People responsible for the care of museum collections are accustomed to handling objects cautiously in order to preserve them. They recognize the need to provide safe environmental conditions to protect artifacts. Museum personnel also need to be aware of hazards to themselves from the objects and from the objects' environment. These can be dangerous, even lethal. This article is intended to acquaint non-specialists with these potentially harmful situations in their museums. It describes some of the hazards and suggests some common-sense measures that should be a part of basic collection management. Resources listed at the end of the article offer more in-depth and technical information about dangers inherent in museum collections.

Understanding the Risk
Toxic materials may be ingested by mouth, inhaled, or absorbed through the skin. They may irritate the eyes, nose, throat, or skin, causing tearing, sneezing, or a rash. They may cause nausea or vomiting. Certain materials can trigger a violent physical reaction or death within a short period of time. Some are especially dangerous in combination with other factors. Others cause long-term health consequences that may not be evident for many years. Museum personnel with allergies, respiratory or cardiac problems, or who are pregnant should exercise special caution about the amount of time spent in closed storage areas.

Safety Procedures
There are some fundamental procedures that should be followed to ensure the safety of anyone who may be dealing with artifacts:

1. Never touch your mouth or eyes after touching a museum object.
2. Always wash your hands thoroughly with soap and running water after touching museum objects. Keep fingernails short and use a nail brush when washing up.
3. Be careful about what touches exposed skin. Some irritants and toxic materials may be absorbed through the skin.
4. Keep a lab coat in the museum storage area. Wear it only, wash it frequently, and do not wash it with other family wash.
5. Limit the time spent in closed storage areas. Do not use these areas as work places.
6. Do not allow any food in storage areas, not only to protect the objects and to control infestation, but also to prevent the contamination of food.
7. Work in well-ventilated areas. Wear an appropriate type of respirator if working with toxic fumes. Wear a particle mask if working with dust.
8. Plan ahead. Think of possible hazards. Do not casually open any container, inhale contents, or expose yourself to possible toxic fumes.
9. Do not touch to your mouth any thread which you are using on historic textiles, garments, or jewelry.
10. Keep your tetanus shot up-to-date.
11. Do not sweep storage areas. Use a vacuum and/or a wet mop. Dispose of the vacuum bag properly and rinse the mop thoroughly.
12. Read all product labels very carefully, including those on items in the collection. Obtain Material Safety Data Sheets (MSDS’s) from the manufacturers or distributors of any solvents or other chemical products, and read and understand them.
13. Be especially careful of any broken artifacts. Loose stuffing from dolls or mounted taxidermy specimens, broken pieces or handles of metal objects, etc., may contain poisonous materials.
14. Restrict young people (such as volunteers or the offspring of staff members) from spending extended time in storage areas. Children's metabolism and their smaller size make them especially vulnerable to hazards in the collections.
15. Encourage personnel to report instances of headaches, dizziness, or nausea, and document them to determine if there might be a pattern suggesting a health hazard on the premises.
16. Appoint a health and safety officer to monitor health hazards and develop a health and safety program as a part of an overall emergency and disaster plan for the museum.

HAZARDS ASSOCIATED WITH COLLECTION OBJECTS

Arsenic. Arsenic is a biocide that was used as a preservative in museum objects, especially during the last quarter of the nineteenth century. Many of these old mounts are now deteriorating, possibly exposing the arsenic-coated material. It is essential to exercise special care in restricting public access to such artifacts, as well as the access of museum personnel. Arsenic may also be present in mummies, in ethnographic objects such as baskets or items containing feathers or fur, and in textiles and clothing. Alson Gemsheim's VICTORIAN AND EDWARDIAN FASHION: A PHOTOGRAPHIC STUDY, notes the popularity in the nineteenth century of a vivid emerald green dye containing arsenic of copper, and its resultant toxic effects. The book cites the testimony of a Berlin physician that "no less than 60 grains of arsenic powdered off from a single dress in the course of an evening's dancing - enough to kill thirty people if administered in doses." This dye was also used in the bright-green cloth covers of many Victorian books. Emerald green pigments in nineteenth-century ceramics may contain arsenic. There is also evidence to suggest that arsenic was included in materials used in nineteenth-century weighted silks. Residues of arsenic that remain in textiles, fabrics, and artifacts can pose hazards for those who handle them today.

Related poisonous materials that may be present in organic collections include cyanide, mercury, and lead compounds. Julia Penn, ethnographic conservator at the Royal Ontario Museum, states, "The presence of biocides is one of the most pervasive hazards in the collection and unfortunately there is often very little record of what was used."2

Cyanide. Wet-cleaning silver- or gold-plated museum artifacts could release deadly cyanide gas, if the plating contains cyanide or if the objects were previously cleaned with cyanide solutions that may be trapped in hard-to-clean areas such as handles. These articles should be cleaned under a fume hood, and handled with caution. Cyanide was also a component of some printers' inks, and it may be present in some nineteenth-century wallpapers. Such papers should not be removed with steam.

Mercury. Fine art and decorative arts pieces may contain dangerous amounts of mercury. Various artist's pigments, especially vermilion shades, may contain mercury; others may have mercury preservatives. Certain objects contain mercury.5 Certain house paints may also contain high levels of mercury. Although a 1990 EPA regulation now bans the use of mercury compounds in interior paints, this does not affect previously manufactured paint.

Lead. Lead or lead compounds present several potential hazards for humans. Most people are acquainted with the dangers of lead poisoning resulting from exposure to lead-based paints. Although this hazard has been reduced by the limitation of the manufacture of such paints, some museum artifacts may have been painted with these substances, and the museum itself may be in a building where lead-based paints were used on the walls. Before 1976, almost all outdoor paints contained lead pigments.7 Artists' pigments such as the popular Flake White (white lead) and other lead-based pigments are hazardous, but are still permitted by law. Toy soldiers, bullets, lead weights, sculpture, leaded glass, coins, weights, and seals are types of objects that may be made of lead or lead-alloys. Ceramic glazes may contain lead or other poisonous substances. Special care should be taken in handling any ceramic piece that has a flaking surface. As lead corrodes, it produces a powdery substance that is easily disturbed and can become airborne. It may be inhaled or picked up if touched. It may cling to clothing and be carried from a storage area to other museum areas or out of the building. Julia Penn describes lead poisoning as one of the most common and potent hazards in museum collections.

Carbon tetrachloride. This colorless, poisonous liquid is a grease solvent. For many years it was used quite commonly as a spot remover. It
was also used as a fire extinguisher; lethal amounts may still remain in old fire-fighting equipment. It is a special hazard in nineteenth-century glass balls that were thrown on a small fire to extinguish the blaze. These glass balls may explode, dispersing poisonous Phosgene gas into the air. The fire department can empty them. Carbon tetrachloride is also a component in some pesticides such as Dowfume 75, registered for restricted use in museums by a certified exterminator. Exposure to carbon tetrachloride can cause severe liver damage.10

Pesticides. Pesticides can cause harmful effects on collection items and on humans, but this may not be evident for many years. Artifacts previously may have been treated with pesticides, such as DDT (widely used in the 1940's and 1950's), impregnating them with poison. Vacuuming textiles so treated could pull the poison into the air. Current collection management policy recommends avoiding as much as possible the use of pesticides to control infestation. Some museums are developing Integrated Pest Management (IPM) programs that reduce the need to use pesticides by eliminating the food, moisture, and habitats that encourage infestation.11 Sticky traps that provide evidence of the type, number and migration pattern of pests are especially useful in monitoring infestation.

Some museums practice limited chemical treatments in controlled situations. Examples of pesticides used in museums include naphthalene (mothballs); dichlorvos (Vapona strips, no-pest strips); and para-dichlorobenzene (PDB). All of these are potentially hazardous. Many experts question the effectiveness of naphthalene. PDB is known to soften some plastics and resins, and to harm feathers and某些 leather. It forms chlorine gas in closed containers, possibly bleaching specimens. Before using no-pest strips or PDB, the museum staff should study how to use them effectively and how to control the level of toxicity. Recommended procedures include isolating in a closed container those artifacts that are to be treated; controlling temperature; and wearing an appropriate respirator. One can avoid a disastrous situation by reading labels and instructions very carefully, and by consulting specialists when necessary.

Other pesticides are even more dangerous and should be used only by certified exterminators, and in fumigation chambers. These include ethylene oxide (which may off-gas for as much as ten years), methyl bromide (which can harm rubber, furs, feathers, leather, woolens, and other hair fibers), and sulfur (which may harm metals).12 Termite extermination, even by licensed companies, may present long-term health hazards, especially if the treated wood is in an area where the public might come into contact with it, for example, a log cabin.13

Medicines and pharmaceuticals. Many museums have collections of physicians', dentists', and veterinarians' equipment. Old vials or medicine containers may contain deadly poisons. The possession of illegal drugs is another consideration. Especially dangerous and should not be handled.

Asbestos. Asbestos is a fire-resistant mineral fiber found in rocks. Even minute exposure to asbestos fibers presents a health hazard. There is no safe level of exposure. Asbestos may be present in household appliances such as toasters, stoves, ovens and clothes dryers, in some ceramic glazes, and in some rocks such as serpentine. Asbestos was frequently used in construction, especially in wall, ceiling, and pipe insulation, in roofing material, shingles, siding, patching compounds, and floor tile. Although many of these uses are now prohibited by law, asbestos is present in many buildings, especially those built or remodeled in the twentieth century before the enactment of regulations in the 1970's.11 If asbestos is present, but not flakey, it should not be disturbed. It should be vacuumed, as it distributes tiny fibers into the air. These minute fibers may remain airborne for hours. The best course is to contact specialists to assist in determining a course of action.22 State or federal regulations may apply.

Toxic minerals. At least 200 mineral species are known or suspected to be either very poisonous or cancer-causing. There is a wide variety of susceptibility among humans. Mineral fibers could be ingested if handled carelessly around food. Such fibers are some ways, some with low levels of exposure, others especially over long periods of time. Minerals could also be the source of radioactive emissions. Uranium minerals have been used in ceramic glazes such as some colors of the American Fiesta Ware of the 1940's and in some enamel jewelry.25

There is a variety of other potential hazards that might be found in museum collections, including lampblack and coal tar dyes which are carcinogenic, and canned tins of food (which have been known to leak or explode). The storage of large amounts of paper in a closed area can off-gas fumes that can cause toxicity.26 The tight construction of contemporary buildings has created a phenomenon known as closed building syndrome. The resulting internal circulation of air has led to discomfort and to chronic and acute illness of employees. Museum administrators need to be aware of potential health hazards for their personnel. A health and safety officer could be one way to establish a program of identifying hazards, monitoring exposure, and developing a program to keep the workplace safe. There are legal as well as ethical reasons to establish such a program.

FURTHER ASSISTANCE
There are numerous resources that can provide assistance in managing the problems of hazards in museum collections. Tests can be conducted to detect the presence of materials such as asbestos, lead, or mineral fibers. Advice is available from several private and governmental agencies. There are supply houses that carry special equipment to reduce exposure to hazards, and there are many written sources that expand the information presented in this paper. A listing of such resources follows.
RESOURCE AGENCIES

Center for Safety in the Arts. This organization (formerly known as the Center for Occupational Hazards) is the most comprehensive source of information concerning safety hazards. It offers numerous low-cost publications (a publication list is available). The center’s Art Hazards Information Center answers telephone and written inquiries about health hazards in museums and has a nine-page listing of occupational health and safety organizations, agencies, and institutions in the United States and Canada. The center also issues a newsletter, ART HAZARDS NEWS. (Copies of some issues and some of the center’s publications are in the IHA circulating library.) Contact: Center for Safety in the Arts, 5 Beckman Street, Suite 1030, New York, NY 10038: (212) 227-6220.

The National Institute for the Conservation of Cultural Property. This national organization has published a bibliography and a reference sheet with thousands of bibliographic entries about conservation and management of collections. Some entries deal specifically with safety issues. Many of the articles cited are available through the institute’s Conservation Information Service for a small fee. Contact: NIC, 3299 K Street NW, Washington DC 20007: (202) 625-1495. Some articles are available from the IHA circulating library.

Cardinal Glennon Children’s Hospital, St. Louis, MO. For Illinois residents, this is the nearest poison control center (PCC), accredited by the American Association of Poison Control Centers. Call (314) 722-5200.

National Institute for Occupational Safety and Health (NIOSH). This agency conducts research, answers inquiries, and conducts health hazard evaluations for worksites. Call toll-free, 1-800-35NIOSH (M-F 8 AM - 4:30 PM EST).

NIOSH-funded Educational Resources Centers (ERC’s). ERCs do research on occupational safety and health. They can often provide technical assistance and information to employers. Contact: Illinois ERC, College of Medicine, University of Illinois, Box 6998, Chicago, IL 60680; (312) 996-7887.

Occupation Safety and Health Administration (OSHA). This federal agency enforces the Occupational Safety and Health Act by promulgating health and safety standards, conducting inspections, and enlisting violators of OSHA standards. Contact: OSHA, 200 Constitution Avenue, NW, Washington DC 20210; (202) 523-8131; or Region V: United States Department of Labor - OSHA, 230 Dearborn St., Room 3244, Chicago, IL 60604; (312) 353-2220.

OSHA State Consultation Services. This OSHA-funded, on-site consultation service provides free inspections of worksites at the request of employers. This is not an enforcement program or a part of OSHA. In Illinois, contact: Division of Industrial Services, (312) 917-2339.

Society for the Preservation of Natural History Collections. A national organization with a biannual newsletter. For membership information, contact SPNHC Treasurer, Sue McLaren, 5900 Baum Blvd., Pittsburgh, PA 15206.

SUPPLY SOURCES

Safety equipment may in itself present hazards if used or stored improperly. It’s important to know what and what kind of equipment to use for specific situations. Pamphlets such as those from the Center for Occupational Hazards describing the use of respirators, protective gloves, etc., should be consulted. The product engineering department of a supply house may provide additional information. All equipment should be NIOSH approved. Two such supply houses are L. Safety Supply Inc., PO Box 1368, Janesville, WI 53547-1368, phone 1-800-528-7405; for technical assistance call 1-800-462-3140, or FAX (602) 438-1690.

Notes
5. Fenn, 31.
8. Fenn, 32.
12. Pelz and Rossol, 4-5.
13. Herskovitz.
14. Fenn, 29.
15. Herkovitz.
17. Fenn, 30.
19. Ibid.
22. Ibid. 4.
24. Herskovitz.

Suggested Readings

Note: The following list of suggested readings contains publications not cited in the notes above. An asterisk denotes that the item is part of the IHA circulating library and is available to borrowers. A more extensive list of readings (approximately ten pages long) is available from the IHA office. The IHA staff is available to assist in locating further resources dealing with specific problems.

• Chemical Storage and Disposal in the Conservation Laboratory. New York: Center for Occupational Hazards, 1985.
• Ethylene Oxide: Problems in Fumigation.” Art Hazards News 5, no. 10 (March/ April 1982):3.
• Cumberland, Donald. “Paradichlorobenzene Residues.” National Park Service Conserv-o-gram, 9/5 May 1980.
• Display and Storage of Museum Objects Containing Cellulose Nitrate.” CCI Notes 15/3. Ottawa: Canadian Conservation Institute, April 1988.

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