# GUIDE TO GAS CABINET SAFETY

## and Code Conformance


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## Introduction

The handling and storage of hazardous gases is covered extensively throughout several National Codes. The codes apply general rules to different classes of gas such as flammable, toxic, corrosive, highly toxic and pyrophoric. The intent of this guide is to:

- Inform its users of the principal code requirements
- Assist in selecting and obtaining the proper equipment
- Help achieve a code-compliant gas cylinder system

This guide will outline some of the requirements given in the following editions of the national codes and standards:

- National Fire Protection Association 2010 Edition ("NFPA")
- International Fire Code 2009 Edition ("IFC")
- International Building Code 2009 ("IBC")
- International Mechanical Code 2009 ("IMC")

Due to the complexity of the codes, this guide is not a replacement for a project specific, complete engineering design and review by a qualified engineer knowledgeable in the application of codes and standards for their construction and use. Also, the user should recognize that Codes and Standards are periodically updated and that any specific citation contained or referenced herein will need to be verified with the latest current edition that applies. Further, it is important to remember that the local authority having jurisdiction, such as a building inspector or fire marshal, can go above and beyond the requirements of the written codes.

The IFC has been adopted in 43 states; the IBC has been adopted in 50 states; and the IMC has been adopted in 46 states. A state adoption table is shown at the end of this document. For the most recent listings, as well as specific jurisdictions within a state, go to: http://www.iccsafe.org/gr/Documents/stateadoptions.pdf

## Classification of Gases

Rather than dealing with individual gases, the national codes address specific hazard types. For example, the codes may not offer guidelines for storage and handling of chlorine but would provide information on toxic gases as a whole.

In order for us to understand how to interpret the codes, we must first have a clear idea of the definition of each gas hazard type. There are five hazard types that are typically stored in gas cabinets. Below is a listing of these classes complete with their definitions as used in NFPA:

**Flammable Gas:** A material that is a gas at 68° F or less at an absolute pressure of 14.7 psi, that is ignitable at an absolute pressure of 14.7 psi when in a mixture of 13 percent or less by volume with air, or that has a flammable range at an absolute pressure of 14.7 psi with air of at least 12 percent, regardless of the lower limit.

A flammable gas is generally a U.S. Department of Transportation ("DOT") Class 2.1 Flammable with a NFPA flammability rating of 4.

The definition of a toxic and highly toxic gas is related to the lethal concentration where 50% of a sample population of albino rats die after exposure. This value is referred to as the LC50, with the levels defined as follows:

**Toxic Gas:** A gas with a median lethal concentration (LC50) in air of more than 200 parts per million (ppm) but not more than 2,000 ppm by volume of gas or vapor. Examples of toxic gas are chlorine, hydrogen sulfide ($H_2S$) and hydrogen fluoride (HF).

**Highly Toxic Gas:** A chemical that has a median lethal concentration (LC50) in air of 200 ppm or less by volume of gas or vapor. Examples of highly toxic gas are arsine, phospine ($PH_3$), and nitric oxide (NO).

A toxic/highly toxic gas is generally a DOT Class 2.3 Poison with a NFPA health rating of 3 or 4.

**Corrosive Gas:** A gas that causes visible destruction of or irreversible alterations in living tissue by chemical action at the site of contact.

A corrosive gas is generally a DOT Class 2.3 Poison with a NFPA health rating of 3 or 4.

**Pyrophoric Gases:** With an autoignition temperature in air at or below 130° F.

A pyrophoric gas is generally a DOT Class 2.1 Flammable with a NFPA reactivity rating of 3.

**Oxidizing Gas:** A gas that can support and accelerate combustion of other materials more than air does.

An oxidizing gas is generally a DOT Class 2.2 Oxidizer.

For further information on gas hazard type, Table 1 provides a partial list of commonly used gases and their classifications.

**Table 1. Partial List of Gases and Their Classifications**

| Gas Chemical Name | Liquefied or Non-Liquefied Gas? | Flammable (see p. 9 for equipment offering) | Toxic (see p. 10 for equipment offering) | Corrosive (see p. 10 for equipment offering) | Pyrophoric (see p. 11 for equipment offering) | Highly Toxic (see p. 11 for equipment offering) |
|---|---|---|---|---|---|---|
| Ammonia | Liquefied | * | | √ | | |
| Arsine | Liquefied | | | | | √ |
| Carbon Monoxide | Non-liquefied | √ | ** | | | |
| Chlorine | Liquefied | | √ | | | |
| Disilane | Liquefied | | | | √ | √ |
| Ethane | Liquefied | √ | | | | |
| Ethyl Chloride | Liquefied | √ | | | | |
| Ethylene | Liquefied | √ | | | | |
| Fluorine | Non-liquefied | | | | | √ |
| Hydrogen | Non-liquefied | √ | | | | |
| Hydrogen Chloride (HCl) | Liquefied | | | √ | | |
| Hydrogen Fluoride (HF) | Liquefied | | √ | | | *** |
| Hydrogen Sulfide ($H_2S$) | Liquefied | √ | √ | | | |
| Methane | Non-liquefied | √ | | | | |
| Nitric Oxide | Non-liquefied | | | | | √ |
| Nitrogen Dioxide | Liquefied | | | | | √ |
| Phosgene | Liquefied | | | | | √ |
| Phosphine | Liquefied | | | | √ | √ |
| Silane | Non-liquefied | | | | √ | |
| Silicon Tetrachloride | Liquefied | | √ | | | *** |
| Silicon Tetrafluoride | Non-liquefied | | | | | √ |
| Sulfur Dioxide | Liquefied | | | √ | | |
| Trimethylamine | Liquefied | √ | √ | | | |
| Tungsten Hexafluoride | Liquefied | | √ | | | *** |

**Ammonia is classified as a corrosive, but does have flammability hazards. Ammonia will ignite and burn although its flammable range is too narrow to fit the definition of a flammable gas. While it doesn't meet the definition of a flammable gas, it is classified as a Group D flammable according to the National Electrical Code.*

***Carbon Monoxide is classified as a flammable but should be used with a toxic gas cabinet.*

****Hydrogen fluoride, silicon tetrachloride and tungsten hexafluoride are classified as toxics, but are recommended to be used with a highly toxic gas cabinet.*

It should be noted that NFPA 55 7.1.10.1.1 references the separation of compressed gas cylinders based on their hazard class type (also see NFPA 55 Table 7.1.10.2 for separation distances). This is an important concept to keep in mind, as it dictates that we cannot store incompatible gas hazard classes in the same gas cabinet. For example, we cannot store both ethane (flammable) and sulfur dioxide (toxic) in the same cabinet as they are two different hazard classifications.

# Control Areas and Threshold Quantities

Chapter 4 of the IBC defines a control area as a space within a building where quantities of hazardous material not exceeding the maximum allowable quantities (MAQ) are stored, dispensed, used or handled. It is advantageous to utilize the control area concept to prevent having the entire room or building of a facility meet Building and Fire Code requirements for high-hazard occupancy.

**Table 2. Maximum Allowable Quantity (MAQ) of Gas per Control Area**

| Gas Hazard Type | Phase | Unsprinklered Area | | Sprinklered Area | |
|---|---|---|---|---|---|
| | | No gas cabinet, gas room or exhausted enclosure | Gas cabinet, gas room or exhausted enclosure | No gas cabinet, gas room or exhausted enclosure | Gas cabinet, gas room or exhausted enclosure |
| Flammable | *Liquefied*<br>*Non-liquefied* | 150 lbs.<br>1,000 $ft^3$ | 300 lbs.<br>2,000 $ft^3$ | 300 lbs.<br>2,000 $ft^3$ | 600 lbs.<br>4,000 $ft^3$ |
| Toxic | *Liquefied*<br>*Non-liquefied* | 150 lbs.<br>810 $ft^3$ | 300 lbs.<br>1,620 $ft^3$ | 300 lbs.<br>1,620 $ft^3$ | 600 lbs.<br>3,240 $ft^3$ |
| Corrosive | *Liquefied*<br>*Non-liquefied* | 150 lbs.<br>810 $ft^3$ | 300 lbs.<br>1,620 $ft^3$ | 300 lbs.<br>1,620 $ft^3$ | 600 lbs.<br>3,240 $ft^3$ |
| Pyrophoric | *Liquefied*<br>*Non-liquefied* | 0 lbs.<br>0 $ft^3$ | 0 lbs.<br>0 $ft^3$ | 4 lbs.<br>50 $ft^3$ | 8 lbs.<br>100 $ft^3$ |
| Highly Toxic | *Liquefied*<br>*Non-liquefied* | 0 lbs.<br>0 $ft^3$ | 4 lbs.<br>20 $ft^3$ | 0 lbs.<br>0 $ft^3$ | 8 lbs.<br>40 $ft^3$ |
| Oxidizers | *Liquefied*<br>*Non-liquefied* | 150 lbs.<br>1,500 $ft^3$ | 300 lbs.<br>3,000 $ft^3$ | 300 lbs.<br>3,000 $ft^3$ | 600 lbs.<br>6,000 $ft^3$ |

*Source: NFPA 55 Table 6.3.1.1*

In order to meet the classification of a control area and avoid classification as high-hazard occupancy, the quantity in use/storage must be reduced, or multiple control areas must be created. Table 3 shows the maximum number of control areas allowed per building. The source of this table is the International Building Code Section 414 (2009 edition). State and local building and fire codes must also be reviewed.

**Table 3. Maximum Number of Control Areas Allowed per Building**

| Floor Level | | Percentage of the MAQ per Control Area | Maximum Number of Control Areas per Floor | Fire Resistance Rating for Fire Barriers (in hours) |
|---|---|---|---|---|
| Above Grade | 1 | 100 | 4 | 1 |
| | 2 | 75 | 3 | 1 |
| | 3 | 50 | 2 | 1 |
| | 4 | 12.5 | 2 | 2 |
| | 5 | 12.5 | 2 | 2 |
| | 6 | 12.5 | 2 | 2 |
| | 7-9 | 5 | 2 | 2 |
| | Higher than 9 | 5 | 1 | 2 |
| Below Grade | 1 | 75 | 3 | 1 |
| | 2 | 50 | 2 | 1 |
| | Lower than 2 | Not Applicable | Not Applicable | Not Applicable |

*Source: IBC Section 414*

# Code Conformance Examples

**Example 1: Customer Using Flammable Gas**
A customer is using methane for one of their plant processes. This non-liquefied flammable gas is (per Table 1 of this guide) both stored and used in an area that was unsprinklered and without a gas cabinet, gas room or exhausted enclosure. The quantities on hand are as follows:

- 3 cylinders of methane x 360 $ft^3$/cylinder = 1,080 $ft^3$ of methane on hand

In this scenario, the customer does not conform with NFPA, IFC and IBC since they are above the MAQ of 1,000 $ft^3$ (per Table 2 of this guide) for an area without a sprinklered gas cabinet, room or exhausted enclosure.

In order to comply with NFPA, IFC and IBC requirements for threshold quantities, a gas cabinet would need to be used. By placing these flammable gas cylinders into a cabinet they would be allowed to keep up to 2,000 $ft^3$ of non-liquefied flammable gases in this particular area. This entire area could now be classified as a control area. Per the International Building Code this customer could have up to three additional control areas on this first floor of their facility (per Table 3 of this guide).

**Example 2: Customer Using Toxic Gases**
A customer is using the following liquefied toxic gases (per Table 1 of this Guide) in one area of their plant without any sprinkler, cabinet, gas room or exhausted enclosure:

- 1 cylinder of hydrogen sulfide x 60 lbs./cylinder = 60 lbs.
- 2 cylinders of chlorine x 90 lbs./cylinder = 180 lbs.
- Total toxic (liquefied) gases in area = 240 lbs.

The 240 lbs. of toxic gases are above the 150 lbs. MAQ for use in an unsprinklered area with no gas cabinet, gas room or exhausted enclosure (see Table 2 of this guide).

In order to conform to NFPA, IFC and IBC, one cabinet could be used for all three cylinders. Since these two gases are both toxics, they are compatible hazardous materials and can be placed together in one cabinet. If they were incompatible gases (e.g., toxic and corrosive) separate cabinets would be required. In a cabinet, the customer can now store up to 300 lbs. of liquefied toxic gases. This entire area could now be classified as a control area per IBC and this customer could have up to three additional control areas on this first floor of their facility (per Table 3 of this guide).

**Example 3: Customer Using Flammable and Corrosive Gases**
A client has both methane (non-liquefied flammable gas) and sulfur dioxide (liquefied corrosive gas) in one room of their facility which is unsprinklered and without a gas cabinet, gas room or exhausted enclosure. The quantities on hand are as follows:

- 3 cylinders of methane x 360 $ft^3$/cylinder = 1,080 $ft^3$ of methane on hand
- 2 cylinders of sulfur dioxide x 150 lbs./cylinder = 300 lbs. of sulfur dioxide on hand

Since this area has no sprinklered gas cabinet, room or exhausted enclosure, the customer does not conform with NFPA, IFC and IBC since they are above the MAQ of 1,000 $ft^3$ for non-liquefied flammable gases and above the MAQ of 150 lbs. for a liquefied corrosive gas (per Table 2 of this guide).

In order to comply with the NFPA, IFC and IBC gas cabinets would need to be used. However, in this scenario, it is important to remember that per NFPA 55, we need to separate different hazard classes. Thus, the customer cannot have one cabinet with both methane and sulfur dioxide inside. Instead, they must have one cabinet for methane and another separate cabinet for sulfur dioxide to comply with NFPA.

By placing the three methane cylinders in one cabinet and the two cylinders of sulfur dioxide in another cabinet the customer would be below the NFPA, IFC and IBC MAQs as stated in Table 2.

# Typical Safety Features of Gas Cabinets

A gas cabinet itself is designed to isolate gas cylinders from the surrounding environment. In doing so, it protects end users from the hazards associated with the different gas types. Per NFPA 55 6.16, cabinets must have the following design features:

- Not less than 12-gauge steel construction
- Access to controls via self closing doors and windows
- Ventilation requirements of 200 ft./minute face velocity at access openings
- Internally sprinklered
- No more than three tanks per cabinet, which must be compatible

In addition to the gas cabinet, extra safety features are often built into the overall system. Such components are considered based on the gas hazard type (e.g., flammable, toxic, pyrophoric, or highly toxic); incorporating these components into the cabinet will serve as additional methods of protection for individuals working with and around hazardous gases. Table 4 lists some of these features and their safety benefits.

**Table 4. Common Safety Components of Airgas Gas Cabinet Systems**

| Feature | Benefit |
|---|---|
| Emergency Shut-Off Valve | Quickly stops flow of gases in the event of leak downstream and can be activated automatically by gas detection system or manually by emergency stop button |
| Excess Flow Control | Halts flow of gas when abnormal (high) gas flow levels occur, which are typically indicative of a leak in the piping |
| Exhaust Alarm | Alerts end users when negative pressure or exhaust flow to cabinet is lost; also shuts down gas flow to ensure operators aren't exposed to potential leaks that may occur during loss of negative pressure |
| Gas Detection System | Provides notification of flammable, toxic, highly toxic or pyrophoric gas concentrations in atmosphere; alarms activated before dangerous levels are reached (i.e. LFL, PEL) |
| Purge System | Used to flush residue of process gas out to vent, helps to ensure that operator is not exposed to hazardous gas during cylinder changeout |
| Vacuum Drive | Used in conjunction with purge system as a means of extracting hazardous gases from delivery equipment |

*Source: Airgas Engineering Solutions*

# Gas Cabinet Descriptions

***Laboratory 1000 Series Flammable Gas Cabinet:***
The 1000 Series Flammable Gas Cabinet is designed with a process panel containing either an individual pressure regulator or automatic changeover manifold to regulate the source gas pressure. The system also includes a gas detector to determine the % lower explosive limit (LEL) of the gas in the cabinet. If a leak is detected, a controller tied into the gas detector closes the emergency shut-off valve on the panel, stopping the flow of gas. For added safety, the cabinet contains a flashback arrestor and excess flow control on the panel outlet. The flammable gas cabinet system also includes a shutoff valve and CGA connection with integrated check nipple on the flex hose(s), so no purge system or vacuum drive is required. Figure 1 shows a standard flammable process panel with the individual regulator configuration.

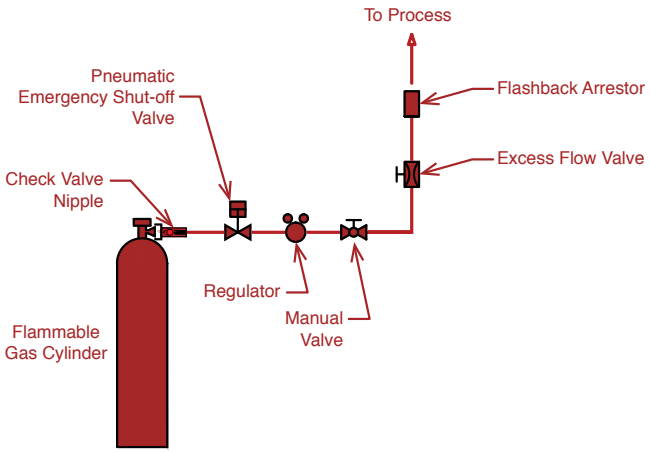



***Figure 1: Flammable gas panel with individual pressure regulator***

***Laboratory 2000 Series Toxic and Corrosive Gas Cabinet:***
The 2000 Series Toxic and Corrosive Gas Cabinet is designed with a process panel containing either an individual pressure regulator or automatic changeover manifold to regulate the source gas pressure. The panel will include a purge system with vacuum drive to protect operator safety during a cylinder change as well as prolong the life of the equipment. The purge process is semi-automated, allowing the operator to open and close a series of valves during the cylinder change out. The cabinet system includes a gas detector to determine the parts per million (ppm) concentration of the gas in the cabinet. If a leak is detected, a controller tied into the gas detector closes the emergency shut-off valve on the panel, stopping the flow of gas. Figure 2 shows a standard toxic and corrosive process panel with the individual pressure regulator configuration.

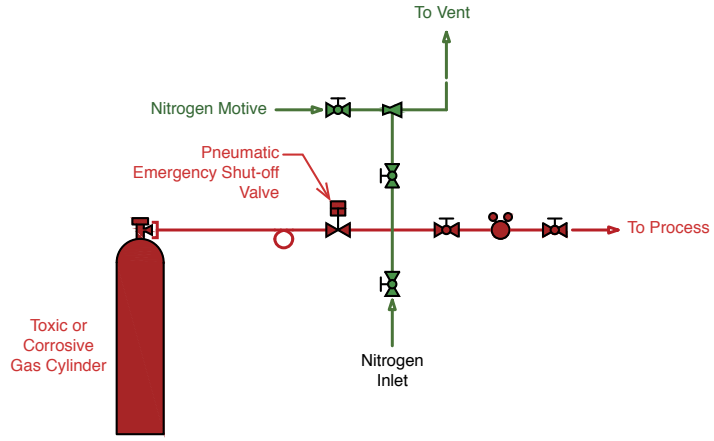



***Figure 2: Toxic & corrosive gas panel with individual pressure regulator***

***Laboratory 3000 Series Highly Toxic and Pyrophoric Gas Cabinet:*** The 3000 Series Highly Toxic and Pyrophoric Gas Cabinet is designed with a process panel containing an individual pressure regulator. The panel will include a purge system with vacuum drive to protect operator safety during a cylinder change as well as prolong the life of the equipment. The purge process is fully-automated, allowing the operator to control the purge cycles from an onboard PLC. The cabinet system includes a gas detector to determine the ppm concentration of the gas in the cabinet. If a leak is detected, a controller tied into the gas detector closes the emergency shut-off valve on the panel, stopping the flow of gas. For additional safety, exhaust alarms are utilized with this line of cabinets. Figure 3 shows a standard highly toxic and pyrophoric process panel with the individual pressure regulator configuration.

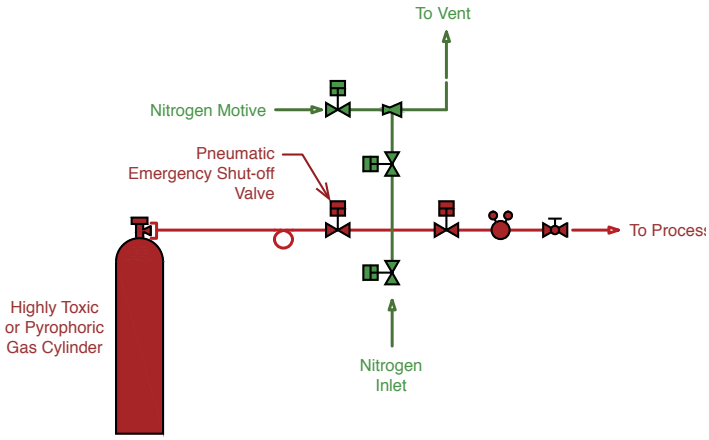



***Figure 3: Highly toxic & pyrophoric gas panel with individual pressure regulator***

# Laboratory 1000 Series Flammable Gas Cabinets


The Laboratory 1000 Series gas cabinets are designed to meet the safe storage requirements for flammable gases while conforming to the guidelines provided in the applicable national codes, such as the International Fire Code (IFC), International Building Code (IBC), International Mechanical Code (IMC) and the National Fire Protection Agency (NFPA).

The flammable gas cabinet includes either a regulator or automatic changeover manifold, gas detector, automatic flow shutoff valve, an excess flow valve and a flashback arrestor.

A control box is provided as a standard with the cabinet to provide power to the gas detector as well as offer an emergency stop button and commands to the automatic shutoff valve.

Additional options such as pressure and flow monitoring, remote E-stop, and remote gas monitoring are available to meet your specific process requirements. Airgas also provides the Nano Semi line of gas cabinets which feature VCR construction and clean room assembly.

| Standard Configurations | |
|---|---|
| **Laboratory 1000 Series Flammable Gas Cabinet with Individual Process Panel**<br><br>**Part # V89 ES1452** | 24" wide steel cylinder cabinet with individual brass pressure regulator to house one process cylinder and one spare cylinder. Cabinet also contains an excess flow valve and flashback arrestor mounted downstream of the regulator. A gas detector and control box mounted to the top of the cabinet provides a means of shutting down the system in the event of a leak. Constructed with NPT connections. |
| **Laboratory 1000 Series Flammable Gas Cabinet with Automatic Changeover Manifold**<br><br>**Part # V89 ES1450** | 24" wide cylinder steel cabinet with brass automatic changeover manifold to house two process cylinders. The panel allows for automatic switching to second cylinder upon depletion of the first cylinder. Cabinet also contains an excess flow valve and flashback arrestor mounted downstream of the manifold. A gas detector and control box mounted to the top of the cabinet provides a means of shutting down the system in the event of a leak. Constructed with NPT connections. |

| Design Features | |
|---|---|
| **Designed for code conformance** | 11-gauge steel cabinet construction with self-closing doors and windows and internal sprinkler head |
| **Protects personnel** | Safely exhausts hazardous gases |
| **Gas detection with cabinet mounted display** | View gas levels from outside the cabinet, automatic shutdown at alarm levels |
| **Automatic shutdown** | Normally closed shutoff valve actuated by emergency stop button or high gas concentration |

| Facilities Requirements | | |
|---|---|---|
| **Power** | 110 VAC | N/A |
| **Pneumatic Supply ($N_2$ or clean, dry air)** | adjustable to 90 psig | 1 slm max. |
| **Sprinkler** | 30 psig | 31 gpm |
| **Exhaust** | > 0.15" $H_20$ | 300scfm (2 cylinder) |

# Laboratory 2000 Series Toxic and Corrosive Gas Cabinets


The Laboratory 2000 Series gas cabinets are designed to meet the safe storage requirements for toxic and corrosive gases while conforming to the guidelines provided in the applicable national codes, such as the International Fire Code (IFC), International Building Code (IBC), International Mechanical Code (IMC) and the National Fire Protection Agency (NFPA).

The toxic and corrosive gas cabinet includes either a regulator or automatic changeover manifold with purge controls utilizing a vacuum venturi, gas detector and automatic flow shutoff valve.

A control box is provided as a standard with the cabinet to provide power to the gas detector as well as offer an emergency stop button and commands to the automatic shutoff valve.

Additional options such as pressure and flow monitoring, remote E-stop, and remote gas monitoring are available to meet your specific process requirements. Airgas also provides the Nano Semi line of gas cabinets which feature VCR construction and clean room assembly.

| Standard Configurations | |
|---|---|
| **Laboratory 2000 Series Toxic and Corrosive Gas Cabinet with Individual Process Panel**<br><br>**Part # V89 ES1453** | 24" wide steel cylinder cabinet with individual stainless steel pressure regulator to house one process cylinder and a purge gas cylinder mounted inside the cabinet. Cabinet also contains a purge gas regulator for vacuum motive supply. A gas detector and control box mounted to the top of the cabinet provides a means of shutting down the system in the event of a leak. Constructed with NPT connections. |
| **Laboratory 2000 Series Toxic and Corrosive Gas Cabinet with Automatic Changeover Manifold**<br><br>**Part # V89 ES1451** | 36" wide steel cylinder cabinet with stainless steel changeover manifold to house two process gas cylinders and a purge gas cylinder mounted inside the cabinet. Cabinet also contains a purge gas regulator for vacuum motive supply. A gas detector and control box mounted to the top of the cabinet provides a means of shutting down the system in the event of a leak. Constructed with NPT connections. |

| Design Features | |
|---|---|
| **Designed for code conformance** | 11-gauge steel cabinet construction with self-closing doors and windows and internal sprinkler head |
| **Protects personnel** | Safely exhausts hazardous gases |
| **Gas detection with cabinet mounted display** | View gas levels from outside the cabinet, automatic shutdown at alarm levels |
| **Automatic shutdown** | Normally closed shutoff valve actuated by emergency stop button or high gas concentration |

| Facilities Requirements | | |
|---|---|---|
| **Power** | 110 VAC | N/A |
| **Pneumatic Supply ($N_2$ or clean, dry air)** | adjustable to 90 psig | 1 slm max. |
| **Process Purge ($N_2$ cylinder)** | adjustable to 80 psig | 30 slm |
| **Vacuum Drive ($N_2$ from cylinder or house line)** | adjustable to 85 psig | 85 slm max |
| **Sprinkler** | 30 psig | 31 gpm |
| **Exhaust** | > 0.15" $H_20$ | 300scfm (2 cylinder) |

# Laboratory 3000 Series Highly Toxic and Pyrophoric Gas Cabinets


The Laboratory 3000 Series gas cabinets are designed to meet the safe storage requirements for highly toxic and pyrophoric gases while conforming to the guidelines provided in the applicable national codes, such as the International Fire Code (IFC), International Building Code (IBC), International Mechanical Code (IMC) and the National Fire Protection Agency (NFPA).

The highly toxic and pyrophoric fully automatic group of cabinets includes a process panel with purge controls utilizing a vacuum venturi, gas detector and automatic flow shutoff valve.

A touch-screen PLC is provided as a standard with the cabinet to provide automated control of all critical functions such as purge sequence, emergency shutoff, alarm outputs and exhaust pressure monitor. Additional options such as automatic switchover, integrated scales, purgeable splitters, restrictive flow orifices, filtration and purification are available to meet your specific process requirements.

| Standard Configuration | |
|---|---|
| **Laboratory 3000 Series Highly Toxic and Pyrophoric Gas Cabinet** | 24" wide steel cylinder cabinet with individual process panel to house one process cylinder and a purge gas cylinder mounted inside the cabinet. Cabinet also contains a purge gas regulator for vacuum motive supply, gas detector and automatic flow shutoff valve. A touch-screen PLC mounted to the top of the cabinet provides automated control of critical functions. Clean room assembly with VCR connections. |

| Design Features | |
|---|---|
| **Designed for code conformance** | 11-gauge steel cabinet construction with self-closing doors and windows and internal sprinkler head |
| **Protects personnel** | Safely exhausts hazardous gases |
| **Gas detection with cabinet mounted display** | View gas levels from outside the cabinet, automatic shutdown at alarm levels |
| **PLC Controls** | Color touch screen interface, auto-sequenced routings of operation and maintenance |

| Facilities Requirements | | |
|---|---|---|
| **Power** | 115 V/3A | N/A |
| **Pneumatic Supply ($N_2$ or clean, dry air)** | adjustable to 90 psig | 1 slm max |
| **Process Purge ($N_2$ cylinder)** | adjustable to 80 psig | 30 slm |
| **Vacuum Drive ($N_2$ from cylinder or house line)** | adjustable to 85 psig | 85 slm max |
| **Process Vent** | > 1.0" WC | 100 slm |
| **Sprinkler** | 30 psig | 31 gpm |
| **Exhaust** | > 0.15" $H_20$ | 300scfm (2 cylinder) |

# Frequently Asked Questions (FAQs)

**1) Why do I need a gas cabinet?**
The main reason for a gas cabinet is to protect individuals and ensure compliance with relevant codes and regulations. Using a gas cabinet allows the maximum storage quantity for flammable and toxic gases. It also provides a fire barrier between two incompatible materials.

**2) How much flammable or toxic gas can I store on site?**
The Maximum Allowable Quantity (MAQ) of flammable and toxic gases that can be stored on site under the NFPA is shown in Table 2 of this guide as well as Table 6.3.1 of NFPA 55.

For flammable gases, the NFPA MAQ is limited to 30 gallons of a liquefied gas and 1,000 $ft^3$ of a non-liquefied gas. This quantity can be doubled if placed into a gas cabinet or exhausted enclosure (2,000 $ft^3$). The quantity can be doubled again if the gas cabinet or exhausted enclosure is a sprinklered area (4,000 $ft^3$).

For toxic and corrosive gases the NFPA MAQ is 150 pounds for a liquefied gas and 810 $ft^3$ for a non-liquefied gas. Again the quantities can be doubled if placed into a gas cabinet (300 pounds/ 1,620 $ft^3$) and doubled again if the gas cabinet or exhausted enclosure is in a sprinklered area (600 pounds/ 3,240 $ft^3$).

**3) What if I exceed the threshold quantity for a given gas?**
The threshold quantities listed per NFPA in Table 2 give the maximum amount of gas that can be stored per control area. If these quantities are exceeded, the area can no longer be considered a control area, but rather high-hazard occupancy ($H_2$ for flammable gases, $H_4$ for toxic gases) and would need to meet the additional requirements as listed in the International Fire Code (IFC) and International Building Code (IBC).

Such items as explosion control, standby emergency power, fire separation, supervised central alarm system, and higher level of sprinkler protection may be required and should be considered.

It is permissible to have multiple control areas in a building in order to spread out the quantity of stored gas within a facility. Table 3 shows the maximum number of control areas for each floor of a building as outlined in IBC Section 414. Always check legal requirements as well.

**4) What if my bottle isn't connected? Does it still count toward my threshold quantity?**
Yes! A control area is defined as a space within a building where quantities of hazardous materials are stored, dispensed, used or handled.

**5) What is a control area and how many can I have in my facility?**
According to Chapter 4 of the IBC, a control area is defined as a space within a building where quantities of hazardous material not exceeding the maximum allowable quantities per control area are stored, dispensed, used or handled.

Table 414.2.2 of the IBC (also shown on Table 3 of this guide) shows the number of control areas and the percentage of allowable quantities that are allowed per floor level.

**6) What is the difference between a toxic and highly toxic gas?**
The difference is based upon the lethal concentration where 50% of a sample population of animals (typically albino rats) dies after exposure. This is referred to as the LC50.

A toxic gas is defined by NFPA as a chemical that has an LC50 between 200 ppm and 2000 ppm. A highly toxic gas is defined as a chemical that has an LC50 between 0 and 200 ppm.

See Table 1 of this guide for some of the most commonly used gases and their classifications

**7) Do I need gas detection if I'm below the Threshold Quantity?**
According to NFPA if a gas has physiological properties below the threshold quantities gas detection is not required. However, in general, gas detectors should be used to detect toxic gases at or below their Permissible Exposure Limits (PEL), and at 25% of the Lower Flammable Limit (LFL) for flammable gases. Further, the gas detection system should be tied to automatic controls that shut off the supply of gas in the event of a leak. Refer to IBC Chapter 9 and IFC Section 2703 for further review.

**8) Do I need excess flow control?**
Yes, per IFC, excess flow protection can be provided in one of two ways. A gas detector tied into an emergency shutoff as described in the previous point is one way. The second method is to use an excess flow valve.

**9) Does the exhaust fan need to run all the time?**
Yes, according to the International Mechanical Code (IMC) Chapter 5, gas cabinets have the following requirements:

- Must be connected to an exhaust system
- Provide a face velocity of 200 feet per minute (FPM) at gas cabinet access ports and windows
- May not be used as the sole means of exhaust for any room or area

# Frequently Asked Questions (FAQs) continued....

**10) How much airflow do I need for my gas cabinet?**
The airflow requirements are given to insure the gas cabinet operates at a negative pressure relative to the surrounding area, as well as to sweep air across access ports.

All access ports, (typically the windows), have a face velocity requirement. The typical gas cabinet requires a ventilation rate of approximately 300 cubic feet per minute (CFM) in order to meet this requirement.

**11) What are the design requirements of my gas cabinet?**
- Not less than 12 gauge steel construction
- Access to controls via self-closing doors and windows
- Ventilation requirements of 200 ft/min face velocity at access openings
- Internally sprinklered
- No more than three tanks per gas cabinet, which must be compatible

See NFPA 55 Chapter 6 for complete reference.

**12) Do I need to have an exhaust alarm on my gas cabinet?**
Gas cabinets storing flammable gases do require an automatic shut down of the source gases if the exhaust flow is lost. (Reference IBC Section 908.)

**13) Do I need a scrubber or abatement system for my gas cabinet?**
According to NFPA 55 Chapter 7, a treatment system is not required for toxic gas systems that have the following two items in place:

- A gas detection system with a sensing interval not exceeding 5 minutes
- The gas detection system shall monitor the exhaust system at the point of discharge from the gas cabinet.

However, under NFPA, a highly toxic gas requires that the cabinet be ventilated through a treatment system. The user must also check local laws including applicable environmental regulations.

**14) What maintenance do I need to do on an ongoing basis?**
The gas detection system, alarms and automatic emergency shutoff valves need to be tested at one of the following intervals:

- Not less than annually
- In accordance with the manufacturer's requirements
- In accordance with approved recognized industry standards
- In accordance with an approved schedule

See IFC Chapter 27 for complete reference.

**15) What type of manifold system should I have in my gas cabinet?**
See pages 9 – 11 in this document for typical gas cabinets with individual regulators as well as changeover manifolds. Items such as process downtime should be considered to determine if a changeover manifold is required. Other options such as low pressure alarm, cylinder scales, and multiple outlets are available to fit your process.

**16) What if I am using hazardous gases at volumes below the threshold quantities?**
In cases where a facility may be below the NFPA MAQ threshold quantity for a particular gas, a cabinet may not be required by code. However, NFPA 55, IFC and IBC all have requirements for gas delivery systems. Most notably IFC 2703.2.2.1:

"Where gases or liquids having a hazard ranking of health hazard Class 3 or 4, Flammability Class 4, or Reactivity Class 3 or 4 in accordance with NFPA 704 that are carried in pressurized piping above 15 psig, an approved means of leak detection and emergency shutoff or excess flow control shall be provided…"

*It is important to note that this IFC requirement applies to gases that are below the threshold quantity of the control area.* In other words, a cabinet may not be needed but specific safety features of a gas delivery system are still necessary to comply with applicable codes such as NFPA, IFC and IBC.

Even though you may be below the threshold quantities, it is often easier and considered best practice to utilize a gas cabinet and related gas delivery equipment with the appropriate safety features.

# Glossary of Terms

**Abatement System:** An assembly of equipment capable of processing a hazardous gas and reducing the gas concentration to a predetermined level at the point of discharge from the system to the atmosphere (also referred to as a scrubber).

**Control Area:** A space within a building where quantities of hazardous material not exceeding the Maximum Allowable Quantities (MAQ) are stored, dispensed, used or handled per IBC.

**Corrosive Gas:** A gas that has the ability to attack and produce irreversible damage to human tissues or the ability to attack and eat away rubber, metal and other substances.

**Emergency Shutoff Valve:** A designated valve designed to shut off the flow of gases or liquids.

**Excess Flow Control:** A fail-safe system or approved means designed to shut off flow due to a rupture in pressurized piping systems.

**Exhaust Alarm:** An alarm that is triggered by low negative pressure or lost exhaust flow in a gas cabinet. Typically the alarm is tied to a means of shutting down gas flow when the alarm level is reached.

**Exhausted Enclosure:** A noncombustible enclosure consisting of two sides, a top, back that provides a means for local exhaust.

**Face Velocity:** Average measured air speed at the face of gas cabinet access ports and windows.

**Fire Resistance Rating:** The amount of time in minutes or hours that a fire protection system has withstood a standard fire resistance test.

**Flammable Gas:** A material that is a gas at 68° F or less at an absolute pressure of 14.7 psi, that is ignitable at an absolute pressure of 14.7 psi when in a mixture of 13 percent or less by volume with air, or that has a flammable range at an absolute pressure of 14.7 psi with air of at least 12 percent, regardless of the lower limit per NFPA.

**Gas Cabinet:** A fully enclosed, noncombustible enclosure used to provide an isolated environment for compressed gas cylinders in storage or use.

**Gas Room:** A separately ventilated, enclosed room, isolated from other parts of a building in which compressed gases are used and/or stored.

**High-Hazard Occupancy:** Classification of an area that contains quantities of substances that exceed the published MAQ. High-hazard occupancies cannot be classified as control areas and require additional safeguards to meet requirements for explosion control, emergency power, alarm systems, sprinkler protection, detached buildings, etc. per IFC and IBC.

**Highly Toxic Gas:** A chemical that has a median lethal concentration (LC50) in air of 200 ppm by volume or less of gas or vapor, or 2 mg/L or less of mist, fume or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 0.44 lb and 0.66 lb each.

**International Building Code (IBC):** A set of model codes published by the International Code Council (ICC) that serves as guidelines for the construction and design of new buildings as well as alterations to existing buildings. The IBC is designed to establish minimum safety levels against hazards associated with building construction or occupancy.

**International Fire Code (IFC):** A set of model codes published by the International Code Council (ICC) that are designed to protect life and property from fires and explosion hazards.

**International Mechanical Code (IMC):** A set of model codes published by the International Code Council (ICC) that regulate the design and installation of mechanical systems. The IMC serves to establish minimum safety levels to protect life and property from the dangers of operation/installation of mechanical systems.

**Liquefied Gas:** A gas which, under the charged pressure, is partially liquid at a temperature of 70° F (21.1° C) per NFPA Glossary of Terms.

**Lower Flammable Limit (LFL):** The minimum percent by volume of a gas which, when mixed with air at normal temperature and pressure, will form a flammable mixture. The LFL is also referred to as the Lower Explosive Limit (LEL).

**Maximum Allowable Quantity (MAQ):** A threshold quantity of hazardous material in a specific hazard class that, once exceeded, requires the application of additional administrative procedures, construction features or engineering controls per NFPA.

**Median Lethal Concentration (LC50):** The concentration of a substance that, when administered to a group of experimental animals, will result in the death of 50% of the sample population over a specified time.

**National Fire Protection Association (NFPA):** An international organization that publishes fire and building safety codes.

**Non-Liquefied Gas:** Gases, other than those in solution, that are contained in a packaging under the charged pressure and are entirely gaseous at a temperature of 68° F (20° C) per NFPA Glossary of Terms.

**Permissible Exposure Limits (PEL):** The legal limits of exposure of an employee to a chemical substance or physical agent. PELs are established by OSHA and typically expressed by substance.

**Purge Gas:** Inert gas used to flush gas delivery equipment to remove contamination or residue.

**Pyrophoric Gas:** A gas with an autoignition temperature in air at or below 130° F.

**Threshold Quantity:** Amounts of a hazardous material, established as a means of safety and code conformance. In this case, the threshold quantity of a substance is set as a trigger for its Maximum Allowable Quantity (MAQ) per NFPA.

**Toxic Gas:** A chemical that has a median lethal concentration (LC50) in air of more than 200 ppm but not more than 2000 ppm by volume of gas or vapor per NFPA.

**Vacuum Drive:** A gas, typically nitrogen, set at a defined pressure which is used to create a vacuum for purging gas delivery components such as regulators or manifolds.

# International Codes: Adoption by State

The International Code Council (ICC) makes every effort to provide current, accurate code adoption information. Not all jurisdictions notify ICC of code adoptions. To obtain more detailed information on amendments and changes to adopted codes, please contact the jurisdiction. To submit code adoption information: www.iccsafe.org/adoption

**X** = Effective Statewide
**S** = Statewide adoptions with limitations
**L** = Adopted by Local Governments

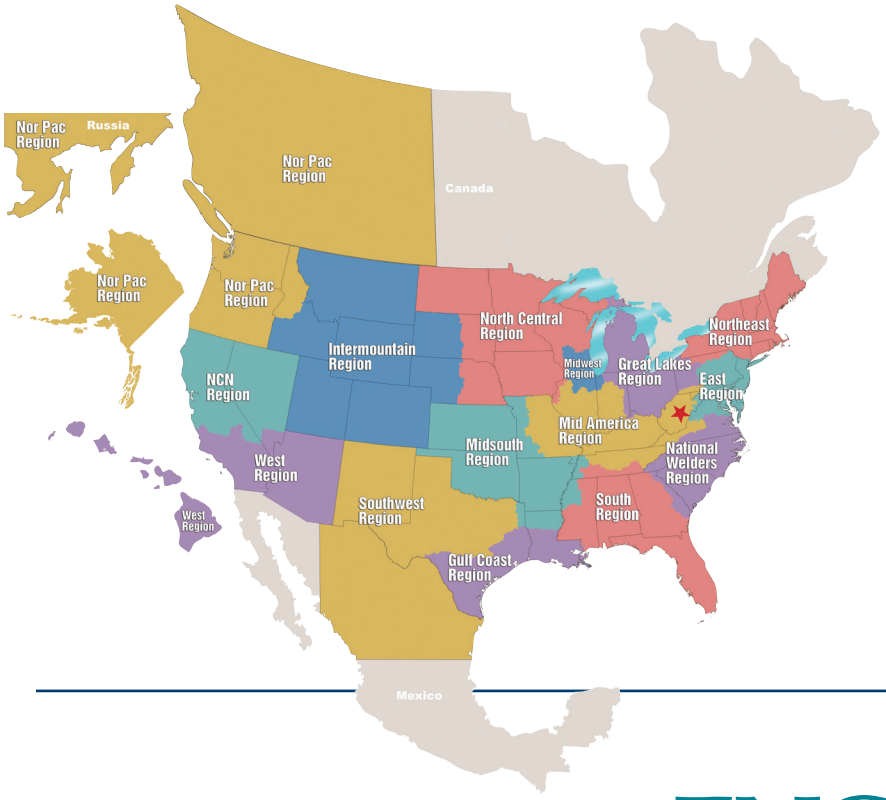
**15** = 2015 Edition
**12** = 2012 Edition
**09** = 2009 Edition
**06** = 2006 Edition
**03** = 2003 Edition
**00** = 2000 Edition

| State | International Fire Code | International Building Code | International Mechanical Code |
|---|---|---|---|
| Alabama | S09, L | S09, L | S09, L |
| Alaska | X09 | X09 | X09 |
| Arizona | S06, L | S09, L | S09, L |
| Arkansas | X12 | X12 | X09 |
| California | X12 | X12 | |
| Colorado | S12, L | S12, L | S12, L |
| Connecticut | X03 | X03 | X03 |
| Delaware | L12 | L12 | L12 |
| District of Columbia | X12 | X12 | X12 |
| Florida | | X09 | X09 |
| Georgia | X12 | X12 | X12 |
| Hawaii | | X06 | |
| Idaho | X12 | X12 | X12 |
| Illinois | S09, L | S09, L | S09, L |
| Indiana | X12 | X12 | X12 |
| Iowa | X09 | S09, L | S09, L |
| Kansas | S06, L | L | L |
| Kentucky | X12 | X12 | X12 |
| Louisiana | L | X12 | X12 |
| Maine | L | X09 | |
| Maryland | | X15 | X15 |
| Massachusetts | | X09 | X09 |
| Michigan | L | X12 | X12 |
| Minnesota | X06 | X06 | X00 |
| Mississippi | S12, L | S12, L | S12, L |
| Missouri | L | S12, L | S12, L |
| Montana | L | X12 | X12 |
| Nebraska | L | S09, L | L |
| Nevada | S12, L | S12, L | L |
| New Hampshire | L | X09 | X09 |
| New Jersey | X06 | X09 | X09 |
| New Mexico | X03 | X09 | L |
| New York | X06 | X06 | X06 |
| North Carolina | X09 | X09 | X09 |
| North Dakota | L | S12, L | S12, L |
| Ohio | X09 | X09 | X09 |
| Oklahoma | S09, X | S09, X | S09, X |
| Oregon | X12 | X12 | X12 |
| Pennsylvania | X09 | X09 | X09 |
| Rhode Island | | X12 | X12 |
| South Carolina | X12 | X12 | X12 |
| South Dakota | S09, L | S12, L | S09, L |
| Tennessee | S06, L | S06, L | L |
| Texas | L06 | X06 | L06 |
| Utah | X12 | X12 | X12 |
| Vermont | | X12 | |
| Virginia | X12 | X12 | X12 |
| Washington | X12, L | X12 | X12 |
| West Virginia | | X12 | X12 |
| Wisconsin | L | X09 | X09 |
| Wyoming | X12, L | X12, L | X12, L |

*Source: International Code Council (February 2015)*

# Airgas

# SALES REGIONS

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**Gulf Coast Region**
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**Mid South Region**
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**Midwest Region**
Serving IN, IL, WI

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★ **Engineering Solutions Group**
Oakwood Village, OH

# ENGINEERING SOLUTIONS GROUP

The Airgas Engineering Solutions Group is a team of engineers specializing in the design, construction and installation of gas delivery equipment. Based in Oakwood Village, OH, the group can provide the right solution for items such as:

- Gas cabinets
- Gas detection systems
- Gas blenders
- Laboratory equipment and piping installations
- Process chemical delivery systems
- Custom gas delivery equipment design and fabrication


Our team works directly with customers to develop equipment solutions that focus on safety, reliability and performance. For more information or to speak with an engineer, please dial toll free **1-800-282-1524**.

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