General Information & Suggestions

for

Gas Cabinets, Valve Manifold Boxes, Rack Units & Hazardous Gas Box Enclosures

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1.0 PURPOSE AND SCOPE

1.1 The purpose of this document is to give suggestion and general information related to the writing of a specification for Gas Cabinets, Valve Manifold Boxes, Rack Units and Hazardous Gas Box Enclosures, and is for client reference ONLY. Please keep in mind that a qualified Engineering Firm will need to be contracted to formalize a specification for your facility and customization will be needed to cover functionality and liability specific issues. This is a “general knowledge and suggestion document ONLY” and should not be interpreted as a formal Engineering Specification. CSI has established this document at the behest of our client base to give them a basis of general information. This document does not apply to systems that use Vacuum Delivery System (VDS) Technology.

1.2 Certain functional requirements may be supplied by the customer. In such cases, the customer-supplied features shall be outlined in the commercial documentation and noted on the equipment specification sheet.

2.0 DEFINITIONS

2.1 **Gas Cabinets:** A fully enclosed noncombustible enclosure used to provide an isolated environment for compressed gas cylinders in storage or use. Doors and access ports for exchanging cylinders and accessing pressure-regulating controls are allowed to be included. Gas Cabinets have a cylinder in use will have an integrated process controller.

2.2 **Excess Flow Switch:** A switch placed in the process line of a gas cabinet which detects an increase in flow beyond a set amount, and sends a signal to the controller of the gas cabinet which then shuts the primary valve closest to the cylinder.

2.3 **Exhausted Enclosure:** A fully enclosed noncombustible enclosure used to provide an isolated, exhausted environment for mechanical connections in an active hazardous gas line. Doors and access ports for exchanging cylinders and accessing gas line mechanical controls may be included. An exhaust port and louvered openings are included to allow a flow of air to sweep the inside of the enclosure eliminating eddies where hazardous gas can reside.

2.4 **Hazardous Gas Box Enclosure:** A non-controlled, manual system
enclosure used to contain the environment around mechanical connections when used with a hazardous gas or fluid.

2.5 **Rack Unit:** A semiautomatic or fully automatic gas system with controller mounted to a back plate assembly. Rack Units are used indoors with inert gases where an exhausted enclosure is not needed per Code, or outdoors with Silane gas having concentrations greater than or equal to 2%.

2.6 **Restricted Flow Orifices:** Orifice placed in a fitting or pipe to restrict the amount of flow that can go through the pipe or fitting.

2.7 **Splitter/Distribution Boxes:** Break in liquid double contained line where connections are housed. These systems are typically manual and without controller.

2.8 **Valve Manifold Boxes:** A fully enclosed, noncombustible enclosure used to provide an isolated environment for breakable connections in a hazardous gas line. Also called a “VMB”, a valve manifold box is automated with a controller to monitor and control the flow of gas to a process.

### 3.0 CYLINDER GAS CABINETS

3.1 The following requirements shall apply to Gas Cabinets used for storing or otherwise containing gases with an NFPA 704 rating of a 1 through 4 for health and/or reactivity and 4 for flammability, unless otherwise noted.

3.2 Unless otherwise indicated, all gases with an NFPA704 rating of 1 through 4 are required to be housed in a gas cabinet that complies with the specifications below. Silane and Silane mixes with non-toxics may be dispensed from an open rack system if located outside. If Silane cabinet is located indoors, a high flow exhausted cabinet is required for concentrations greater than or equal to 2%.

3.3 Gas cabinets must include a single automated gas controller that services both gas cylinders. Controller must be capable of automated cylinder purging, and have the option of network communication.

3.4 Enclosure doors, or the bottom of the enclosure, must have louvered exhaust ducts suitable of exhaust ventilation volume to meet the Code requirement for the applicable hazardous gas, with a high flow option to comply with CGA Code 13 for Silane and Disilane cylinders of concentrations 2% or greater. Exhaust ports and louvers must be situated in a manner to allow a flow of air to sweep the inside of the enclosure eliminating eddies where hazardous gas can reside.
3.5 Enclosure shells must be rated for Class I Div II service.

3.6 Gas Cabinets must be made of 12 gauge steel, door(s) must be self-closing and cabinet must be grounded. Steel plate cylinder separation panels must be used for Silane and Disilane cylinders for concentrations 2% or greater.

3.7 Gas Cabinets must be provided with self-closing limited access ports or non-combustible windows to give access to equipment controls.

3.8 Gas Cabinets must have ability to accept the output of hazardous gas monitors such that upon detection of a leak the controller will enact a shut off flow of gas, and provide indication via a local visual and audible alarm.

3.9 Gas Cabinet Controllers must be equipped with an EMO (emergency off) button. This EMO must be hard wired to the respective unit and have the ability to trigger cylinder shutdown and indicate via a visual and audible alarm.

3.10 Temperature/Flame Monitor – For flammable, Pyrophoric and ClF3 gases, either a temperature switch or a flame detector is required. For Silane and Silane mixtures of 2% or greater, an infrared flame monitor (UVIR) must be used. For Disilane and Disilane mixtures of 2% or greater, either a flame monitor or a temperature switch is allowed. For Trimethylboron (TMB) and Trimethylaluminum (TMA), a UVIR, factory suitable for TMA, must be used.

3.11 Exhaust Flow Indication - All Gas cabinets containing hazardous production material (HPM), at a minimum are to have a visual indicator of exhaust flow. If system shutdown due to loss of exhaust flow is required, an analog DP monitor shall be used due to the exhaust flow rate variation.

3.12 The average exhaust flow velocity taken at the face of access ports shall be not less than 200 feet per minute (fpm) with a minimum of 150 fpm at any access port. The average velocity for Silane and Disilane systems with concentrations 2% or greater shall be not less than 810 feet per minute (fpm) per CGA Code 13.

3.13 Gas Cabinets shall be operated at a negative pressure in relation to the surrounding area.

3.14 The number of cylinders contained in a single Gas Cabinet shall not exceed two process gases with one purge gas if using a 3 cylinder cabinet.
Dedicated purge cylinders must be used per Gas Cabinet. Purge panels for these cylinders can be housed in the Gas Cabinet or mounted exterior to the Cabinet within the constraints allowed. Purge panels/cylinders are not to be shared between Cabinets.

All cylinder connections for process gases and purge gases are to be UHP CGA (DISS) connections. Gas cylinder connections must be unique and be different for each gas used. Only UHP Grade nitrogen is to be used as the purge gas.

All components within the Gas Cabinet must be industry recognized as high purity, with Electropolished surfaces and no elastomeric seals to atmosphere. Process panels to be constructed where components or component sections, are easily removed for replacement, and have components from known accepted brands that are readily available. Captured bonnet vents must be used with Silane and Silane mixtures with a concentration of 2% or greater.

Automatic Shutoff Valves (ASO) are required as follows: Required on the cylinder for all Pyrophoric gases; Required, and must be a high pressure valve, for ClF3; Required for shut off with customer’s gas monitoring system for toxic, highly toxic and flammable gases; for any TGO Class 1 environment, ASO is required at the cylinder or on the pigtail.

Process Relief Valves are required for all gases greater than 990 psig with no component containing a bourdon tube, and all gases greater than 180 psig, with components containing a bourdon tube. For UHP applications, a pressure switch or pressure transducer must be used to trigger closure of the automated shutoff valve because process relief valves do not meet UHP certification.

Fire suppression and detection in the form of a wax coated sprinkler head must be installed in Gas Cabinets with the exception of ClF3 due to the possibility of explosion. See local authority requirements for sprinklers in ClF3 service.

Compliance with CGA Code 13 – CGA Code 13 must be adhered to with Silane systems having concentrations of 2% or greater. For gas cabinet applications, respective gas system must have the following:

a. High flow exhaust doors
b. UVIR flame detection
c. Regulator bonnet kits routing the bonnet vent to exhaust
d. Excess flow switch
e. 0.010” Restricted flow orifice on gas cylinder
f. Pneumatic cylinder valve - user must provide SiH4
cylinders with pneumatic cylinder valve and controller must recognize this feature.

g. Exhaust flow monitoring

h. Vacuum venturi trickle purge valve

i. Delayed start, remote shutdown and gas monitoring shutdown

j. Z-purge controller

4.0 VALVE MANIFOLD BOXES

4.1 The following requirements shall apply to Valve Manifold Boxes used for gases with an NFPA rating of a 3 or 4 for health and/or reactivity and 4 for flammability, unless otherwise noted.

4.2 Valve Manifold Boxes must include an automated gas box controller.

4.3 Enclosure shells must be rated for Class I Div II service.

4.4 Valve Manifold Boxes must be made of 12 gauge steel, door(s) must be self-closing and cabinet must be grounded.

4.5 Valve Manifold Boxes must be provided with self-closing limited access ports or non-combustible windows to give access to equipment controls.

4.6 Valve Manifold Box Controllers must be equipped with an EMO button. This EMO must be hard wired to the respective unit and have the ability to trigger a visual and audible alarm.

4.7 Temperature/Flame Monitor – For flammable, Pyrophoric and ClF3 gases either a temperature switch or a flame detector is required. For Silane and Silane mixtures of 2% or greater, a infrared flame monitor (UVIR) must be used. For Disilane and Disilane mixtures of 2% or greater, either a flame monitor or a temperature switch is allowed. For Trimethylboron (TMB) and Trimethylaluminum (TMA), a UVIR, factory suitable for TMA, must be used.

4.8 Enclosure doors, or the bottom of the enclosure, must have louvered exhaust ducts suitable of exhaust ventilation volume to meet the Code requirement for the applicable hazardous gas, with a high flow option to comply with CGA Code 13 for Silane and Disilane of concentrations 2% or greater. Exhaust ports and louvers must be situated in a manner to allow a flow of air to sweep the inside of the enclosure eliminating eddies where hazardous gas can reside.

4.9 A minimum of 200 feet per minute (fpm) air velocity must be achieved an opened hatch to prevent the operator from exposure to
hazardous gas. This velocity must be achieved as an average with 150 feet per minute at any point of the opening. The average velocity for systems requiring a UVIR (see Section 5.7) shall be not less than 285 feet per minute per CGA Code 13.

4.10 Valve Manifold Boxes shall be operated at a negative pressure in relation to the surrounding area.

4.11 All components within the Valve Manifold Boxes must be industry recognized as high purity, with Electropolished surfaces and no elastomeric seals to atmosphere. Process panels to be constructed where components or component sections, are easily removed for replacement, and have components from known accepted brands that are readily available.

4.12 Fire suppression and detection in the form of a wax coated sprinkler head must be installed in Valve Manifold Boxes, with the exception of ClF3 due to the possibility of explosion. See local authority requirements for sprinklers in ClF3 service.

5.0 RACK UNITS

5.1 The following requirements shall apply to Gas Systems used for distributing gases deemed to be inert or not requiring an exhausted enclosure, unless otherwise noted. Gases shall have an NFPA 704 Health Rating of 0, and no rating from the IFC or CGA P-20.

5.2 Silane and Silane mixes with non-toxics may be dispensed from an open Rack Unit if located outside. Silane Rack Units must have the venturi output, at a minimum, routed above the top of the roof that covers the system.

5.3 Rack Units must include a single automated gas controller that services both gas cylinders. If necessary, controller must be capable of automated cylinder purging, and have the option of network communication.

5.4 Free standing units must utilize steel plate cylinder separation panels and side walls for Silane cylinders with concentrations 2% or greater.

5.5 Gas Cabinet Controllers must be equipped with an EMO button. This EMO must be hard wired to the respective unit and have the ability to trigger cylinder shutdown and indicate via a visual and audible alarm.

5.6 Temperature/Flame Monitor - For inert cylinder applications, a temperature/flame monitor is not required. For Silane and Silane mixtures of 2% or greater, an infrared flame monitor (UVIR) must be
used.

5.7 If gas requires a process purge, a dedicated purge cylinder must be used per gas system.

5.8 All cylinder connections for process gases and purge gases are to be UHP CGA (DISS) connections. Gas cylinder connections must be unique and be different for each gas used. Only UHP Grade nitrogen is to be used as the purge gas.

5.9 All components within the Rack Unit must be industry recognized as high purity, with Electropolished surfaces and no elastomeric seals to atmosphere. Process panels to be constructed where components or component sections, are easily removed for replacement, and have components from known accepted brands that are readily available.

5.10 Process Relief Valves are required for all gases greater than 990 psig with no component containing a bourdon tube, and all gases greater than 180 psig, with components containing a bourdon tube. For UHP applications, a pressure switch or pressure transducer must be used to trigger closure of the automated shutoff valve because process relief valves do not meet UHP certification.

6. HAZARDOUS GAS BOX ENCLOSURES

6.1 Construction: The following requirements shall apply to purifier cabinets, splitter boxes, GIBs and/or exhausted enclosures used for containing the mechanical connections on hazardous gas lines as required by Code. Not applicable to Gas Cabinets and Valve Manifold Boxes which are covered in Sections 3 and 4.

6.2 The interior of enclosures shall be treated, coated or constructed of materials that are nonreactive with the hazardous material stored. Such treatment, coating or construction shall include the entire interior of the cabinet. Enclosures shall either be listed in accordance with UL 1275 as suitable for the intended storage or constructed in accordance with the following:

6.3 Enclosures shall be of stainless steel or carbon steel having a thickness of not less than 0.0478 inch (1.2 mm) (No. 18 gauge). Carbon Steel enclosures are to be painted for indoor or outdoor service with 2-part polyurethane epoxy with UV inhibitor or powder coated for indoor/outdoor service. Hinges, handles and door locks shall be stainless, suitable for indoor or outdoor service.

6.4 Enclosures must be suitable for Class I Div II if required by gas and
area.

6.5 Joints shall be riveted or welded and shall be tight fitting.

6.6 Doors shall be well-fitted, self-closing and equipped with a self-latching device.

6.7 Enclosure must have ventilation louvers suitable of exhaust volume to meet the Code requirement for the applicable hazardous gas.

6.8 An exhaust duct connection and louvers, suitable to allow required exhaust flow, must be included and situated in a manner to allow a flow of air to sweep the inside of the enclosure, eliminating eddies where hazardous gas can reside.

7.0 Reconditioned Gas Systems

7.1 Reconditioned Gas Cabinets and VMBs are acceptable and encouraged, provided they meet the following criteria:

7.1.1 Vendor must provide proof that Gas Cabinets and VMBs were professionally decommissioned from their original location.

7.1.2 Vendor must provide a well documented reconditioning procedure and have a history of reconditioned Gas Cabinets and VMBs supply which shows a history of successful performance providing a contamination free, reliable system.

7.1.3 Process piping in Gas Cabinets and VMBs can only be used with the same family of gas. (ex. Oxidizer to Oxidizer or Pyrophoric to Pyrophoric) In their submittal package, Vendor is to provide proof of original gas type with new gas type for each cabinet.

7.1.4 Vendor must have the ability and passwords to modify and manipulate the Gas Cabinet or VMB controller code information to allow for Client’s maintenance of the system, as well as the ability to make changes to the system at a later date. (ex. changing a process/purge system to dual cylinder system, a dual process system to auto-crossover system, etc.)

7.1.5 Vendor must provide on-site commissioning and training for the gas systems provided.

7.1.6 Vendor must provide a warranty on the gas system piping and controller for a minimum of six (6) months. Warranty to cover items which fail due to manufacturer defect or age. Contamination induced failure, not caused by the controller or components, will not be subject to a warranty claim.
7.1.7 Vendor must helium leak check, and have the ability to particle test (if required) the gas lines within the Gas Cabinets and VMBs.

7.1.8 Vendor must have replacement parts for cabinets in stock with the ability to ship replacement parts immediately upon need.

Disclaimer:

The information presented in this document is intended to help customers in the writing of their engineering specification for gas delivery systems. Critical Systems provides this document as a service to help in the proper selection of gas systems, but as Codes and Code requirements are continually evolving, it is up to the customer to verify and assure that the information contained herein is both accurate and correct. Critical Systems has written this document based on information we have gathered from sources considered of importance and value in the area of gas delivery. The customer, engineering firm or facility using this document is ultimately liable and responsible to assure the information provided meets with their applicable needs and current industry Codes. CSI will not be held liable for any damage caused by the use of the information herein.