IMPLODING DEWAR

A researcher was about to prepare an ice trap in a Dewar to cool a stationary stainless steel receiver on a chemical reactor system. The researcher had positioned the Dewar on a laboratory jack stand and had raised the Dewar into position. The Dewar imploded, propelling glass shards toward the researcher, who fortunately was wearing prescription safety glasses and received only minor facial cuts. The researcher should have been wearing a full-length face shield and should have had a cover on the Dewar.

should be used whenever there is a possibility of breakage.

Styrofoam buckets with lids can be a safer form of short-term storage and conveyance of cryogenic liquids than glass vacuum Dewars. Although they do not insulate as well as Dewar flasks, they eliminate the danger of implosion.

6.E.3.3 Desiccators

If a glass vacuum desiccator is used, it should be made of Pyrex or similar glass, completely enclosed in a shield or wrapped with friction tape in a grid pattern that leaves the contents visible and at the same time guards against flying glass should the vessel implode. Plastic (e.g., polycarbonate) desiccators reduce the risk of implosion and may be preferable, but should also be shielded while evacuated. Solid desiccants are preferred. *An evacuated desiccator should never be carried or moved.* Care should be taken in opening the valve to avoid a shock wave into the desiccator.

6.E.3.4 Rotary Evaporators

Glass components of the rotary evaporator should be made of Pyrex or similar glass, completely enclosed in a shield to guard against flying glass should the components implode. Increase in rotation speed and application of vacuum to the flask whose solvent is to be evaporated should be gradual.

6.E.3.5 Assembly of Vacuum Apparatus

Vacuum apparatus should be assembled so as to avoid strain. Joints must be assembled so as to allow various sections of the apparatus to be moved if necessary without transmitting strain to the necks of the flasks. Heavy apparatus should be supported from below as well as by the neck. The assembler should avoid putting pressure on a vacuum line. Failure to keep the pressure below 1 atmosphere could lead to the stopcocks popping out at high velocity or to an explosion of the glass apparatus. Such increased pressure could result from warming of the contents of the trap due to failure to maintain low temperatures.

Vacuum apparatus should be placed well back onto the bench or into the hood where they will not be inadvertently hit. If the back of the vacuum setup faces the open laboratory, it should be protected with panels of suitably heavy transparent plastic to prevent injury to nearby workers from flying glass in case of explosion.

6.F USING PERSONAL PROTECTIVE, SAFETY, AND EMERGENCY EQUIPMENT

As outlined in previous chapters, it is essential for each laboratory worker to be proactive to ensure the laboratory is a safe working environment. This attitude begins with wearing appropriate apparel and using proper eye, face, hand, and foot protection when working with hazardous chemicals. It is the responsibility of the institution to provide appropriate safety and emergency equipment for laboratory workers and for emergency personnel. (See also section 5.C.)

6.F.1 Personal Protective Equipment and Apparel

6.F.1.1 Personal Clothing

Clothing that leaves large areas of skin exposed is inappropriate in laboratories where hazardous chemicals are in use. The worker's personal clothing should be fully covering. Appropriate laboratory coats should be worn, buttoned, with the sleeves rolled down. Laboratory coats should be fire-resistant. Those fabricated of polyester are not appropriate for glassblowing or work with flammable materials. Cotton coats are inexpensive and do not burn readily. Laboratory coats or laboratory aprons made of special materials are available for high-risk activities. Laboratory coats that have been used in the laboratory should be left there to minimize the possibility of spreading chemicals to public assembly, eating, or office areas, and they should be cleaned regularly. (For more information, see the OSHA Personal Protective Equipment Standard (29 CFR 1910.132) and the OSHA Laboratory Standard (29 CFR 1910.1450).)

Unrestrained long hair and loose clothing such as neckties, baggy pants, and coats are inappropriate in a laboratory where hazardous chemicals are in use. Such items can catch fire, be dipped in chemicals, and get caught in equipment. Similarly, rings, bracelets, watches, or other jewelry that could be damaged, trap chemicals close to the skin, come in contact with electrical sources, or get caught in machinery should not be worn. Leather clothing or accessories should not be worn in situations where chemicals could be absorbed in the leather and held close to the skin.

Protective apparel should always be worn if there is a possibility that personal clothing could become contaminated with chemically hazardous material. Washable or disposable clothing worn for laboratory work with especially hazardous chemicals includes special laboratory coats and aprons, jumpsuits, special boots, shoe covers, and gauntlets, as well as splash suits. Protection from heat, moisture, cold, and/or radiation may be required in special situations. Among the factors to be considered in choosing protective apparel, in addition to the specific application, are resistance to physical hazards, flexibility and ease of movement, chemical and thermal resistance, and ease of cleaning or disposal. Although cotton is a good material for laboratory coats, it reacts rapidly with acids. Plastic or rubber aprons can provide good protection from corrosive liquids but can be inappropriate in the event of a fire. Plastic aprons can also accumulate static electricity, and so they should not be used around flammable solvents, explosives sensitive to electrostatic discharge, or materials that can be ignited by static discharge. Disposable garments provide only limited protection from vapor or gas penetration. Disposable garments that have been used when handling carcinogenic or other highly hazardous material should be removed without exposing any individual to toxic materials and disposed of as hazardous waste. (See Chapter 5, sections 5.C.2.5 and 5.C.2.6.)

6.F.1.2 Foot Protection

Street shoes may not be appropriate in the laboratory, where both chemical and mechanical hazards may exist. Substantial shoes should be worn in areas where hazardous chemicals are in use or mechanical work is being done. Clogs, perforated shoes, sandals, and cloth shoes do not provide protection against spilled chemicals. In many cases, safety shoes are advisable. Shoe covers may be required for work with especially hazardous materials. Shoes with conductive soles are useful to prevent buildup of static charge, and insulated soles can protect against electrical shock.

6.F.1.3 Eye and Face Protection

Safety glasses with side shields that conform to ANSI standard Z87.1-1989 should be required for work with hazardous chemicals. Ordinary prescription glasses with hardened lenses do not serve as safety glasses. Contact lenses can sometimes be worn safely if appropriate eye and face protection is also worn **(see, however, section 5.C.2.1).** Although safety glasses can provide satisfactory protection from injury from flying particles, they do not fit tightly against the face and offer little protection against splashes or sprays of chemicals. It is appropriate for a laboratory to provide impact goggles that include splash protection (splash goggles), full-face shields that also protect the throat, and specialized eye protection (i.e., protection against ultraviolet light or laser light). Splash goggles, which have splash-proof sides to fully protect the eyes, should be worn if there is a splash hazard in any operation involving hazardous chemicals. Impact protection goggles should be worn if there is a danger of flying particles, and full-face shields with safety glasses and side shields are needed for complete face and throat protection. When there is a possibility of liquid splashes, both a face shield and splash goggles should be worn; this is especially important for work with highly corrosive liquids. Full-face shields with throat protection and safety glasses with side shields should be used when handling explosive or highly hazardous chemicals. If work in the laboratory could involve exposure to lasers, ultraviolet light, infrared light, or intense visible light, specialized eye protection should be worn. It also is appropriate for a laboratory to provide visitor safety glasses and a sign indicating that eye protection is required in laboratories where hazardous chemicals are in use.

6.F.1.4 Hand Protection

Gloves appropriate to the hazard should be used at all times. It is important that the hands and any skin that is likely to be exposed to hazardous chemicals receive special attention. Proper protective gloves should be worn when handling hazardous chemicals, toxic materials, materials of unknown toxicity, corrosive materials, rough or sharp-edged objects, and very hot or very cold objects. Before the gloves are used, it is important that they be inspected for discoloration, punctures, or tears. A defective or improper glove can itself be a serious hazard in handling hazardous chemicals. If chemicals do penetrate glove material, they could then be held in prolonged contact with the hand and cause more serious damage than in the absence of a proper glove.

The degradation and permeation characteristics of the glove material selected must be appropriate for protection from the hazardous chemicals being handled. Glove selection guides (available from most manufacturers) should be consulted, with careful consideration given to the permeability of any material, particularly when working with organic solvents, which may be able to permeate or dissolve the glove materials. The thin latex "surgical" vinyl and nitryl gloves that are popular in many laboratories because of their composition and thin construction may not be appropriate for use with highly toxic chemicals or solvents. For example, because latex is readily permeated by carbon disulfide, a hand covered by a latex glove immersed in carbon disulfide would receive constant wetting by this toxic chemical, which would by then be absorbed through the skin. Gloves should be replaced immediately if they are contaminated or torn. The use of double gloves may be appropriate in situations involving chemicals of high or multiple hazards. Leather gloves are appropriate for handling broken glassware and inserting tubing into stoppers, where protection from chemicals is not needed. Insulated gloves should be used when working with very hot or very cold materials. With cryogenic fluids the gloves must be impervious to fluid, but loose enough to be tossed off easily. Absorbent gloves could freeze on the hand and intensify any exposure to liquefied gases. Turning up the cuffs on gloves can prevent liquids from running down the arms when hands are raised.

Gloves should be decontaminated or washed appropriately before they are taken off and should be left in the work area and not be allowed to touch any uncontaminated objects in the laboratory or any other area. Gloves should be replaced periodically, depending on the frequency of use. Regular inspection of their serviceability is important. If they cannot be cleaned, contaminated gloves should be disposed of according to institutional procedures.

Barrier creams and lotions can provide some skin protection but should never be a substitute for gloves, protective clothing, or other protective equipment. These creams should be used only to supplement the protection offered by personal equipment.

6.F.2 Safety and Emergency Equipment

Safety equipment, including spill control kits, safety shields, fire safety equipment, respirators, safety showers and eyewash fountains, and emergency equipment should be available in well-marked, highly visible locations in all chemical laboratories. Fire alarm pull stations and telephones with emergency telephone numbers clearly indicated must be readily accessible. In addition to the standard items, there may also be a need for other safety devices. It is the responsibility of the laboratory supervisor to ensure proper training and provide supplementary equipment as needed.

6.F.2.1 Spill Control Kits and Cleanup

In most cases, researchers are responsible for cleaning up their own spills. If a spill exceeds their ability or challenges their safety, they should leave the spill site and call the emergency telephone number for help. Emergency response spill cleanup personnel should be given all available information about the spill.

A spill control kit should be on hand. A typical cleanup kit may be a container on wheels that can be moved to the location of the spill and may include such items as instructions; absorbent pads; a spill absorbent mixture for liquid spills; a polyethylene scoop for dispensing spill absorbent; mixing it with the spill, and picking up the mixture; thick polyethylene bags for deposit of the mixture; and tags and ties for labeling the bags. Any kit should be used in conjunction with the personal protective equipment needed for the chemical that is to be cleaned up. Before beginning an operation that could produce a spill, the worker should locate the specialized spill control kits for that operation.

(Also see Chapter 5, section 5.C.11.5.)

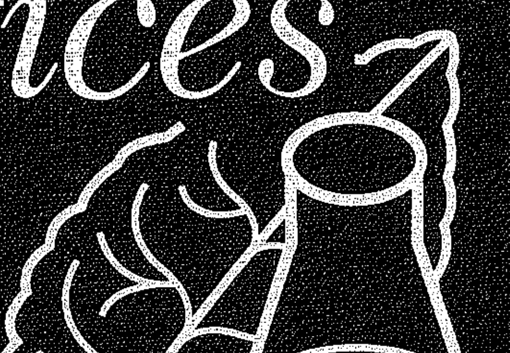
6.F.2.2 Safety Shields

Safety shields should be used for protection against possible explosions or splash hazards. Laboratory equipment should be shielded on all sides so that there is no line-of-sight exposure of personnel. The front sashes of conventional laboratory exhaust hoods can provide shielding. However, a portable shield should also be used when manipulations are performed, particularly with hoods that have vertical-rising doors rather than horizontal-sliding sashes.

Portable shields can be used to protect against hazards of limited severity, such as small splashes, heat, and fires. A portable shield, however, provides no protection at the sides or back of the equipment, and many such shields not sufficiently weighted for forward protection may topple toward the worker when there is a blast. A fixed shield that completely surrounds the experimental apparatus can afford protection against minor blast damage.

Polymethyl methacrylate, polycarbonate, polyvinyl chloride, and laminated safety plate glass are all satisfactory transparent shielding materials. Where combustion is possible, the shielding material should be nonflammable or slow burning; if it can withstand the working blast pressure, laminated safety plate glass may be the best material for such circumstances. When cost, transparency, high tensile strength, resistance to bending loads, impact strength, shatter resistance, and burning rate are considered, polymethyl methacrylate offers an excellent overall combination of shielding characteristics.

Prudent Practices in the Laboratory



Handling and Disposal of Chemicals

NATIONAL RESEARCH COUNCIL