FIRE PREVENTION

A fire prevention program for the fluid collection should be developed with a professional fire prevention specialist and the local fire code enforcement authority (Stemen 2010). Ethyl alcohol and most other preservatives are flammable liquids and must be stored and used within approved fire safety guidelines. In the United States, a flammable liquid is defined as one with a flashpoint below 38°C (100°F). The flashpoint of a volatile liquid is the lowest temperature at which it can vaporize and form a mixture with the air that can be ignited. The flashpoint of 96 percent ethyl alcohol is 13°C (55°F); the flashpoint of 70 percent ethyl alcohol is 21°C (70°F) (Stemen 2010).

According to Stemen (2010), fire prevention measures for bulk alcohol (e.g., 96 percent ethyl alcohol in large containers) may include storage in a room that is separated from other areas by fire-rated construction, equipped with explosion-proof electrical connections, and with appropriate ventilation. Fire prevention measures for fluid-preserved collections may include heat and smoke detectors; limited capacity rooms with their own ventilation systems; limits on the amount of alcohol that can be stored per room; fire-rated doors, walls, ceiling, and floors; floor drains and a fire suppression system using wet pipe sprinklers, carbon dioxide gas, foam, or an inert gas mixture. Fire prevention measures may include lowering the temperature in storage to lower the flashpoint of the alcohol (see earlier discussion of preservatives at low temperatures). The design for fluid-collection storage at the Smithsonian Institution includes aggressive ventilation, a hydrocarbon gas detection system, compartmentalization of the facility, automatic sprinklers, run-off control, and maintenance of the temperature at 18.3°C (65°F) to lower the flashpoint of the alcohol (Stemen 2010).

In fluid-preserved collections, a good exhaust system should prevent the accumulation of alcohol vapors. Alcohol vapors disperse rapidly, and the ignition danger drops quickly with increased distance from the source. Bulk alcohol and fluid-preserved collections should not be stored below grade, because alcohol vapors are heavier than air. Possible sources of ignition (sparks, heat, and flame) should be eliminated in the collection storage area (e.g., keep wall plugs at least 1 m above the floor; do not allow the use of electric motors at floor level). All areas where fluid-preserved collections are used should be equipped with wet pipe sprinklers and both heat and smoke detectors. Although lowering the temperature of the collection storage area will lower the flashpoint of alcohol, it is not recommended that the temperature be lower than 18°C (65°F) to protect the quality of the preservative and the specimens, as discussed earlier.

Fires in fluid-preserved collections are rare, but when they do occur, the results can be disastrous. In May 2010, a fire at the Instituto Butantan in Sao Paulo, Brazil, destroyed a historic and valuable collection of eighty thousand preserved snakes, spiders, and scorpions. The building that the collection was housed in was not equipped with a fire suppression system. Although the fire burned very hot (due to the presence of ethanol), according to eyewitnesses and photographs published in the news media, the glass containers of specimens did not explode but broke open due to the

heat, allowing the contents to ignite. News photographs of the aftermath of the fire showed the remains of shelving, specimens, and broken containers collapsed in place, a further indication that no explosions occurred.

Fire codes do not directly address the storage of museum specimens in standard preservatives, but typically address the storage of beverage alcohol (which is typically 5–40 percent ETOH) and the storage of large containers of 95 percent ETOH. Neither of these storage situations is comparable with museum specimens in 70 percent ETOH. As a result, local fire officials must adapt the code regulations to museum storage, which means that what is standard practice varies from one place to another. For example, some institutions are required to use explosion-proof safety cabinets, some are not; most institutions are required to have wet pipe sprinkler systems (usually around 0.30 gallons per minute per square foot capacity), but the required output of the system will vary. Most fluid specimen storage facilities are required to be above grade and well ventilated using floor vents because alcohol is heavier than air (ventilation systems are usually 1 cubic foot per minute per square foot). The Natural History Museum of London relocated its collection of more than 450,000 containers of fluid-preserved specimens (approximately half a million liters of alcohol) to a new, purpose-built, energy-efficient facility in 2002 (Brice 2002). The collection storage areas are kept at 13°C, which lowers the flashpoint of the alcohol to the point that sprinklers are not required and standard light fixtures and other electrical equipment can be used. Alcohol (in the form of IMS, or industrial methylated spirits) is piped through the building to the laboratories. The building (which has an area of 10,000 m^2) is divided into sixty fire alarm zones with heat and smoke detectors as well as a gas detection system for alcohol vapors.

Collections managers must work with their local fire marshal or other safety experts to get an interpretation of the regulations that is reasonable and ensures the safety of the collection and those working with it. In general, storage of fluid-preserved collections means a reduced number of ignition sources in fluid storage areas (e.g., few or no wall sockets, no work activities in fluid storage, explosion-proof electrical switches), reduction of the chance of spills (e.g., earthquake bars on shelves), a good ventilation system to prevent the buildup of fumes, and restricted access to fluid collection storage. The design of safe, reasonable facilities for fluid-preserved collections requires the input of a qualified fire protection engineer who has experience with museum fluid-preservation issues and who is willing to work with the museum staff and consultants. Some of the factors to consider when planning storage for fluid-preserved collections include:

- Wet-pipe, water-based sprinkler systems are generally the best option for fire suppression. A very aggressive sprinkler system will probably be required if compactors are used in the space to assure sprinkler penetration. In addition to putting out the fire, water from sprinklers will dilute whatever fixatives and preservatives leak from ruptured containers. Furthermore, water is generally available in a relatively unlimited supply (compared to chemical fire suppression systems, which hold a finite amount of foam or gas in reserve).

- Both smoke and heat detectors should be included in the fire detection system.
- Good closures for specimen containers will limit alcohol vapor evaporation and make the storage area safer.
- Several small rooms are usually required rather than one large room to limit the amount of alcohol in a given area. The maximum room size will be based on the maximum capacity of the fire suppression system, the water or other suppressant supply, and the amount of alcohol to be housed in the space.
- Passive features such as fire walls, fire-rated floors, and fire barriers between storage areas will greatly enhance safety.
- Aggressive ventilation to remove alcohol vapors and prevent a flammable mixture from accumulating will probably be required. Systems with 100 percent air makeup should be avoided, as they are extremely expensive to operate and create a host of problems related to changes in relative humidity and its effects on containers and seals.
- Smoke detectors may be required in return and supply ducts for the ventilation system.
- The HVAC system should be designed to maintain moderate temperatures between 18°C and 21°C (65°F and 75°F), preferably at the low end, with fluctuations of no more than 2°C (5°F), with a relative humidity below 65 percent, but as high as can be reasonably achieved at the temperature set point (it is better to allow relative humidity to drift to maintain a steady temperature).
- There will be restrictions on use of the space for anything other than storage of the collections (collection storage areas should not be used for research, offices, storage, etc.).

FORMALDEHYDE SAFETY

For a good many years following its discovery, formaldehyde was not recognized as a dangerous substance. In 1899, in reference to the irritation of the mucous membranes, Drowne wrote (apparently with no sense of irony) that "one becomes hardened after enduring it for a time and it ceases to annoy much." A 1915 publication called *Formaldehyde the Farmer's Friend* (published by a company that sold formaldehyde) recommended its use "For breaking up colds in the head, place one teaspoon of formaldehyde in a bowl of hot water and inhale the fumes through the nostrils. Repeat from time to time." The pamphlet also recommended using formaldehyde to clean bedding, clothing, floors, cupboards, sinks, and refrigerators. A note published in *Science* magazine in 1931 recommended treating "formalin poisoning" of the fingers with lanolin (Holt 1931). The poisoning was, of course, the fixing of the cells of the epidermis and dermis, so the lanolin would be of minimal help. A note in the widely read *Turtox News* recommended "denaturing" formaldehyde-preserved specimens before working with them by submerging the specimens in a solution of urea and ammonium phosphate (Anon. 1939; Foust et al. 1935).

Fluid Preservation

A Comprehensive Reference

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