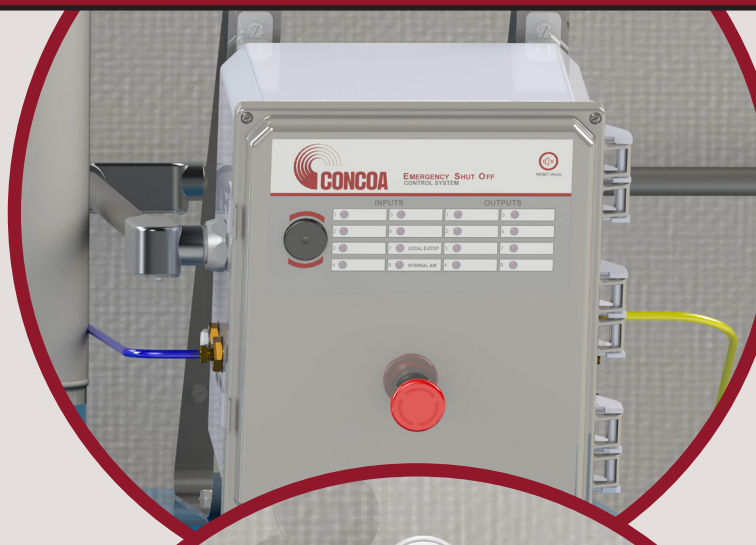
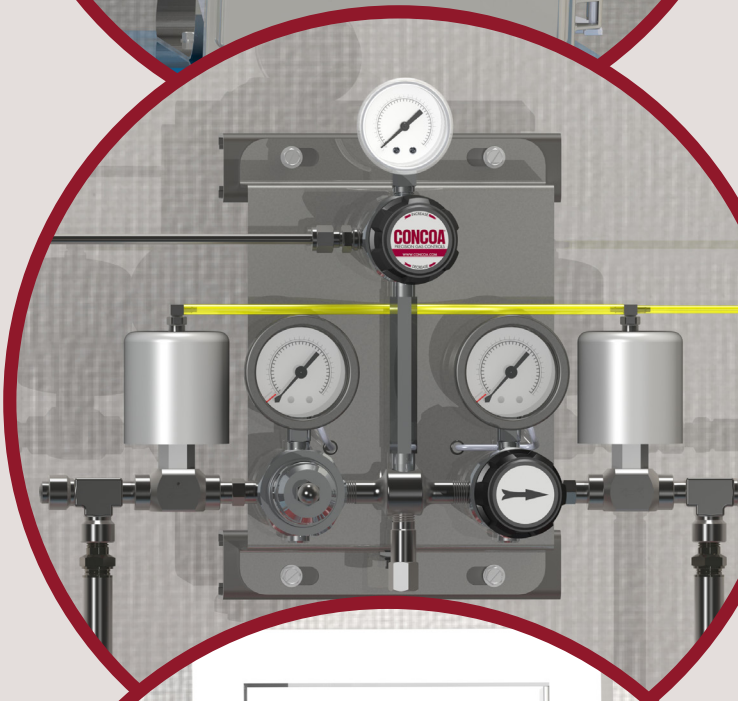
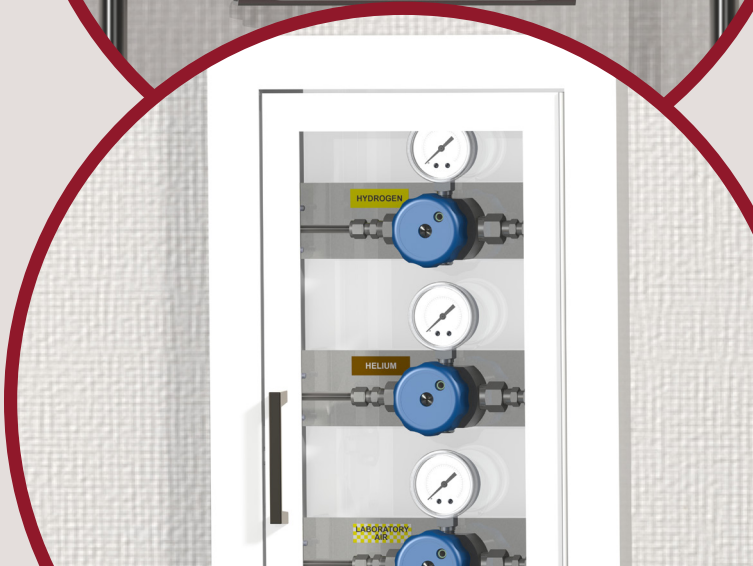
HYDROGEN • ACETYLENE • METHANE • PROPANE

SAFE HANDLING OF FLAMMABLE GASES *IN LABORATORIES*

The demand for flammable gases in laboratories is increasing. The scarcity of helium has bolstered the use of hydrogen in gas chromatography. Growing environmental concerns have spurred research into combustion and alternative fuels that require hydrocarbons. CONCOA offers a complete line of equipment with all of the components necessary to design an **integrated**, **safe**, and **compliant** gas delivery system for non-corrosive, high purity, flammable gases in laboratories and other analytical processes.







CONCOA®
PRECISION GAS CONTROLS

54 Series Point-of-Use Panels

The 54 Series Point-of-Use Panel with 400 Seriers regulators provides final pressure regulation at the point-of-use. Both the pressure regulator and diaphragm valve at each station feature metal-to-metal diaphragm seals that ensure the highest possible leak integrity. Up to six different delivery pressures allows the user to select the pressure that is best for a specific application. The 54 Series Point-of-Use Panel, available with stainless steel, brass, or chrome-plated brass components, is suitable for the most demanding high purity, flammable, or hazardous gas applications.

532 Series Flashback Arrestors

The 532 Series flashback arrestors prevent the transmission of flame in the supply line and the equipment of high purity gas systems. An automatic valve in the 532 Series flashback arrestor cuts off the gas supply in the event of flame stabilization inside the body of the arrestor, and each arrestor incorporates a non-return valve to prevent the reverse flow of gases into the hoses and other equipment. Available in stainless steel or brass, 532 Series flashback arrestors are ideal for high volume gas flow applications in pipelines and manifolds.

5ZV Series High Purity Zone Valve Box

The 5ZV Series high purity zone valve box provides branch control for large distribution systems in laboratories and other facilities that require high purity gases. Each high flow, stainless steel valve uses a metal-to-metal diaphragm seal to achieve maximal leak integrity. Suitable for use with any high purity gas, options include trim for in-wall installation, exhaust and louvers for use with flammable gases, and pressure switch gauges for alarm integration.

Gas Safety Devices

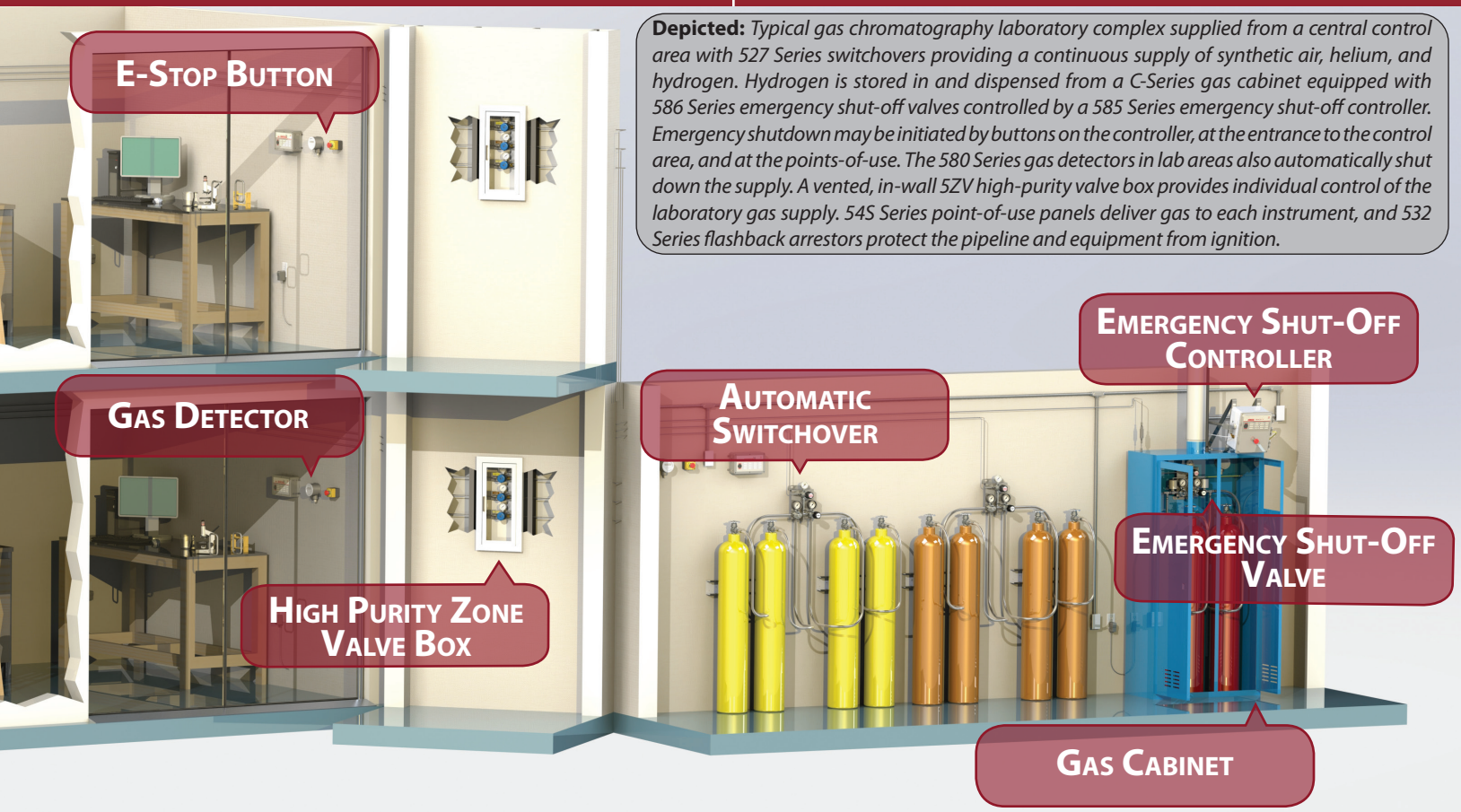
CONCOA offers a variety of gas safety devices to initiate a manual or automatic shut-off for use with 585 Series emergency shut-off controllers. Emergency stop buttons installed at the source or the point-of-use allow a user to immediately stop the flow of gases. Flow switches automatically interrupt the supply if a break in the line occurs. Gas detectors at the point-of -use or the source prevent hazardous concentration levels by automatically initiating shut-off. Loss of ventilation detectors ensure that hazardous gas flows only when unexpected leaks can be mitigated by proper exhaust. In most cases, the specific choice and configuration of gas safety devices to actuate shut-off relies on the gas service and application; contact CONCOA for more information.

C-Series
Gas Cabinets

The C-Series gas cabinet systems, designed to store and isolate flammable or hazardous laboratory gases safely and reliably, provide unparalleled protection for the mounted gas supply system and their attached gas cylinders. The vented gas cabinets are constructed with sturdy 12-gauge thick steel, come pre-installed with a 165°F sprinkler head near the exhaust vent, and are equipped with self-closing doors and windows. When configured with the appropriate CONCOA gas delivery equipment, C-Series gas cabinets conform to international fire codes, including NFPA 55 (2023) section 6.18.

585 Series
Emergency Shut-Off Controller

The CONCOA 585 Series emergency shut-off controller automatically shuts down up to eight independent flammable, toxic, corrosive, or high-purity gas sources based on inputs from up to six gas monitoring devices. The shut-off controller features an emergency stop button, audible and visual alarm, and onboard web server with email and real-time display for remote monitoring and program status. Ideal for flammable or toxic gas shutdown control in the event of a gas leak or fire, the 585 Series emergency shut-off controller is designed for broad integration into a comprehensive facility safety program.



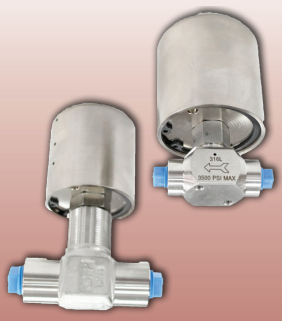
Depicted: *Typical gas chromatography laboratory complex supplied from a central control area with 527 Series switchovers providing a continuous supply of synthetic air, helium, and hydrogen. Hydrogen is stored in and dispensed from a C-Series gas cabinet equipped with 586 Series emergency shut-off valves controlled by a 585 Series emergency shut-off controller. Emergency shutdown may be initiated by buttons on the controller, at the entrance to the control area, and at the points-of-use. The 580 Series gas detectors in lab areas also automatically shut down the supply. A vented, in-wall 5ZV high-purity valve box provides individual control of the laboratory gas supply. 54S Series point-of-use panels deliver gas to each instrument, and 532 Series flashback arrestors protect the pipeline and equipment from ignition.*

526/527 Series
Automatic Switchovers

526/527 Series automatic switchovers provide an uninterrupted supply of gas from high pressure cylinders. Available with stainless steel or brass components, these pressure differential switchovers feature 316L stainless steel diaphragms and metal-to-metal seals. Typically supplied with metal-lined flexible hoses with inlet gland check valves, CONCOA switchovers may be configured for any high purity gas service and mounted in cabinets. Options include purge valves and pressure switch gauges or transducers for remote alarm integration. For larger installations or those requiring longer run times, CONCOA switchovers can be expanded using the 52 Series maniflex manifold system.

586 Series
Emergency Shut-Off Valves

The 586 Series emergency shut-off valve kits are ideal for use as safety devices in high purity, flammable, toxic, or corrosive gas systems where fail-safe shutdown of gas supply and flow is required. The high-purity, emergency shut-off valve kit attaches to the inlets of CONCOA regulators and switchovers between the product and the inlet source. Unlike typical solenoid valves, these shut-off valves feature metal-to-metal diaphragm seals, making them suitable for use with high purity or flammable gases in laboratory and other analytical applications.



Code Requirements

Maximum Allowable Quantities

Several national and international organizations provide extensive guidelines for the safe use of flammable gases, most prominently the National Fire Protection Association (NFPA) and the International Code Council (ICC). According to the Compressed Gases and Cryogenics Fluid Code (NFPA 55), "Flammable and oxidizing gases shall not be stored or used in other than industrial and storage occupancies" with the exception that "cylinders, containers, or tanks not exceeding 250 scf…and used for maintenance purposes, patient care, or operation of equipment shall be permitted." (6.3.1.6)

Notwithstanding this use case, NFPA 55, as well as the International Fire Code (IFC) and International Building Code (IBC) published by the ICC, define control areas "within which hazardous materials are allowed to be stored, dispensed, used, or handled in quantities not exceeding the maximum allowable quantities (MAQ)." (3.3.6.1) **Table 1** below summarizes those quantities for flammable gases in a control area by building floor based on whether the building has an approved automatic sprinkler system or whether all cylinders containing hazardous gases are in gas cabinets or both.

Table 1.
Maximum quantity of flammable gas allowable in a control area. Adapted from NFPA 55 (6.2.1, 6.3.1.1), IFC (5003.1.1), IBC (307.1)

Floor Level	Unsprinklered building AND Not all cylinders in gas cabinets	Sprinklered bulding OR All cylinders in gas cabinets	Sprinklered building AND All cylinders in gas cabinets	Number of control areas per floor	Fire resistance rating for barriers
> 9 above grade	50 scf / 7.5 lbs	100 scf / 15 lbs	200 scf / 30 lbs	1	2
7-9 above grade	50 scf / 7.5 lbs	100 scf / 15 lbs	200 scf / 30 lbs	2	2
4-6 above grade	125 scf / 18.75 lbs	250 scf / 37.5 lbs	500 scf / 75 lbs	2	2
3 above grade	500 scf / 75 lbs	1000 scf / 150 lbs	2000 scf / 300 lbs	2	1
2 above grade	750 scf / 112.5 lbs	1500 scf / 225 lbs	3000 scf / 450 lbs	3	1
1 above grade	1000 scf / 150 lbs	2000 scf / 300 lbs	4000 scf / 600 lbs	4	1
1 below grade	750 scf / 112.5 lbs	1500 scf / 225 lbs	3000 scf / 450 lbs	3	1
2 below grade	500 scf / 75 lbs	1000 scf / 150 lbs	2000 scf / 300 lbs	2	1

According to NFPA 55, quantities beyond the MAQ must be stored in rooms that meet several special provisions, a detached building, or outside with distance restrictions. Quantities beyond 15,000 scf of hydrogen must be stored in a detached building. (6.5) **Table 2** contrasts the typical capacity of cylinders supplied for continuous analysis in laboratories with those used for demonstration and maintenance.

Flammable Gas	Production (continuous use)		Demonstration or maintenance (intermittent use)	
	Cylinder height / diameter	Cylinder capacity	Cylinder height / diameter	Cylinder capacity
Acetylene	51 in / 12 in	360 scf	20 in / 6 in	40 scf
Hydrogen	55 in / 9.25 in	261 scf	19 in / 6 in	30 scf
Methane	55 in / 9.25 in	355 scf	19 in / 6 in	40 scf
Propane	45 in / 15 in	100 lbs	18 in / 12 in	20 scf

Table 2.
Typical cylinder size and capacity for flammable gases. Actual size may vary with gas supplier.

Thus, the MAQ guidelines severely constrain the supply of flammable gas for production analysis. For example, the applicable codes prohibit the supply of flammable gas in an unsprinklered building above the third floor in efficient cylinder sizes. Additionally, since the continuous availability of process gas requires at least two co-located cylinders, it is almost impossible to comply with code requirements without the use of gas cabinets.

General Recommendations

Based on the references below and decades of experience designing gas control systems, CONCOA makes the following recommendations for the safe delivery of non-corrosive, flammable gases in laboratory environments:

- Flammable gases shall be stored in and dispensed from gas cabinets containing not more than three cylinders of compatible gases, constructed of 12 gauge steel with self-closing doors, noncombustible windows, and an exhaust ventilation system designed to operate at a negative pressure relative to the surrounding area. (NFPA 55 6.18)
- Fail-safe emergency shut-off shall be provided at the source and points of use. For gases with a similar or greater flammability rating than hydrogen carried in pressurized piping above 15 PSIG, excess flow control shall be provided at the source. (IBC 5003.2.2.1)
- Leak detection that provides audible and visual warning of danger and automatically shuts down supply as the lower explosive limit is approached shall be used at the source, and should be used in each point-of-use area if dispensed remotely. (IFC 5303.16.10)
- To maintain purity, all shut-off valves and pressure regulators (including those in manifolds) shall use metal diaphragms. Pressure regulators with metal diaphragms shall be designed to withstand 10,000 cycles of operation without mechanical failure. (CGA E-4 4.6)
- Flashback arrestors with reverse flow check valves shall be required at the point of use and the piping source.

References

The information presented in this document addresses only guidelines related to CONCOA products and does not constitute the comprehensive code review required to specify a gas delivery system for flammable gases. For more information, consult the following publications, in addition to any local regulations.

American Society of Mechanical Engineers (ASME), Two Park Avenue, New York, NY.
- ASME A13.1, *Scheme for the Identification of Piping Systems*, 2020 edition.
- ASME B31.3, *Process Piping*, 2022 edition.
- ASME B31.12, *Hydrogen Piping and Pipelines*, 2019 edition.

Compressed Gas Association (CGA), 14501 George Carter Way, Suite 103, Chantilly, VA.
- CGA E-4, *Standard for Gas Pressure Regulators*, 2021 edition.
- CGA P-1, *Safe Handling of Compressed Gases in Containers*, 2022 edition.

International Code Council (ICC), 500 New Jersey Avenue, NW, 6th Floor, Washington, DC.
- *International Building Code* (IBC), 2021 edition (second printing).
- *International Fire Code* (IFC), 2021 edition (second printing).

National Fire Protection Agency (NFPA), 1 Batterymarch Park, Quincy, MA.
- NFPA 1, *Fire Code*, 2021 edition
- NFPA 2, *Hydrogen Technologies Code*, 2023 edition.
- NFPA 55, *Compressed Gases and Cryogenic Fluids Code*, 2023 edition.

CONCOA®
PRECISION GAS CONTROLS

1501 Harpers Road • Virginia Beach, Virginia 23454
1.800.225.0473 • www.CONCOA.com