

NFPA 318

Standard for the Protection of Semiconductor Fabrication Facilities

2006 Edition



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

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Standard for the

Protection of Semiconductor Fabrication Facilities

2006 Edition

This edition of NFPA 318, *Standard for the Protection of Semiconductor Fabrication Facilities*, was prepared by the Technical Committee on Cleanrooms and acted on by NFPA at its June Association Technical Meeting held June 6–10, 2005, in Las Vegas, NV. It was issued by the Standards Council on July 29, 2005, with an effective date of August 18, 2005, and supersedes all previous editions.

This edition of NFPA 318 was approved as an American National Standard on August 18, 2005.

Origin and Development of NFPA 318

The Committee on Cleanrooms was formed in 1988 and held its first meeting during May of that year. The Committee was organized into chapter subcommittees that separately prepared individual chapters and related appendix material for review by the full committee at meetings held October 1988, March 1989, September 1989, March 1990, September 1990, and June 1991.

The standard was submitted and adopted at the Fall Meeting in Montréal in 1991. The 1992 edition was the first edition of this standard.

The standard was revised in 1995.

The 1998 and 2000 editions were partial revisions of the standard.

The 2002 edition of this standard incorporated Article 51 of the *Uniform Fire Code* and was reformatted to comply with the *Manual of Style for NFPA Technical Committee Documents*.

The 2006 edition contains a new chapter addressing quantity limits for hazardous materials following coordination of this information with *NFPA 5000®*, *Building Construction and Safety Code®*.

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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on fire protection for cleanrooms.

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

Changes other than editorial are indicated by a vertical rule beside the paragraph, table, or figure in which the change occurred. These rules are included as an aid to the user in identifying changes from the previous edition. Where one or more complete paragraphs have been deleted, the deletion is indicated by a bullet (•) between the paragraphs that remain.

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 extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex D. 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 D.

Chapter 1 Administration

1.1 Scope. This standard applies to semiconductor fabrication facilities and comparable research and development areas in which hazardous chemicals are used, stored, and handled and containing what is herein defined as a clean-room or clean zone, or both.

1.2* Purpose. This standard is intended to provide reasonable safeguards for the protection of facilities containing clean-rooms from fire and related hazards. These safeguards are intended to provide protection against injury, loss of life, and property damage.

1.3 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.

1.3.1 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.

1.3.2 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.

1.3.3 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.

1.4 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.

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

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

1.4.3* Alternative systems, methods, or devices approved as equivalent by the authority having jurisdiction shall be recognized as being in compliance with this standard.

1.5* Units. Metric units of measurement in this standard are in accordance with the modernized metric system known as the International System of Units (SI). The liter unit, which is not part of but is recognized by SI, is commonly used in international fire protection. Conversion factors for this unit are found in Table 1.5.

Table 1.5 Metric Units of Measure

Name of Unit	Unit Symbol	Conversion Factor
millimeter	mm	1 in. = 25.4 mm
meter	m	1 ft = 0.3048 m
square meter	m ²	1 ft ² = 0.093 m ²
kilopascal	kPa	1 psi = 6.895 kPa
liter	L	1 gal = 3.785 L
liter/minute	L/min	1 gal/min = 3.785 L/min 1 ft ³ /min = 28.3 L/min
liter/minute/m ²	L/min·m ²	1 gal/min·ft ² = 40.746 L/min·m ² (mm/min)
liter/second/m ²	L/s·m ²	1 ft ³ /min·ft ² = 0.044 L/s·m ²

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 1, *Uniform Fire Code*™, 2006 edition.

NFPA 13, *Standard for the Installation of Sprinkler 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 70, *National Electrical Code*®, 2005 edition.

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

NFPA 79, *Electrical Standard for Industrial Machinery*, 2002 edition.

NFPA 101®, *Life Safety Code*®, 2006 edition.

NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*, 2006 edition.

NFPA 385, *Standard for Tank Vehicles for Flammable and Combustible Liquids*, 2000 edition.

NFPA 430, *Code for the Storage of Liquid and Solid Oxidizers*, 2004 edition.

NFPA 432, *Code for the Storage of Organic Peroxide Formulations*, 2002 edition.

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

NFPA 5000®, *Building Construction and Safety Code*®, 2006 edition.

2.3 Other Publications.

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

ASME B31.3, *Process Piping*, 2004.

2.3.2 ASTM Publications. American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D 5, *Standard Test Method for Penetration of Bituminous Materials*, 2005.

ASTM D 323, *Standard Test Method for Vapor Pressure of Petroleum Products*, 2001.

ASTM E 136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*, 2004.

2.3.3 ISO Publication. International Organization for Standardization, 1, rue de Varembe, Case postale 56, CH-1211 Geneva 20, Switzerland.

ISO 14644-1, *Cleanrooms and Associated Controlled Environments — Part 1: Classification of Air Cleanliness*, 1999.

2.3.4 SEMI Publication. Semiconductor Equipment and Materials International, 3081 Zanker Road, San Jose, CA 95134.

SEMI F1, *Specification for Leak Integrity of High-Purity Gas Piping Systems and Components*, 1996.

2.3.5 UL Publication. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 900, *Standard for Safety for Air Filter Units*, 2004.

2.3.6 U.S. Government Publication. U.S. Government Printing Office, Washington, DC 20402.

Title 29, Code of Federal Regulations, Part 1910.1000, "Air Contaminants."

2.3.7 Other Publication.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

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

NFPA 101®, *Life Safety Code*®, 2006 edition.

NFPA 1670, *Standard on Operations and Training for Technical Search and Rescue Incidents*, 2004 edition.

NFPA 5000®, *Building Construction and Safety Code*®, 2006 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

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* 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.

3.2.4 Shall. Indicates a mandatory requirement.

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

3.2.6 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 Cleanroom. A room in which the concentration of airborne particles is controlled to specified limits, including areas below the raised floor and above the ceiling grid if these areas are part of the air path and within the rated construction.

3.3.2 Clean Zone. A defined space in which the concentration of airborne particles is controlled to specified limits.

3.3.3 Compressed Gas. In semiconductor fabrication facilities, any material or mixture having, when in its container, an absolute pressure exceeding 276 kPa (40 psia) at 21°C (70°F) or, regardless of the pressure at 21°C (70°F), having an absolute pressure exceeding 717 kPa (104 psia) at 54.4°C (130°F) or any flammable liquid having an absolute vapor pressure exceeding 275.8 kPa at 37.8°C (40 psia at 100°F) as determined by ASTM D 323, *Standard Test Method for Vapor Pressure of Petroleum Products*.

3.3.4 Compressed Gas Container. A pressure vessel designed to hold compressed gases at pressures greater than 1 atmosphere at 68°F (20°C) that includes cylinders, containers, and tanks. [5000, 2006]

3.3.5 Exempt Amount per Control Area. The amount of hazardous material allowed to be stored, used, or handled in a control area as set forth in NFPA 1, *Uniform Fire Code*, and

NFPA 5000, *Building Construction and Safety Code*. The exempt amount per control area is based on the material state (solid, liquid, or gas) and the material storage or use conditions.

3.3.6 Exhausted Enclosure. In semiconductor fabrication facilities, exhausted enclosures provide secondary containment for pieces of equipment, mechanical fittings, or valves, providing a means of local exhaust for capturing potential gases, fumes, vapors, and mists resulting from abnormal conditions.

3.3.7 Explosion. The bursting or rupture of an enclosure or a container due to the development of internal pressure from a deflagration. [69, 2002]

3.3.8 Fabrication Area (Fab Area). An area within a semiconductor fabrication facility and related research and development areas in which there are processes using hazardous production materials; such areas include cleanrooms, process equipment support areas, parts clean and ancillary rooms that are directly related to the fab area processes.

3.3.9 Flammable Vapors or Fumes. The concentration of flammable constituents in air that exceed 25 percent of their flammability limit.

3.3.10 Gas Cabinet. A fully enclosed, noncombustible enclosure used to provide an isolated environment for compressed gas cylinders in storage or use. Doors and access ports for exchanging cylinders and accessing pressure-regulating controls are allowed to be included.

3.3.11* Hazardous Chemical. In semiconductor fabrication facilities, any solid, liquid, or gas that has a degree-of-hazard rating in health, flammability, or reactivity of Class 3 or 4 as ranked by NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*.

3.3.12 Immediately Dangerous to Life or Health (IDLH). Any condition that would pose an immediate or delayed threat to life, cause irreversible adverse health effects, or interfere with an individual's ability to escape unaided from a hazardous environment. [1670, 2004]

3.3.13 Incompatible Materials. Materials that, when making contact with each other in an upset condition, can react in a manner that generates heat, fumes, gases, or by-products that could cause damage to life or property.

3.3.14 Interface. That place at which independent systems meet and act on or communicate with each other.

3.3.15 Interlock. A device, or an arrangement of devices, in which the operation of one part or one mechanism of the device or arrangement controls the operation of another part of another mechanism.

3.3.16 Limit.

3.3.16.1 Ceiling Limit. The maximum concentration of an airborne contaminant to which one can be exposed; the ceiling limits used are those published in 29 CFR 1910.1000.

3.3.16.2* Permissible Exposure Limit (PEL). The maximum permitted 8-hour, time-weighted average concentration of an airborne contaminant. [5000, 2006]

3.3.17 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 for Penetration of Bituminous Materials*. Unless otherwise specified, the term *liquid* includes both flammable and combustible liquids.

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

3.3.17.2 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).

3.3.18 Noncombustible. In semiconductor fabrication facilities, a material that, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat. Materials that are reported as passing ASTM E 136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*, shall be considered noncombustible materials.

3.3.19 Pass-Through. An enclosure, installed in a wall and with a door on each side, that allows chemicals, production materials, equipment, and parts to be transferred from one side of the wall to the other.

3.3.20 Pyrophoric. A chemical with an autoignition temperature in air at or below 54.4°C (130°F).

3.3.21 Restricted-Flow Orifice (RFO). A device located in the gas cylinder valve body that restricts the maximum flow rate to 30 L/min (1.06 ft³/min).

3.3.22 Room.

3.3.22.1 Gas Room. A separately ventilated, fully enclosed room in which only compressed gases and associated equipment and supplies are stored or used.

3.3.22.2 Hazardous Chemical Storage and Dispensing Room. A room used in conjunction with or serving a fabrication area where hazardous chemicals are stored, used, or transferred from vessels in the room through piping systems to a fabrication area.

3.3.23 Semiconductor Fabrication Facility. Buildings or portions thereof used for the fabrication of semiconductors and related research containing quantities of hazardous materials exceeding the maximum allowable quantities of Level 5 contents permitted in control area.

3.3.24 Service Corridor. A fully enclosed passage used for transporting HPM and for purposes other than required means of egress. [5000, 2006]

3.3.25 Smoke. The airborne solid and liquid particulates and gases evolved when a material undergoes pyrolysis or combustion, together with the quantity of air that is entrained or otherwise mixed into the mass.

3.3.26 Standby Mode. A mode wherein all flow of flammable gas or liquid ceases and heaters have power removed.

3.3.27 System.

3.3.27.1 Access Floor System. An assembly consisting of panels mounted on pedestals to provide an under-floor space for the installations of mechanical, electrical communication, or similar systems or to serve as an air supply or return-air plenum.

3.3.27.2 Compressed Gas System. An assembly of equipment designed to contain, distribute, or transport compressed gases.

3.3.27.3 Continuous Gas Detection System. A gas detection system where the instrument is maintained in continuous operation and the interval between sampling of any point does not exceed 30 minutes. [5000, 2006]

3.3.27.4 Emergency Alarm System. A system to provide indication and warning of emergency situations involving hazardous materials and to summon appropriate aid.

3.3.27.5 Subatmospheric Gas Delivery System. A system that includes a gas cylinder which under normal operation allows for gas flow from a cylinder only when the cylinder valve outlet is exposed to a pressure of less than one atmosphere pressure (760 Torr).

3.3.28 Third Party. A professional, qualified as the result of training, education, and experience, who can perform a compliance and hazardous analysis of process equipment in accordance with this standard.

3.3.29 Tool. Any device, storage cabinet, workstation, or process machine used in the cleanroom.

3.3.30* Workstation. A defined space or an independent, principal piece of equipment using hazardous chemicals within a cleanroom or clean zone, where a specific function, a laboratory procedure, or a research activity occurs.

Chapter 4 Fire Protection

4.1 Automatic Fire-Extinguishing Systems.

4.1.1* General. Wet pipe automatic sprinkler protection shall be provided throughout facilities containing cleanrooms and clean zones.

4.1.2 Automatic Sprinkler Systems.

4.1.2.1* Automatic sprinklers for cleanrooms or clean zones shall be installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, and shall be hydraulically designed for a density of 8.15 L/min·m² (0.20 gpm/ft²) over a design area of 278.8 m² (3000 ft²).

4.1.2.2* Approved quick-response sprinklers shall be utilized for sprinkler installations within down-flow airstreams in cleanrooms and clean zones.

4.1.2.3* Gas Cabinets.

4.1.2.3.1 Sprinklers shall be installed in gas cabinets that contain hazardous chemical flammable gases.

4.1.2.3.2 Sprinklers shall not be required in gas cabinets located in a hazardous chemical room or gas room, other than in those cabinets containing pyrophoric gases.

4.1.2.4* Automatic quick-response sprinklers or a deluge system shall be provided in the proximity of and directed at individual silane cylinders in silane-dispensing areas, as described in Sections 8.4 and 8.5.

4.1.2.4.1 Where the open dispensing system is in accordance with Sections 8.4 and 8.5 and Chapter 9, and designed to mitigate the effects of detonation, the automatic deluge water spray system shall not be required.

4.1.2.5 Automatic sprinkler protection shall be designed and installed in the plenum and interstitial space above cleanrooms in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, for a density of 8.15 L/min·m² (0.20 gpm/ft²) over a design area of 278.8 m² (3000 ft²).

4.1.2.5.1* Automatic sprinklers shall be permitted to be omitted if the construction and occupancy of these spaces are non-combustible.

4.1.2.6 Exhaust Ducts. Interior automatic sprinklers shall be provided in exhaust ducts conveying vapors, fumes, or mists generated by hazardous chemicals as follows:

- (1) Automatic sprinklers shall be provided in metallic and noncombustible, nonmetallic exhaust ducts when all of the following conditions are present:
 - (a)*Largest interior cross-sectional area is equal to or greater than 480 cm² (75 in.²).
 - (b) Ducts are located within the building.
 - (c) Ducts are conveying flammable vapors or fumes.
- (2) Automatic sprinklers shall be provided in combustible non-metallic exhaust ducts when the largest interior cross-sectional area is equal to or greater than 480 cm² (75 in.²).

4.1.2.6.1 Internal sprinklers shall not be required where ducts are approved for use without internal automatic sprinklers.

4.1.2.6.2 Sprinklers installed in duct systems shall be hydraulically designed to provide 1.9 L/min (0.5 gpm) over an area derived by multiplying the distance between the sprinklers in a horizontal duct by the width of the duct.

4.1.2.6.2.1* Minimum discharge shall be 76 L/min (20 gpm) per sprinkler from the five hydraulically most remote sprinklers.

4.1.2.6.2.2 Sprinklers shall be spaced a maximum of 6.1 m (20 ft) apart horizontally and 3.7 m (12 ft) apart vertically.

4.1.2.6.3 A separate indicating control valve shall be provided for sprinklers installed in ductwork.

4.1.2.6.4* Drainage shall be provided to remove all sprinkler water discharged in ductwork.

4.1.2.6.5 Where corrosive atmospheres exist, duct sprinklers and pipe fittings shall be manufactured of corrosion-resistant materials or coated with approved materials.

4.1.2.6.6 The sprinklers shall be accessible for periodic inspection and maintenance.

4.1.2.6.7* Where the branch exhaust ductwork is constructed of combustible material, automatic sprinkler protection shall be provided within the workstation transition piece or the branch exhaust duct.

4.1.2.6.8 Where the branch exhaust ductwork is subject to combustible residue buildup, regardless of the material of construction, automatic sprinkler protection shall be provided.

4.1.2.7* Automatic sprinklers shall be provided in pass-throughs used to convey combustible chemicals.

4.2 Alarm Systems.

4.2.1 The discharge of an automatic fire suppression system shall activate an audible fire alarm system on the premises and an audible or visual alarm at a constantly attended location.

4.2.2 Signal transmission for alarms designed to activate signals at more than one location shall be verified at each location during each test of the alarm system.

4.2.3 Manual Fire Alarm System.

4.2.3.1 A manual fire alarm system shall be installed throughout buildings containing fabrication areas.

4.2.3.2 Activation of the alarm system shall transmit a signal to the emergency control station.

4.2.3.3 Manual fire alarm systems shall be designed and installed in accordance with NFPA 72, *National Fire Alarm Code*.

4.3 Detection Systems.

4.3.1* A listed or approved smoke detection system shall be provided in the cleanroom return airstream at a point before dilution from makeup air occurs.

4.3.2* Smoke detection within a cleanroom air system shall result in an alarm transmission to a constantly attended location as well as a local alarm signal within the cleanroom that is distinctive from both the facility evacuation alarm signal and any process equipment alarm signals in the cleanroom.

4.3.3 Optical flame detectors that will respond to the flame signature of silane shall be provided at silane gas cylinders in the open dispensing systems described in Section 8.4. Activation of detectors shall result in the closing of the cylinder automatic shutoff valves described in 8.1.2.

4.3.4* Where the potential exists for flammable gas concentrations to exceed 25 percent of the lower flammability limit (LFL), a continuous gas detection system shall be provided.

4.3.5 Listed or approved smoke detectors shall be provided at the exit of both the makeup and air-handling units.

Chapter 5 Ventilation and Exhaust Systems

5.1 Air Supply and Recirculation Systems.

5.1.1 The location of outside air intakes shall be chosen to avoid drawing in hazardous chemicals or products of combustion coming either from the building itself or from other structures and devices.

5.1.2* High-efficiency particulate air (HEPA) modules, ultra low penetration air (ULPA) filter modules, and pre- or final filters in makeup and recirculation air-handling units shall all meet a Class I rating as outlined in UL 900, *Standard for Air Filter Units*.

5.1.2.1 UL 900 Class II filters shall be acceptable in makeup air handlers (MAHs) and recirculating air handlers (RAHs) provided that there are listed or approved smoke detectors in the makeup and recirculation air handlers where Class II filters are used.

5.1.3 Air supply and recirculation ducts shall have a flame spread index of not more than 25 and a smoke-developed index of not more than 50 when tested in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*.

5.1.4 A manually operated remote switch(es) to shut off the affected areas of the cleanroom air recirculation system(s) shall be provided at an approved location(s).

5.1.5 Testing.

5.1.5.1* Where automatic detection devices are used to shut down ventilation systems and/or control smoke, they shall be periodically tested.

5.1.5.2 To avoid contamination of the cleanroom, the detection and control components shall be permitted to be tested separately to simulate functional operation without affecting fan energy.

5.2 Local Hazardous Chemical Exhaust System.

5.2.1 Exhaust air discharged from cleanrooms shall not be recirculated.

5.2.1.1 Ducts shall lead to the outside as directly as practicable and shall discharge above the roof at a location, height, and velocity sufficient to prevent re-entry of hazardous chemicals.

5.2.1.2 A hazardous chemical exhaust system of a fabrication area shall not connect to nonhazardous exhaust systems.

5.2.2 Energy conservation devices that create a risk of returning contaminants to the cleanroom air supply shall not be used in exhaust systems.

5.2.3 Air containing hazardous chemicals shall be conveyed through duct systems that are maintained at a negative pressure relative to the pressure of normally occupied areas of the building.

5.2.3.1 The requirements of 5.2.3 shall not apply to ducts downstream of fans, scrubbers, and treatment devices.

5.2.4 Workstation exhaust ventilation shall be designed to capture and exhaust contaminants generated in the station.

5.3 Local Hazardous Chemical Exhaust System Construction.

5.3.1* Flexible connections, unless listed for fume exhaust and for use without internal automatic sprinkler protection, shall not be used in exhaust ductwork that is connected to combustible workstations or to workstations where combustible chemicals are used.

5.3.2 The entire exhaust duct system shall be self-contained.

5.3.2.1 No portions of the building shall be used as an integral part of the system.

5.3.3 Two or more operations shall not be connected to the same exhaust system when the combination of the substances removed might create a fire, an explosion, or a chemical reaction hazard within the duct system.

5.3.4 Exhaust ducts penetrating fire resistance-rated construction shall be contained in an enclosure of equivalent fire-resistive construction. Fire resistance construction and enclosure with equivalent fire-resistive construction shall extend 1.8 m (6 ft) or a distance equivalent to two times the duct diameter, whichever is greater, on either side of the rated construction.

5.3.5 Fire dampers shall not be installed in exhaust ducts.

5.3.6* Exhaust duct systems shall be constructed of noncombustible materials or protected with sprinklers in accordance with 4.1.2.6.

5.3.6.1 Ducts approved for use without automatic sprinklers shall not require sprinkler protection.

5.3.7 The interior and exterior surface of nonmetallic exhaust ducts shall have a flame spread rating of 25 or less, and the exterior surface of nonmetallic exhaust ducts shall have a smoke-developed rating of 25 or less when the interior or exterior of the duct is exposed to fire, when tested in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*.

5.4 General Conditions.

5.4.1 Fabrication Areas and Cleanrooms. Mechanical exhaust ventilation shall be provided throughout a fabrication area or cleanroom at the rate of not less than 0.044 L/sec·m² (1 ft³/min·ft²) of floor area.

5.4.2 Workstations. Workstations shall be in accordance with Sections 5.2 and 5.3 of this standard.

5.4.3 Hazardous Chemical Rooms. Exhaust ventilation shall be provided in hazardous chemical rooms in accordance with NFPA 1, *Uniform Fire Code*.

5.4.4 Gas Cabinets. Exhaust ventilation shall be provided for gas cabinets in accordance with NFPA 1, *Uniform Fire Code*. For silane and silane mixes, also see 8.5.3(B) of this standard.

5.4.5 Exhausted Enclosures. Exhaust ventilation shall be provided for exhausted enclosures in accordance with NFPA 1, *Uniform Fire Code*.

5.4.6 Gas Rooms. Exhaust ventilation shall be provided in gas rooms in accordance with NFPA 1, *Uniform Fire Code*.

5.5 Hazardous Chemical Exhaust Duct Airflow and Dilution.

5.5.1* Airflow in cleanroom exhaust systems shall be designed to ensure dilution such that flammable vapors are not conveyed in the ducts.

5.5.2* To determine the presence of flammable vapors in ductwork, calculations shall be made at, but not prior to, the point where the process effluent enters ductwork with a cross-sectional area equal to or greater than 480 cm² (75 in.²).

5.6 Hazardous Chemical Exhaust Controls.

5.6.1* The emergency power shall operate the exhaust system at not less than 50 percent capacity when it is demonstrated that the level of exhaust maintains a safe atmosphere.

5.6.2 Fire detection and alarm systems shall not be interlocked to shut down local exhaust fans automatically.

5.6.3 Exhaust dampers, where required for balancing or control of the exhaust system, shall be of the locking type.

Chapter 6 Construction

6.1 Classification of Occupancy. Semiconductor manufacturing facilities containing cleanrooms and associated support facilities shall be considered to be general or special purpose industrial occupancies as defined in NFPA 101, *Life Safety Code*.

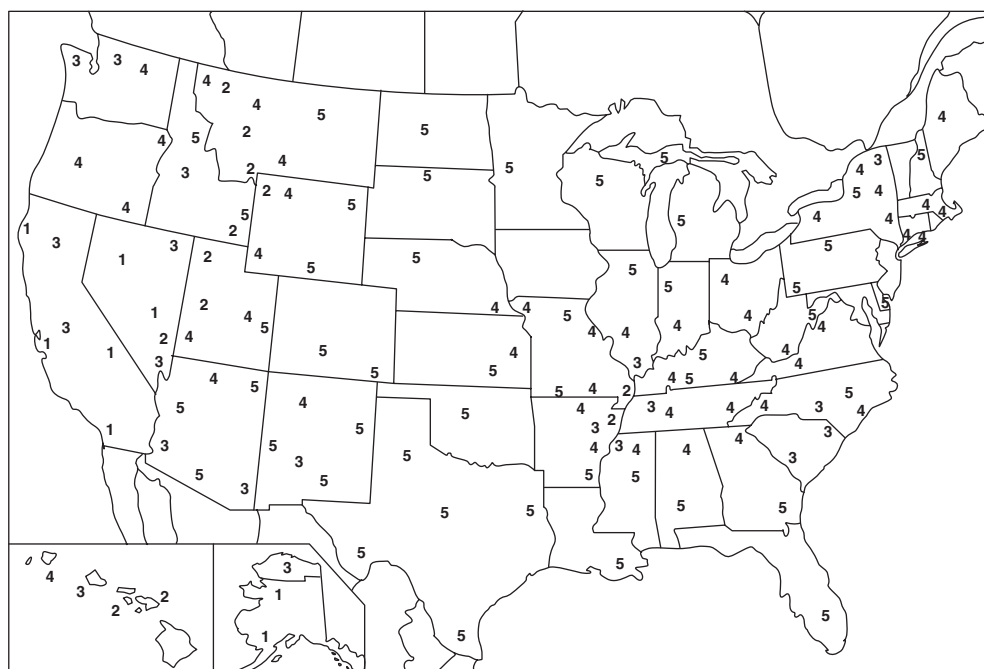
6.2* Noncombustible Construction Components. Cleanrooms rated ISO Class 5 or cleaner in accordance with ISO 14644-1, *Cleanrooms and Associated Controlled Environments — Part 1: Classification of Air Cleanliness*, or cleanrooms having clean zones rated ISO Class 5 or cleaner shall have approved, noncombustible components for walls, floors, ceilings, and partitions.

6.3 Fire Resistance Rating.

6.3.1 Fabrication areas shall be separated from each other by 1-hour fire resistance-rated construction.

6.3.2 Fabrication areas shall be separated from adjacent occupancies by not less than 1-hour fire resistance-rated construction and not less than the fire resistance rating required in NFPA 5000, *Building Construction and Safety Code*.

6.4 Access Floors. Cleanroom access floors shall be designed to resist a force of 0.5 G magnitude in seismic zones 1, 2, and 3, depicted in Figure 6.4.



Earthquake Zones:

- 1 — Maximum potential for earthquake damage
- 2 — Reasonable potential
- 3 — Slight potential
- 4 and 5 — Earthquake protection not required

FIGURE 6.4 Sample Seismic Map.