C.11.1 Fire Incidents in Laboratories. The following descriptions of laboratory fires are selected from previous editions of NFPA 99 and from the National Fire Incident Reporting System data base.

C.11.1.1 Iowa, October 1980. A hospital fire, originating in a second-floor pathology laboratory, occurred when electrical wires arced and ignited cloth towels placed under beakers. The beakers contained tissue samples, alcohol, and formaldehyde. The contents of the beakers caused the fire to spread to other larger containers of chemicals in the lab.

There was a 20- to 30-minute delay in detection of this fire because there was no automatic smoke detection equipment in the laboratory. Smoke detectors in the air ducts located in the hallways did operate when the smoke filtered out of the lab. There was no automatic sprinkler system.

No other specifics were reported as to the cause of the electrical arcing.

Direct property damage was estimated at $20,000.

C.11.1.2 Pennsylvania, December 1980. A small fire, of electrical nature, broke out in a hospital laboratory. The fire involved a condensate drip tray that was used to dissipate water from a refrigerator unit. The probable fire scenario was that a short circuit resulted from the aging rubber insulation of the cord. The unit is always left “on.”

No direct property damage was reported for this fire. There were no automatic sprinklers in the lab area of the hospital. There were heat detectors in the area, but no smoke detectors. The fire generated large amounts of smoke.

C.11.1.3 Rhode Island, October 1981. A fire occurred in a blood bank/donor lab in a hospital. A patient was lying on one of three contour couches in the donor room giving blood. The technician pushed a button to raise the couch, then heard a pop, and saw flames and smoke coming from the couch. The technician tried unsuccessfully to extinguish the fire with a portable fire extinguisher.

A supervisor pulled the manual pull station and the fire department arrived within 3 minutes.

One civilian and one fire fighter were injured in the fire.

There was extensive smoke and soot damage in the area. Direct property damage was estimated at $12,000. The fire occurred in an unsprinklered building.

The cause of the fire was determined to be a short circuit in the wiring in the motor of the couch.

C.11.1.4 New Jersey, April 1982. A small hospital fire occurred in a processing laboratory where tissue samples are cut and mounted in metal or polypropylene cassettes and then run through a processor. In the processor, the mounted samples are dipped in a series of baths. The cassettes were stored in polystyrene cabinets.

The cause of the fire was undetermined. Damage was confined to a 6-ft^2 area in the corner of the tissue lab. The fronts of the cassette cabinets suffered partial melting and some cassettes had the paraffin melted. It was estimated that 80 percent of the specimen cassettes were intact and salvageable.

Total direct property damage was estimated at $70,000 and business interruption at $4,000.

A single sprinkler head operated and extinguished the fire. The waterflow alarm was received by the hospital switchboard and the municipal dispatching service.

C.11.1.5 Massachusetts, April 1982. A tissue laboratory in a hospital was the scene of a fire that resulted in $50,000 in direct property damage. An additional $50,000 was lost due to business interruption.

The tissue lab was located in the pathology area of the lab building and housed 11 tissue processing machines. Eight of the machines were used to dehydrate tissue samples in a xylene concentrated solution or an alcohol solution.

When a technician left the room at 5:15 p.m., all the machines were functioning properly. Twenty minutes later, a waterflow and smoke detection alarm was received at the command center with direct transmission to the fire department. Two sprinkler heads helped control the fire. The fire was extinguished by the fire department using a 1½-in. hand line from an interior standpipe. The fire was attributed to the jamming of one of the baskets of a processing machine as it was being moved from one carriage to another. The motor failed to shut down as it should have, overheated, and eventually ignited the flammable xylene and alcohol solutions.

C.11.1.6 Tennessee, May 1984. The overheating of xylene inside a distiller located in the hospital lab resulted in a fire. Apparently, the escaping flammable vapors were ignited by ordinary electrical equipment in the room. Prompt and effective automatic sprinkler activation helped minimize fire damage.

The fire occurred in a fourth floor histology lab. Among the contents of the lab were small xylene stills for reclaiming used solvent, and also tissue processing equipment. A technician had filled the distiller with xylene. Some time later, another person working in the area of the distiller noticed that an odor was coming from the unit and that the solution had a brown color to it. This employee left to find someone to inspect the distiller. This employee returned with another worker to find a grayish haze around the console. Just after leaving the room, the employees saw smoke coming from under the door. A “Code Red” was sounded and the lab was evacuated. The technician who originally was running the machine returned at the sound of the alarm and tried to turn off the instrument by crawling on the floor, but was unable to do so because of the smoke and smell of xylene.

Property loss was estimated at $150,000, and business interruption resulted in an additional $15,000.

C.11.1.7 Florida, December 1985. A fire broke out in a hospital pathology lab and resulted in $100,000 in property damage, and an additional $2,000 in business interruption. The pathology lab analyzes tissue samples from patients. These samples are preserved in an embedding center using paraffin as the preserving agent.

The cause of the fire was determined to be the failure of a thermostat that controls the temperature of the heating element that melts the paraffin in the tissue embedding center.

The fire damaged two tissue-embedding centers, an ultrasonic cleaner, two light fixtures, a wood wall cabinet, as well as damaging the wall and ceiling. Microscopes, computer terminals, measuring equipment, and tissue slides and samples were among the items damaged by smoke and soot. The fire damage was confined to the lab.

An employee smelled smoke coming from the lab and noticed that the lab door was hot. A security guard was called immediately and pulled the alarm at a manual station in the hallway. The fire department extinguished the fire with dry chemicals and an inside hose stream located in the hallway. There were no heat or smoke detectors inside the pathology lab. The building was unsprinklered.

C.11.1.8 New York, April 1988. A hospital laboratory was the scene of a $250,000 fire. The fire started when a professor was sterilizing a pair of scissors using the “flaming” procedure. The “flaming” method involves dipping an item into alcohol and then burning off that alcohol with a Bunsen burner. The professor carried out the procedure once, then tried to do it a second time because he thought he had contaminated the scissors. During the second attempt, the alcohol he dipped the scissors into ignited because the scissors were still hot. The container of alcohol was dropped and the fire spread to nearby combustibles, including other flammable liquids.

A security guard noticed the fire and immediately pulled the alarm signaling the fire department and hospital fire brigade. The fire department responded promptly and extinguished the fire.

There were no automatic sprinklers in the fire area. Three civilians were injured in the fire.

C.11.1.9 California, April 1989. The thermostat of a low-temperature lab oven (incubator) malfunctioned, causing the oven to overheat. The unit heated to approximately 200 degrees overnight, causing a smoldering fire. An employee discovered the fire in the sixth-floor laboratory in the medical center when he arrived early to work. His first action was to shut off the incubator, after which he called the fire department.

Fire destroyed the contents of the incubator, and the incubator itself needed repairs due to exposure to dry powder agent. Smoke damage also occurred in the lab and hallway. Property damage was estimated at $1,000.

An alarm sounded after the fire department had used an extinguisher on the fire. The type of alarm was not reported.

C.11.1.10 California, November 1989. Four fire fighters were injured at a fire in a pathology lab at a multi-story hospital medical center when they were exposed to toxic chemical debris and human tissue. The fire originated in a stainless steel cabinet that had two glass-windowed doors. There were two pieces of equipment in the cabinet that were used to process tissue by dipping trays of tissues into a series of containers. The machines were about 20 years old.

The official cause of the fire was listed as a malfunctioning piece of electrically powered lab equipment igniting volatile flammable liquid. The exact point of failure could not be determined.

Automatic detection equipment was present and operated. There was no automatic sprinkler system present in the lab. Direct property loss was estimated at $325,000. No estimates were given for business interruption.

C.11.1.11 Michigan, March 1981. A building that housed various analytical research and development laboratories was the scene of a $60,000 fire. The laboratory involved in the fire was used essentially for liquid and gas chromatography.

The fire occurred when solvent leakage inside, or adjacent to, a liquid chromatograph ignited from an electrical source. Apparently, a small amount of solvent was spilled for up to 25 minutes and subsequently ignited. The fire burned through a plastic tube feeding a waste solvent container on a shelf. The spilled waste solvent intensified the fire. Liquid chromatography uses solvents of methanol and iso-octane.

An employee first heard a crackling and then saw flames at the base of the liquid chromatography instrument. Employees immediately attacked the fire with a dry chemical fire extinguisher. Also, two sprinkler heads operated, limiting the spread of fire within the laboratory. The fire department received a waterflow alarm, a manual fire alarm box, and several phone calls. Fire fighters found the fire nearly out on arrival because of sprinkler activation and consumption of the spilled liquid.

C.11.1.12 Virginia, June 1981. A small fire occurred in a laboratory that manufactures interferon. During this process, red and white blood cells are separated, and the white cells are placed in beakers with nutrients. A virus is introduced to the white cell cultures, which then produce the interferon. A centrifuge is used to separate the interferon from the white cells. The process is carried out in a small refrigerated room isolated from other areas by insulated metal panel walls and ceiling.

In the early afternoon, an employee stabilized a magnetic stirring rod that had been banging the side of one of the glass beakers.

Minutes later, personnel noticed smoke and fire within the refrigerated room and immediately extinguished the fires with extinguishers. The fire department also was notified.

Alcohol spilling onto the electrical parts of the magnetic stirrer caused the fire. The spilling was caused by inadequate supervision of the magnetic stirrer.

The fire resulted in $235,000 in direct property damage and an additional $40,000 in business interruption. Metal walls and ceiling panels, some laboratory equipment, and an unknown quantity of interferon were destroyed or damaged in the fire.

There were no automatic detection or suppression systems in the building. There were manual pull stations and portable extinguishers.

C.11.1.13 Tissue Processor Fire. Operated 24 hours per day, but unattended from 11 p.m. to 7 a.m., a tissue processor was suspected of causing $200,000 damage because the incident occurred after 11 p.m. and there were no detectors or automatic extinguishing equipment in the laboratory. Flammable liquids in glass containers stored in an open shelf below the equipment contributed to the intensity of the fire.

Aside from damage to the laboratory, electrical cables in the corridor near the incident shorted and caused power to be interrupted in the hospital. Fire doors closed, but the fire alarm was not sounded.

C.11.1.14 Hot Plate Fires. Acetone, being poured at the sink in a patient treatment lab, was ignited by a nearby hot plate that had just been turned off. The technician dropped the container, which was metal and which, fortunately, fell in an upright position. The patient was safely evacuated, but the fire was intense enough to melt the sweated water pipe fittings of the window ventilator.

Petroleum ether caught fire while a chemist was pouring it in a fume hood from its large glass container — presumably ignited by a nearby hot plate that had recently been turned off. He dropped the glass container on the floor and ran from the room. The bottle broke; ignition caused enough pressure to blow open the lab escape hatch and slam the entrance door shut.

C.11.1.15 Refrigerator Explosion. Eighty ml of diazomethane dissolved in ether detonated in a domestic-type refrigerator. The door blew open, the frame bowed out, and the plastic lining ignited, causing a heavy blanket of soot to be deposited far down the adjoining corridor. *(See 11.7.2.5.)*

C.11.1.16 Pressure Filter Fire. At an eastern hospital pharmacy, a fire-conscious technician prepared for pressure filtering of 50 gal (220 L) of isopropyl alcohol by placing a towel on a table adjacent to the pump; in the event of fire he planned to smother flames of alcohol inadvertently spilled on his person. As he attempted to turn on the pump, the defective switch ignited alcohol on his hands. Instinctively, he reached for the towel as he had previously rehearsed in his mind but, in doing so, he tripped over the hose that was conducting alcohol by gravity from a large open kettle to the suction side of the pump. The hose slipped from its fittings, thereby dumping 50 gal (220 L) of the flaming solvent onto the floor. He escaped with minor injuries, but the pharmacy was destroyed. (Many fires are intensified by an unfortunate sequence of minor unsafe practices that in themselves seem almost too insignificant to worry about.)

C.11.1.17 Water Bath Fire. When the thermostat on a water bath malfunctioned, the bath overheated, causing the acrylic lid to sag and contact the heater elements. A fire resulted. Heater equipment should always be protected by overtemperature shutoffs. (Based on *DuPont Safety News*, June 14, 1965.)

C.11.1.18 Peroxide Explosion. A distillation apparatus exploded within a lab fume hood. It was caused by the detonation of the residual peroxide. The drawn sash prevented injury, although the electric mantle was torn to shreds. The investigator was using “some isopropyl ether,” which had been kept in a clear glass bottle. He allowed the distillation to continue to dryness.

Investigators should become more aware of the nature of ether peroxide formations. Dioxane and ethyl and isopropyl ethers are the most common offenders. Age, sunlight, air space above liquid, and clear glass containers help to create these explosive peroxides. Test frequently for peroxide; filter out peroxides through a column of 80 mesh Alorco activated alumina, as suggested by Dasler and Bauer, *Ind. Eng. Chem. Anal.*, Ed. 18, 52 (1964). Never leave distillations unattended.

C.11.2 Related Definitions, Laboratories. The following definitions are taken from other NFPA documents and are critical to the understanding of Chapter 11.

C.11.2.1 The following definitions are taken from NFPA 30, *Flammable and Combustible Liquids Code*:

Flammable Liquid. Any liquid that has a closed-cup flash point below 100°F (37.8°C), as determined by the test procedures and apparatus set forth in 1.7.4.1 through 1.7.4.4. Flammable liquids are classified as Class I as follows: *Class I Liquid* — any liquid that has a closed-cup flash point below 100°F (37.8°C) and a Reid vapor pressure not exceeding 40 psia (2068.6 mm Hg) at 100°F (37.8°C), as determined by ASTM D 323, *Standard Method of Test for Vapor Pressure of Petroleum Products (Reid Method)*. Class I liquids are further classified as follows: (1) Class IA liquids — those liquids that have flash points below 73°F (22.8°C) and boiling points below 100°F (37.8°C); (2) Class IB liquids — those liquids that have flash points below 73°F (22.8°C) and boiling points at or above 100°F (37.8°C); (3) Class IC liquids — those liquids that have flash points at or above 73°F (22.8°C), but below 100°F (37.8°C). [**30:**3.3.25.2]

Combustible Liquid. Any liquid that has a closed-cup flash point at or above 100°F (37.8°C), as determined by the test procedures and apparatus set forth in 1.7.4.1 through 1.7.4.4. Combustible liquids are classified as Class II or Class III as follows: (1) *Class II Liquid* — any liquid that has a flash point at or above 100°F (37.8°C) and below 140°F (60°C); (2) *Class IIIA* — any liquid that has a flash point at or above 140°F (60°C), but below 200°F (93°C); (3) *Class IIIB* — any liquid that has a flash point at or above 200°F (93°C). [**30:**3.3.25.1]

C.11.2.2 The following definition is also taken from NFPA 30, *Flammable and Combustible Liquids Code*:

Flash Point. The minimum temperature of a liquid at which sufficient vapor is given off to form an ignitible mixture with the air, near the surface of the liquid or within the vessel used, as determined by the appropriate test procedure and apparatus specified in 1.7.4. [**30:**3.3.16]

C.11.2.3 The following definitions are based on NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*.

C.11.2.3.1 Health Hazard. A health hazard is any property of a material that, either directly or indirectly, can cause injury or incapacitation, either temporary or permanent, from exposure by contact, inhalation, or ingestion. Table C.11.2.3.1 is extracted from NFPA 704 and defines degrees of health hazard.

Table C.11.2.3.1 Degrees of Health Hazards

Degree of Hazard*	Criteria
4 — Materials that, under emergency conditions, can be lethal.	Gases whose LC_{50} for acute inhalation toxicity is less thar equal to 1000 parts per million (ppm). Any liquid whose saturated vapor concentration at 20°C (6 is equal to or greater than ten times its LC_{50} for acute inhalation toxicity, if its LC_{50} is less than or equal to 1000 ppm. Dusts and mists whose LC_{50} for acute inhalation toxicity i less than or equal to 0.5 milligrams per liter (mg/L). Materials whose LD_{50} for acute dermal toxicity is less tha equal to 40 milligrams per kilogram (mg/kg). Materials whose LD_{50} for acute oral toxicity is less than o equal to 5 mg/kg.
3 — Materials that, under emergency conditions, can cause serious or permanent injury.	Gases whose LC_{50} for acute inhalation toxicity is greater t 1000 ppm but less than or equal to 3000 ppm. Any liquid whose saturated vapor concentration at 20°C (6 is equal to or greater than its LC_{50} for acute inhalation toxicity, if its LC_{50} is less than or equal to 3000 ppm and t does not meet the criteria for degree of hazard 4. Dusts and mists whose LC_{50} for acute inhalation toxicity i greater than 0.5 mg/L but less than or equal to 2 mg/L. Materials whose LD_{50} for acute dermal toxicity is greater 40 mg/kg but less than or equal to 200 mg/kg. Materials that are corrosive to the respiratory tract. Materials that are corrosive to the eye or cause irreversible corneal opacity. Materials that are corrosive to skin. Cryogenic gases that cause frostbite and irreversible tissue damage. Compressed liquefied gases with boiling points at or belov -55°C (-66.5°F) that cause frostbite and irreversible tissue damage. Materials whose LD_{50} for acute oral toxicity is greater tha mg/kg but less than or equal to 50 mg/kg.
2 — Materials that, under emergency conditions, can cause temporary incapacitation or residual injury.	Gases whose LC_{50} for acute inhalation toxicity is greater t 3000 ppm but less than or equal to 5000 ppm.

Table C.11.2.3.1 Degrees of Health Hazards

Degree of Hazard*	Criteria
	Any liquid whose saturated vapor concentration at 20°C (6 is equal to or greater than one-fifth its LC_{50} for acute inhalation toxicity, if its LC_{50} is less than or equal to 5000 ppm and that does not meet the criteria for either degree of hazard 3 or degree of hazard 4. Dusts and mists whose LC_{50} for acute inhalation toxicity i greater than 2 mg/L but less than or equal to 10 mg/L. Materials whose LD_{50} for acute dermal toxicity is greater 200 mg/kg but less than or equal to 1000 mg/kg. Compressed liquefied gases with boiling points between -3 (-22°F) and -55°C (-66.5°F) that can cause severe tissue damage, depending on duration of exposure. Materials that are respiratory irritants. Materials that cause severe but reversible irritation to the e or lacrimators. Materials that are primary skin irritants or sensitizers. Materials whose LD_{50} for acute oral toxicity is greater tha mg/kg but less than or equal to 500 mg/kg.
1 — Materials that, under emergency conditions, can cause significant irritation.	Gases and vapors whose LC_{50} for acute inhalation toxicity greater than 5000 ppm but less than or equal to 10,000 ppm Dusts and mists whose LC_{50} for acute inhalation toxicity i greater than 10 mg/L but less than or equal to 200 mg/L. Materials whose LD_{50} for acute dermal toxicity is greater 1000 mg/kg but less than or equal to 2000 mg/kg. Materials that cause slight to moderate irritation to the respiratory tract, eyes, and skin. Materials whose LD_{50} for acute oral toxicity is greater tha 500 mg/kg but less than or equal to 2000 mg/kg.
0 — Materials that, under emergency conditions, would offer no hazard beyond that of ordinary combustible materials.	Gases and vapors whose LC_{50} for acute inhalation toxicity greater than 10,000 ppm. Dusts and mists whose LC_{50} for acute inhalation toxicity i greater than 200 mg/L. Materials whose LD_{50} for acute dermal toxicity is greater 2000 mg/kg. Materials whose LD_{50} for acute oral toxicity is greater tha 2000 mg/kg. Materials that are essentially nonirritating to the respiratory tract, eyes, and skin.

*For each degree of hazard, the criteria are listed in a priority order based upon the likelihood of exposure.