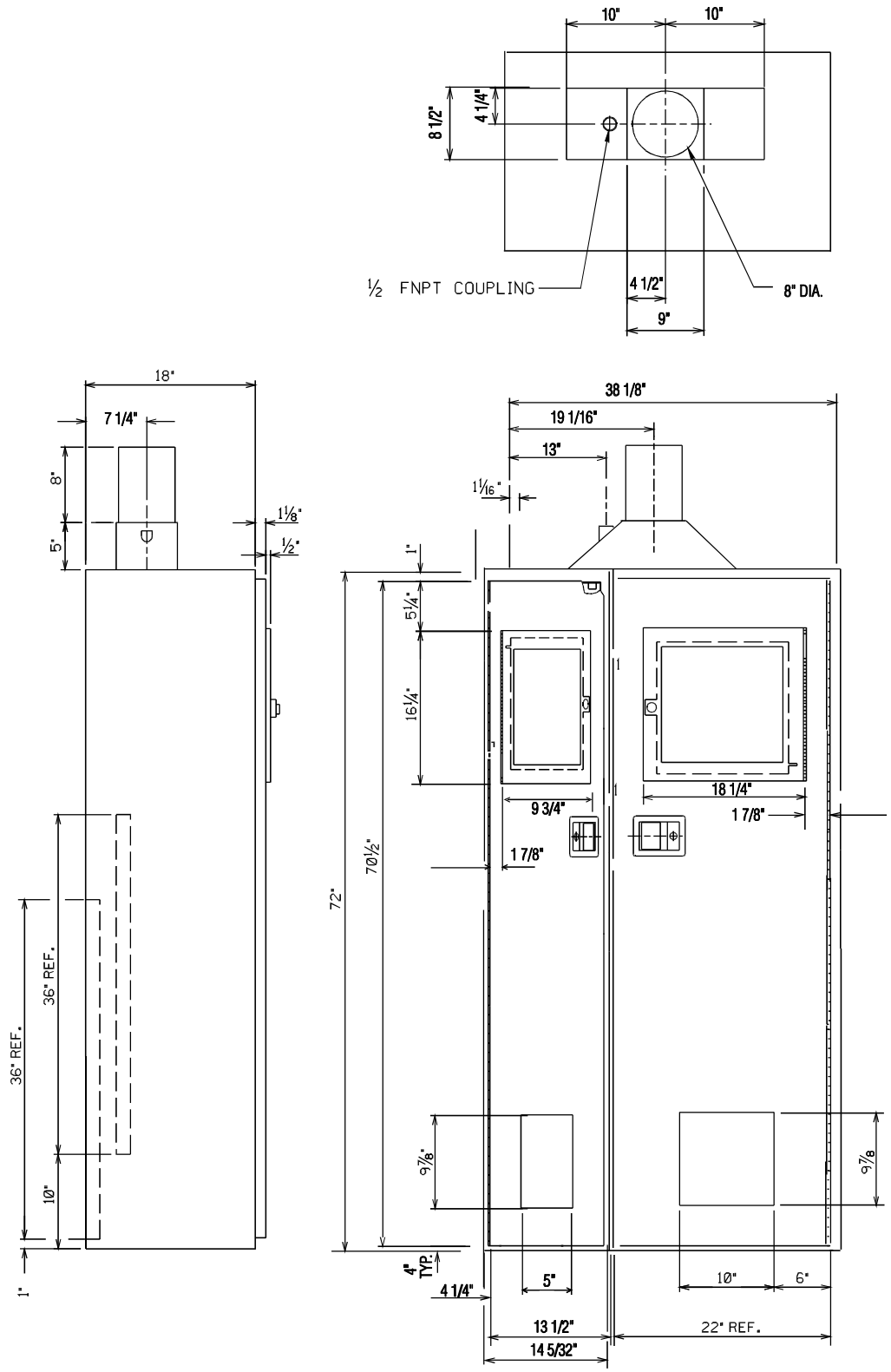

Figure 2.1: Outline Dimensions for 3 Cylinder Cabinet

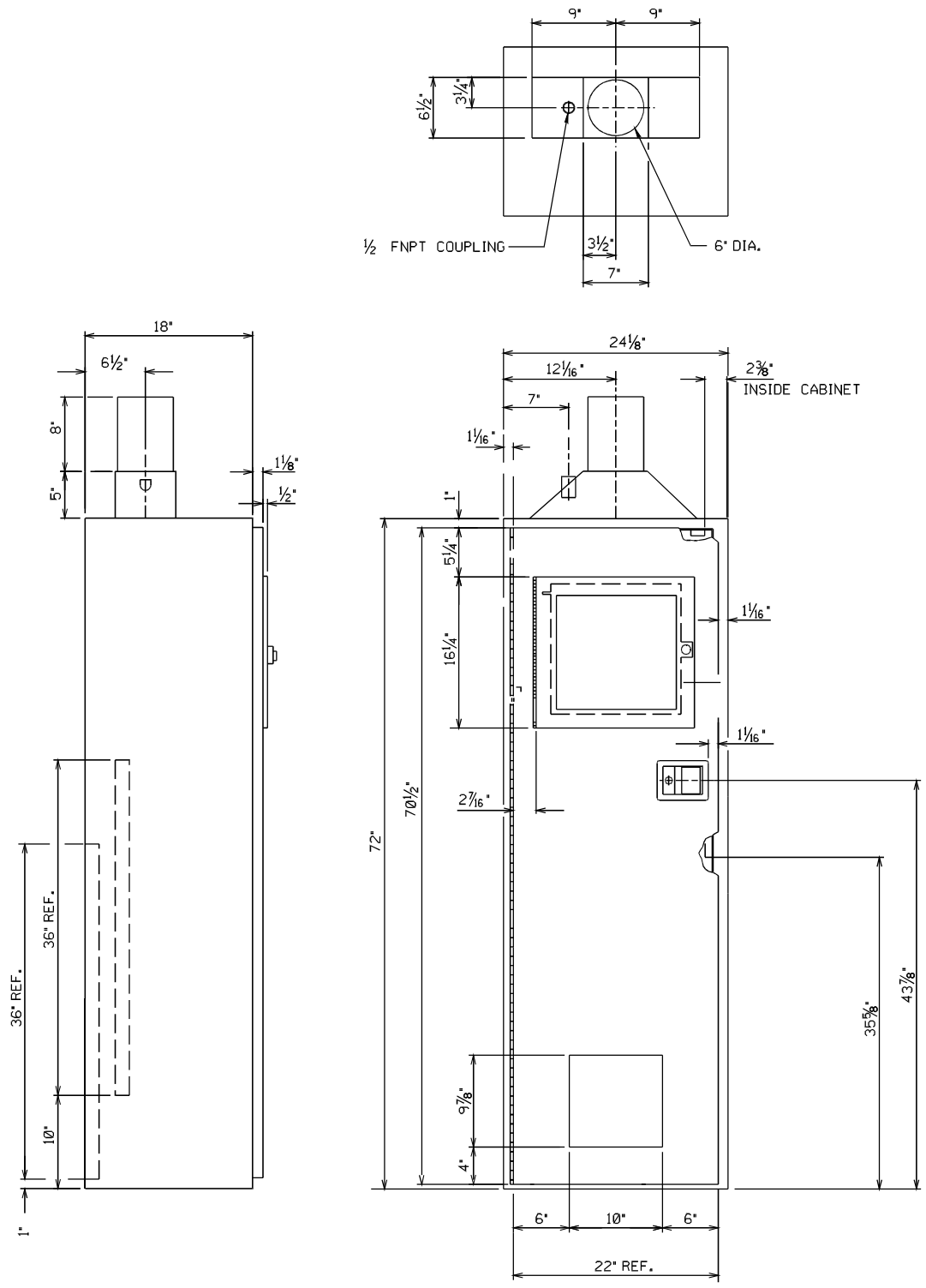

Figure 2.2: Outline Dimensions for 2 Cylinder Cabinet

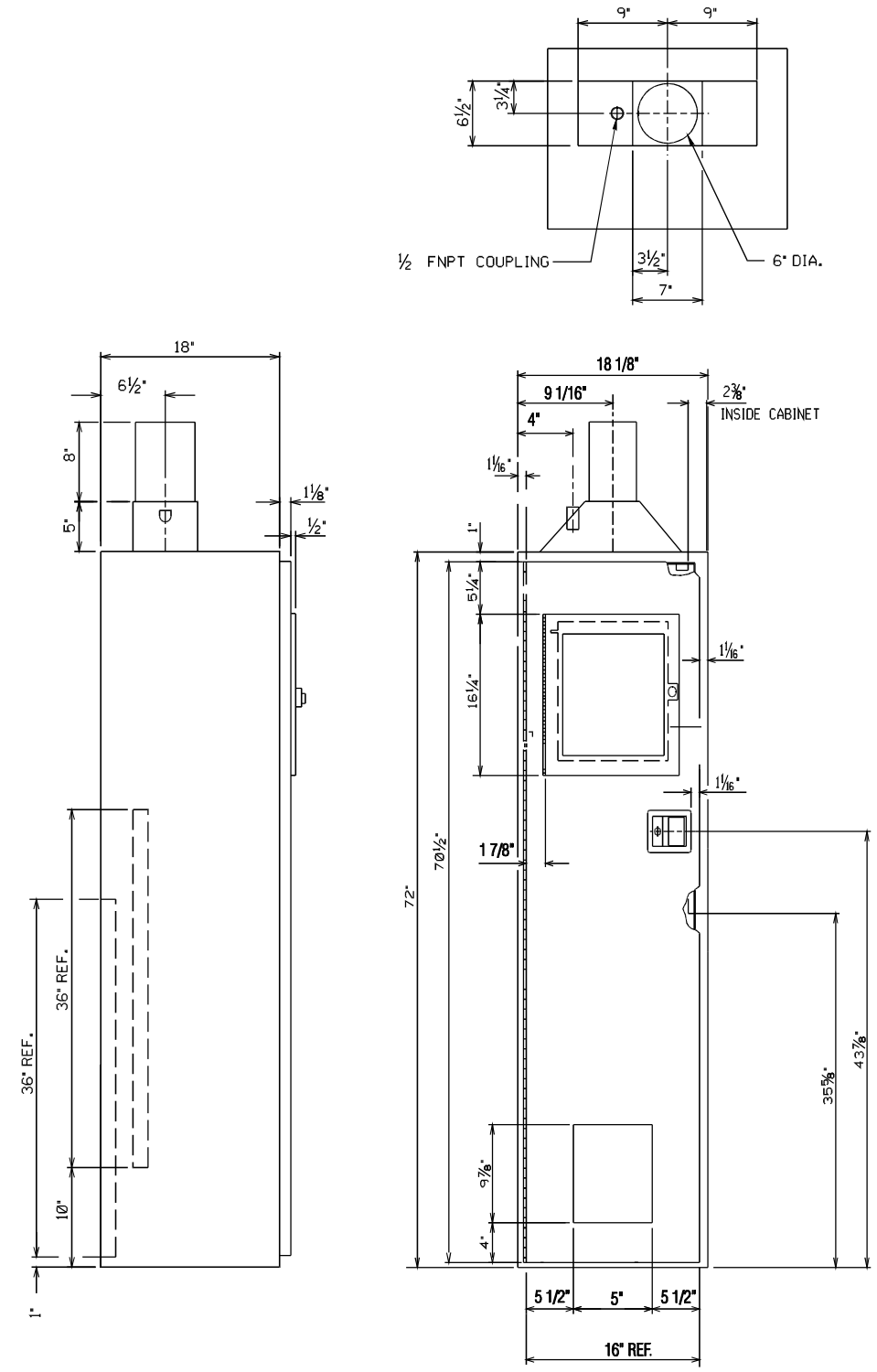

Figure 2.3: Outline Dimensions for 1 Cylinder Cabinet

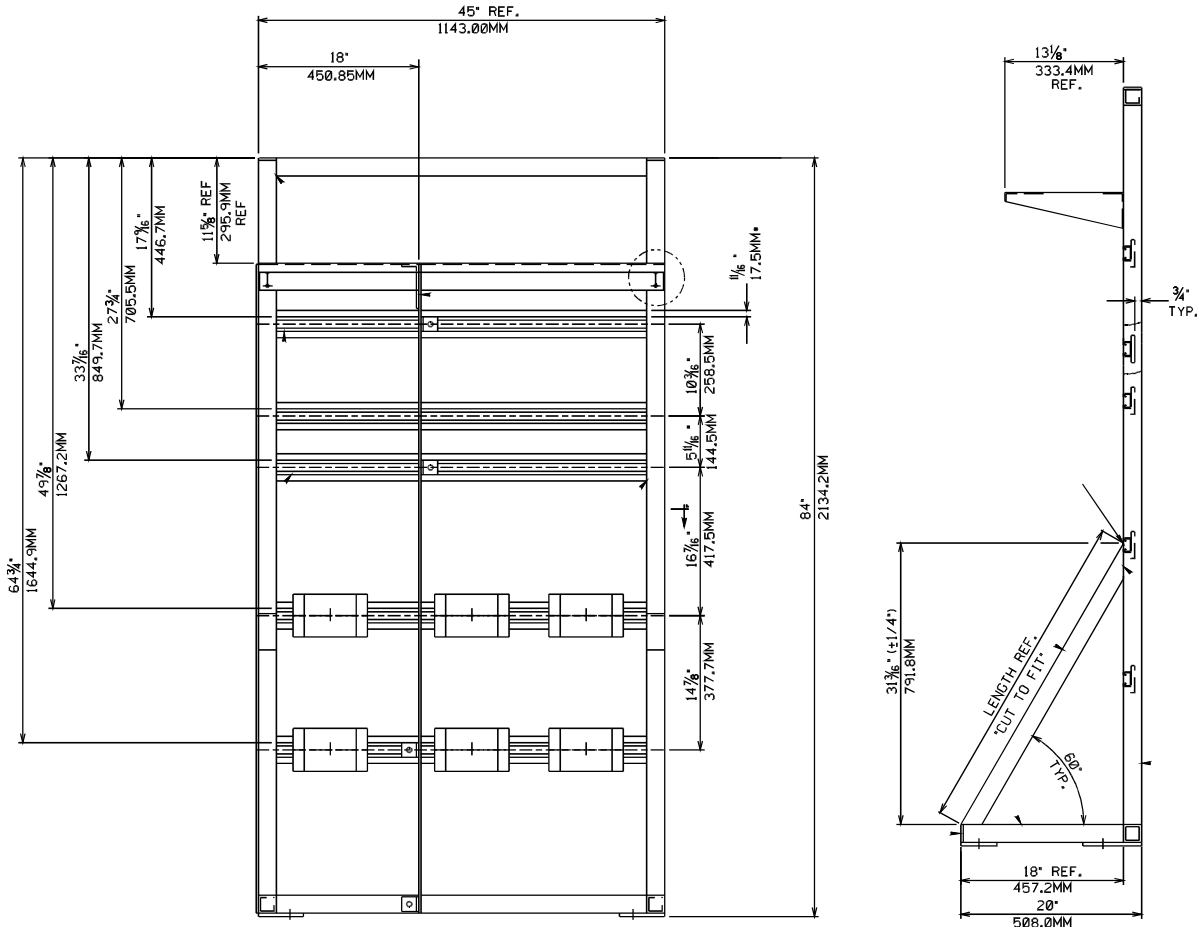

Figure 2.4: Outline Dimensions for Typical Silane Rack Assembly

2.2 Mounting Hole Locations

The Gasguard 450 cabinet and racks are mounted to the floor using the four (4) 3/8" holes located in each corner of the cabinet base. See Figures 2.5 through 2.8 for mounting hole locations for the various configurations. The mounting location should be clean and level.

NOTE: Do not use the four inner holes for mounting the units. Those holes are used for shipping pad installation.

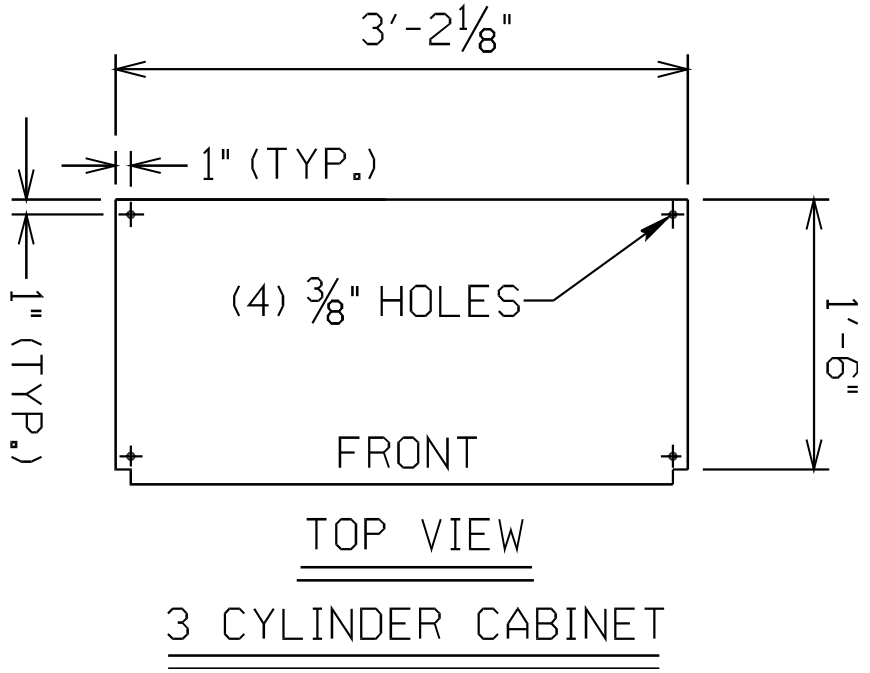

Figure 2.5: Mounting Hole Locations for 3 Cylinder Cabinet

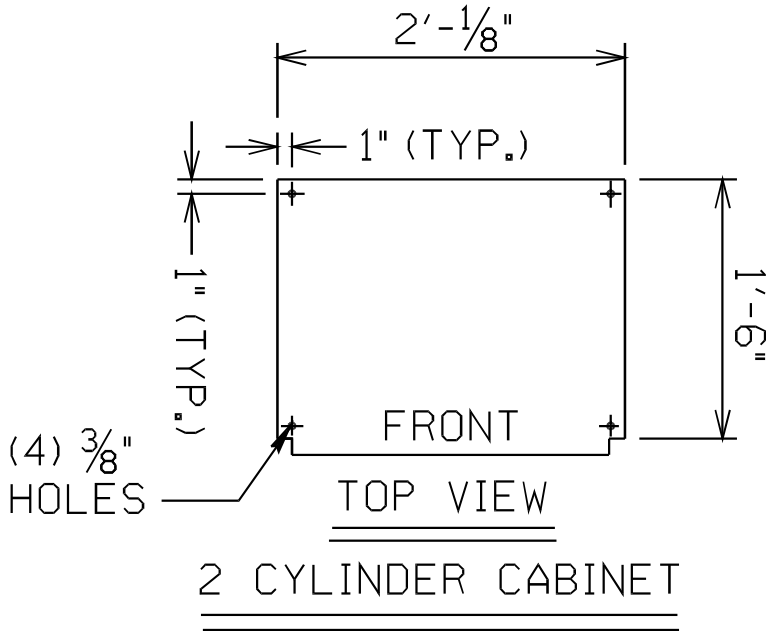

Figure 2.6: Mounting Hole Locations for 2 Cylinder Cabinet

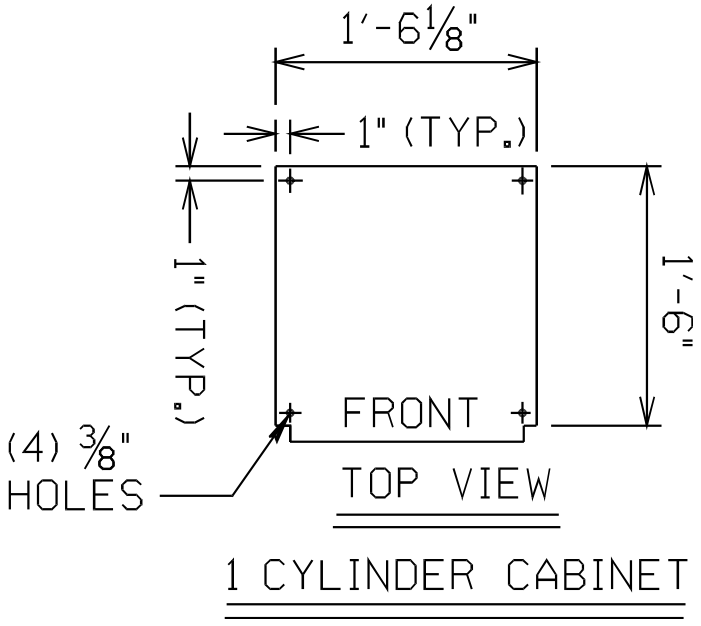

Figure 2.7: Mounting Hole Locations for 1 Cylinder Cabinet

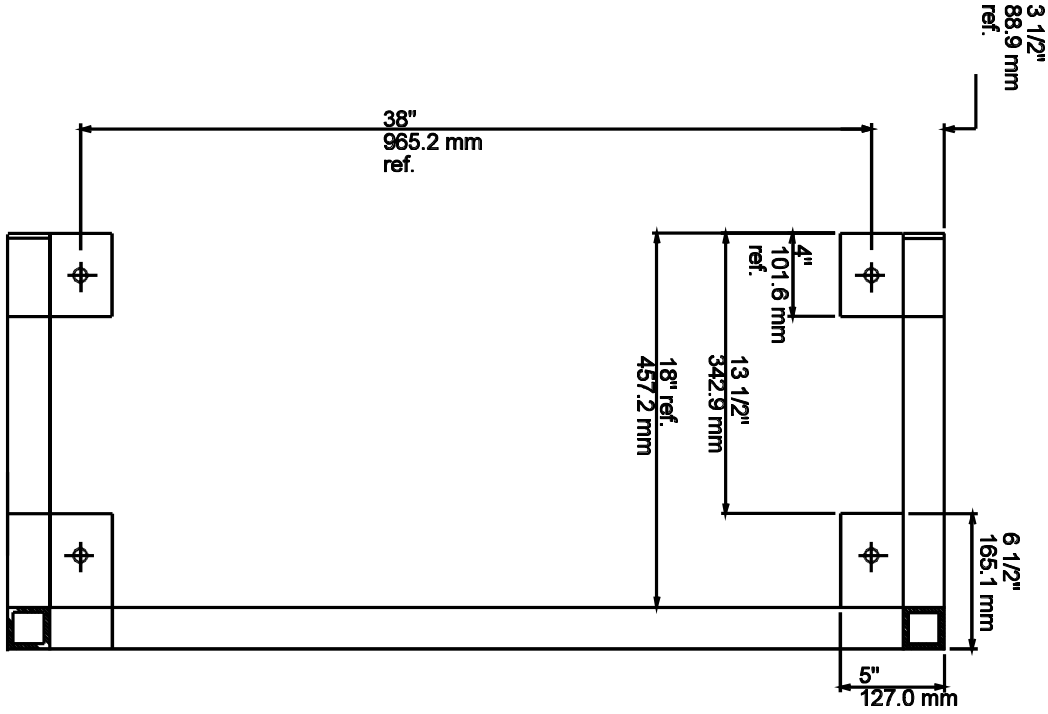

Figure 2.8: Mounting Hole Locations for Rack Assembly

2.3 Open Controller Dimensional Requirements

The dimensions of the controller, when opened, are detailed in Figure 2.9 below.

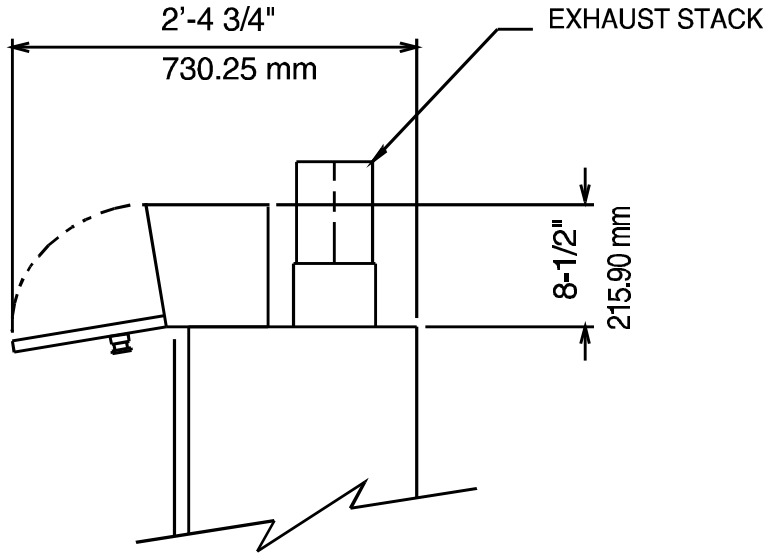

Figure 2.9: Dimensions of Open Controller (side view)

Section 3: Tubing Connections

All tubing should be designed and installed following the local piping codes and the following:

- ASME B31.3 "Chemical Plant and Petroleum Refinery Piping"
- SEMC-005 "UHP Tubing and Fitting Specification" (found in the Appendix)

Tubing must be sized to flow the maximum amount of gas required by the process system. All tubing is constructed of 316L stainless steel.

All tubing connections are made at the top rear of the cabinet. All tube stubs are labeled with their function. Process and purge lines are double bagged and taped for shipment. Vent and venturi supply lines are single bagged. The tube end has been faced and is ready for welding to facility piping. Welding should be performed using established high purity welding techniques.

3.1 Tubing Interconnections

Process outlet: (coaxial tubing option)	1/4" diameter, 0.035" wall thickness (coax - 1/2" diameter, 0.035" wall)
Venturi inlet:	1/4" diameter, 0.035" wall thickness
Purge inlet:	1/4" diameter, 0.035" wall thickness
Vent outlet:	3/8" diameter, 0.035" wall thickness

Figure 3.1 shows typical two cylinder installation connection points. See the drawings located in the Appendix of this manual for the specific piping connection locations for this system.

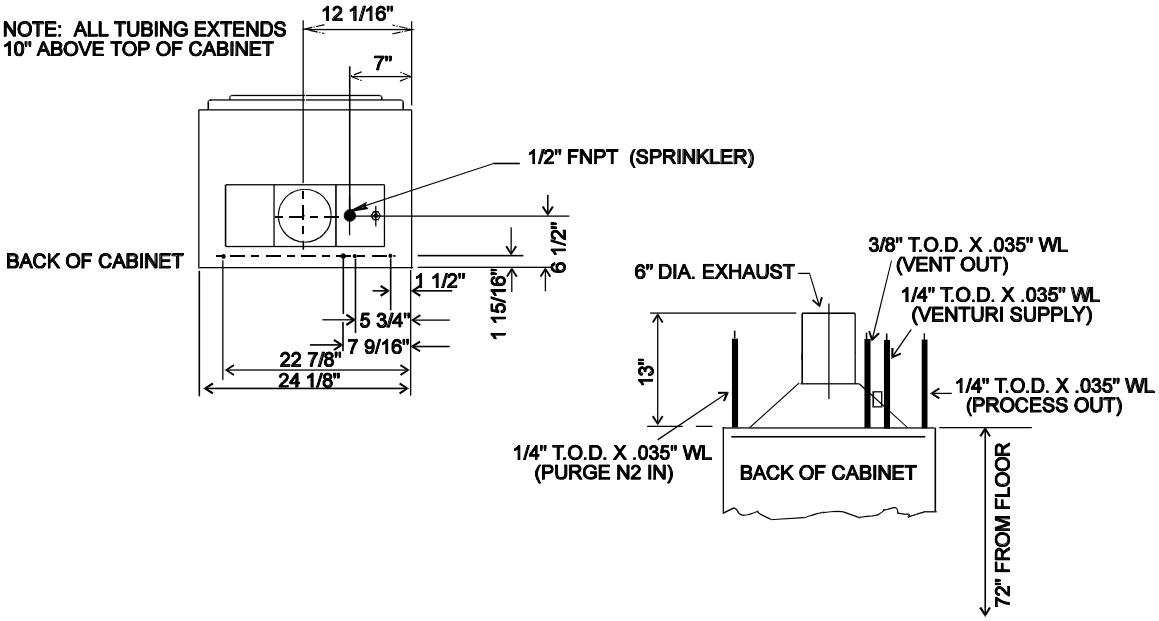

Figure 3.1: Typical 2 Cylinder Installation Connection Points

WARNING

The above figure shows typical installation connection points. Reference the system drawings for the exact tubing connection locations for your system.

3.2 Process Line Connection

The process line connection is designed to use a 1/2" stainless steel outer jacket which can be attached to a coaxial tee supplied at the gas cabinet. This outer jacket is either pressurized with nitrogen at a pressure above that of the process line and monitored with a pressure switch, or purged with nitrogen into an exhaust system which contains gas detection devices. Full cylinder pressures could be introduced into the process line under certain component failures. A shutdown signal must be supplied to the gas cabinet if a leak in the process line is detected using one of the above monitoring methods. This requirement is from a model

ordinance for toxic gas regulation from the state of California. In other geographical locations, reference all other industrial, federal, state and local Uniform Building Codes and ordinances that apply.

Figure 3.2 shows a typical coaxial tee type process line connection. Figure 3.3 shows an alternate process line connection.

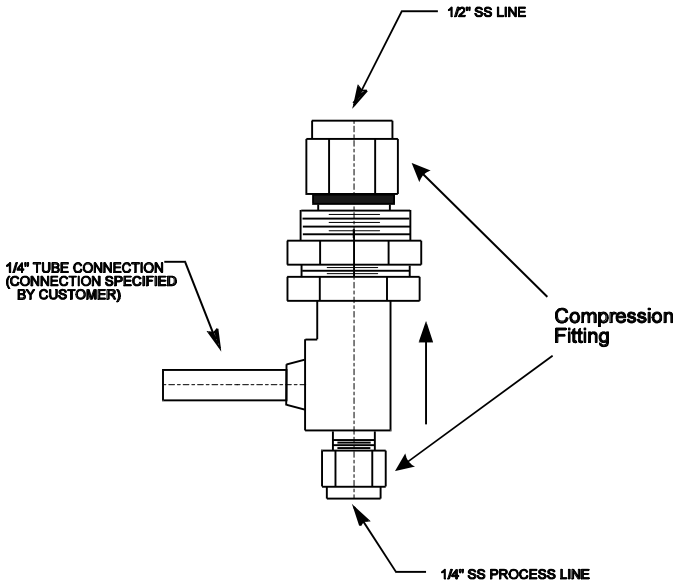

Figure 3.2: Typical Process Line Connection

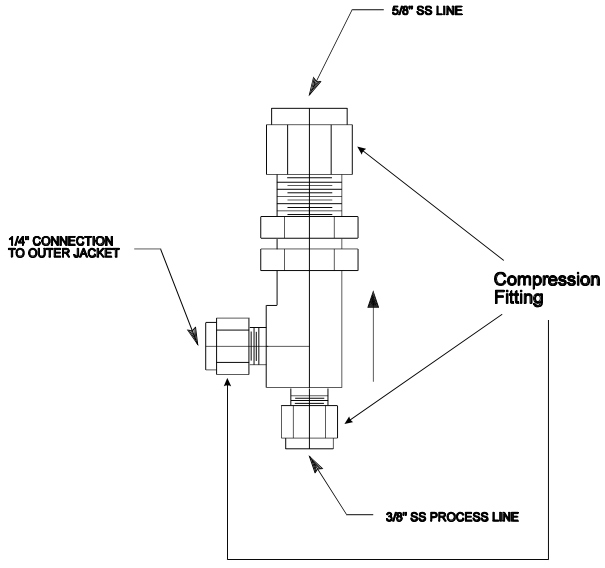

Figure 3.3: Alternate Process Line Connection

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 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 Air Products Representative for this information. A nitrogen trickle purge is constantly bled into the vent line to maintain an inert atmosphere when certain corrosive and pyrophoric gases are being used. The flow rate of this trickle purge is approximately 2-5 SLPM (4-10 SCFH). Figure 3.4 below shows a typical trickle purge assembly. An alternate trickle purge assembly may contain a trickle flow valve. This valve typically has a 0.010" orifice and may be used as an alternative for the trickle flow bypass shown in Figure 3.4.

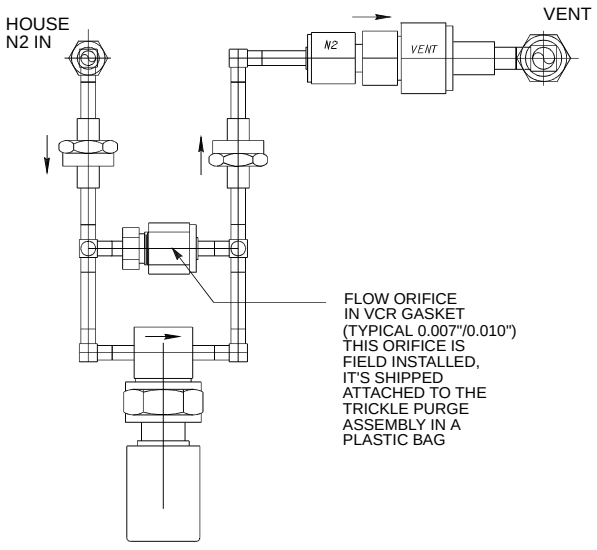

Figure 3.4: Trickle Purge Assembly

3.4 Venturi Line

Air Products strongly recommends a 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 Air Products representative for design details.

The venturi line requires 75-95 psig 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 of nitrogen during purge cycles.

3.5 Purge Line

A purge inlet line may be provided when the nitrogen purge cylinder is not included in the cabinet. This purge line must be connected to the designated purge source for the cabinet. The pressure required during cylinder purging is 80-90 psig. If an external purge source is used, sufficient over pressure protection must be provided. Do not exceed the gas cabinet component maximum allowable working pressure (MAWP) in the event of purge source regulator failure. If an internal purge cylinder is included in the cabinet the purge line connection does not apply.

The purge gas source for the gas cabinet should be used only to purge other gas cabinets or VMBs handling the same process gas. It must not be used to purge systems handling other process gases. It is recommended that the purge gas cylinders be placed in an exhausted enclosure.

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 75-95 psig. The flow rate required for pneumatic valve operation is negligible.

Typically this supply is taken from a bulk liquid source and can be branched from the venturi line supply. A 1/4" Swagelok® connection at the back of the controller is supplied for the pneumatic supply inlet connection. Overpressurization protection must be provided for the solenoids.

In Class I, Division II applications this supply is also used for Type Z purge of the electrical enclosure per NFPA Article 496. The Type Z purge will require an average of approximately 6 SCFH of nitrogen flow into the enclosure.

3.7 Cabinet Exhaust System Requirements

The gas cabinet must be connected to an exhaust system that is capable of meeting the following criteria:

1. A minimum of 200 feet per minute air velocity must be achieved across an opened access hatch to prevent operator exposure to hazardous gas. This velocity must be achieved as an average with 150 feet per minute minimum at any point of the opening.
2. A minimum volume of air must flow through the cabinet to prevent a leak of hazardous gas from escaping the cabinet.
3. In silane service, an air velocity of 200 feet per minute must be achieved across all unwelded fittings per UFC Article 80, Section 8004.1.18, 1994 edition.

The table below lists the exhaust requirement for GG450 Cabinets to meet the above requirements.

Standard Cabinet (Width)	Duct Size	Hatch Status	Exhaust Requirement	Static Pressure Requirement (inches water column)
1 cylinder (18")	6"	Open	205 CFM	0.09"
		Closed	175 CFM	0.42"
2 cylinder (24")	6"	Open	335 CFM	0.23"
		Closed	225 CFM	0.30"
3 cylinder (38")	8"	Open	370 CFM	0.09"
		Closed	356 CFM	0.30"

Silane (SiH4) Cabinet	Duct Size	Hatch Status	Exhaust Requirement	Static Pressure Requirement (inches water column)
1 cylinder	6"	Open	350 CFM	0.25"
		Closed	325 CFM	0.31"
2 cylinder	6"	Open	490 CFM	0.49"
		Closed	475 CFM	0.55"

The static pressure is measured in the exhaust duct 3 to 6 inches above the entrance to the round duct.

Baffles are used within the enclosure in silane service to direct the major portion of the exhaust flow across the panel piping.

This exhaust system must be independent of any general plant exhaust system and must be designed for the types of gases being used. Ensure that only compatible gases are fed into the exhaust system. Be certain the exhaust system power and shut down interlocks comply with UFC and NFPA code requirements.

Figure 3.6 shows the typical exhaust hook-up location. See installation drawing in the Appendix for specific location and size of exhaust duct on cabinets.

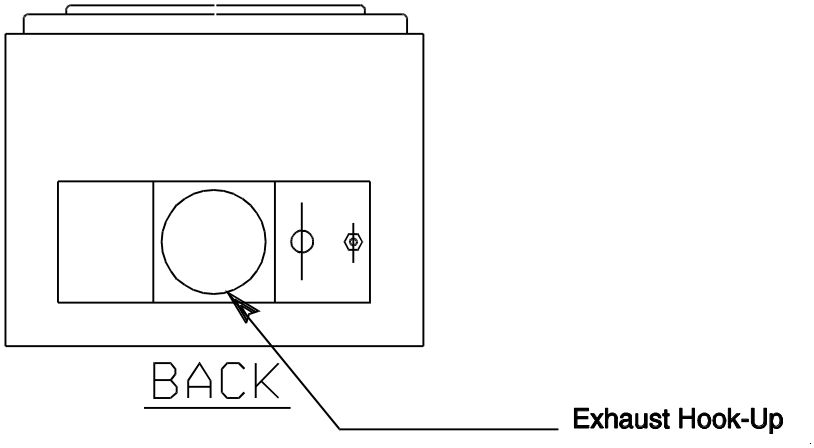

Figure 3.6: Exhaust Hook-Up Location

3.8 Sprinkler Installation

The Gasguard 450 cabinet contains a coated sprinkler head with a trip point of 165° F. It is located on the ceiling of the cabinet with an external 1/2" FNPT connection. The sprinkler head is capable of flowing 32 GPM @ 31 psig.

Figure 3.7 shows the sprinkler connection location.

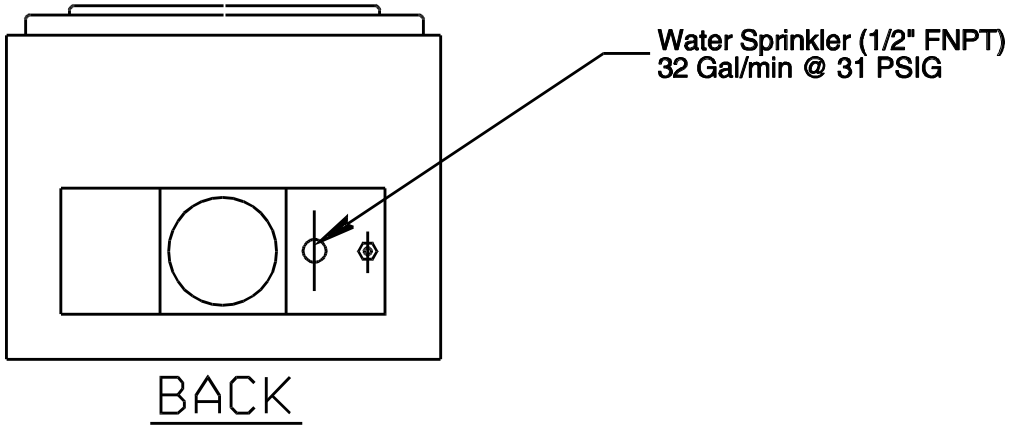

Figure 3.7: Sprinkler Connection Location

3.9 Helium Leak Test Port

A helium leak test port may be provided on the vent header for connection to a helium mass spectrometer. A manual valve, MV-22, 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 MV-22 should be opened and left open during normal operation of the gas cabinet.

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 450 cabinet. The detection points must include the interior of the gas cabinet. If a leak is detected, the system must provide a signal that will shutdown the gas cabinet. See specific I/O field wiring drawings provided in Section 6 of this manual.

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

Section 4: Electrical Connections

All electrical connections must comply with Article 300 - Wiring Methods and Article 500 - Hazardous (Classified) Locations of the National Electric Code 1993.

4.1 Grounding Method

The equipment must be grounded in accordance with Article 250 - Grounding in the National Electrical Code 1993. 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.

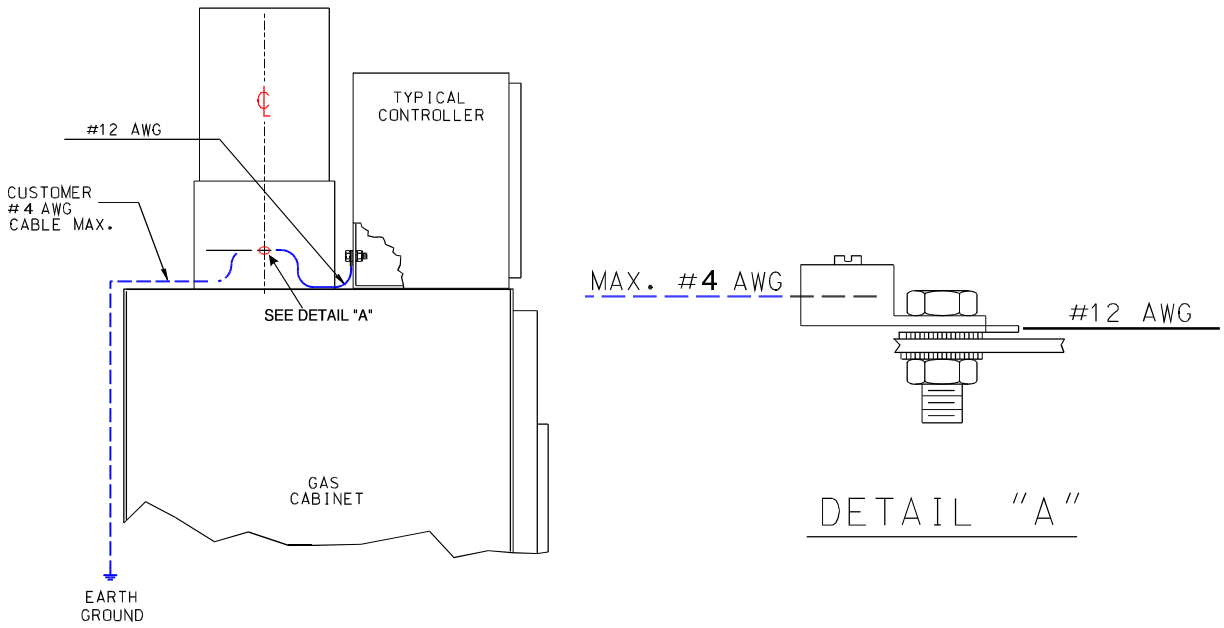

Figure 4.1: Suggested Grounding Method

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

4.2 Power Supply Connection

Each cabinet should be installed with an independent circuit breaker or disconnect to remove power from the unit when maintenance on the controller is required.

The power supply connections are made through a locking pin/socket type receptacle on top of the enclosure. See Figure 4.3 for location of the receptacle. The conduit connection is 3/8" FNPT, but an adapter is supplied to provide a 1/2" FNPT conduit connection.

The power input pin connector must be wired as shown below in Figure 4.2.

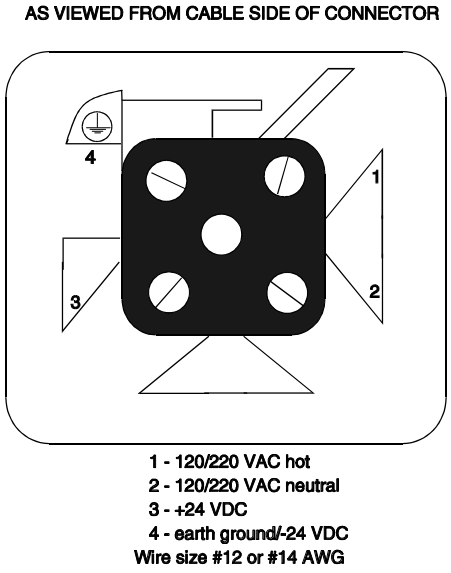

Figure 4.2: Power Supply Connection

The following table lists the appropriate part numbers for the components required to make the power supply connections. One set of the appropriate parts for the power supply are supplied with the system.

Component	Air Products Part Number	Manufacturer's (Harting) Part Number
Top Entry Hood, 3/8" NPT	809-418473	09-20-503-1440
Side Entry Hood, 3/8" FNPT	809-421500	09-20-503-1640
Female Insert	809-418474	09-20-003-2711
Reducing Adapter-Pipe 1/2" FNPT x 3/8" MNPT	809-422140	Recommended Vendor Mid-Atlantic Instrumentation Parker #8-6RA-S

The power requirements are as follows:

120/240 VAC, 50/60 Hz, 1 phase

Typical Load: Single controller:
220 milliamperes @ 120 volts
110 milliamperes @ 240 volts

Dual controller:
440 milliamperes @ 120 volts
220 milliamperes @ 240 volts

24 VDC

Typical Load: 2 amperes @ 22 to 26 VDC (single controller)
4 amperes @ 22 to 26 VDC (dual controller)

Dynamic regulation: 25 mv ripple RMS (max)

Static regulation: Line = ± 0.25% full line range
Load = ± 0.25% over no load to full load

Overvoltage protection: Recommended

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

All field electrical connections are made through the locking pin/socket type receptacle on the top of the enclosure. The receptacle on the single controller is located on the left. A dual controller has a second receptacle on the right side. See Figure 4.3.

The field wiring is taken directly into the controller latching receptacle consisting of the 72-pin hood, insert and connector pins. The following table lists the appropriate part numbers for the components required to make these connections.

NOTE. An appropriate crimping tool is required to attach the connector pins to the field wiring.

Component	Air Products Part Number	Manufacturer's (Harting) Part Number
Top Entry Hood, 1" FNPT	809-418470	09-30-516-0441
Side Entry Hood, 1" FNPT	809-421499	09-30-516-0541
Insert	809-418471	09-16-072-3101
* Connector Pin (14 AWG)	809-418803	09-15-000-6206
* Connector Pin (18 AWG)	809-419074	09-15-000-6202
* Connector Pin (20 AWG)	809-418472	09-15-000-6203
** Crimp Tool	287-422865	09-999-000-0001
** Locator	287-422868	09-99-000-0028
** Extractor	287-422866	09-99-000-0012

* A top or side entry hood (as specified by customer), insert, and twenty (20) spare connector pins of the appropriate type are supplied with the system.

** These parts are not supplied with the system.

WARNING

In Class I, Division II areas, a conduit seal ("pour fitting") or equivalent must be installed between each electrical connection point on the cabinet and the electrical source. Liquidtight flexible conduit can be installed between the GG450 connectors and the conduit seals to facilitate these connections. A maximum length of 18" is allowed between the last pour fitting and the cabinet connector. See Figure 4.3 for details.

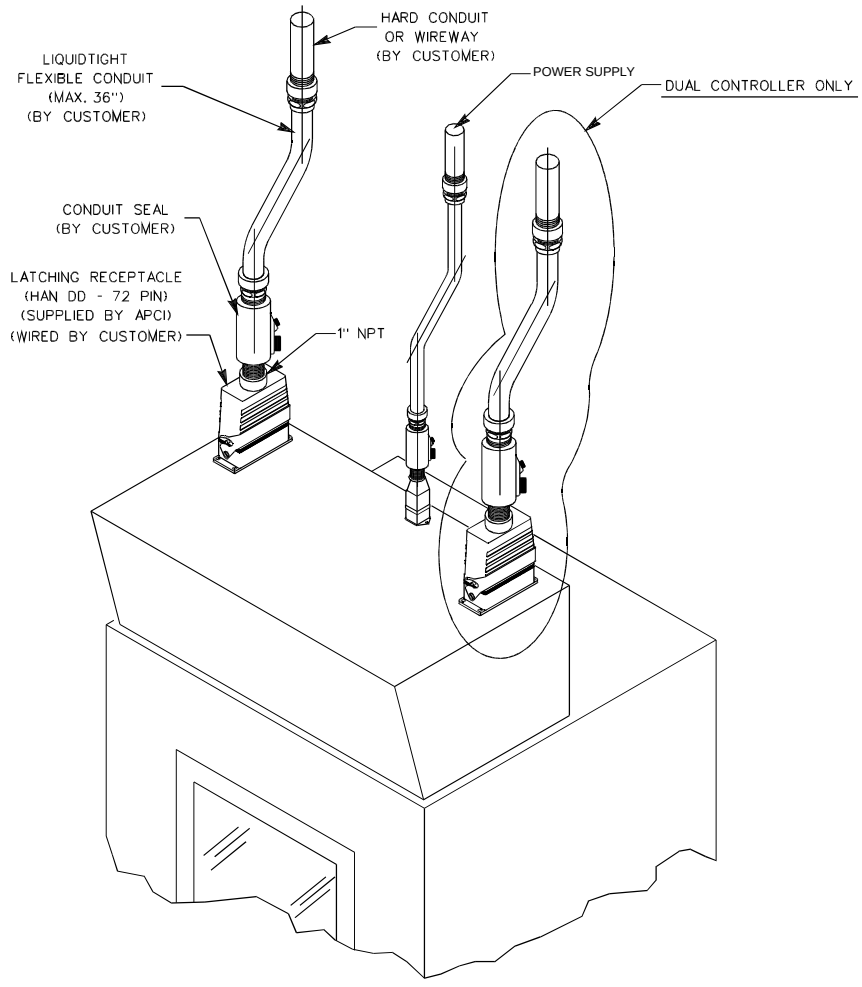

Figure 4.3: Conduit and Conduit Seals

4.4 External I/O Communication

All connections between the GG450 controller and external devices are made through the 72 pin latching receptacle mounted on the top of the enclosure.

NOTE: Both left and right sides of a dual controller will have its own I/O connections. See Figure 4.4 for pin configuration.

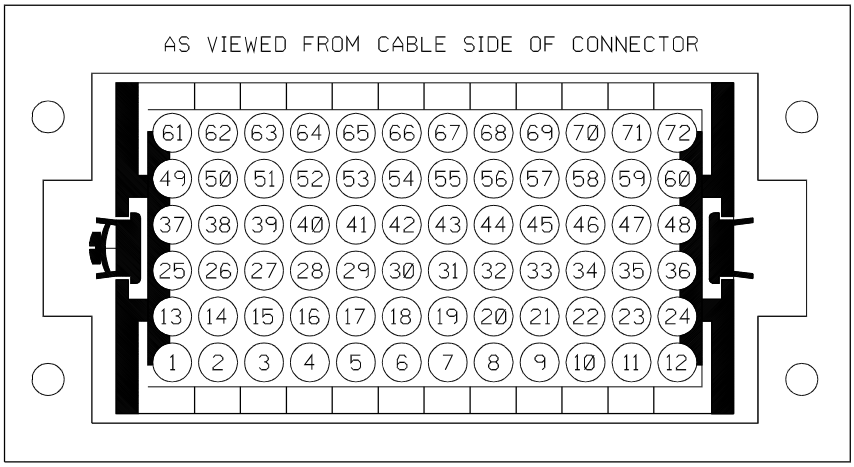

Figure 4.4: 72 Pin Latching Receptacle

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

Specific I/O field wiring connections for this system are found on the drawings in the Appendix of this manual.

Recommended External I/O Communications

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

Digital Inputs	Response
Process tool down	Prevent cabinet from flowing process gas
Process gas leak	Shut down gas cabinet
Remote Emergency Stop	Shut down gas cabinet
Vent system unavailable	Prevents purge modes from starting

The GG450 Controller is equipped with a "vent unavailable" feature which prevents process gas from being vented from the panel if the scrubber system is not operating. Utilization of this feature requires the installation of a hardwire between the controller and the scrubber. Failure to utilize this feature may result in the discharge of process gas to a non-functioning vent system.

Digital Outputs Dry (Relay Output Pin-Outs)

Rating - 24 VDC @ 1 Amp maximum

Digital Output #	Relay Output #	COMMON	NO	NC
		Pin Numbers		
1	1	01	25	13
2	2	61	37	49
3	3	02	26	14
4	4	62	38	50
5	5	03	27	15
6	6	63	39	57
7	7	04	28	16
8	8	64	40	52
21	Horn	34	22	N/A

Digital Inputs (Main I/O Board Pin-Outs)

Digital Input #	Input	Ground
	Pin #	
2	69	43
3	57	30
4	45	44
5	33	32
6	21	42
7	09	31
8	70	47
33	10	48

4.5 PC and MMMS Gasguard Networks

4.5.1 General Description

The Gasguard Networks provide continuous on-line 24 hour per day monitoring of the status of all connected Gasguard Cabinets and VMBs. Figure 4.5 shows the required daisy-chain network wiring configuration between the GG450 controllers/ VMBs and the network host computer. It is the customer's responsibility to install and ensure the integrity of all interconnect wiring between the GG450 controllers/ VMBs and the network host computer.

It is recommended that a suitable uninterruptible power supply (UPS) be provided for the network host computer system.

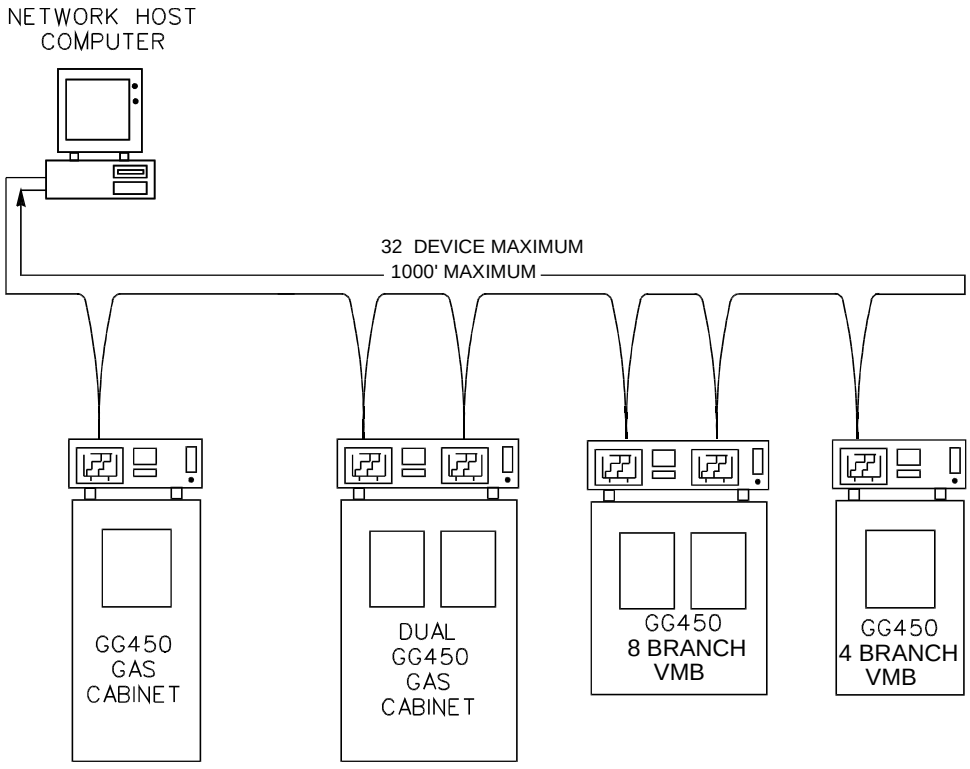

Figure 4.5: Daisy-Chain Network Wiring Configuration

4.5.2 Gasguard 450 Controller Connections

Network electrical connections are made through the 72 pin latching receptacle on the top left of the controller. For dual controllers, a second network connection must be made through the second 72 pin receptacle on the top right of the controller. See Figures 4.5 and Sections 4.5.4 and 4.5.7 for additional details.

4.5.3 PC Network Breakout Box

This box is located with the network host computer and contains eight 9 pin plugs for connection of eight 32 device daisy chains. A 32 pin ribbon cable connects this box to the network host computer. See Figure 4.6 for details of the pin connections on the Breakout Box.

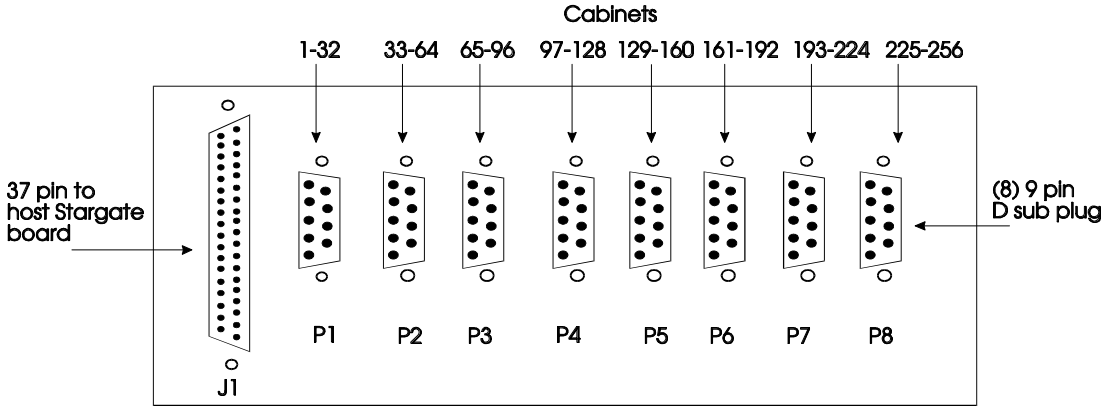

Figure 4.6 PC Network Break-Out Box

4.5.4 PC Network Field Wiring

Figure 4.7 shows the PC network field wiring between GG450 cabinets/VMBs and the host PC. Figure 4.8 shows the field wiring between Span LR300 displays and the host PC. Cable specifications follow:

Recommended cable - Belden specification 9842
Acceptable alternates - Belden specifications 8132, 8102 or 8162

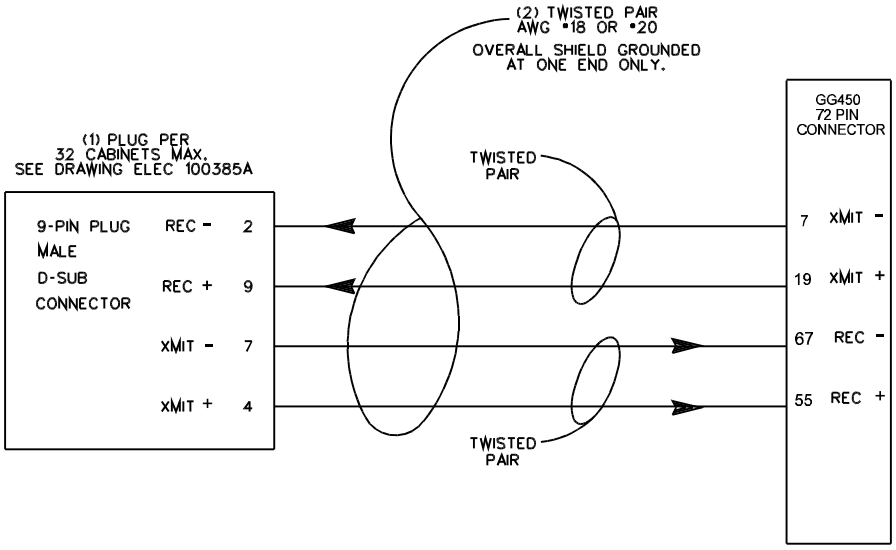

Figure 4.7: Network Field Wiring Between Cabinets / VMBs and Host PC

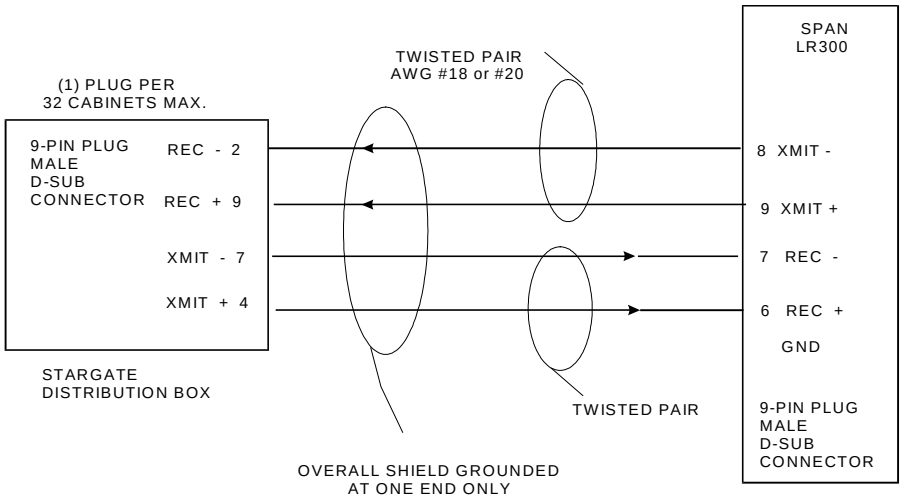

Figure 4.8: Network Field Wiring Between Span LR300 and Host PC

4.5.5 MMMS Network Wiring Configuration

Figure 4.9 shows the MMMS Gasguard Network Wiring Configuration.

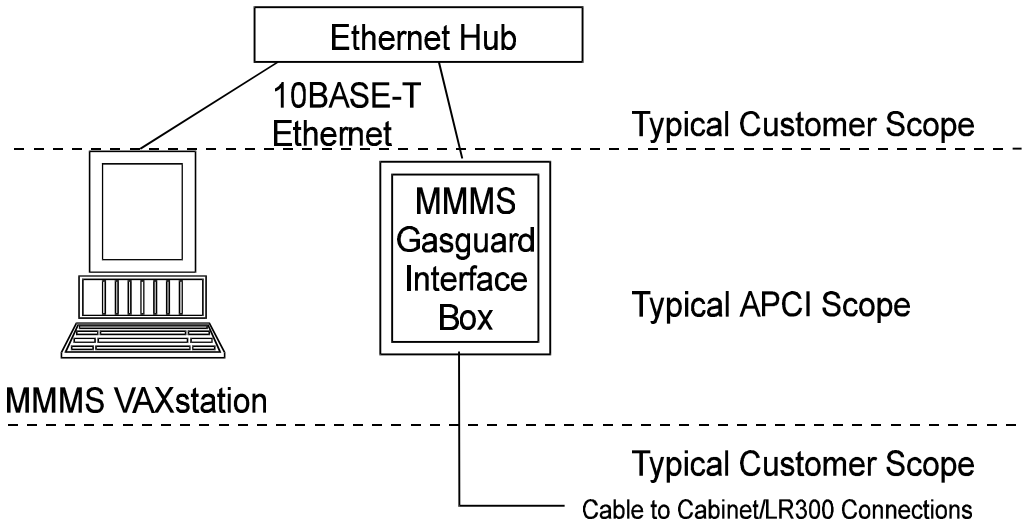

Figure 4.9: MMMS Network Interface

4.5.6 MMMS Network Interface Box

The MMMS Network Interface Box consists of a rack enclosure which contains a RS232 communications processor and a bank of RS-485 converter boards. The cabling which connects to the cabinet and VMB controllers is terminated to the rear of the RS-485 converter rack via screw terminals. Each of the 16 ports is provided with a set of screw terminals. The RS232 communications processor has a single 10BASE-T Ethernet connection and an AUI type Ethernet connection on its rear apron. This Ethernet connection is used for connecting the communications processor to the MMMS VAX station. The provided AUI port can be used in installations where the Ethernet connection available is other than 10BASE-T, and accepts a variety of standard Ethernet converter modules.

The MMMS Network Interface Box was designed to allow front and back access to the rack mounted components, even if the assembly was wall mounted. To accomplish this, the box is double hinged, and contains conduit penetration areas on the top and bottom of the rear stationary section. This conduit area is used for the connections to the RS-485 signal wires (to the cabinets), Ethernet, and for power connections.

The MMMS Network Interface Box was designed with additional space to allow for the field installation of an additional communications processor and an addition bank of RS-485 converter boards to expand the number of available ports from 16 to 32.

4.5.7 MMMS Network Field Wiring

Figure 4.10 shows the MMMS network field wiring between Gasguard cabinets/ VMBs and the Gasguard Interface Box. Figure 4.11 shows the field wiring between Span LR300 displays and the Gasguard Interface Box.

Recommended cable - Belden specification 9842
Acceptable alternates - Belden specifications 8132, 8102 or 8162

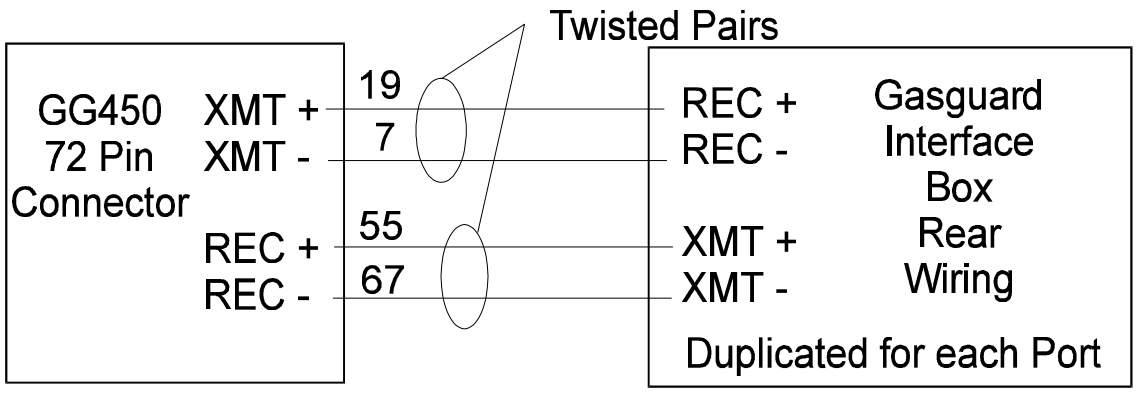

Figure 4.10: Network Field Wiring Between Cabinets/VMBs and MMMS Gasguard Interface Box

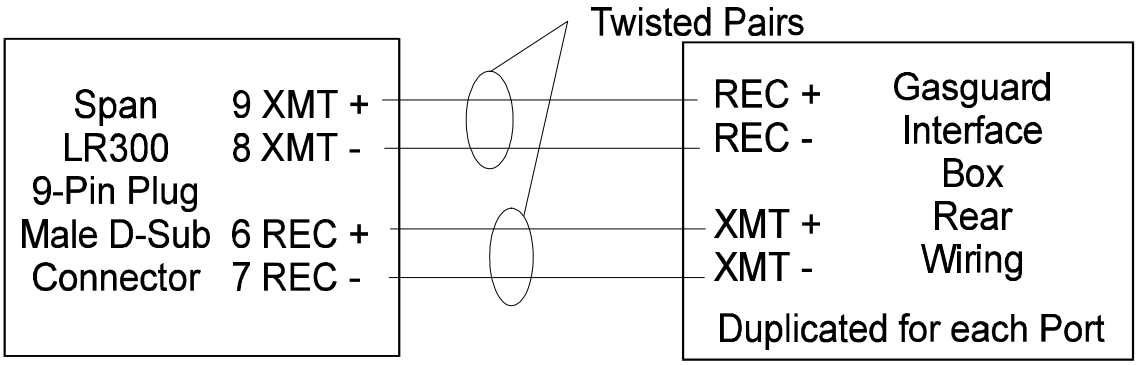

Figure 4.11: Network Field Wiring Between SPAN LR300 and MMMS Gasguard Interface Box

Section 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 gas cabinet be completely leak tight. Leak testing should be performed in accordance with the current industry standard, SEMI (Semiconductor Equipment and Materials International) #F1-90, Specification for Leak Integrity of Toxic Gas Piping Systems and all applicable codes. A suitable helium leak detector is required to attain the level of sensitivity required by the above standard.

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

> Inboard - The component being tested is evacuated to a negative pressure and sprayed externally with helium.
>
> Outboard - The component is pressurized with helium and sniffed externally with the detector.
>
> ***NOTE: It is recommended that the internal gas cabinet panel, which was helium leak tested at the factory, be rechecked at this time to ensure no leaks have developed during installation or shipment. Consult Air Products for proper helium leak detection procedures.***

In order to adequately leak test the gas cabinet internal and external piping, various pneumatic 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 450 Controller. Air Products **strongly recommends** that anyone who has not already done so, receive operations training by an Air Products representative prior to operating the GG450 Gas Cabinet 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 Air Products representative to discuss this.

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

How to Perform Helium Leak Checking in Manual Mode

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.***

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 Air Products and Chemicals representative for system verification.

NOTE: Due to the potential hazards listed above, Manual Mode operation requires a second or higher level security code. See Section 3.2 of the Operation and Maintenance Manual for more details on the password security system.

NOTE: Prior to shipment, the gas cabinet 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 75-95 psig of nitrogen needs to be available to actuate the valves.

NOTE: Certain shutdown alarms (indicated by the red SHUTDOWN LED being lit) prevent access to Manual Mode If the cause for the shutdown cannot be corrected, contact an Air Products representative for system verification prior to leak testing

1. If using a dual controller, activate the left or right controller for the panel to be operated. An arrow on the screen and a lit LED below the screen indicates the active side. To change active sides, use the [ESC MNU ↑] and [+ ↓ -] keys.

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

   Press [→ SHIFT], then [ESC MNU ↑] to request the Main Menu.

   The LCD screen will prompt: "PASSWORD"

   Type in the password using shifted or unshifted keys as required.

   Press ENTER

   If the password is correct, the Main Menu will be displayed. If the password is incorrect, "** ACCESS DENIED **" will be displayed for 5 seconds; the primary screen will then be displayed.

3. From the Main Menu screen, highlight "CABINET CONFIGURATION", by using the [+ ↓ -] key to lower the highlight bar.

4. Press ENTER

5. From the configuration menu, highlight "MANUAL MODE", by using the [+ ↓ -] key to lower the highlight bar.

6. Press ENTER

7. There are two ways to open and close valves in Manual Mode. The simplest is to press the hexagonal membrane switch located next to the valve symbol on the graphic display. Pressing the switch toggles the valve from OPEN to CLOSED or CLOSED to OPEN. The operator may be prompted to confirm

the opening of certain valves by pressing [SHIFT], then [Y Z .] for yes. This is done as a reminder to check for potentially dangerous situations prior to opening these valves.

An alternate method is to use the keypad.

To open a valve:

7.1. Press [SHIFT], then [O 7 P] The screen prompts: OPEN VALVE #.

7.2. Type the number of the valve you wish to open. Press [ENTER]

7.3. The valve will open.

To close a valve:

7.4. Press [SHIFT], then [C 2 D]. The screen prompts: CLOSE VALVE #.

7.5. Type the number of the valve you wish to close. Press [ENTER]

7.6. The valve will close.

WARNING

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

8. When leak testing is complete, press [SHIFT], then [ESC MNU ↑] to return to Cabinet Configuration menu.
   NOTE: Any valves left in open position will be closed automatically.
9. Press [SHIFT], then [ESC MNU ↑] to return to the Main Menu.
10. From the Main Menu screen, highlight "RETURN TO DISPLAY".
11. Press [ENTER] to return to normal display.

12. An alternate to steps 10 and 11 is to press [← SHIFT], then [ESC MNU ↑] to return to normal display.

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

Section 6: Cabinet Functional Checklist

After all connections have been made and installation of the gas cabinets is complete, the appropriate Air Products Representative should be contacted to schedule the final on-site gas cabinet 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 Air Products Representative to discuss this. The Air Products and Chemicals, Inc. Technical Representative and/or Megasys® Technician will ensure that all the mechanical and electrical components in the gas cabinets are functioning properly and all programmed sequences are operational.

A copy of the completed cabinet functional checklist should be supplied to Air Products for placement into the gas cabinet maintenance file. The Gas Cabinet Utility Checklist is found on the following two pages.

Gas Cabinet Utility Checklist

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

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

_____ 3. Sprinkler line installed (if applicable) and pressurized (see Section 3.8).

_____ 4. Grounding wire installed (cabinet and controller) and checked for less than 1 ohm resistance (see Section 4.1).

_____ 5. Electrical power (120/240 VAC, 50/60 Hz or 24 VDC) connected (see Section 4.2).

_____ 6. Remote I/O wiring installed and checked (see Section 4.3).

_____ 7. Gasguard Network wiring installed (if applicable) and configured on the host (see Section 4.5).

_____ 8. Process line installed and helium leak tested (see Section 3.2).

_____ 9. Vent line installed and helium leak tested (see Section 3.3).

_____ 10. Venturi line installed, leak tested and 75-95 psig of nitrogen available (see Section 3.4).

_____ 11. Purge line installed and helium leak tested (see Section 3.5). (If external purge cylinder utilized.)

_____ 12. Pneumatic supply connected to controller and 75-95 psig of nitrogen available (see Section 3.6).

_____ 13. Gas cabinet internal piping helium leak tested (see Section 5).

_____ 14. Purge cylinder available.

_____ 15. Hazardous gas monitor installed and operating.

Inspection Sign-Offs

Electrical

Mechanical

Quality

Safety

APCI (Field Start-Up Checklist Complete)

AIR PRODUCTS GAS CABINET FIELD START-UP CHECKLIST page 1 of 6

CUSTOMER _____CABINET # _____ 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**
Verify cabinet facilitation complete by DWG#_____		
Cabinet labeled correctly per associated parent document # See section 6		
No nylon collars stripped		
Cabinet information received (SEMC inspection and test, functional test, owners manual) (circle)		
All open connections sealed		
General appearance satisfactory		
Panel analyzed for contaminants See sections 3 and 4	SEMC See attached Gasguard inspection and test sheet	
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		
Tel tails installed		
Verify exhaust line functioning		
Panel under pressure 20 psig $\geq$ $\leq$ 25 psig		
Visual welds satisfactory See section 1	SEMC See attached Gasguard inspection and test sheet	
All panel valves labeled per parent doc See section 6	SEMC See attached Gasguard inspection and test sheet	
Valve flow path correct See section 1	SEMC See attached Gasguard inspection and test sheet	
Manual valve handles correct color See section 6	SEMC See attached Gasguard inspection and test sheet	
Pigtail valve connection correct. See section 6 Reference appendix A	SEMC See attached Gasguard inspection and test sheet	
Correct process purifier installed per gas service		
CGA Seating surface condition acceptable		
Verify and record orifice size See section 1	SEMC See attached Gasguard inspection and test sheet	
Shelf kit installed and adjusted		
Cyl. chains / Cyl. straps (circle)		
Trickle purge gasket installed (.007/ .010)		
Correct venturi pressure present min. 75 psig		
Correct pneumatic pressure present 75 psig to 95 psig		
Purge cylinder installed		
Gas detection system operational		
Secondary containment installed		
Pneumatics for cylinder valve operator installed		

AIR PRODUCTS GAS CABINET FIELD START-UP CHECKLIST page 2 of 6

PIPING/MECHANICAL (cont.)	**Check off line item when completed Sign and date when section completed**	
	Left side or single	**Right side**
Verify and record flow switch rating See section 1	SEMC See attached Gasguard inspection and test sheet	
High pressure rating		
Low pressure rating		

SECTION COMPLETED SIGNATURE_____ DATE _____

Notes:_____

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		
72 pin connector wired per DWG # EE-_____ series		
APCI supplied temperature control unit functional		
Verify temperature control power		
Verify heat tape power		
	Jacket temp._____	Jacket temp._____
	Set point _____	Set point _____

SECTION COMPLETED SIGNATURE_____ DATE _____

CONTROLLER	**Left side or single**	**Right side**
Seat all circuit boards and eproms (caution: remove power before removing eproms or circuit boards)		
E-stop guard in place		
All pneumatic valve graphics illuminating		
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.		
Verify correct CPU eprom **VERS.# _____**		
Verify correct COMMO eprom **VERS.#_____**		
Verify correct DISPLAY eprom **VERS.#_____**		
External Shutdown wired		
Supervisory circuit utilized		
Correct program loaded / version		
Program name and date		
Life safety system utilized (yes / no)		
Life safety system contact N.O. (yes / no)		
Barriers installed per controller item # verification	SEMC See attached Gasguard inspection and test sheet	
Shorting blocks per controller item # verification	SEMC See attached Gasguard inspection and test sheet	

AIR PRODUCTS GAS CABINET FIELD START-UP CHECKLIST

CONTROLLER (cont.)	**Left side or single**	**Right side**
Verify port and loop # indicated on the controller		
Network addressed		
Cabinet name _____		
Port number _____		
Loop number _____		
Gas cabinet communicating with network		
Controller door adjustment		
Z - purge set @ 3-6 scfh		

SECTION COMPLETED SIGNATURE_____ DATE _____

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	Completed
		before	after	before	after		before	after	before	after	
1											
2											
3											
4											
5											
6											
7											
8											

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		Zero	Zero	Span	Span	Completed
		before	after	before	after		before	after	before	after	
9											
10											
11											
12											
13											
14											
15											
16											

SECTION COMPLETED SIGNATURE_____ DATE _____

Notes:

_____

AIR PRODUCTS GAS CABINET FIELD START-UP CHECKLIST page 4 of 6

FUNCTIONAL TEST - DIGITAL ALARMS					
Record label from software documentation . Record verify and test the digital alarms and the hardwire shutdowns. Note: Location of the hardwire jumper is designated by " P " for pneumatic card and " D " for the digital card. See Appendix B					
		Left side or single		**Right side**	
Digital In #	Label (Left / Right) if applicable	Hardwire SD loc.	Checked	Hardwire SD loc.	Checked
1	Emergency Stop				
2		P		P	
3		P		P	
4		P		P	
5		P		P	
6		P		P	
7		P		P	
8		P		P	
9		D		D	
10		D		D	
11		D		D	
12		D		D	
13		D		D	
14		D		D	
15		D		D	
16		D		D	
33		NA		NA	

SECTION COMPLETED SIGNATURE_____ DATE _____

NOTES:

_____

_____

_____

FUNCTIONAL TEST - RELAY OUTPUTS Check off line item when completed Sign and date when section is completed		
	Left side or single	**Right side**
Relay outputs (digital outputs) tested		
Relay # 1		
Relay # 2		
Relay # 3		
Relay # 4		
Relay # 5		
Relay # 6		
Relay # 7		
Relay # 8		
Verify First Security		
Verify Second security		
Verify Third security		

AIR PRODUCTS GAS CABINET FIELD START-UP CHECKLIST page 5 of 6

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 _____

FUNCTIONAL TEST- PROGRAM MODES **Check off line item when completed** **Sign and date when section is completed**		
	Left side or single	**Right side**
Gas cabinet 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 test.		
Aux purge		
Lamp test		
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:

_____

_____

_____

_____

_____

AIR PRODUCTS GAS CABINET FIELD START-UP CHECKLIST page 6 of 6

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 APCI set points per software documentation		
Cabinet cleaned inside and out		
Suggested Customer Signoff (Optional)	**Date**	**Signature**
Section: Required / Not required (Circle one)		
Exhaust signed off		
Electrical Signed off		
Safety signed off		
Environmental documentation submitted		
Plumbing signed off		
Environmental sign off		

SECTION COMPLETED SIGNATURE_____ DATE _____

Comments_____

_____

_____

_____

_____

_____

_____

Gas service to CGA and DISS fitting cross-reference			
Appendix A			
Gas	**Gas abreviation**	**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
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

Hardwire Alarm Jumper Configuration Chart for Gasguard 450 Controllers

Left side or single		
Digital Input Number	**Jumper Number SD1**	**Circuit Board Jumper Location**
2	J17	Pneumatic
3	J16	Pneumatic
4	J15	Pneumatic
5	J14	Pneumatic
6	J13	Pneumatic
7	J12	Pneumatic
8	J11	Pneumatic
33	J10	Pneumatic
9	J3	Digital
10	J5	Digital
11	J7	Digital
12	J9	Digital
13	J11	Digital
14	J13	Digital
15	J15	Digital
16	J17	Digital
Right side		
Digital Input Number	**Jumper Number SD1**	**Circuit Board Jumper Location**
2	J4	Pneumatic
3	J5	Pneumatic
4	J6	Pneumatic
5	J7	Pneumatic
6	J8	Pneumatic
7	J9	Pneumatic
8	J10	Pneumatic
33	J11	Pneumatic
9	J3	Digital
10	J5	Digital
11	J7	Digital
12	J9	Digital
13	J11	Digital
14	J13	Digital
15	J15	Digital
16	J17	Digital

Note: When hardwire jumpers are installed power will be disconnected to the solenoid card when the digital in circuit is open.

Appendix

The Appendix contains the SEMC-005 "UHP Tubing and Fitting Specification" and the system specific drawings referenced in this manual.

DOC.NUM.: SEMC-005
TITLE: UHP TUBING AND FITTING SPECIFICATION
REV. NO.: A DATE: 3/31/1992
Page 1 of 6

UHP TUBING AND FITTING SPECIFICATION

REV A FORMAL RELEASE **2/28/92**

1. 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. 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. GENERAL

3.1 The vendor shall review and respond to this specification on a line by line basis consuming acceptance or exceptions to each requirement

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

4. RELATED DOCUMENTS

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

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

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

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

5. RAW MATERIAL REQUIREMENTS

5.1 All tube and bar stock shall be produced from ASTM grade TP316L raw material. Tubing sized smaller than 3" shall be seamless and larger than 3" may be welded.

5.2 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.

5.3 Sulfur content shall be in the range 0.005-0.017 percent This range is an actual range and does not allow for rounding of numbers as set forth in ASTM A269.

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

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

6. DIMENSIONAL TOLERANCE REQUIREMENTS

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

Dimension	Component	Tolerance
Linear	Fittings	+- 1/32"
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 l/2",+- 0.005";

11/2" up to not including 3 1/2", +- 0.010"; 3 1/2" up to and including 4"; +- 0.015"

7. INTERIOR SURFACE FINISH REQUIREMENTS

7.1 The interior surface of each tube and fitting shall be electropolished to a microinch surface roughness standard of 5 Ra microinch average (7 Ra maximum). See section 12.4. The weld seam on tubing and fittings 3" and larger shall have a 10 Ra maximum microinch surface roughness.

8. GASES AND DEIONIZED WATER FOR DRYING, CLEANING, TESTING

8.1 Argon 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.

8.2 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/l00 milliliters
Filtered to: 0.1 microns at point of use
DI water purity shall conform to the guidelines set forth by SEMC.

9. CLEANING

9.1 After electropolishing, tubing and fittings 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

9.2 Final cleaning of tubing and fittings shall be performed under Class 100 clean room conditions. Tubing shall be flushed with hot DI water (60° C minimum) for one minute. Rotate the tube so that the interior surface is uniformly wetted and heated to about 60° C. The tube shall then be flushed with ambient DI water until resistivity of the ambient temperature effluent measures at least 17.5 megohm centimeters for diameters less than three inches, and 17.0 megohm centimeters for diameters greater than or equal to three inches. A Dl water saturated plug shall then be blown through the tube with nitrogen. The plug must be of sufficient size to require a minimum of 50 psig gas pressure to propel the plug through the tube. Immediately blow a dry plug through the tube, then examine the tube. If any moisture condensation remains, blow another dry plug through the tube. Blow ambient temperature nitrogen gas through the tube for 1-3 minutes while slowly rotating the tube. Blow hot nitrogen gas through for 1-3 minutes while slowly rotating the tube until the outlet gas temperature is 140° F. Each tube shall then be bagged per section 10.1.

9.3 Fittings shall be friction cleaned and rinsed under flowing, heated DI water. While rinsing, hold the fitting so that the water drains readily. Do not allow water to collect and evaporate in the fitting. Blow each fitting dry with ambient temperature nitrogen gas. Blow hot nitrogen gas through the fitting until the outlet temperature is 140° F. Make a final inspection of the fitting and package it per section 10.2.

10. PACKAGING

10.1 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 enclosed in a 6 mil polyethylene bag and heat sealed at both ends.

10.2 Fitting ends shall be sealed with polyethylene caps pressed over polyamide nylon squares (1.75 mil) after being purged with nitrogen. The fittings shall then be double bagged and heat sealed in nitrogen filled polyethylene bags (6 mil).

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

11. TRACEABILITY

11.1 Finished components shall be mill and heat traceable, and permanently marked for correspondence to the applicable mill test report 5.

12. TESTING AND INSPECTION

All tests and inspections required in this section shall be performed for each order unless otherwise stated in the purchase order. The tube vendor shall provide a detailed procedure for each test required in sections 12.3 - 12.9 for APCI review and acceptance.

12.1 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.

12.2 Twenty five percent (25%) of tubes and all fittings shall be measured with calipers and/or micrometers or by other repeatable methods to verify conformance to the dimensional requirements in Section 6 of this specification.

12.3 All welded fittings shall be helium leak tested to a I x 10. 9 ATM cc/sec gaseous helium with a mass spectrometer leak detector.

12.4 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.l -1985. Surface roughness shall be measured at three locations for each piece tested as shown in figure 1. 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 5 microinch Ra with no single reading above 7 microinch Ra. Sampling length cutoff shall be 0.030" and traverse length will be 0.150".

12.5 Scanning electron microscopy (SEM) photographs of finished component surfaces shall be analyzed from each mill heat of raw material. 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 9012040lA-STD.

12.6 Chemistry analysis (ESCA) of electropolished surfaces shall be performed for each mill heat of raw material 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.

12.7 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 N2 gas at a flow not to exceed 10 SCFH/N2.

12.8 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 as described in section 8.1 of this specification at turbulent conditions.

12.9 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, SEMC-003. Weld test shall be deemed acceptable if no internal discoloration of the weld is visible. Go/no go samples can be developed between APCI and the tube vendor to judge acceptable welds.

12.10 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".

12.11 APCI reserves the right to source inspect all tubing and fittings and inspect the manufacturers facilities upon request

13. REPORTS AND CERTIFICATIONS

13.1 The vendor shall supply the following reports and certifications as follows:

One set of reports shall be included with each partial or whole shipment. A second set shall be

sent directly to the APCI requisitioner and a final set shall be included with each invoice as a condition for payment.

13.1.1 Mill Test Reports.

13.1.2 Surface Roughness Certification.

13.1.3 Scanning Electron Microscopy Certification (SEEM).

13.1.4 Electron Spectroscopy for Chemical Analysis Certification (ESCA).

13.1.5 Resistivity Test Certification.

13.1.6 Moisture Test Certification

13.1.7 Particle Test Certification.

13.1.8 Weld Test Certification and Weld Samples.

13.1.9 Certification of hardness test for each mill heat and size of tubing.