

# STORAGE AND USE OF FLAMMABLE GASES

## PROCEDURES FOR APPROVAL

### *SUMMARY*

- I. Risk Class 0  
The Risk Analysis shall be reviewed by the Fire Hazard Subcommittee (FHS) or by an independent reviewer appointed by the Division/Section head. A copy of the independent review shall be sent to the FHS. Approval by the Division/Section head is required before the introduction of flammable gas into a system.
  
- II. Risk Classes I and II  
The Risk Analysis and the installed system shall be reviewed by the FHS or by an independent reviewer appointed by the Division/Section head. A copy of the independent review shall be sent to the FHS for concurrence that the requirements of this chapter have been met. Approval by the Division/ Section head is required before the introduction of flammable gas into a system.
  
- III. Nothing in this Chapter is intended to prevent the use of methods or materials of equivalent or superior quality to those prescribed below. The Fire Hazard Subcommittee will review documented requests for equivalency.

## FLAMMABLE GAS INSTALLATION REQUIREMENTS

### Risk Class 0 Installations:

1. The area shall be posted "Danger-Flammable Gases, No Ignition Sources" using standard signs available from the Fermilab ESH Section. A list of responsible persons with their phone numbers shall also be posted.
  
2. Combustibles and ignition sources shall be minimized within three meters of gas handling equipment, piping or apparatus.
  
3. A pressure regulator appropriate for the gas and its environment shall be used.
  
4. An orifice, excess flow valve or other fixed means of limiting the flow to no higher than ten times the maximum operational flow rate shall be installed.
  
5. All gas cylinders shall be secured. Cylinders not in use shall be capped. Empty cylinders shall be promptly removed.
  
6. Enclosed volumes containing piping or equipment shall be incapable of becoming pressurized. For example, chest freezers shall not have latching doors. Electrical devices enclosing or

enclosed within these volumes shall be listed for use in Class 1, Division 2 locations per NEC article 500 or otherwise be documented and approved as non-sparking devices.

7. Leaks from experimental devices such as drift chambers shall be measured and documented prior to initial operation (with nonflammable gas, if possible). Leakage above seven liters/hour from any one chamber shall be mitigated. Recheck for leaks after major repairs or modifications, and at least every twelve months. If the aggregate leak rate is constant individual detectors do not need to be checked. Leakage exceeding 20% of the lower explosive limit at a distance over two inches from an identified "point" leak shall be repaired.
8. Ventilation above one air change per hour shall be maintained in areas using or storing flammable gas. This may be accomplished by mechanical or natural ventilation. For natural ventilation, a room vent with a minimum of 1/2 square foot free area shall be provided per 1000 cubic feet of room volume.
9. Welding burning, brazing, and grinding permits shall not be issued for areas within ten meters of the equipment containing flammable gas unless approved in advance by the responsible D/S Head or designee.
10. Oxidizers shall be stored separately from flammable gas containers or combustible materials. Either a distance of 20 ft (6.1 m) or a noncombustible barrier at least 5 ft (1.5 m) high having a fire resistance rating of at least 1/2 hour is a minimum separation requirement.
11. Inert chamber systems prior to introducing flammable gas. Require sufficient chamber purging prior to allowing high voltage to the chambers.

### Risk Class I Installations

Risk Class I installations are subject to the Risk Class 0 requirements, as well as the following requirements:

1. The system, including vessels, chambers, supply and vent piping, and exhaust points shall be labeled "flammable gas".
2. Piping requirements: Exceptions to this paragraph are permitted adjacent to experimental apparatus where needed for flexibility, electrical isolation, repairs or because of congestion. This exception is limited to within five meters of the normal operating position.
  - a. Piping and fittings shall be protected from mechanical damage.
  - b. Piping shall be rated for the expected temperature and pressure.
  - c. Supply piping shall be metallic.
  - d. Piping shall be supported in a substantial and workmanlike manner.
  - e. Piping shall not be installed inside cable trays with electrical conductors.

3. Joints shall be made by brazing, pipe thread, or commercial fittings appropriately installed. Custom-made fittings required by detector design shall provide secure connections.
4. The entire piping system shall be pneumatically tested for leaks at approximately 0.9 times the relief pressure before operating the system. Any piping with relief valve settings above 150 PSIG shall be tested at 1.25 times the relief pressure per Chapter 5034 of the Fermilab ES&H Manual.
5. Bubblers, flow meters and other instruments shall be securely mounted and protected from possible breakage.
6. Provisions shall be made to purge the entire system with an inert gas. If vacuum pumps are used for this, they shall be listed for flammable gas service.
7. Pressure relief devices shall be provided to limit the pressure to the maximum working pressure in various parts of the system. In the case of low pressure equipment, dedicated bubblers may be used as relief devices. Common exhaust piping shall not be used if equipment overpressure could result due to built up back pressure.
8. Relief devices in flammable gas service with a capacity over two standard liters per minute shall be vented outdoors. The exhaust locations shall be chosen to minimize fire hazards and shall not be within three meters of an air intake. Vents shall be protected from clogging by debris, snow or ice.
9. Flammable gas detectors shall be installed near equipment installations, mixing stations, and in storage sheds:
  - a. A high level alarm shall be installed and set no higher than 20% of the lower explosive limit (LEL) to summon the Fire Department through the FIRUS system. (Local alarms at a lower percentage of LEL may be used to initiate corrective action.)
  - b. A high level alarm shall automatically shut off the supply of flammable gas and turn off power to potential ignition sources within three meters of operative gas usage apparatus.
  - c. "Crash buttons" shall be provided to accomplish the shutdowns described in b. These devices shall be conveniently located, and one shall be adjacent to the fire alarm panel, if present. Crash buttons shall be labeled "Gas System and Experiment Power Shutdown". They shall be shown on the Building Hazard Maps.
  - d. Automatic restart of flammable gas systems and power sources shall not be allowed after a high level alarm. This restriction is intended to require a safety assessment of the situation. In case of an alarm follow the local emergency plan.
10. Visual indication of the actual use of flammable gas shall be provided at both the storage location and at the experimental apparatus. Such lights shall be controlled automatically and

shall indicate actual "gas on" and "gas off" status in real time. Flammable gas alarm status shall be also displayed at the locations of these warning lights.

11. Possible Oxygen Deficiency Hazards shall be addressed according to FESHM Chapter 5064. The hazard shall be considered for each building or room using or storing flammable or inert gas.
12. **The following documentation shall be provided to the FSH**, and all applicable Division /Section safety subpanels if convened, and a copy kept at the system site.
  - a. A general description of the system, including the types of gases to be used.
  - b. An accurate piping and instrument diagram with symbols per ISA S5.1 (Instrument Society of America), including the normal set point of regulators.
  - c. An instrument and valve summary.
  - d. A plan view of the installation including the locations of flammable gas detector heads.
  - e. Procedures for normal and abnormal operations including purging, startup, gas bottle changes, mixing, leak detection, tests, alarms, shutdown, emergency situations and ventilation.
  - f. Documentation and/or test results demonstrating the adequacy of the pressure relief system.
  - g. A call list, including home telephone numbers and available pagers, of personnel familiar with the operation of the system.
  - h. A summary of leak test measurements.
13. The Fire Department shall be notified of actual gas startup and system shutdown.
14. The chemist in the Fermilab ES&H section shall be notified before using any types of gas not found in the stockroom.

### Risk Class II Installations

Risk Class II installations are subject to the Risk Class 0 and I requirements, as well as the following requirements:

1. Storage and processing enclosures shall be constructed, where practical, to comply with the guidelines of Chapter 7 of NFPA-58 (Appendix 2). While this document is specifically applicable only to LP gas storage facilities, it is a useful guide. Exceptions may be made with the approval of the Fire Hazard Subcommittee.
2. In addition:
  - a. All storage enclosures shall be maintained free of standing water and/or ice to prevent falls of personnel handling gas system components.

- b. Adequate hardware for securing all cylinders used or stored shall be available.
  - c. Windows in gas sheds shall be wire glass set in metal frames with a fixed sash.
  - d. Enclosures near areas of vehicle access shall be protected with bumper posts.
  - e. The use of gas system enclosures to store oxidizers or gases used as fuels shall be prohibited. These enclosures shall not be used to store items not relevant to the gas system.
  - f. Electrical installation shall comply with NEC Article 500, Hazardous (Classified) Locations. The classification guidelines are shown in Appendices 5 and 6.
  - g. There shall be provisions for the ventilation of such enclosures per NFPA-58 (Appendix 2). Mechanical ventilation failure shall be alarmed.
3. The use of line-regulators downstream of cylinder regulators is strongly encouraged.
4. Fire sprinklers shall be installed in accordance with NFPA 13 to protect any adjoining or enclosing buildings from a fire in the gas storage facility. Sprinklers shall not be installed within the gas storage facility itself since it is not desirable to quench a gas fire with the leak still present.