

NFPA 45

Standard on Fire Protection for Laboratories Using Chemicals

2004 Edition



NFPA, 1 Batterymarch Park, Quincy, MA 02169-7471
An International Codes and Standards Organization

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NFPA 45

Standard on

Fire Protection for Laboratories Using Chemicals

2004 Edition

This edition of NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*, was prepared by the Technical Committee on Laboratories Using Chemicals and acted on by NFPA at its May Association Technical Meeting held May 23–26, 2004, in Salt Lake City, UT. It was issued by the Standards Council on July 16, 2004, with an effective date of August 5, 2004, and supersedes all previous editions.

This edition of NFPA 45 was approved as an American National Standard on August 5, 2004.

Origin and Development of NFPA 45

The first edition of NFPA 45 was developed by the Technical Committee on Chemistry Laboratories. It was tentatively adopted at the 1974 NFPA Annual Meeting and was officially adopted at the 1975 NFPA Fall Meeting. The committee wishes to acknowledge that NFPA 45 is due in large part to the leadership and efforts of the late Russell H. Scott, who served as chairman of the committee during the planning and drafting stages of the first edition of NFPA 45. After the document had been in use for two years, the technical committee began an exhaustive review of the text; amendments were adopted for the 1982, 1986, and 1991 editions.

The 1996 edition of NFPA 45 included clarification on the scope and application of the standard as it applied to various types of educational, industrial, and medical laboratory facilities. Clarification of objectives was made to ensure a fire is contained to the room of origin. The requirements for maximum quantities of flammable and combustible liquids, construction, and fire protection in laboratory units were separated into two tables, one for sprinklered laboratory units and the other for nonsprinklered laboratory units. In addition, the committee revised the fire hazard classifications to recognize that clinical laboratories were using this standard as directed by NFPA 99, *Standard for Health Care Facilities*, and to identify that NFPA 101®, *Life Safety Code*®, no longer addresses laboratory occupancies.

The 2000 edition of NFPA 45 included modified laboratory separation requirements, and nonsprinklered laboratories of Class A or B and Class C (over 10,000 ft²) were prohibited. Expanded requirements and advisory information for compressed and liquefied gases were added. Additional changes included modified laboratory ventilating systems and hood requirements. Average face velocity is used to determine the safe operating levels for hood exhaust systems. Changes were made to address the current industry trend in the utilization of VAV (Variable Air Volume) laboratory ventilation systems, which provide clear requirements for the containment of contaminants within the hood. The language was clarified regarding multiple or manifold exhaust ducts within buildings.

This 2004 edition of NFPA 45 includes a new requirement that all new laboratories must be protected with automatic extinguishing systems. Pressurized liquid dispensing containers not previously recognized but indirectly prohibited because of quantity restrictions are now defined, addressed, and regulated. Clarification of the scope is provided for labs containing the minimum quantity of *either* flammable and combustible liquids *or* gas that would qualify the lab for coverage under NFPA 45. Clarification is also made that the minimum quantity of gas does not include low-pressure utility gas in accordance with NFPA 54, *National Fuel Gas Code*. This edition includes expanded advisory material on biological safety cabinets and recognition of listed Class II, Type B2 biological safety cabinets in lieu of chemical fume hoods under certain circumstances. All flammable and combustible liquids requirements were consolidated into one chapter. Requirements are incorporated to limit hazchem storage spill scenarios to less than 20 L (5 gal). Expanded requirements and advisory information have been created for compressed and liquefied gases. Maximum quantity requirements are clarified for outside cylinder storage.

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Committee Scope: This Committee shall have primary responsibility for documents for the prevention of loss of life and damage to property from fire and explosion in chemical laboratories not located in health care facilities.

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A reference in brackets [] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for mandatory extracts are given in Chapter 2 and those for nonmandatory extracts are given in Annex G. Editorial changes to extracted material consist of revising references to an appropriate division in this document or the inclusion of the document number with the division number when the reference is to the original document. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex G.

Chapter 1 Administration**1.1 Scope.**

1.1.1 This standard shall apply to laboratory buildings, laboratory units, and laboratory work areas whether located above or below grade in which chemicals, as defined, are handled or stored.

1.1.2 This standard shall not apply to the following:

- (1)*If conditions (a) and (b) exist, this standard shall not apply:
 - (a) Laboratory units that contain less than or equal to 4 L (1 gal) of flammable or combustible liquid
 - (b) Laboratory units that contain less than 2.2 standard m³ (75 scf) of flammable gas, not including piped-in low-pressure utility gas installed in accordance with NFPA 54, *National Fuel Gas Code*
- (2) Laboratories that are pilot plants
- (3) Laboratories that handle only chemicals with a hazard rating of zero or one, as defined by NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*, for all of the following: health, flammability, and instability
- (4) Laboratories that are primarily manufacturing plants
- (5) Incidental testing facilities
- (6) Physical, electronic, instrument, laser, or similar laboratories that use chemicals only for incidental purposes, such as cleaning

- (7) Laboratories that work only with radioactive materials, as covered by NFPA 801, *Standard for Fire Protection for Facilities Handling Radioactive Materials*
- (8) Laboratories that work only with explosive material, as covered by NFPA 495, *Explosive Materials Code*

1.1.3 This standard contains requirements, but not all-inclusive requirements, for handling and storage of chemicals where laboratory-scale operations are conducted and shall not cover the following:

- (1) The special fire protection required when handling explosive materials (See NFPA 495, *Explosive Materials Code*.)
- (2) The special fire protection required when handling radioactive materials

1.2 Purpose.

1.2.1 The purpose of this standard shall be to provide basic requirements for the protection of life and property through prevention and control of fires and explosions involving the use of chemicals in laboratory-scale operations.

1.2.2 This standard is designed to control hazards and protect personnel from the toxic, corrosive, or other harmful effects of chemicals to which personnel might be exposed as a result of fire or explosion.

1.2.3 The goal of this standard shall be to achieve a comprehensive laboratory fire prevention and protection program to prevent injury or death to occupants and emergency response personnel.

1.2.4 The objectives of this standard shall be as follows:

- (1) Limit injury to the occupants at the point of fire origin
- (2) Limit injury to emergency response personnel
- (3) Limit property loss to a maximum of a single laboratory unit

1.2.5 It is not the objective of this standard to address financial losses such as business interruption or property loss when the loss of a laboratory unit is unacceptable.

1.3* Application.

1.3.1 The provisions of this document shall be considered necessary to provide a reasonable level of protection from loss of life and property from fire and explosion. They reflect situations and the state of the art prevalent at the time the standard was issued.

1.3.2 When interface with existing NFPA or other consensus codes and standards occurs, reference shall be made to the appropriate source in the text.

1.3.3* NFPA 99, *Standard for Health Care Facilities*, shall be used for additional requirements for laboratories in health care occupancies.

1.3.4 Due to the special nature of laboratories using chemicals, this standard modifies and supplements existing codes and standards so as to apply more specifically to buildings or portions of buildings devoted to laboratory-scale operations.

1.3.5 Where a construction or protection requirement of a governmental agency having jurisdiction is more stringent than a requirement in this standard, the more stringent requirement shall apply.

1.4 Retroactivity. The provisions of this standard reflect a consensus of what is necessary to provide an acceptable degree of protection from the hazards addressed in this standard at the time the standard was issued.

1.4.1 Unless otherwise specified, the provisions of this standard shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the standard. Where specified, the provisions of this standard shall be retroactive.

1.4.2 In those cases where the authority having jurisdiction determines that the existing situation presents an unacceptable degree of risk, the authority having jurisdiction shall be permitted to apply retroactively any portions of this standard deemed appropriate.

1.4.3 The retroactive requirements of this standard shall be permitted to be modified if their application clearly would be impractical in the judgment of the authority having jurisdiction, and only where it is clearly evident that a reasonable degree of safety is provided.

1.5 Equivalency. Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this standard.

1.5.1 Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.

1.5.2 The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 10, *Standard for Portable Fire Extinguishers*, 2002 edition.

NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*, 2002 edition.

NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems*, 1999 edition.

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, 2000 edition.

NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*, 2004 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2002 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 2003 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 2001 edition.

NFPA 17, *Standard for Dry Chemical Extinguishing Systems*, 2002 edition.

NFPA 17A, *Standard for Wet Chemical Extinguishing Systems*, 2002 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2002 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 2003 edition.

NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*, 2003 edition.

NFPA 50, *Standard for Bulk Oxygen Systems at Consumer Sites*, 2001 edition.

NFPA 50A, *Standard for Gaseous Hydrogen Systems at Consumer Sites*, 1999 edition.

NFPA 50B, *Standard for Liquefied Hydrogen Systems at Consumer Sites*, 1999 edition.

NFPA 51, *Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes*, 2002 edition.

NFPA 54, *National Fuel Gas Code*, 2002 edition.

NFPA 55, *Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks*, 2003 edition.

NFPA 58, *Liquefied Petroleum Gas Code*, 2004 edition.

NFPA 69, *Standard on Explosion Prevention Systems*, 2002 edition.

NFPA 70, *National Electrical Code*[®], 2005 edition.

NFPA 72[®], *National Fire Alarm Code*[®], 2002 edition.

NFPA 80, *Standard for Fire Doors and Fire Windows*, 1999 edition.

NFPA 86, *Standard for Ovens and Furnaces*, 2003 edition.

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, 2002 edition.

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids*, 2004 edition.

NFPA 99, *Standard for Health Care Facilities*, 2002 edition.

NFPA 101[®], *Life Safety Code*[®], 2003 edition.

NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*, 2000 edition.

NFPA 495, *Explosive Materials Code*, 2001 edition.

NFPA 496, *Standard for Purged and Pressurized Enclosures for Electrical Equipment*, 2003 edition.

NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*, 2001 edition.

NFPA 750, *Standard on Water Mist Fire Protection Systems*, 2003 edition.

NFPA 801, *Standard for Fire Protection for Facilities Handling Radioactive Materials*, 2003 edition.

NFPA 1962, *Standard for the Inspection, Care, and Use of Fire Hose, Couplings, and Nozzles and the Service Testing of Fire Hose*, 2003 edition.

NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*, 2004 edition.

2.3 Other Publications.

2.3.1 AIHA Publication. American Industrial Hygiene Association, 2700 Prosperity Avenue, Suite 250, Fairfax, VA 22031-4319.

ANSI/AIHA Z9.5, *Laboratory Ventilation*, 2003.

2.3.2 ANSI Publications. American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor, New York, NY 10036.

ANSI Z535.1, *Safety Color Code*, 2002.

ANSI Z535.2, *Environmental and Facility Safety Signs*, 2002.

ANSI Z535.3, *Criteria for Safety Symbols*, 2002.

ANSI Z535.4, *Product Safety Signs and Labels*, 2002.

2.3.3 ASME Publication. American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990.

ASME Boiler and Pressure Vessel Code, Section VIII, 2004.

2.3.4 NSF Publication. National Sanitation Foundation International, 789 North Dixboro Road, P.O. Box 130140, Ann Arbor, MI 48113-1040.

NSF/ANSI 49, *Class II (Laminar Flow) Biosafety Cabinetry*, 2004.

Chapter 3 Definitions

3.1 Definitions. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not included, common usage of the terms shall apply.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.4* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Shall. Indicates a mandatory requirement.

3.2.6 Should. Indicates a recommendation or that which is advised but not required.

3.2.7 Standard. A document, the main text of which contains only mandatory provisions using the word “shall” to indicate requirements and which is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions shall be located in an appendix or annex, footnote, or fine-print note and are not to be considered a part of the requirements of a standard.

3.3 General Definitions.

3.3.1 Apparatus. Furniture, chemical fume hoods, centrifuges, refrigerators, and commercial or made-on-site equipment used in a laboratory.

3.3.2 Auxiliary Air. Supply or supplemental air delivered near the outside face of a chemical fume hood to reduce room air consumption.

3.3.3 Baffle. An object placed in an appliance to change the direction of or to retard the flow of air, air-gas mixtures, or flue gases. [54:3.3]

3.3.4* Biological Safety Cabinet. A ventilated cabinet for personnel, product and environmental protection having an open

front with inward airflow for personnel protection, downward HEPA filtered laminar airflow for product protection, and HEPA filtered exhausted air for environmental protection.

3.3.5 Business Occupancy. See 3.3.45.1.

3.3.6 Bypass. An airflow-compensating opening that maintains a relatively constant volume exhaust through a chemical fume hood regardless of sash position, serving to limit the maximum face velocity as the sash is lowered.

3.3.7 Canopy Hood. A suspended ventilating device used only to exhaust heat, water vapor, odors, and other nonhazardous materials. This is not a chemical fume hood and generally is not effective for exhausting toxic or flammable materials.

3.3.8* Chemical. A substance with one or more of the following hazard ratings as defined in NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*: Health — 2, 3, or 4; Flammability — 2, 3, or 4; Instability — 2, 3, or 4. (See also Section B.2.)

3.3.9* Chemical Fume Hood. A ventilated enclosure designed to contain and exhaust fumes, gases, vapors, mists, and particulate matter generated within the hood interior.

3.3.10 Combustible Liquid. A liquid that has a closed-cup flash point at or above 37.8°C (100°F).

3.3.11 Compressed Gas Cylinder. Any portable pressure vessel of 45.4 kg (100 lb) water capacity or less designed to contain a gas or liquid that is authorized for use at gauge pressures over 276 kPa (40 psi) at 21°C (70°F) by the U.S. Department of Transportation (DOT) or Transport Canada (T.C.).

3.3.12* Cryogenic Fluid. Substance that exists only in the vapor phase above -73°C (-99°F) at one atmosphere pressure and that is handled, stored, and used in the liquid state at temperatures at or below -73°C (-99°F) while at any pressure.

3.3.13 Deflector Vane. An airfoil-shaped vane along the bottom of the hood face that directs incoming air across the work surface to the lower baffle opening. The opening between the work surface and the deflector vane is open even with the sash fully closed.

3.3.14 Educational Laboratory Unit. A laboratory unit that is used for educational purposes through the twelfth grade by six or more persons for four or more hours per day or more than 12 hours per week.

3.3.15 Educational Occupancy. See 3.3.45.2.

3.3.16 Exit Access Corridor. A corridor used as exit access that leads to an exit that is separated from other parts of the building by walls.

3.3.17 Explosive Material. Any explosive, blasting agent, emulsion explosive, water gel, or detonator.

3.3.18* Face (of hood). The hood opening or the plane of the inside surface of the sash.

3.3.19 Face Velocity. The rate of flow or velocity of air moving into the chemical fume hood entrance or face, as measured at the plane of the chemical fume hood face.

3.3.20 Fire Separation. A horizontal or vertical fire resistance-rated assembly of materials that have protected openings and are designed to restrict the spread of fire.

3.3.21 Flammable Gas. Any substance that exists in the gaseous state at normal atmospheric temperature and pressure and is capable of being ignited and burned when mixed with the proper proportions of air, oxygen, or other oxidizers. [99:3.3]

3.3.22 Flammable Liquid. A liquid that has a closed-cup flash point that is below 37.8°C (100°F) and a maximum vapor pressure of 2068 mm Hg (40 psia) at 37.8°C (100°F).

3.3.23* Flammable Solid. A solid, other than a blasting agent or explosive, that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or that can be ignited readily and when ignited, burns so vigorously and persistently as to create a serious hazard.

3.3.24 Flash Point. The minimum temperature at which a liquid or a solid emits vapor sufficient to form an ignitable mixture with air near the surface of the liquid or the solid.

3.3.25 Health Care Facilities. Buildings or portions of buildings in which medical, dental, psychiatric, nursing, obstetrical, or surgical care are provided. Health care facilities include, but are not limited to, hospitals, nursing homes, limited care facilities, clinics, medical and dental offices, and ambulatory care centers. [99:3.3]

3.3.26 Health Care Occupancy. See 3.3.45.3.

3.3.27 Hood Interior. The volume enclosed by the side, back, and top enclosure panels, the work surface, the access opening (called the face), the sash or sashes, and the exhaust plenum, including the baffle system for airflow distribution.

3.3.28 Incidental Testing Facility. An area within a production facility set aside for the purpose of conducting in-process control tests that are related to the production process.

3.3.29 Industrial Occupancy. See 3.3.45.4.

3.3.30* Inside Liquid Storage Area. A room or building used for the storage of liquids in containers or portable tanks, separated from other types of occupancies.

3.3.31 Instructional Laboratory Unit. A laboratory unit used for education past the 12th grade and before post-college graduate level instruction for the purposes of instruction of six or more persons for four or more hours per day or more than 12 hours per week. Experiments and tests conducted in instructional laboratory units are under the direct supervision of an instructor. Laboratory units used for graduate or post-graduate research are not to be considered instructional laboratory units.

3.3.32 Laboratory. A facility where the containers used for reactions, transfers, and other handling of chemicals are designed to be easily and safely manipulated by one person. It is a workplace where chemicals are used or synthesized on a nonproduction basis.

3.3.33 Laboratory Building. A structure consisting wholly or principally of one or more laboratory units.

3.3.34 Laboratory Equipment. See 3.3.1, Apparatus.

3.3.35 Laboratory Scale. Work with chemicals in which the containers used for reactions, transfers, and other handling of chemicals are designed to be easily and safely manipulated by one person.

3.3.36 Laboratory Unit. An enclosed space used for experiments or tests. A laboratory unit can include offices, lavatories, and other incidental contiguous rooms maintained for or used by laboratory personnel, and corridors within the unit. It can contain one or more separate laboratory work areas. It can be an entire building. A laboratory unit is classified as A, B, C, or D in accordance with Section 4.2. (See also Annex D.)

3.3.37 Laboratory Unit Separation. All walls, partitions, floors, and ceilings, including openings in them, that separate a laboratory unit from adjoining areas.

3.3.38* Laboratory Work Area. A room or space for testing, analysis, research, instruction, or similar activities that involve the use of chemicals.

3.3.39 Laminar Flow Cabinet. A ventilated, partially enclosed cabinet primarily intended to provide filtered airflow over the work surface by use of laminar airflow methods.

3.3.40 Lecture Bottle. A small compressed gas cylinder up to a size of approximately 5 cm × 33 cm (2 in. × 13 in.).

3.3.41 Liquefied Gas Cylinder. A compressed gas cylinder used for liquefied gas.

3.3.42 Liquid. A material that has a fluidity greater than that of 300 penetration asphalt when tested in accordance with ASTM D 5, *Standard Test Method of Penetration of Bituminous Materials*. Unless otherwise specified, the term liquid includes both flammable and combustible liquids.

3.3.43 Maximum Allowable Working Pressure. The maximum gauge pressure permissible at the top of completed equipment, a container, or a vessel in its operating position for a design temperature.

3.3.44 Non-Laboratory Area. Any space within a building not included in a laboratory unit. (See also 3.3.36.)

3.3.45 Occupancy.

3.3.45.1 Business Occupancy. An occupancy used for account and record keeping or the transaction of business other than mercantile. [5000:3.3]

3.3.45.2* Educational Occupancy. An occupancy used for educational purposes through the twelfth grade by six or more persons for four or more hours per day or more than 12 hours per week.

3.3.45.3 Health Care Occupancy. An occupancy used for purposes of medical or other treatment or care of four or more persons where such occupants are mostly incapable of self-preservation due to age, physical or mental disability, or because of security measures not under the occupants' control. [5000:3.3]

3.3.45.4* Industrial Occupancy. An occupancy in which products are manufactured or in which processing, assembling, mixing, packaging, finishing, decorating, or repair operations are conducted. [5000:3.3]

3.3.46 Open Plan Building. A building having rooms, spaces and corridors delineated by tables, chairs, desks, bookcases, counters, low-height partitions, floor patterns, or any similar finishes or furnishings.

3.3.47 Organic Peroxide. Any organic compound having a double oxygen or peroxy (-O-O-) group in its chemical structure.

3.3.48* Oxidizer. Any material that readily yields oxygen or other oxidizing gas, or that readily reacts to promote or initiate combustion of combustible materials.

3.3.49 Pilot Plant. An experimental assembly of manufacturing equipment for exploring process variables or for producing semicommercial quantities of materials.

3.3.50 Pressurized Liquid Dispensing Container (PLDC). DOT, UN 1A1, or ASME pressure container designed to dispense flammable or combustible liquids by gas pressure.

3.3.51 Pyrophoric Gas. A gas that will spontaneously ignite in air at or below a temperature of 54.4°C (130°F).

3.3.52 Qualified Person. A person who, by possession of a recognized degree, certificate, professional standing, or skill, and who, by knowledge, training, and experience, has demonstrated the ability to deal with problems relating to a particular subject matter, work, or project.

3.3.53 Reactive Material. A material that, by itself, is readily capable of detonation, explosive decomposition, or explosive reaction at normal or elevated temperatures and pressures. (See B.2.5 for definitions of Instability 2, 3, or 4.)

3.3.54 Refrigerating Equipment. Any mechanically operated equipment used for storing materials below normal ambient temperature, including refrigerators, freezers, and similar equipment. (See 12.2.2 and A.12.2.2.2.)

3.3.55 Safety Can. A listed container, of not more than 18.9 L (5 gal) capacity, having a spring-closing lid and spout cover and so designed that it will safely relieve internal pressure when subjected to fire exposure.

3.3.56 Sash. A movable panel or panels set in the hood entrance. (See C.5.1.)

3.3.57* Storage Cabinet. A cabinet for the storage of flammable and combustible liquids constructed in accordance with Section 6.3 of NFPA 30, *Flammable and Combustible Liquids Code*.

3.3.58 Street Floor. A story or floor level accessible from the street or from outside the building at ground level, with the floor level at the main entrance not more than three risers above or below ground level and arranged and utilized to qualify as the main floor. [101B:3.3]

3.3.59* Unattended Laboratory Operation. A laboratory procedure or operation at which there is no person present who is knowledgeable regarding the operation and emergency shut-down procedures.

Chapter 4 Laboratory Unit Hazard Classification

4.1 General.

4.1.1 This chapter shall classify laboratory units based on the amount of flammable and combustible liquids or flammable gases contained within the unit, both in storage and in use.

4.1.2 This chapter also shall define the existence of an explosion hazard in a laboratory unit or in a laboratory work area.

4.1.3 This chapter shall further define limitations on instructional laboratory units.

4.2 Laboratory Unit Fire Hazard Classification.

4.2.1* Classifications.

4.2.1.1 Laboratory units shall be classified as Class A (high fire hazard), Class B (moderate fire hazard), Class C (low fire hazard), or Class D (minimal fire hazard), according to the quantities of flammable and combustible liquids specified in Table 10.1.1 or Table 10.1.5.

4.2.1.2 Liquefied flammable gases located outdoors shall not be included in the quantity calculations. (See Annex D for further information on laboratory unit fire hazard classification.)

4.2.1.3 Liquefied Flammable Gases.

4.2.1.3.1 For the purposes of determining laboratory fire hazard classification and the use of Table 10.1.1 or Table 10.1.5, quantities of liquefied flammable gases shall be treated as if they were Class I flammable liquids; that is, 4 L (1 gal) of liquefied flammable gas is to be considered equivalent to 4 L (1 gal) of Class I flammable liquid.

4.2.1.3.2 If a risk assessment acceptable to the authority having jurisdiction demonstrates that a material poses a fire loading different from the method indicated in 4.2.1.3.1, a more specific conversion shall be permitted to be used.

4.2.2 Additional Requirements for Educational and Instructional Laboratory Units.

4.2.2.1 Experiments and tests conducted in educational and instructional laboratory units shall be under the direct supervision of an instructor.

4.2.2.2 Instructional laboratory units shall be classified as Class C or Class D laboratory units.

4.2.2.3 Educational laboratory units shall be classified as Class D or shall be limited to 50 percent of the flammable and combustible liquids quantity for Class C laboratory units presented in Table 10.1.1 or Table 10.1.5.

4.3 Laboratory Work Area and Laboratory Unit Explosion Hazard Classification.

4.3.1* A laboratory work area shall be considered to contain an explosion hazard if an explosion of quantities or concentrations of materials, including but not limited to those listed in 4.3.1(1) through 4.3.1(6), could result in serious or fatal injuries to personnel within that laboratory work area. (See Annex C.)

- (1) Storage of materials with a instability hazard rating of 4 (see B.2.5)
- (2) Use or formation of materials with a instability hazard rating of 4 (see B.2.5)
- (3)* Presence of highly exothermic reactions such as polymerizations, oxidations, nitrations, peroxidations, hydrogenations, or organo-metallic reactions
- (4) Use or formation of materials whose chemical structures indicate a potential hazard, but whose properties have not been established, such as triple bonds, epoxy radicals, nitro and nitroso compounds, and peroxides
- (5) Presence of high-pressure reactions (see Figure C.4.5)
- (6) Other explosion hazards as determined by a qualified person

4.3.2 A laboratory unit shall not be considered to contain an explosion hazard unless a laboratory work area within that unit contains an explosion hazard great enough to cause major property damage or serious injury outside that laboratory work area.

Chapter 5 Laboratory Unit Design and Construction

5.1 Laboratory Unit Enclosure.

5.1.1 The required construction of laboratory units shall be in accordance with Table 5.1.1.

Table 5.1.1 Fire Separation Requirements for Sprinklered Laboratory Units

Laboratory Unit	Area of Lab Unit	Fire Separation*
A	≤10,000 ft ²	2 hours
	> 10,000 ft ²	Not permitted [†]
B	≤10,000 ft ²	1 hour
	> 10,000 ft ²	Not permitted [†]
C	Any size	Not required
D	Any size	Not required

*Separation in this table refers to separation from laboratory unit(s) to non-laboratory areas and/or separations from laboratory unit(s) of equal or lower hazard classification.

[†]Labs of this classification and size are not permitted.

5.1.2 The construction requirements shall be the minimum permitted and shall not exclude the use of construction with greater fire resistance.

5.1.3 Regardless of the construction and fire protection requirements for laboratory units that are specified in Table 5.1.1, laboratory units in educational occupancies shall be separated from non-laboratory areas by 1-hour construction.

5.1.4 Table 5.1.1 shall pertain to laboratory units protected by automatic sprinkler systems in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*. Where water will create a serious fire or personnel hazard, a suitable nonwater automatic extinguishing system shall be permitted to be an acceptable substitute for sprinklers.

5.1.5 Penetrations through fire-rated floor/ceiling and wall assemblies by pipes, conduits, bus ducts, cables, wires, air ducts, pneumatic tubes and ducts, and similar building service equipment shall be protected in accordance with NFPA 101, *Life Safety Code*.

5.1.6 All floor openings shall be sealed or curbed to prevent liquid leakage to lower floors.

5.1.7 Door assemblies in required 1-hour-rated fire separations shall be ¾-hour rated. Door assemblies in required 2-hour-rated fire separations shall be 1½-hour rated.

5.1.8 Window assemblies shall be permitted in fire-rated wall assemblies having a required fire resistance rating of 1 hour or less.

5.1.8.1 Window assemblies shall be of an approved type and shall have a fire protection rating in accordance with NFPA 101, *Life Safety Code*.

5.1.8.2 Fire window assemblies shall be installed in accordance with NFPA 80, *Standard for Fire Doors and Fire Windows*.

5.1.9* Openings in fire-rated floor/ceiling and wall assemblies for air-handling ductwork or air movement shall be protected in accordance with NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*.

5.2 Maximum Area of Laboratory Units. The maximum area of a laboratory unit shall be determined by the fire hazard classification and the construction of the laboratory unit, as shown in Table 5.1.1.

5.3 Requirements for Life Safety. Life safety features for laboratory buildings, laboratory units, and laboratory work areas shall comply with NFPA 101, *Life Safety Code*, unless otherwise modified by other provisions of this standard.

5.3.1 Class A, B, and C laboratory units shall be classified as industrial occupancies in accordance with NFPA 101, *Life Safety Code*.

5.3.2 Educational laboratory units shall be classified as educational occupancies in accordance with NFPA 101, *Life Safety Code*.

5.3.3 Instructional laboratory units and Class D laboratories shall be classified as business occupancies in accordance with NFPA 101, *Life Safety Code*.

5.3.4 Life safety requirements for instructional laboratory units for past the 12th grade, and for Class D laboratories located in facilities classified as business occupancies, shall be in accordance with the NFPA 101, *Life Safety Code*, requirements for business occupancies.

5.4 Means of Access to an Exit.

5.4.1* A second means of access to an exit shall be provided from a laboratory work area if any of the following situations exist:

- (1) A laboratory work area contains an explosion hazard located so that an incident would block escape from or access to the laboratory work area.
- (2) A laboratory work area within a Class A laboratory unit exceeds 46.5 m² (500 ft²).
- (3) A laboratory work area within a Class B, Class C, or Class D laboratory unit exceeds 93 m² (1000 ft²).
- (4) A hood in a laboratory work area is located adjacent to the primary means of exit access.
- (5) A compressed gas cylinder larger than lecture bottle size [approximately 5 cm × 33 cm (2 in. × 13 in.)] located such that it could prevent safe egress in the event of accidental release of cylinder contents.
- (6) A cryogenic container located such that it could prevent safe egress in the event of accidental release of container contents.

5.4.2 The required exit access doors of all laboratory work areas within Class A or Class B laboratory units shall swing in the direction of exit travel.

5.4.3* The required exit access doors of all laboratory work areas within Class C or Class D laboratory units shall be permitted to swing against the direction of exit travel or shall be permitted to be a horizontal sliding door complying with NFPA 101, *Life Safety Code*.

5.4.4 Emergency lighting facilities shall be provided for any laboratory work area requiring a second means of access to an exit, in accordance with 5.4.1.

5.4.5 Emergency lighting in laboratory work areas and exits shall be installed in accordance with Section 7.9, Emergency Lighting, of NFPA 101, *Life Safety Code*.

5.5* Furniture, Casework, and Equipment. Furniture, casework, and equipment in laboratory units shall be arranged so that means of access to an exit can be reached easily from any point.

5.6 Electrical Installation. All electrical installations, including wiring and appurtenances, apparatus, lighting, signal systems, alarm systems, remote control systems, or parts thereof, shall comply with NFPA 70, *National Electrical Code*.

5.6.1 Electrical receptacles, switches, and controls shall be located so as not to be subject to liquid spills.

5.6.2* Laboratory work areas, laboratory units, and chemical fume hood interiors shall be considered as unclassified electrically with respect to Article 500 of NFPA 70, *National Electrical Code*.

Exception: Under some conditions of hazard, it could be necessary to classify a laboratory work area, or a part thereof, as a hazardous location, for the purpose of designating the electrical installations. [See 10.5.5 (electric motors) and 12.2.2.2 (refrigerators).]

Chapter 6 Fire Protection

6.1 General.

6.1.1 All laboratory units shall be provided with fire protection appropriate to the fire hazard, as follows:

- (1) Portable fire extinguishers (*see Section 6.4*)
- (2) Fire alarm systems (*see Section 6.5*)
- (3) Evacuation and emergency plans (*see 6.6.3*)

6.1.2 In addition to the fire protection specified in 6.1.1, laboratory units under some conditions shall be provided with automatic extinguishing systems (*see Section 6.2*) and inside standpipe and hose systems (*see Section 6.3*).

6.2 Automatic Fire Extinguishing Systems.

6.2.1 Automatic Sprinkler Systems.

6.2.1.1 Automatic sprinkler system protection shall be required for all new laboratories in accordance with the following:

- (1) Automatic sprinkler system protection for Class A and Class B laboratories shall be in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, for ordinary hazard (Group 2) occupancies.
- (2) Automatic sprinkler system protection for Class C and Class D laboratories shall be in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, for ordinary hazard (Group 1) occupancies.

6.2.1.2 Automatic sprinkler systems shall be regularly inspected, tested, and maintained in accordance with NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

6.2.2 Other Automatic Extinguishing Systems. Where required or used in place of automatic sprinkler systems, special hazard extinguishing systems and nonwater automatic extinguishing systems shall be designed, installed, and maintained in accordance with the following standards, as applicable:

- (1) NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*
- (2) NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems*
- (3) NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*
- (4) NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*
- (5) NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*
- (6) NFPA 17, *Standard for Dry Chemical Extinguishing Systems*

- (7) NFPA 17A, *Standard for Wet Chemical Extinguishing Systems*
- (8) NFPA 69, *Standard on Explosion Prevention Systems*
- (9) NFPA 750, *Standard on Water Mist Fire Protection Systems*
- (10) NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*

6.2.3* Discharge. The discharge of an automatic fire extinguishing system shall activate an audible fire alarm system on the premises.

6.3 Standpipe and Hose Systems.

6.3.1* In all laboratory buildings that are two or more stories above or below the grade level (level of exit discharge), standpipes shall be installed in accordance with NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*.

6.3.2* Standpipe systems shall be regularly inspected, tested, and maintained in accordance with NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

6.3.3 Hose lines shall be of an approved type and shall be tested and maintained in accordance with NFPA 1962, *Standard for the Inspection, Care, and Use of Fire Hose, Couplings, and Nozzles and the Service Testing of Fire Hose*.

6.4 Portable Fire Extinguishers.

6.4.1 Portable fire extinguishers shall be installed, located, and maintained in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*.

6.4.2 For purposes of sizing and placement of fire extinguishers for Class B fires (*see Table 5.3.1 of NFPA 10, Standard for Portable Fire Extinguishers*), Class A laboratory units shall be rated as extra (high) hazard, and Class B, Class C, and Class D laboratory units shall be rated as ordinary (moderate) hazard.

6.5 Fire Alarm Systems.

6.5.1 Fire alarm systems, where provided, shall be installed and maintained in accordance with NFPA 72, *National Fire Alarm Code*.

6.5.2 Class A and Class B laboratory units shall have a manual fire alarm system installed and maintained in accordance with NFPA 72, *National Fire Alarm Code*.

6.5.3 The fire alarm system, where provided, shall be designed so that all personnel endangered by the fire condition or a contingent condition shall be alerted.

6.5.4 The fire alarm system shall alert local emergency responders or the public fire department.

6.6 Fire Prevention.

6.6.1 Fire Prevention Procedures.

6.6.1.1 Fire prevention procedures shall be established.

6.6.1.2 Certain critical areas shall require special consideration, including, but not limited to, the following:

- (1) Handling and storage of chemicals, flammable and combustible liquids, and gases
- (2) Open flame and spark-producing equipment work permit system
- (3) Arrangements and use of portable electric cords
- (4) Smoking area controls

6.6.2* Maintenance Procedures. Maintenance procedures shall be established.

6.6.3* Emergency Plans.

6.6.3.1 Plans for laboratory emergencies shall be developed, which shall include the following:

- (1) Alarm activation
- (2) Evacuation and building re-entry procedures
- (3) Equipment shutdown procedures or applicable emergency operation
- (4) Fire-fighting operations
- (5)*Non-fire hazards
- (6) Information as required by the authority having jurisdiction (AHJ) to allow the emergency responders to develop response tactics

6.6.3.2* Procedures for extinguishing clothing fires shall be established.

Chapter 7 Explosion Hazard Protection

7.1 General.

7.1.1 When a laboratory work area or a laboratory unit is considered to contain an explosion hazard, as defined in 4.3.1 and 4.3.2, appropriate protection shall be provided for the occupants of the laboratory work area, the laboratory unit, adjoining laboratory units, and non-laboratory areas. (*See Annex C for further information.*)

7.1.2 Protection shall be provided by one or more of the following:

- (1) Limiting amounts of flammable or reactive chemicals or chemicals with unknown characteristics used in or exposed by experiments
- (2) Special preventive or protective measures for the reactions, equipment, or materials themselves (e.g., high-speed fire detection with deluge sprinklers, explosion-resistant equipment or enclosures, explosion suppression, and explosion venting directed to a safe location)
- (3) Explosion-resistant walls or barricades around the laboratory work area containing the explosion hazard (*see Section 7.2*)
- (4) Remote control of equipment to minimize personnel exposure
- (5) Sufficient deflagration venting in outside walls to maintain the integrity of the walls separating the hazardous laboratory work area or laboratory unit from adjoining areas
- (6) Conducting experiments in a detached or isolated building, or outdoors

7.2 Explosion-Resistant Construction. When explosion-resistant construction is used, adequately designed explosion resistance shall be achieved by the use of one of the following methods:

- (1) Reinforced concrete walls
- (2) Reinforced and fully grouted concrete block walls
- (3) Steel walls
- (4) Steel plate walls with energy-absorbing linings
- (5) Barricades, such as those used for explosives operations, constructed of reinforced concrete, sand-filled/wood-sandwich walls, wood-lined steel plate, or earthen or rock berms
- (6) Specifically engineered construction assemblies

7.3 Explosion Venting. When explosion venting is used, it shall be designed as follows:

- (1) So that fragments will not strike other occupied buildings or emergency response staging areas
- (2) So that fragments will not strike critical equipment (e.g., production, storage, utility services, and fire protection)
- (3)*So that fragments will be intercepted by blast mats, energy-absorbing barrier walls, or earthen berms

7.4 Unauthorized Access. Properly posted doors, gates, fences, or other barriers shall be provided to prevent unauthorized access to the following:

- (1) Laboratory work areas containing an explosion hazard
- (2) Laboratory units containing an explosion hazard
- (3) The space between explosion vents and fragment barriers

7.5 Inspection and Maintenance.

7.5.1 Inspection of all protective construction devices and systems shall be conducted at least annually.

7.5.2 Required maintenance shall be done to assure integrity and operability.

7.5.3* Explosion shields and special explosion-containing hoods shall be inspected prior to each use for deterioration, especially transparent shields and sight panels in special explosion-containing hoods.

Chapter 8 Laboratory Ventilating Systems and Hood Requirements

8.1* General.

8.1.1 This chapter shall apply to laboratory exhaust systems, including chemical fume hoods, special local exhaust devices, and other systems for exhausting air from laboratory work areas in which flammable gases, vapors, or particulate matter are released.

8.1.2 This chapter shall apply to laboratory air supply systems and shall provide requirements for identification, inspection, and maintenance of laboratory ventilation systems and hoods.

8.2 Basic Requirements.

8.2.1* Laboratory ventilation systems shall be designed to ensure that fire hazards and risks are minimized.

8.2.2* Laboratory units and laboratory hoods in which chemicals are present shall be continuously ventilated under normal operating conditions.

8.2.3* Chemical fume hoods shall not be relied upon to provide explosion (blast) protection unless specifically designed to do so. (*See also C.5.4 and C.5.5 for further information on explosion-resistant hoods and shields.*)

8.2.4 Chemical fume hoods using perchloric acid shall be in accordance with Section 8.11.

8.3 Supply Systems.

8.3.1 Laboratory ventilation systems shall be designed to ensure that chemicals originating from the laboratory shall not be recirculated.

8.3.2 The release of chemicals into the laboratory shall be controlled by enclosure(s) or captured to prevent any flammable and/or combustible concentrations of vapors from reaching any source of ignition.

8.3.3* The location and configuration of fresh air intakes shall be chosen so as to avoid drawing in chemicals or products of combustion coming either from the laboratory building itself or from other structures and devices.

8.3.4 The air pressure in the laboratory work areas shall be negative with respect to corridors and non-laboratory areas of the laboratory unit except in the following instances:

- (1) Where operations such as those requiring clean rooms preclude a negative pressure relative to surrounding areas, alternate means shall be provided to prevent escape of the atmosphere in the laboratory work area or unit to the surrounding spaces.
- (2) The desired static pressure level with respect to corridors and non-laboratory areas shall be permitted to undergo momentary variations as the ventilation system components respond to door openings, changes in chemical fume hood sash positions, and other activities that can for a short term affect the static pressure level and its negative relationship.
- (3) Laboratory work areas located within a designated hazardous electrically classified area with a positive air pressure system as described in NFPA 496, *Standard for Purged and Pressurized Enclosures for Electrical Equipment*, Chapter 7, Pressurized Control Rooms.

8.3.5* The location of air supply diffusion devices shall be chosen so as to avoid air currents that would adversely affect the performance of chemical fume hoods, exhaust systems, and fire detection or extinguishing systems. (See Sections 6.2, 6.5, and 8.9.1.)

8.4 Exhaust Air Discharge.

8.4.1* Air exhausted from chemical fume hoods and other special local exhaust systems shall not be recirculated. (See also 8.3.1.)

8.4.2* Energy Conservation Devices.

8.4.2.1 If energy conservation devices are used, they shall be designed in accordance with 8.3.1 through 8.3.3.

8.4.2.2 Devices that could result in recirculation of exhaust air or exhausted contaminants shall not be used unless designed in accordance with Section 4:10.1, "Nonlaboratory Air," and Section 4:10.2, "General Room Exhaust," of ANSI/AIHA Z9.5, *Laboratory Ventilation*.

8.4.3 Air exhausted from laboratory work areas shall not pass unducted through other areas.

8.4.4* Air from laboratory units and laboratory work areas in which chemicals are present shall be continuously discharged through duct systems maintained at a negative pressure relative to the pressure of normally occupied areas of the building.

8.4.5 Positive pressure portions of the lab hood exhaust systems (e.g., fans, coils, flexible connections, and ductwork) located within the laboratory building shall be sealed airtight or located in a continuously mechanically ventilated room.

8.4.6 Chemical fume hood face velocities and exhaust volumes shall be sufficient to contain contaminants generated within the hood and exhaust them outside of the laboratory building.

8.4.7* The hood shall provide containment of the possible hazards and protection for personnel at all times when chemicals are present in the hood.

8.4.8 Special local exhaust systems, such as snorkels or "elephant trunks," shall have sufficient capture velocities to entrain the chemical being released.

8.4.9* Canopy hoods shall not be used in lieu of chemical fume hoods.

8.4.10 Only Class II, Type B2 biological safety cabinets listed by National Sanitation Foundation as meeting NSF/ANSI 49, *Class II (Laminar Flow) Biosafety Cabinetry*, shall be permitted to be used in lieu of chemical fume hoods, as determined by a qualified person.

8.4.11 Laminar flow cabinets shall not be used in lieu of chemical fume hoods.

8.4.12* Air exhausted from chemical fume hoods and special exhaust systems shall be discharged above the roof at a location, height, and velocity sufficient to prevent re-entry of chemicals and to prevent exposures to personnel.

8.5 Duct Construction for Hoods and Local Exhaust Systems.

8.5.1* Ducts from chemical fume hoods and from local exhaust systems shall be constructed entirely of noncombustible materials except in the following cases:

- (1) Flexible ducts of combustible construction shall be permitted to be used for special local exhaust systems within a laboratory work area. (See 8.5.2.)
- (2) Combustible ducts shall be permitted to be used if enclosed in a shaft of noncombustible or limited-combustible construction where they pass through non-laboratory areas or through laboratory units other than the one they serve. (See 8.5.2.)
- (3) Combustible ducts shall be permitted to be used if all areas through which they pass are protected with an approved automatic fire extinguishing system, as described in Chapter 6. (See 8.5.2.)

8.5.2 Combustible ducts or duct linings shall have a flame spread index of 25 or less when tested in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*. Test specimens shall be of the minimum thickness used in the construction of the duct or duct lining.

8.5.3 Linings and coatings containing such fill as fiberglass, mineral wool, foam, or other similar material that could accumulate chemical deposits shall not be permitted within laboratory exhaust systems.

8.5.4 Duct systems for perchloric acid hoods shall be constructed in accordance with Section 8.11.

8.5.5 Ducts shall be of adequate strength and rigidity to meet the conditions of service and installation requirements and shall be protected against mechanical damage.

8.5.6 Materials used for vibration isolation connectors shall comply with 8.5.2.

8.5.7 Flexible connectors containing pockets in which conveyed material can collect shall not be used in any concealed space or where strong oxidizing chemicals are used (e.g., perchloric acid).

8.5.8 Controls and dampers, where required for balancing or control of the exhaust system, shall be of a type that, in event of failure, will fail open to ensure continuous draft. (See 8.10.3 through 8.10.5.)

8.5.9 Hand holes, where installed for damper, sprinkler, or fusible link inspection or resetting and for residue clean-out purposes, shall be equipped with tight-fitting covers provided with substantial fasteners.

8.5.10 Manifolding of Chemical Fume Hood and Ducts.

8.5.10.1 Exhaust ducts from each laboratory unit shall be separately ducted to a point outside the building, to a mechanical room, or to a shaft. (See 5.1.5 and 8.10.3.)

8.5.10.2 Connection to a common chemical fume hood exhaust duct system shall be permitted to occur within a building only in any of the following locations:

- (1) Mechanical room protected in accordance with Table 5.1.1
- (2) Shaft protected in accordance with the chapter for protection of vertical openings of NFPA 101, *Life Safety Code*
- (3) A point outside the building

8.5.10.3 Exhaust ducts from chemical fume hoods and other exhaust systems within the same laboratory unit shall be permitted to be combined within that laboratory unit. (See 8.4.1.)

8.6 Duct Velocities. Duct velocities of laboratory exhaust systems shall be high enough to minimize the deposition of liquids or condensable solids in the exhaust systems during normal operations in the chemical fume hood.

8.7 Exhausters (Fans), Controls, Velocities, and Discharge.

8.7.1 Fans shall be selected to meet requirements for fire, explosion, and corrosion.

8.7.2 Fans conveying both corrosive and flammable or combustible materials shall be permitted to be lined with or constructed of corrosion-resistant materials having a flame spread index of 25 or less when tested in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*.

8.7.3 Fans shall be located and arranged so as to afford ready access for repairs, cleaning, inspection, and maintenance.

8.7.4* Where flammable gases or vapors or combustible dusts are passed through the fans, the rotating element shall be of nonferrous or spark-resistant construction. Alternatively, the casing shall be constructed of or lined with such material.

8.7.4.1 Where there is the possibility of solid material passing through the fan that would produce a spark, both the rotating element and the casing shall be constructed of such material.

8.7.4.2 Nonferrous or spark-resistant materials shall have a flame spread index of 25 or less when tested in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*.

8.7.5 Motors and their controls shall be located outside the location where flammable or combustible vapors or combustible dusts are generated or conveyed, unless specifically approved for that location and use.

8.7.6* Fans shall be marked with an arrow or other means to indicate direction of rotation and with the location of chemical fume hoods and exhaust systems served.

8.8 Chemical Fume Hood Construction. (See also 8.2.2 and Section 8.11.)

8.8.1 Chemical Fume Hood Interiors.

8.8.1.1* Materials of construction used for the interiors of new chemical fume hoods or for the modification of the interiors

of existing chemical fume hoods shall have a flame spread index of 25 or less when tested according to NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*, unless the interior of the hood is provided with automatic fire protection in accordance with 8.10.2.

8.8.1.2* Baffles shall be constructed so that they are unable to be adjusted to materially restrict the volume of air exhausted through the chemical fume hood.

8.8.1.3* Chemical fume hoods shall be provided with a means of preventing overflow of a spill of 2 L (0.5 gal) of liquid.

8.8.2* Chemical Fume Hood Sash Glazing. The sash, if provided, shall be glazed with material that will provide protection to the operator against the hazards associated with the use of the hood. (See also Annex C.)

8.8.3* Chemical Fume Hood Sash Closure.

8.8.3.1 Chemical fume hood sashes shall be kept closed whenever possible.

8.8.3.2 When a fume hood is unattended, its sash shall remain fully closed.

8.8.4* Electrical Devices.

8.8.4.1 In installations where services and controls are within the hood, additional electrical disconnects shall be located within 15 m (50 ft) of the hood and shall be accessible and clearly marked.

8.8.4.2 If electrical receptacles are located external to the hood, no additional electrical disconnect shall be required. (See 5.6.1.)

8.8.5 Other Hood Services.

8.8.5.1 For new installations or modifications of existing installations, controls for chemical fume hood services (gas, air, water, etc.) shall be located external to the hood and within easy reach.

8.8.5.2 In existing installations where service controls are within the hood, additional shutoffs shall be located within 15 m (50 ft) of the hood and shall be accessible and clearly marked.

8.8.6 Auxiliary Air. For auxiliary air hoods, auxiliary air shall be introduced exterior to the hood face in such a manner that the airflow does not compromise the protection provided by the hood and so that an imbalance of auxiliary air to exhaust air will not pressurize the hood interior.

8.8.7 Measuring Device for Hood Airflow.

8.8.7.1 A measuring device for hood airflow shall be provided on each chemical fume hood.

8.8.7.2 The measuring device for hood airflow shall be a permanently installed device and shall provide constant indication to the hood user of adequate or inadequate hood airflow.

8.9 Chemical Fume Hood Location.

8.9.1* Chemical fume hoods shall be located in areas of minimum air turbulence.

8.9.2 Chemical fume hoods shall not be located adjacent to a single means of access to an exit or to high-traffic areas.

8.9.3* Work stations not directly related to the chemical fume hood activity shall not be located directly in front of chemical fume hood openings.

8.10 Chemical Fume Hood Fire Protection.

8.10.1 Automatic fire protection systems shall not be required in chemical fume hoods or exhaust systems except in the following cases:

- (1) Existing hoods having interiors with a flame spread index greater than 25 in which flammable liquids are handled.
- (2) If a hazard assessment shows that an automatic extinguishing system is required for the chemical fume hood, then the applicable automatic fire protection system standard shall be followed.

8.10.2 Automatic fire protection systems, where provided, shall comply with the following standards, as applicable:

- (1) NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*
- (2) NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems*
- (3) NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*
- (4) NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*
- (5) NFPA 13, *Standard for the Installation of Sprinkler Systems*
- (6) NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*
- (7) NFPA 17, *Standard for Dry Chemical Extinguishing Systems*
- (8) NFPA 17A, *Standard for Wet Chemical Extinguishing Systems*
- (9) NFPA 69, *Standard on Explosion Prevention Systems*
- (10)*NFPA 750, *Standard on Water Mist Fire Protection Systems*
- (11) NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*

8.10.2.1 The fire extinguishing system shall be suitable to extinguish fires within the chemical fume hood under the anticipated conditions of use.

8.10.3 The design and installation of ducts from chemical fume hoods shall be in accordance with NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Non-combustible Particulate Solids*, except that specific requirements in NFPA 45 shall take precedence.

8.10.3.1* Automatic fire dampers shall not be used in chemical fume hood exhaust systems.

8.10.4 Fire detection and alarm systems shall not be interlocked to automatically shut down chemical fume hood exhaust fans.

8.10.5 Proper door operation for egress shall be maintained when the supply system shuts down and the lab exhaust system operates, creating a pressure differential.

8.10.6 Chemical fume hoods equipped with control systems that vary the hood exhaust airflow as the sash opening varies and/or in conjunction with whether the laboratory room is in use (occupied/unoccupied) shall be equipped with a user accessible means to attain maximum exhaust hood airflow regardless of sash position when necessary or desirable to ensure containment and removal of a potential hazard within the hood.

8.10.7* Chemical fume hoods shall be installed in a manner that prevents fire or smoke from a fire in the chemical fume hood from spreading into the voids above the ceiling.

8.11 Perchloric Acid Hoods.

8.11.1* Perchloric acid heated above ambient temperatures shall only be used in a chemical fume hood specifically designed for its use and identified as follows:

FOR PERCHLORIC ACID OPERATIONS

Exception: Hoods not specifically designed for use with perchloric acid shall be permitted to be used where the vapors are trapped and scrubbed before they are released into the hood. (See also 12.1.2.5.)

8.11.2 Perchloric acid hoods and exhaust ductwork shall be constructed of materials that are acid resistant, nonreactive, and impervious to perchloric acid.

8.11.3 The exhaust fan shall be acid resistant and spark resistant.

8.11.4 The exhaust fan motor shall not be located within the ductwork.

8.11.5 Drive belts shall be conductive and shall not be located within the ductwork.

8.11.6 Ductwork for perchloric acid hoods and exhaust systems shall take the shortest and straightest path to the outside of the building and shall not be manifolded with other exhaust systems.

8.11.6.1 Horizontal runs shall be as short as possible, with no sharp turns or bends.

8.11.6.2 The ductwork shall provide a positive drainage slope back into the hood.

8.11.6.3 Ductwork shall consist of sealed sections.

8.11.6.4 Flexible connectors shall not be used.

8.11.7 Sealants, gaskets, and lubricants used with perchloric acid hoods, ductwork, and exhaust systems shall be acid resistant and nonreactive with perchloric acid.

8.11.8* A water spray system shall be provided for washing down the hood interior behind the baffle and the entire exhaust system.

8.11.8.1 The hood work surface shall be watertight with a minimum depression of 13 mm (½ in.) at the front and sides.

8.11.8.2 An integral trough shall be provided at the rear of the hood to collect wash-down water.

8.11.9 The hood baffle shall be removable for inspection and cleaning.

8.11.10* If a chemical fume hood or exhaust system was used for perchloric acid heated above ambient temperature, tests shall be conducted for explosive perchlorates before any inspection, cleaning, maintenance, or any other work is done on any part of the exhaust system or hood interior.

8.11.11 Prior to using a perchloric acid hood for any purpose, the hood shall be water-washed and shall be tested according to 8.11.9 to ensure residual perchlorates are not present.

8.12 Identification of Chemical Fume Hood Systems.

8.12.1* Special-use chemical fume hoods and special-use local exhaust systems shall be identified to indicate their intended use.

8.12.2 A sign shall be affixed to each hood containing the following information from the last inspection, or a properly maintained log of all hoods providing the following information shall be maintained:

- (1) Inspection interval
- (2) Last inspection date
- (3) Average face velocity
- (4) Location of fan that serves hood
- (5) Inspector's name

8.13 Inspection, Testing, and Maintenance.

8.13.1* When installed or modified and at least annually thereafter, chemical fume hoods, chemical fume hood exhaust systems, and laboratory special exhaust systems shall be inspected and tested as applicable, as follows:

- (1) Visual inspection of the physical condition of the hood interior, sash, and ductwork (*see 7.5.3*)
- (2) Measuring device for hood airflow
- (3) Low airflow and loss-of-airflow alarms at each alarm location
- (4) Face velocity
- (5) Verification of inward airflow over the entire hood face
- (6) Changes in work area conditions that might affect hood performance

8.13.2 Deficiencies in hood performance shall be corrected or one of the following shall apply:

- (1) The activity within the hood shall be restricted to the capability of the hood.
- (2) The hood shall not be used.

8.13.3 Chemical fume hood face velocity profile or hood exhaust air quantity shall be checked after any adjustment to the ventilation system balance.

8.13.4 Detectors and Alarms.

8.13.4.1 Air system flow detectors, if installed, shall be inspected and tested annually.

8.13.4.2 Where potentially corrosive or obstructive conditions exist, the inspection and test frequency shall be increased.

8.13.5 Fans and Motors.

8.13.5.1* Air supply and exhaust fans, motors, and components shall be inspected at least annually.

8.13.5.2 Where airflow detectors are not provided or airflow-rate tests are not made, fan belts shall be inspected quarterly; double sheaves and belts shall be permitted to be inspected semiannually.

8.13.5.3 Frayed or broken belts shall be replaced promptly.

8.13.6 Fixed fire extinguishing systems protecting filters shall be inspected quarterly for accumulation of deposits on nozzles and cleaned as necessary.

Chapter 9 Chemical Storage, Handling, and Waste Disposal

9.1* Ordering Procedures.

9.1.1 When a chemical is ordered, steps shall be taken to determine its hazards and to transmit that information to those who will receive, store, use, or dispose of the chemical.

9.1.2 Restrictions imposed by governmental regulations and in-house rules shall be followed.

9.2 Handling and Storage.

9.2.1 Facilities.

9.2.1.1 Chemicals shall not be brought into a laboratory work area unless design, construction, and fire protection of receiving and storage facilities are commensurate with the quantities and hazards of chemicals involved.

9.2.1.2 Safe storage facilities shall be provided for materials that have unique physical or hazardous properties, such as temperature sensitivity, water reactivity, or explosibility. (*See A.9.1 for sources of additional information.*)

9.2.2 Handling.

9.2.2.1* Receiving, transporting, unpacking, and dispensing of chemicals and other hazardous materials shall be carried out by trained personnel in such locations and in such a manner as to minimize hazards from flammable, reactive, or toxic materials.

9.2.2.2* Materials of construction for ducts, piping, and vessels shall be compatible with materials to be transferred or handled.

9.2.2.3 Before a chemical material is used, the user shall determine that information and facilities are available for safe disposal of hazardous materials and waste products.

9.2.2.4 Class I liquids shall not be stored or transferred from one vessel to another in any exit access corridor, open plan buildings, or ancillary spaces unprotected from the exit access corridor.

9.2.2.5 Pressurized liquid dispensing containers containing chemicals shall be in accordance with Section 10.4.

9.2.3* Storage.

9.2.3.1 Hazardous chemicals shall be stored in such a manner as to limit a spill scenario to less than 20 L (5 gal).

9.2.3.2* Chemical inventories shall be maintained within the prescribed capacities of the storage facility.

9.2.3.3* Incompatible materials shall be segregated to prevent accidental contact with one another.

9.2.3.4* Containers of materials that might become hazardous during prolonged storage shall be dated when first opened.

9.2.3.4.1 At the end of 6 months, the material shall be evaluated or tested for continued safe use.

9.2.3.4.2 Material that is found to be safe or that can be treated to be made safe shall be permitted to be redated and retained for an additional 6-month period.

9.2.3.4.3 All other material shall be safely discarded.

9.2.3.5* Storage cabinets used in laboratories shall not be required to be vented for fire protection purposes.

9.2.3.6 Laboratory storage facilities shall be inspected to ensure compliance with the provisions of Chapter 9.

9.3* Flammable Solids.

9.3.1 The quantity of flammable solids allowed shall be limited to the minimum quantity necessary to perform the work being done.

9.3.2 Handling of the materials shall conform to the manufacturers' recommendations.

9.4 Oxidizers.

9.4.1 The quantity of solid and liquid oxidizers allowed shall be limited to the minimum quantity necessary to perform the work being done.

9.4.2 Handling of the materials shall conform to the manufacturers' recommendations.