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0001. Purpose

1.0 Introduction

A. For the purpose of this program "Dangerous Gases" refers to highly toxic, toxic, flammable, corrosive, and/or pyrophoric gases. A list of commonly used dangerous gases can be found in Appendix A of this program. Purchases of highly toxic and pyrophoric gases are restricted and require pre-notification to Georgia Tech (GT) Environmental Health and Safety (EHS) and pre-approval by Georgia Tech Chemical and Environmental Safety Committee (CESC). A form for this approval can be found in Appendix F of this document. This program outlines the requirements and responsibilities necessary to provide suitable accommodation for the presence of dangerous gas in GT laboratories. These accommodations include, but are not limited to, gas cabinets, gas monitoring systems (permanent and temporary), building fire sprinklers, and administrative controls.

0002. Scope

A. This program applies to all use of dangerous compressed gases other than short term use of limited quantities (i.e. lecture bottle size amounts) in a chemical fume hood. Fume hood applications involving dangerous gases shall be reviewed by GT EHS prior to implementation. All usage reviews shall be submitted to lab-chemsafety@gatech.edu.

B. Those parts of this program involved with toxic gases (Sections 4, 9-11, and 14, as well as related to sections on responsibilities – section 6) are effective immediately in all Georgia Tech facilities. Sections on flammable and/or corrosive gases are effective immediately for all labs, existing processes, or new uses. Any exception to this shall be reviewed by EHS.

0003. Criteria

1.0 References

A. County of Santa Clara Hazardous Materials Compliance Division. Toxic Gas Storage. Santa Clara County of Ordinances, Title B, Division B11, Chapter XIV, Supplement 39. November 2018. https://library.municode.com/ca/santa_clara_county/codes/code_of_ordinances?nodeId=TITBRE_DIVB11ENHE_CHXIVTOGAST

B. International Code Council. International Fire Code. 2015

C. National Fire Protection Association. Compressed Gases and Cryogenic Fluids Code. Standard 55, 2016.

D. National Fire Protection Association. Fire Protection for Laboratories Using Chemicals. Standard 45, 2015.

E. National Research Council of the National Academies. Prudent Practices in the Laboratory. Handling and Management of Chemical Hazards. 2011.

F. North Carolina State University. Gas Monitoring Program. August 2017. https://drive.google.com/file/d/0Bwfv9WVwZC73VFlFeUh1M2pmcW8/view

G. Occupational Safety and Health Administration, Hazard Communication, Standard 19190.1200. Toxic and Hazardous Substances, Occupational Safety and Health Standards. 2012. https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=10099&p_table=STANDARDS

H. State of Georgia. International Fire Code with Georgia State Amendments. 2014.

I. White, Logan T. Hazardous Gas Monitoring, 5th ed. A Guide for Semiconductor and Other Hazardous Occupancies. 2001.

J. American Conference of Governmental Industrial Hygienists. TLV and VEI Documentation. 2022.

K. National Institutes of Occupational Safety and Health. NIOSH Pocket Guide. 2022. Pocket Guide to Chemical Hazards | NIOSH | CDC

L. Environmental Protection Agency. 40 CFR 302.4(a). 07/08/2022.

eCFR :: 40 CFR 302.4 -- Hazardous substances and reportable quantities.

0004. Definitions

1.0 Class I Toxic Gases

A. Gases having a lethal concentration – 50 percent (LC_{50}) in air of ≤200 parts per million (ppm) by volume of gas or gas vapor; or

B. Gases having a LC_{50} of 2 milligrams per liter (mg/L) or less of mist, fumes, or dusts when administered by continuous inhalation for ≤ 1 hour, if death occurs within 1 hour, to albino rats weighing between 200 to 300 grams each; or

C. Gases having a dermal LC_{50} of 40ppm or less; or

D. Gases indicated by a "4" on the health hazards (blue section) of the National Fire Protection Association (NFPA) diamond label.

E. *Examples: Arsine and Phosphine. Refer to Appendix A for more examples.*

2.0 Class II Toxic Gases

A. Gases having an LC_{50} in air > 200 ppm but ≤ 3000 ppm by volume of gas or gas vapor; or

B. Gases having ≥ 2 mg/L but ≤ 30 mg/L of mist, fumes, or dust when administered by continuous inhalation for ≤ 1 hour, if death occurs within 1 hour, to albino rats weighing between 200 and 300 grams each.
C. Gases having a dermal LC_{50} of ≥40 ppm but ≤ 200ppm.
D. Gases indicated by a "3" on the health hazard section of the NFPA label.
E. *Examples: Ammonia and Chlorine. Refer to Appendix A for more examples.*

3.0 Class III Toxic Gases

A. Gases having an LC_{50} in air of > 3000 ppm by volume of gas or as vapor; or
B. Gases having > 30 mg/L of mist, fumes, or dust when administered by continuous inhalation for ≤ 1 hour, if death occurs within 1 hour, to albino rats weighing between 200 to 300 grams each; or
C. Gases indicated by a "2" on the health hazard section of the NFPA diamond label; ***And***
D. The toxic gases captured that have poor warning properties such as no odor or obvious physical symptoms (such as burning of the eyes or mucous membranes) upon exposure to the gas.
E. *Example: Methyl Chloride. Refer to Appendix A for more examples.*

4.0 Cylinders in Use

A. Cylinders which have a regulator attached and are connected to a gas delivery system such as to deliver gas to an instrument or process and which is used no less than monthly.
B. Cylinders maintained with a regulator in place to accommodate frequent use, no less than weekly.
C. Cylinders *used less* than described above (4.A and 4.B) shall be disconnected from the delivery system and capped.

5.0 Gas Cabinet

A. A continuously ventilated enclosure intended to house gas cylinders that provides automatic gas shut offs when leaks are detected and/or when gas flow exceeds predetermined levels (See section 0010.A).
B. Pyrophoric and toxic gases shall be housed in a gas cabinet equipped with purge panels (see sections 0009.1.D and 0010.2.A).
C. Flammable gases shall be housed in gas cabinets equipped with water sprinklers or other appropriate fire-suppression systems.

6.0 Georgia Tech Dangerous Gas Monitoring System (DGMS)

A. An integrated gas monitoring system that included all GT buildings where dangerous gases are used. This system monitors laboratories, gas cabinets, and other spaces for gas leaks, gas releases, ventilation failures, and power failures. The system will alarm locally via a visible

and audible alarm as well as send a text message and/or email notifications to various personnel, including but not limited to, researchers, building managers, EHS, and the GT Police (GTPD). Each gas monitoring point generally has two alarm levels with the first serving as a warning (usually, at half of the Threshold Limit Value or TLV) and the second (usually set at the TLV) serving as the alarm level which triggers emergency response by communicating with the first responders via the fired dialer or its own dedicated dialer. Status of individual monitors, viewing gas detection trends, troubleshooting, and resetting alarms, as well as many other functions useful to interface with the system is conducted through the Honeywell Indusoft program (with the exception of the Petit Microelectronics Research Center.)

7.0 Georgia Tech Chemical and Environmental Safety Committee (CESC)

A. Advises EHS and the Institute Council on Environmental Health and Safety (IC-EHS) on policies and procedures regarding the safe acquisition, storage, use, and disposal of chemicals in Georgia Tech facilities. The CESC considers, evaluates, and recommends policies and procedures regarding laboratory safety and chemical hygiene plans. The CESC reviews chemical research protocols for compliance with sponsor agency requirements, federal/state laws, and the GT policies and procedures. The Chair of the CESC is appointed by the Executive Vice President for Administration and Finance as well as the Executive Vice President for Research. CESC members are nominated and appointed by the Chair, in consultation with the Assistance Vice President of EHS, and are selected in a manner to ensure adequate representation across schools and departments.

8.0 Georgia Tech Environmental Health and Safety (EHS)

A. Provides occupational and environmental protection services to comply with applicable regulations and to prevent occupationally induced disease, injury, property loss, and/or degradation to the environment for all GT personnel including students, staff, and faculty.

9.0 Fire Compartment

A. Area of a building separated from adjacent areas by a fire separation which is rated by an assembly of materials with protected openings designed to restrict the spread of fire.

10.0 Flammable Gases

A. Gases that, at ambient air temperature and pressure, form a flammable mixture with air at a concentration of 13% or less; or

B. Gases Limit (LFL) or Lower Explosive Limit (LEL). Refer to the SDS for specific flammable gases.
C. *Examples: Hydrogen, Acetylene, Propane. Refer to Appendix A for more examples.*

11.0 Local Monitoring

A. Monitoring that is not directly connected to an emergency response mechanism (i.e. text/email notification and dialer-directed communications to alert GTPD). Information may be administered via ambient air monitoring and/or personnel monitors.
B. Shall be determined on a case-by-case basis by EHS.
C. Shall require specific training and orientation, as directed by EHS, for use and appropriate response in the event of an alarm.

12.0 Pyrophoric Gases

A. Gases that will ignite spontaneously upon contact with air at temperatures of 130°F (54.4°C). Refer to the safety data sheet (SDS) for specific pyrophoric gases.
B. *Examples: Silane, Disilane, Diborane, Phosphine. Refer to Appendix A for more examples.*

13.0 Threshold Limit Value (TLV)

A. Exposure limit established by the American Conference of Governmental Industrial Hygienists (ACGIH). TLV is usually based on an eight-hour time-weighted average (TWA), but occasionally includes a requirement that at no time during an eight-hour period may exposures exceed a maximum (ceiling) limit.

0005. Dangerous Gas Usage Requirements

1.0 Restricted Purchase/Acquisition Rules

A. All purchases/acquisitions and usage of gases included under this program shall be reviewed by the EHS Laboratory and Chemical Safety unit and are subject to approval by the GT CESC prior to acquisition.
B. All laboratory groups seeking approval of dangerous gas use must have a completed dangerous gas standard operating procedure (can be found in Appendix E) that documents:
    i. Principal Investigator name and emergency contact information.
    ii. Name of the chemical and CAS number.
    iii. Date the material is to go into use.
    iv. Hazards associated with the material.
    v. Engineering controls installed to control hazards.
    vi. Administrative controls in place to control hazards.
    vii. Safety precautions, use of appropriate personal protection equipment (PPE), etc.

viii. Possible consequences of “catastrophic failure” of safety controls in place.
ix. Training information made available to all who will be using the material as well as those who may be affected by a “catastrophic failure” (i.e adjacent labs, the building manager, EHS, etc).
x. Emergency procedures following an accident or a “catastrophic failure" of safety controls (See Appendix D).
xi. Contact information (24/7) for at least three representatives from the lab who can respond to the event and/or answer questions in the event of an emergency for the first responders. (Note: this shall also be posted on the pink card on the exterior of the lab door.)

0006. Responsibilities

1.0 Principle Investigator (PI)

A. Shall be responsible for directing all laboratory personnel to this document outlining all safety guidelines and protocols to use dangerous gases.
B. Provide and verify site-specific orientation and training on dangerous gas use, and/or awareness of its pressure.
C. Notifying EHS of any plans for a new gas acquisition and/or new process which required a dangerous gas, as defined in section 0004.7.A and 0005.1A and B.
D. PI may empower a senior researcher, lab manager, or safety captain who is knowledgeable about the dangerous gas to perform the tasks in provisions in the above section (0006.1.A, B, and C).

2.0 Researchers; Graduate and Undergraduate Students; Post-Docs

A. Shall be delegated tasks, as deemed appropriate by the PI.
B. Follow guidelines outlined in this document for setup, handling, storage, and usage of dangerous gases.

3.0 Environmental Health and Safety (EHS)

A. Shall enforce the guidelines outlined in this document.
B. Providing support and consultation before acquisition; during implementation of; and use of dangerous gases, as outlined in this document, to stakeholders. This includes, but is not limited to, PIs, college representatives (i.e., College of Science, College of Engineering, etc.), Facilities Design and Construction, Building Managers, etc.

4.0 Building Managers

A. Shall be offered awareness training from the lab personnel and/or EHS as to the hazards of gases acquired, stored, and used by personnel in their designated facility.

B. Must understand what would be inquired of and expected of their expertise with the designated building he/she oversees during an emergency response.

0007. Flammable Gas Storage and Usage Requirements

1.0 Flammable Gases in Sprinkler-Equipped Laboratories

A. Cylinders outside of gas cabinets shall be equipped with excess flow control or flow-restricting devices (see section 0010.8.A for examples).
    i. No requirement to monitor.

B. Lecture bottles containing less than $10ft^3$ of gas by volume may be used.
    i. No requirement to monitor.

C. Cylinders stored in a gas cabinet.
    i. No requirement to monitor.

D. Quantities of *non-liquefied* flammable gases in laboratories (including cylinders in use and allowed back-up cylinders.)
    i. When in gas cabinets, shall be limited to 112 m^3 (4000 ft^3) total or approximately 16 full-sized (i.e. 250 ft3) cylinders per fire compartment.
    ii. When NOT in gas cabinets, shall be limited to 56 m^3 (2000 ft^3) total or approximately 8 full sized (i.e. 250 ft^3) cylinders per fire compartment.
    iii. The quantities of flammable gases in provisions 0007.1.D.i and 0007.1.D.ii shall be disallowed if the total flammable liquids in the fire compartment exceeds 908 L (240 gal.).

E. Quantities of *liquefied* flammable gases in laboratories (including cylinders in use and allowed back up cylinders).
    i. When in gas cabinets, shall be limited to 272 kg (600lbs) total per fire compartment.
    ii. When NOT in gas cabinets, shall be limited to 137kg (300lbs) total per fire compartment.
    iii. The quantities of flammable gases in provisions 0007.1.E.i and 0007.1.E.ii shall be disallowed if the total amount of flammable liquids in the fire compartment exceeds 908L (240 gals).

F. Any additional flammable gas cylinders must be stored outside the building in accordance with NFPA 55.

2.0 Flammable Gases in Non-Sprinkler Equipped Laboratories

A. Cylinders (any size) outside of gas cabinets shall be equipped with excess flow control or flow-restricting devices (see section 0010.8.A for examples)

B. Continuous monitoring is required via DGMS with monitors set at 5% and 10% (alarm level 1 and 2 respectively) of the LEL of the gas in question.
    i. Required for any gas cylinder larger than a lecture bottle. Lecture bottle requirements are described in 0007.2.G.
C. Cylinders inside of gas cabinets shall be equipped with excess flow control or flow-restricting devices (see section 10.4 for examples). Additionally, the gas cabinet shall be equipped with a fire-suppression system.
    i. Cylinders fulfilling the criteria described in provision 0007.2.C are not required to be monitored.
D. Quantities of non-liquefied flammable gases in laboratories (including cylinders in use and allowed back up cylinders).
    i. When in gas cabinets, shall be limited to 56 m^3 (2000 ft^3) total or approximately 8 full-sized (i.e. 250 ft^3) cylinders per fire compartment.
    ii. When NOT in gas cabinets, shall be limited to 28 m^3 (1000 ft^3) total or approximately 4 full-sized (i.e. 250 ft^3) cylinders per fire compartment.
    iii. The quantities of flammable gases in provisions 0007.2.D.i and 0007.2.D.ii shall be disallowed if the total amount of flammable liquids in the fire compartment exceeds 454 L (120 gal).
E. Quantities of liquefied flammable gases in laboratories (including cylinders in use and allowed back up cylinders).
    i. When in gas cabinets, shall be limited to 136kg (300lbs) total per fire compartment.
    ii. When not in gas cabinets, shall be limited to 68kg (150lbs) total per fire compartment.
    iii. The quantities of flammable gases in provisions 0007.2.E.i and 0007.2.E.ii shall be disallowed if the total of flammable liquids in the fire compartment exceeds 454L (120 gal).
F. Any additional flammable gas cylinders must be store outside the building in accordance with NFPA 55.
G. Lecture bottles containing < 10ft^3 of gas by volume shall be kept in gas cabinets or inside chemical fume hoods are allowable, given the following criteria:
    i. Stored there at all times, regardless of whether or not they are in use.
    ii. Use is restricted to a chemical fume hood.
        a. No requirement to monitor via the DGMS
        b. May be subject to local monitoring as determined by EHS.
    iii. When use cannot be restricted to inside the fume hood (i.e., gas is “plumbed” to equipment outside the hood) the lecture bottle shall be equipped with an excess control device and the equipment and/or ambient air is subject to monitoring via the DGMS.

a. Local monitoring contrary to full-scale DGMS requirements shall only be made on a case-by-case basis by EHS.

3.0 Exemptions to Flammable Gas Monitoring Requirements

A. Lecture bottles, as described in provision 0007.2.G.
B. Natural gas, when provided as "house gas."
C. Gas mixtures in which the flammable gas content is below the LEL, are allowed in non-sprinkler equipped buildings, provided it meets the provisions of 0007.2.

0008. Pyrophoric Storage and Usage Requirements

1.0 Pyrophoric Gases in Sprinkler-Equipped Laboratories

A. Initial purchases of pyrophoric gases (any concentration) require pre-notification to GT EHS and pre-approval by the CESC.
B. Cylinders shall be contained in as cabinets equipped with excess flow or flow restricting devices and fire suppression systems. Continuous monitoring is also required via the DGMS.
C. Processes and/or tools in which pyrophoric gases are used shall be continuously ventilated, equipped with exhaust scrubbers/burn boxes, and monitored via the DGMS.
D. Lecture bottles containing < 10 ft^3 of gas by volume shall be kept in gas cabinets or inside chemical fume hoods are allowable, given the following criteria:
    i. Stored there at all times, regardless of whether or not they are in use.
    ii. Use is restricted to a chemical fume hood.
        a. No requirement to monitor
E. When use cannot be restricted to inside the fume hood (i.e. gas is "plumbed" to equipment outside the hood) the lecture bottle must be equipped with an excess control device and the equipment and ambient air is subject to monitoring via the DGMS.

2.0 Pyrophoric Gases in Non-Sprinkler Equipped Laboratories

A. Shall not be allowed under any conditions at Georgia Tech.

3.0 Exemptions to Pyrophoric Gas Monitoring Requirements

A. Lecture bottles, as described in provision 0008.1.D (except 0008.1.E)
B. In sprinkler-equipped buildings, pyrophoric gas mixtures that are below the pyrophoric concentration limit may be kept outside of gas cabinets**.**
    i. No requirement to monitor via the DGMS.
    ii. May be subject to local monitoring, as determined by EHS.

C. Processes and/or tools using pyrophoric gases in concentrations below the pyrophoric limit for that material shall be continuously ventilated.
    i. No requirement to monitor via the DGMS.
    ii. May be subject to local monitoring, as determined by EHS.

0009. Toxic Gas Storage and Use Requirements

1.0 General Requirements

A. Initial purchases of toxic gases above TLV concentrations require pre-notification to EHS and pre-approval by the CESC.
B. Toxic gases shall be monitored via the DGMS. Monitoring plans for toxic gases must be pre-approved by EHS.
C. Toxic gas cylinders not in use must be stored inside gas cabinets when stored inside any buildings. Otherwise, toxic gas cylinders must be stored outside in accordance with NFPA 55.
D. Cylinders of toxic gases in use (Class I, II, and III) shall be contained inside gas cabinets which shall be equipped with flow-restricting devices and purge panels.
    i. Continuous monitoring is required via the DGMS with two alarm levels. The first alarm level shall be set at half of the TLV (warning) and the second alarm level shall be set at the TLV.
E. Lecture bottles containing < 10 ft^3 of gas by volume shall be kept in gas cabinets or inside chemical fume hoods are allowable, given the following criteria:
    i. Lecture bottles are limited to one (1) back up bottle per gas type for every gas in use, not to exceed a total of six (6) lecture bottles.
    ii. Require local or DGMS monitoring when stored and/or used in a gas cabinet or chemical fume hood.
        a. Shall be evaluated on a case by case scenario by EHS.
    iii. When use cannot be restricted to inside the fume hood (i.e. gas is "plumbed" to equipment outside the hood) the lecture bottle must be equipped with an excess control device and the equipment and ambient air shall be subject to monitoring via the DGMS.

2.0 Ethylene Oxide Storage and Use Requirements

A. Ethylene Oxide (EtO) sterilizers, of the type that use sealed vials of EtO which are placed inside the sterilizer just prior to beginning a run cycle, require local monitoring from the time the vial is broken until after the load in the sterilizer has been removed.
    i. These operations require administrative controls including
        a. SOPs specific to the sterilizer and location where it is used;

b. Hazard Communication training of all personnel working in the area of the EtO sterilizer. Please see the formal requirements of EtO use at https://ehs.gatech.edu/sites/default/files/eto_document-_updated.pdf

B. Areas where EtO vials are stored do not require monitoring.
C. EtO sterilizers using cylinders of EtO are not permitted at GT.

3.0 Exemptions from DGMS Requirements for Toxic Gases

A. Lecture bottles, as described in the provisions of 0009.1.E.
B. Mixtures of a single toxic gas mixed with non-toxic/inert gas(es) when the concentration of the toxic gas is less than the TLV for that gas.
    i. Before mixing any toxic gases with inert gases, please contact EHS at lab-chemsafety@gatech.eduThe following information below is what EHS would be using to determine any allowable exemption.

0010. Equipment/Hardware Requirements

1.0 Gas Cabinet

A. Shall be equipped with automatic shut-off valves and excess flow devices.
B. Along with all associated equipment, shall be approved and installed via a Georgia Tech Facilities Management Design and Construction (D&C) project request: https://facilities.gatech.edu/dc/prf.
C. No improvised or self-made gas cabinets or ventilated enclosures are permitted.
D. Custom-made gas cabinets shall be considered on a case by case basis, pre-approved by EHS before installation and use.

2.0 Purge Panels

A. Shall be standard design
    i. Five-valve panels shall be required for all toxic and pyrophoric gases.
    ii. Matheson® PAN-5500, or equivalent (as determined by D&C), shall be used.
    iii. No improvised or self-made purge panels are permitted.

3.0 Tubing

A. All hazardous gases:
    i. Shall be stainless steel unless contraindicated due to chemical incompatibility (see Appendix B for assistance with appropriate tubing selection.)

a. Shall be high quality, welded and drawn type (304, 316, 321, 347, etc.)
b. Shall be ≤ 80 HRB (Rockwell B scale).
c. Shall be free of scratches and free of uneven seams.
d. Shall be suitable for bending and flaring without kinking at the bend radius used.
e. Outside diameter (OD) tolerances for 1/16" and 1/8" tubing is not to exceed ± 0.003".

4.0 Flammable gas systems:

A. Shall be stainless steel unless contraindicated by chemical incompatibility (see Appendix B for assistance with appropriate tubing selection.) Combustible materials shall not be used for flammable gases in GT laboratories.
B. Any exception to the provisions in 10.3.2. shall be obtained only by submitting appropriate justification to EHS. Justification examples may include, but are not limited to, specified tubing materials causing an additional larger hazard, compromising the accuracy of the research, or unjust financial burden that can be avoided by using another material – provided it does not compromise the safety of personnel.

5.0 Pyrophoric gas systems:

A. Shall be stainless steel unless contraindicated due to chemical incompatibility (see Appendix B for assistance with appropriate tubing selection.) Combustible materials shall not be used for pyrophoric gases in GT laboratories.
B. Swagelok® VCR fittings, or equivalent (as determined by D&C), shall be used.
    i. Any exception to the provisions in 10.3.3. shall be obtained only by submitting appropriate justification to EHS. Justification examples may include, but are not limited to, specified tubing materials causing an additional larger hazard, compromising the accuracy of the research, or unjust financial burden that can be avoided by using another material – provided it does not compromise the safety of personnel.

6.0 Toxic gas systems:

A. Shall be stainless steel unless contraindicated due to chemical incompatibility (see Appendix B for assistance with appropriate tubing selection.) Combustible materials shall not be used for pyrophoric gases in GT laboratories.
B. Swagelok® VCR fittings, or equivalent (as determined by D&C), shall be used.

i. Any exception to the provisions in 0010.3.A shall be obtained only by submitting appropriate justification to EHS. Justification examples may include, but are not limited to, specified tubing materials causing an additional larger hazard, compromising the accuracy of the research, or unjust financial burden that can be avoided by using another material – provided it does not compromise the safety of personnel.
ii. An exception may also be obtained if the entire process is contained within a chemical fume hood, pre-approved by EHS before implementation and use.

7.0 Oxidizing gas systems:

A. Shall be selected based on chemical compatibility
   i. Shall be stainless steel when the process to which the gas is being delivered is a hot process such as an oven or furnace.
   ii. Any exception to the provisions in 0010.6.B shall be obtained only by submitting appropriate justification to EHS. Justification examples may include, but are not limited to, specified tubing materials causing an additional larger hazard, compromising the accuracy of the research, or unjust financial burden that can be avoided by using another material – provided it does not compromise the safety of personnel.

8.0 Excess Flow Devices

A. Airgas® Y99 series shut-off valve, or equivalent (as determined by D&C), shall be used. The valve must:
   i. Wide range of operating inlet pressures
   ii. Capable of automatically shutting off if the delivery of gas exceeds a pre-set limit.

9.0 Fittings

A. Swagelok® fittings, or D&C-approved equivalent, shall be used throughout for all dangerous gas system gases and applications, except where braided tubing is employed.
B. Tubing must always be softer than the fitting material.
C. Fittings must be chosen based on chemical compatibility with the process and the tubing being employed. See Appendix B for help in choosing a fitting material which will be compatible with your process.

10.0 Pressure Testing

A. Pressure testing on metallic systems shall be performed using leak testing criteria. See Appendix C for detailed criteria.

B. Documentation of a successful pressure test will be provided to EHS prior to charging the system with a hazardous gas as per Appendix C section A.g and section 3.

0011. Location of Monitoring Sensors

1.0 All monitoring equipment/configurations shall be approved by EHS.

A. Toxic gas and pyrophoric gas monitoring:

i. Sensors/sensor ports shall be located in the gas cabinet, exhaust duct and the each of the following locations:
ii. In or at the equipment (where the delivery gas line terminates at the equipment).
iii. In the lab operator area (ambient).
iv. Location of the sensor (floor to ceiling) shall be determined by the density of the gas with respect to air (vapor density).

B. Flammable gas monitoring:

i. For non-toxic flammable gases in non-sprinkler-equipped laboratories, sensing ports shall be located near the cylinder and near the tool.
ii. Sensor location (floor to ceiling) shall be determined by the molecular weight of the gas.

0012. Continuous/Permanent Versus Temporary Monitoring Systems

A. The GT Dangerous Gas Monitoring System (DGMS):

i. Is a permanently installed continuous monitoring system for dangerous gases providing local audible and visual alarms;
ii. May provide interlock functions in the event of an alarm;
iii. Is tied to an online interface system where alarms and gas data trends can be viewed/reset;
iv. Is separately connected to a fire alarm or dedicated dialer relay for the purposes of emergency response/life safety.

B. Design and Installation of Dangerous Gas Equipment/Monitoring Equipment

i. Should be done through GT Design and Construction (D&C).
   a. **Step One**- fill out and submit a project request at http://www.facilities.gatech.edu/dc/prf/
   b. **Step Two-** A design team will be assigned and the requesting department will be contacted.

C. Temporary Monitoring System

i. Is on that may be portable and is used only when the gas system is active with the person running the tool. It will only provide an alarm that is visual and audible. Processes with temporary monitoring systems must be continuously monitored by lab personnel and may not be left unattended. *(Exception: ethylene oxide sterilizers).*
ii. Installation of temporary monitoring equipment requires pre-approval from EHS.

0013. Gas Monitoring Responsibility

A. Designation of responsible persons:
i. Each lab with dangerous gases shall designate a person or persons as being responsible for dangerous gas safety. The point of contact (POC) responsible for monitoring in most cases will be the P.I. but can be modified to reflect a graduate student. This/these person(s) shall be identified in the SOP written by each laboratory (See SOP template in Appendix E). Procedures shall be documented for response to all gas monitor alarms. The POC will be responsible in responding to any incidence that may occur. (EHS should be notified to assess and respond).
ii. Contact names and numbers for business and after-hours response must be provided to GT EHS and must be posted on the laboratory door to be visible from the outside. (This is your pink card.)

B. Automated Alarms
i. GT EHS and the responsible persons designated for each lab will receive an automated (text or email message) notice from the DGMS whenever a gas monitor reaches the alarm state.

C. Response Level
i. The response made to a gas alarm will depend on the nature of the gas and the location of the monitor. (See GT Dangerous Gas Alarm Procedures, Appendix D).

0014. Gas Alarm Set Points

A. When a gas is both toxic and flammable or pyrophoric,
i. The more stringent (sensitive) monitoring requirement shall be used.
ii. Both toxic and flammable monitors are not required.

B. Gas Detectors shall provide constant readout with the following alarm set points established:
i. Flammable gas monitors shall go into warning mode at 5% of the LEL and alarm at 10% of the LEL.
ii. Toxic gas monitors shall go into warning mode at ¼ of the TLV and alarm at ½ of the TLV.

iii. Pyrophoric gas alarms shall go into warning mode at ¼ of the TLV and alarm at ½ of the pyrophoric limit.

C. Alarm condition should be annunciated locally

i. Such as with an audible buzzer and/or flashing strobe so the laboratory occupant(s) can take appropriate action.

ii. The alarm should also send an automated (text or e-mail) message to GT EHS, GT Police, and the lab designated responsible person.

0015. Compatibility Requirements

A. All dangerous gas monitoring systems

i. Shall be designed to interface with the building fire alarm system.

ii. GT Fire Alarm System Guidelines are available through: Fire Safety Documents & Resources | Environmental Health & Safety (gatech.edu)

0016. DGMS Responsibilities

1.0 Users/Owners/Managers are responsible for:

A. The primary user/owning manager of the tool/process/experiment requiring gas monitoring per this program shall ensure the following areas are addressed:

i. Gas usage which requires monitoring according to this program shall not commence prior to meeting all the applicable elements.

ii. The gas shall not be procured until the GT EHS Laboratory and Chemical Safety Officer has been notified and pre-approval is received from the GT CESC (See Appendix F).

iii. Procurement of temporary gas monitoring shall be approved by the GT EHS Laboratory and Chemical Safety Officer.

iv. Monitoring system must meet the requirements of this program.

v. Final system review by EHS prior to start-up has been completed.

vi. Report alarm conditions of local/temporary monitoring systems to the GT EHS Laboratory and Chemical Safety Officer within 24 hours.

vii. Temporary monitoring units are calibrated per recommendations with documentation kept in the lab and available for review by EHS laboratory and chemical safety personnel.

viii. Periodic evaluations/calibrations on local/temporary monitor/alarm systems in conjunction with the GT EHS.

ix. Documentation and Training Requirements are met:
    a. Employees utilizing gases requiring monitoring are trained in the operation of the monitoring system. (Documentation of this training should be kept.)
    b. Emergency response procedures are documented, and all laboratory personnel are fully trained in cooperation with GT EHS
    c. Cylinder change and equipment purging procedures are fully documented in the form of a Standard Operating Procedure (SOP) (Appendix E) and all personnel are fully trained regarding the procedures.
    d. Emergency Response Plan/Procedure shall be reviewed and documented with GT Environmental Health and Safety.

B. GT EHS Chemical Safety is responsible for:
    i. Periodic checks of the GT DGMS for the events and faults.
    ii. EHS is responsible for custodial control of the contract for preventative maintenance, repairs, calibration, and change out of sensors as recommended by the manufacturer for the GT DGMS.
    iii. Assuring that laboratory groups are keeping up with local/temporary monitoring system calibration requirements per manufacturer specifications.
    iv. Providing technical advice to laboratory management as to the requirements of this program and the type of monitoring required, temporary or continuous. Reviewing design and installation of monitoring systems.
    v. Conducting periodic inspections/audits as appropriate per the manufacturer's specifications or as requested.
    vi. Follow-up investigation of reported alarms.
    vii. Assure appropriate personnel are knowledgeable about building alarms including building managers, EHS personnel, and GT Police.
    viii. At least annually, conduct a test of all gas monitors and alarms in cooperation with the primary user/owner.

Appendices

Appendix A: Commonly Used Dangerous Gases

The following is a **non-exhaustive** list of **some** of the gases that are captured under the GT Dangerous Gas Safety Program and/or GT Restricted Purchase Rules. Researchers are responsible for determining whether the gases they use qualify under the description of a toxic or flammable gas by referring to the Safety Data Sheet and the GT Dangerous Gas Safety Program. This information can be found by visiting https://ehs.gatech.edu/chemical/dangerous-gas. Determination should be made before acquiring the gas. The "Below This Concentration" column on the table below indicates the concentration under which these gases are **not subject** to the DGSP rules.[1] If you need assistance in determining if the material you would like to use is captured under these rules, please email lab-chemsafety@gatech.edu.

Gas	**CAS Number**	**Not Subject to DGSP if gas is used Below This Concentration**	**NFPA** ***Health Rating***	**NFPA** ***Flammability Rating***	**NFPA** ***Reactivity Rating***	**NFPA** ***Special Notes***
Acetylene (C_2H_2)	74-86-2	2.5%	1	4	3	Simple Asphyxiant
Ammonia *anhydrous* (NH_3)	7664-41-7	25 ppm	3	1	0	
Arsine (AsH_3)	7784-42-1	0.025 ppm	4	4	2	
Boron trichloride (BCl_3)	10294-34-1	0.35 ppm	3	0	1	
Boron trifluoride (BF_3)	7/2/7637	0.5 ppm	3	0	1	
n-Butane (C_4H_{10})	106-97-8	400 ppm	1	4	0	Simple Asphyxiant
Carbon monoxide[2] (CO)	630-08-0	25 ppm	3	4	0	Simple Asphyxiant, Narcotic Effects

Chlorine (l_2)	7782-50-5	0.5 ppm	3	0	0	OX
Diborane (B_2H_6)	19284-45-7	0.05 ppm	3	4	3	~~W moist air~~
Dichlorsilane (SiH_2Cl_2)	4109-96-0	**Always included**	3	4	2	~~W moist air~~
Difluoromethane (CH_2F_2)	75-10-5	0.00125 ppm	1	4	1	Simple Asphyxiant
Disilane[1] (SI_2H_6)	1590-87-0	0.20%	1	4	2	pyrophoric
Deuterium[1] (D_2(H-2))	7782-39-0	5%	1	4	0	Simple Asphyxiant
Ethane[1] (C_2H_6)	74-84-0	3%	1	4	0	Simple Asphyxiant
Ethylene (C_2H_4)	74-85-1	200 ppm	2	4	2	~~W~~
Fluorine (F_2)	7782-41-4	0.05 ppm	3	0	4	OX
Germane (*Germanium tetrahydride;* G_3H_4)	7782-65-2	**Always included**	4	4	3	~~W~~ pyrophoric
Hexafluoro-1,3-butadiene [1] (C_4F_6)	685-63-2	7%	3	4	0	Simple Asphyxiant
Hydrogen (H_2)[1]	1333-74-0	4%	0	4	0	Simple Asphyxiant
Hydrogen bromide (HBr)	10035-10-6	1.5 ppm	3	2	0	
Hydrogen chloride (HCl)	7647-01-0	1 ppm	3	0	0	
Hydrogen fluoride (HF)	7664-39-3	1.5 ppm	4	0	1	
Hydrogen sulfide (H_2S)	6/4/7783	5 ppm	3	4	0	
Methane (CH_4)[1]	74-82-8	5%	1	4	0	Simple Asphyxiant
Methyl mercaptan (CH_4S)	74-93-1	0.5 ppm	3	4	0	~~W~~
Methyl germane (CH_6Ge)	1449-65-6	**Always included**	3	4	2	~~W~~ pyrophoric
Methyl fluoride (CH_3F)	593-53-3	**Always included**	1	4	0	Simple Asphyxiant
Nitric Oxide (NO)	10102-43-9	12.5 ppm	3	0	0	Ox

Nitrogen Dioxide (NO_2)	10102-44-0	2.5 ppm	3	0	0	Ox
Nitrogen Trifluoride (NF_3)	7783-54-2	5 ppm	2	0	0	Ox
Nitrous Oxide[3] (N_2O)	10024-97-2	12.5 ppm	1	0	0	Ox, Narcotic Effects

Oxygen[3] (O_2)	7782-44-7	Always included	0	0	0	Ox
Oxygen (liquid) [3] (O_2)	7782-44-7	Always Included	3	0	0	Ox
Ozone (O_3)	10028-15-6	0.05 ppm	4	0	3	Ox
Phosgene (CCl_2O)	75-44-5	0.05 ppm	4	0	1	
Phosphine (PH_3)	7803-51-2	0.125 ppm	4	4	2	~~W~~
Propane (C_3H_8)	74-98-6	500 ppm	1	4	0	Simple Asphyxiant
Silane (silica tetrahydride; SiH_4)	7803-62-5	2.5 ppm	2	4	3	pyrophoric
Silicon tetrachloride ($SiCl_4$)	10026-04-7	1 ppm	3	0	2	~~W~~
Sulfur dioxide (SO_2)	7446-09-5	2.5 ppm	3	0	0	
Trichlorosilane (Cl_3HSi)	19165-34-5	Always included	3	4	2	~~W moist air~~
Trimethylboron ($B(CH_3)_3$)	593-90-8	Always included	4	4	3	~~W~~
Tungsten Hexafluoride (WF_6)	7783-82-6	0.001 ppm	3	0	2	

NOTE

[1] Unless otherwise indicated, the values for toxic gases are given in PPM and are based on the Occupational Health and Safety administration Permissible Exposure Limits (OSHA PEL), National Institutes of Occupational Safety and Health Recommended Exposure Limits (NIOSH REL.

[2] Due to poor warning properties, some monitoring will be required, even at concentrations < 25 ppm. Please contact Georgia Tech Environmental Health and Safety at lab-chemsafety@gatech.edu for help in establishing an acceptable monitoring system.

[3] Included here because storage may be problematic- Cylinders may not be located within 20 feet of a flammable gas cylinder unless separated by a 0.5 hour rated fire separation.

Appendix B: Corrosion Information and Hardware Compatibility for Commonly Used Dangerous Gases

This table should be used with caution. This chart cannot cover all possible conditions. It is recommended that this information be used to select possible materials for use and then more extensive research be conducted to determine which material is best under the specific conditions anticipated. Contact GT EHS for help if needed by using lab-chemsafety@gatech.edu.

Gas	Excellent	Good *under most conditions*	Not Compatible
Acetylene	Aluminum, Steel, Alloy 400/405, 316 Stainless Steel, TFE/PFA Buna-N, Viton, Neoprene	Brass	Nylon, Polyethylene
Ammonia, anhydrous	Steel, Alloy 400/405, 316 Stainless Steel, TFE/PFA	Aluminum, Nylon, Polyethylene, Neoprene, Buna-N	Brass
Chlorine, dry	Alloy 400/405, TFE/PFA,	Steel, 316 Stainless Steel, Neoprene	Aluminum, Brass, Nylon
Chlorine, wet	TFE/PFA	Viton, Alloy 400/405	Aluminum, Brass, Steel, 316 Stainless Steel, Nylon
Fluorine, dry	Steel, Alloy 400/405, TFE/PFA	Aluminum, 316 Stainless Steel, Polyethylene	Nylon, Buna-N, Viton, Neoprene
Fluorine, wet	TFE/PFA	Alloy 400/405, Polyethylene	Aluminum, Brass, Steel, 316 Stainless Steel, Nylon, Buna-N, Viton
Hydrogen, cold	Aluminum, Brass, Steel, Alloy 400/405, 316 Stainless Steel, TFE/PFA		Buna-N, Viton, Neoprene, Nylon, Polyethylene
Hydrogen chloride, dry	Alloy 400/405, TFE/PFA	Steel, 316 Stainless Steel, Polyethylene	Buna-N, Viton, Neoprene, Nylon, Aluminum

Gas	Excellent	Good *under most conditions*	Not Compatible
Hydrogen Cyanide	Viton, Polyproylene, Santoprene, Teflon, EPR/EPDM, PVDF, Cast Iron	Stainless Steel	Neoprene, aluminum
Hydrogen sulfide, wet	Alloy 400/405, 316 Stainless Steel, TFE/PFA	Aluminum, Polyethylene	Brass, Nylon, Viton, Neoprene
Methane	Aluminum, Brass, Steel, Alloy 400/405, 316 Stainless Steel, TFE/PFA, Buna-N, Viton	Neoprene	Nylon, Polyethylene
Nitrous Oxide		Brass, Steel, 316 Stainless Steel, Buna-N, Neoprene	Alloy 400/405, Nylon, Polyethylene
Oxygen	Aluminum, Brass, Alloy 400/405, 316 Stainless Steel, TFE/PFA, Buna-N, Viton, Neoprene	Steel	Nylon, Polyethylene
Ozone- Dry	Aluminum, Steel Alloy 400/405, 316 Stainless Steel		TFE/PFA, Buna-N, Viton, Neoprene, Brass, Nylon, Polyethylene
Propane	Aluminum, Brass, Steel, Alloy 400/405, 316 Stainless Steel, TFE/PFA, Buna-N, Viton	Neoprene	Nylon, Polyethylene

Gas	Excellent	Good *under most conditions*	Not Compatible
Sulphur dioxide, dry	Aluminum, 316 Stainless Steel, TFE/PFA, Viton	Steel, Alloy 400/405,	Nylon, Polyethylene
Sulphur dioxide, wet	316 Stainless Steel, TFE/PFA		Nylon, Polyethylene, Buna-N, Viton, Neoprene, Aluminum, Brass, Steel, Alloy 400/405

Note

These recommendations come from the Cole-Palmer Compatibility Matrix. Chemical Compatibility Database from Cole-Parmer (coleparmer.com)

Appendix C: Pressure Testing Metallic Systems

A. System Testing:

i. Using Agency or Installation Contractor will perform a pressure check as follows:

a. Apply 250 pounds per square in gauge (PSIG) pressure to system and record ambient temperature in the daily log. Use semiconductor grade nitrogen or argon, filtered to 0.01 micron, and of the purity as the gas used to purge tubing during the welding process for pressure testing of all lines.

b. System shall be considered passed if the 250 PSIG pressure is maintained for 8 consecutive hours with no drop in pressure (temperature compensated).

c. Upon completion of 250 PSIG pressure test, replace all valves, filters, regulators, and other fittings not rated for the 250 PSIG pressure test. A second pressure test shall then be performed at the pressure of the lowest rated fitting in the system. The procedure and acceptance criteria for this test shall be the same as the 250 PSIG test.

d. If pressure test fails, bubble test all joints with ionic free agent (ex: soapy water) to detect gross leaks. Outside contractors must submit SDS for

approval of ionic free agent to be used. All joints failing pressure test shall be marked for replacement.

e. All joints failing pressure test shall be cut out and replaced while under purge or as per manufacturer's specifications.
f. All tests shall be witnessed and verified by the Using Agency/contractor.
g. Check all pressure relief valves and regulators for pressure settings. Pressure relief valves shall be reset and documented following the procedures outlined in the Using Agency Pressure Safety Manual.
h. Maintain system at positive pressure until system is placed in service. Pressure shall be maintained using 0.01 micron filtered nitrogen or argon from a cryogenic source. Gas shall be of the same purity as that used to purge tubing during the welding process.
i. Any deviations from approved testing procedures must be secured in writing from the Georgia Tech Environmental Health and Safety Chemical Safety Office prior to incorporating as part of the scope of work.

B. Joint and Miscellaneous Component Testing

i. Using Agency/Contractor will perform a helium leak test on all welded and mechanical joints, and miscellaneous components upon completion of the pressure test performed as detailed above- Pressure Test Procedure Appendix C, subsection A.i.
ii. The test shall be performed as follows:
    a. Using the turbo molecular pump on the helium leak detector, the system shall be evacuated to a maximum pressure of $1 \times 10^{(-)4}$ mbar.
    b. The background level of the leak detector shall be measured and recorded at less than $1 \times 10^{(-)8}$ atm cc/sec prior to beginning testing.
    c. Each weld, fitting, valve, and miscellaneous component shall be flooded with helium gas. Allow a minimum of 1 minute per 100 feet of tubing from the helium leak detector for leak detection. The joint, fitting, or component shall be considered passed if there is no single leak greater than $1 \times 10^{(-)8}$ atm cc/sec above the recorded background level. All joints, fittings, or components not passing the helium leak test shall be repaired or replaced at the Contractor's expense, and a second test performed.
    d. The entire system shall be considered passed if the sum of all recorded leak rates at individual joints, fittings, and miscellaneous components does not exceed $3 \times 10^{(-)8}$ atm cc/sec.

C. Safety during testing/documentation

i. Comply with all applicable codes and regulations to ensure personnel safety during pressure tests.
ii. At the conclusion of the testing, the Contractor/Installer shall provide a certified statement reporting all the following;

a. Brief test description
b. Extent of systems tested
c. Test results and date(s) preformed
d. Note all failed joints, and all corrective action taken.

Appendix D: Georgia Tech Dangerous Gas Alarm Procedures

This section goes over what to do in the event of a gas alarm. The scope of this section is not aimed toward GTPD, EHS, AFR, or any other emergency responders. While they are briefly mentioned, this section is geared toward researchers in the lab and what to do if a dangerous gas alarm goes off. It should be noted that if an alarm sounds while the lab is unoccupied a designated lab member(s) and EHS staff will get a text message from the MIDAS system alerting them to the possible gas leak. GTPD should be called by the lab member to notify them of the situation. Further steps will be determined during the call. Additionally, when an All Clear is called occupants will be allowed to re-enter the building or lab. Atlanta Fire department will make this determination on whole building evacuations. EHS will make this determination when it is on single or multiple lab spaces.

A. Possible Causes of Alarms

1) Dangerous (toxic and/or flammable) gas in an occupied or potentially occupied room.
2) Dangerous gas above acceptable levels in an exhaust duct
3) Dangerous gas leaking inside of a gas cabinet
4) Hydrogen/Nitrogen gas leaking from pipe outside of lab.

B. Occupant Response Procedure

1) Evacuate lab; No exceptions, close door.
2) Follow emergency procedures as posted on door.

C. Georgia Tech Police Response Actions: *In the event of a gas alarm:*

1) Call GT EH&S 404-216-5237
2) GT EHS will log on remotely to DGMS and determine cause of alarm
3) Call the Facilities on-call person
4) Consult with GT EH&S and/or lab staff
    a. To determine the source and cause of the gas release.
    b. To verify that the release has stopped.
    c. To determine if the gas monitor indicates that the gas levels have returned to below the alarm threshold level.
    d. If you are unable to consult with GT EHS, or a lab staff member, call Atlanta Fire Response (AFR) Hazmat (911).
    e. If you have not heard from lab occupants, EHS will determine if you can enter the building to look inside the lab or if you should call AFR.
    f. EHS will determine what, if any, evacuations procedures are appropriate: lab, wing, building, or all buildings within 330 feet of the lab.
    g. Do not enter the lab.
    h. Do not allow occupants to reenter the lab.

D. GT EHS Response Procedures

1) Call GT Police to report nature of the gas alarm.
2) Log on to the DGMS via GT Gas monitoring connection.
3) Reset only if cause of problem is known and is over.
4) If the problem is:
    a. Gas Release into a room
        i. If you cannot verify that the room is safe to re-enter, where the source of the leak is, or that the leak has stopped, inform GT Police that AFR Hazmat should be called.
    b. Dangerous gas above acceptance levels in exhaust duct
        i. Call GT Area Maintenance- have them check their computers to verify that the exhaust ventilation system is working as it should.
        ii. If gas levels in the duct do not recede AND the gas is flammable, pull the fire alarm and evacuate the building until the gas levels in the duct drop below alarm threshold levels.
        iii. If gas levels in the duct do not recede AND the gas is toxic, AND Facilities Maintenance reports that the exhaust fans in the duct are not working – pull the fire alarm and evacuate the building until the gas levels in the duct drop below alarm threshold levels.
5) Determine if reportable quantities (RQ) have been released.
   If so, then contact:
    - Georgia Environmental Protection Agency: 404-656-4863
    - Atlanta/Fulton County Local Emergency Planning Group: 404-730-5600
    - National Response Center: 1-800-424-8802

Gas	**RQ in Pounds**	**RQ in Ft^3** **unless otherwise noted**
Ammonia	100	2090
Arsine	100*	4.6
Boron trichloride	100*	3.1
Chlorine	10	51
Hydrazine	1	1 lecture bottle or 500 mLs
Phosphine	100	104
Nitric oxide	10@	119
Nitrogen dioxide	10@	43
Silane	1*	111
Silicon tetrachloride	1*	2.1
Sulfur dioxide	1*	5.6

NOTE:

@ - Releases in amounts less than 1,000 pounds per 24 hours of nitrogen oxide or nitrogen dioxide to the air that are the result of combustion and combustion related activities are exempt from the notification requirements of EPCRA section 304 and CERCLA.

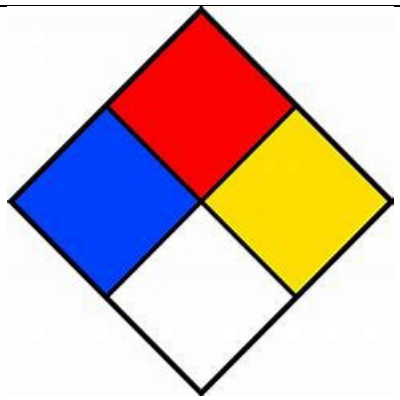
* - Georgia Tech imposed RQ- please report to Environmental Protection Division and your Local Emergency Planning Committees (LEPC courtesy call) .

Note that a “standard” cylinder is approximately 250 cubic feet.

Appendix E: Dangerous Gas Standard Operating Procedure (SOP)

This SOP is a general guideline and helps to ensure safe usage of gas while in the lab. A separate SOP should be created upon purchase of every new gas.

Dangerous Gas Standard Operating Procedure	
Primary Contact:	Primary Contact Phone Number:
Department:	Role in Lab:
SOP Objective and/or Purpose:	
Characteristics	
Gas Name:	**EX: Hydrogen**
Amount of Gas:	**EX: 30 Liters or 1.06 ft^3**
Formula:	**EX: H_2**
Reaction Potential:	**EX: Can react violently with Oxygen if combined at a 2:1 ratio.**
Hazards	
Health Hazards:	**EX: Hydrogen can be an asphyxiant.**
Physical Hazards:	**EX: Hydrogen is extremely Flammable**
Toxicity Data:	**EX: No toxicity**

NFPA Information: **Fill out the NFPA diamond appropriately for the gas you are using.**	 Blue: Health Red: Flammability Yellow: Reactivity White: Special **EX: Hydrogen should be filled out with 0 on blue/health, 4 on red/flammability, and 0 on yellow/reactivity and nothing on white/special.**
Saftey Requirnments	

Engineering Controls	• **EX: Experiments are preformed in a fume hood.** • **EX: Gas cylinders are strapped in between the middle and shoulder.** • •
Administrative Controls	• **EX: All trainings have been taken** • **EX: All personel have reviewed SOP and SDS** • •
PPE	• **EX: Lab coats are worn while working** • **EX: Safety glasses and gloves are worn while working** • •

Procedural Steps

Sequence of Steps	*Potential Accidents or Hazards*	*Preventative Measures*
1. **EX: Turn on gas**	**EX: Possible Gas Leak**	**EX: Check fitting before starting to make sure it is secure.**
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		

10.			
Emergency Procedures			
EX: Call GTPD; Call Emergency EHS phone			
Ocular	Wash eyes at eyewash station for **15 minutes.** *Hold eyes open while rinsing.*		
Full Body	Remove clothes enroute to the emergency shower and rinse for **15 minutes.**		
Other	Wash area at the sink with water for **15 minutes.**		
EX: Run scenerios with team about events that could happen during install, operations, and cylinder change outs, etc.			
Additional Requirements			
Work Practices			
Regulatory			
References			
SDS			
Record Keeping			
Approval Letter	**(Attach PDF here)**		
Barcode # (this should be assocaited with your chemical inventory)			
Training Information	Name of who completed training:	Training Name:	Date Completed:

Appendix F: Application to Acquire Restricted Purchase Items

Laboratory and/or Research Equipment and Materials Requiring Review by Georgia Tech EHS and/or Pre-approval from the GT Chemical and Environmental Safety Committee (CESC) before Acquiring:

- This Document Is Taken from the GT EHS Website Where it Is Found Under the Heading “Restricted Purchases”
  https://ehs.gatech.edu/sites/default/files/dg_restricted_purchases.pdf