STORAGE DESIGN FOR OBJECT AND SPECIMEN COLLECTIONS

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Museums are increasingly involved in construction or renovation of collections storage facilities. A few guidelines can be used to help improve the storage spaces that result from these efforts, particularly for specimen and object collections. Good design, coupled with appropriate maintenance of the finished areas can promote the long-term care of these collections.

Two important concepts to keep in mind are: storage areas are not meant to be inviting, and storage areas should be easy to monitor and clean.

Considerations During Renovation or New Construction

- Plan for segregated storage rooms. Space for storage of collections should not be used for other museum functions. The storage rooms should not be designed to incorporate offices, collections processing, storage of curatorial supplies, or anything other than brief curatorial and collections care activities.

- If possible, provide 350psf floor loading for storage areas that will house compact or mobile storage systems. This will also permit cabinets, collections on pallets, or objects in crates to be safely moved using lift equipment such as power lift stackers and pallet trucks. Access corridors between freight elevators, storerooms and exhibit areas should have similar floor loading capacities.

- Ensure that the entrance to any storage area is large enough in both dimensions to accommodate full-unit cabinets and large objects.

- Install keycode or other electronic entry control devices for storage rooms. If electronic security is not possible, use a highly restricted key system for entry (Keller and Willson 1995, Kelly 1998). Consider adding a security window to the door to permit inspection of the room from the exterior. Lighting should be activated from outside the room to facilitate inspection.

- Avoid dropped ceilings in all storage areas, and anywhere else in the building that they can be eliminated. Dropped ceilings provide a habitat for pests, disguise the source of leaks, and the ceiling materials can generate dust and debris that foul particulate filtration systems.

- Equip all storerooms with water-based, automatic fire suppression systems and plan for regular maintenance of the systems. Individually active heads are preferred for museum storage. Dry pipe systems are not acceptable unless there is a real danger that the pipes will freeze. Mist systems have not yet been proved to be effective against fire, and in many areas of the country, may not meet fire codes. Gas systems have proved to be far more damaging to collections and staff than water based systems (Wilson, 1995).

- Label all pipes and ductwork so that staff can adequately protect collections that may have to be stored below them. Ideally, there would be no pipes other than sprinkler lines, and very minimal ductwork inside storage rooms.

- Install seals around all duct and pipe chases where they pass through walls, floors, or ceilings of

storerooms. A good material that will keep insect pests from using these as arterials to reach the collections is 'Stuf-it' copper wool gauze, available from:

Allen Special Products, Inc.
1610 Bethelem Pike #B3
Hatfield, PA 19440-1602
T 800.848.6805 or 215.997.9077

- Avoid interior duct linings. Where needed for noise control or to reduce condensation, use external duct linings.

- Install climate control equipment outside the storage room, so that it does not require room entry to maintain the equipment. This will also help protect the collections from equipment leaks.

- Filter all incoming and recirculated air to the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 90-95% level. Externally generated particulate pollutants are far more damaging to collections than externally generated gaseous pollutants, mainly because the particulates adsorb and absorb the gas phase pollutants and hold them directly on objects or specimens. Particulate pollutants can etch and abrade the surface of collections storage furniture, as well as objects, and can obscure fine detail on collection items.

- Plan for a moderately dry environment. The relative humidity (RH) range that is most suited to the majority of natural history collections is 40-60%, assuming that the building fabric is designed for this range (Conrad 1995). Specimens and objects inside well-sealed cabinets can withstand external environments from 30-65% RH over the course of a year. In a temperate climate, the collections inside the cabinets will enjoy a very stable RH somewhere between 45% and 55%. Some materials are very sensitive to mechanical damage at RHs below 40%, (teeth, bone, and shell) and at fluctuations in RHs below 40% these materials will undergo cracking and spalling, even with out the impetus of mechanical damage (Williams 1991, Morton 1996). There are some collections that benefit from very low RH, for example, film based photographic materials (Nishimura 1995); fossil and mineral specimens that contain reactive iron sulfides (Howie 1992); and low access, paper based archival materials (van der Reyden 1995). An discussion of the impact of humidity levels on various collection materials is given by Alten (2000).

- Plan for a moderately cool environment. While temperature is less important than humidity levels for most collections, the rate of chemical degradation of organic materials doubles with every 10°C rise in temperature. Consequently a temperature range of 18-21°C (~65-70°F) is acceptable because it will permit staff to work with collections safely (*i.e.*, without numb fingers) although it is cooler than the normal human comfort level. Film based photographic materials require both low temperatures and low humidity for good preservation (Reilly1993, 1998).

  For fluid-preserved collections, relative humidity is unimportant as long as it is not above 65% (high RH promotes corrosion of glass and of any metal lids or bails). For fluid-preserved specimens of all kinds, the primary concern is that temperature be constant. Changes in temperature cause pressure changes that result in damage to container seals, allowing storage fluids to evaporate (Simmons 1995). For collections that are **not** fixed in formaldehyde prior to storage in alcohol solution, a steady, low temperature (above freezing) can facilitate preservation. For specimens fixed in formaldehyde solutions and stored in either formalin or an alcohol, it is important to keep a steady temperature that is not lower than about 18°C (65°F). Temperatures

below this foster polymerization of the unfixed formaldehyde that is a critical component in the equilibrium reaction involved in tissue fixation (Simmons 1995). Polymerization of the free formaldehyde drives the equation towards removal of the fixative from the tissue.

- Always filter fluorescent lighting to remove as much as possible of the ultraviolet radiation (UV) produced by the lights. Keep in mind that no filter will be completely effective and that damage from UV is more than a matter of the microwatts/lumen of the radiation emitted by a light source. The intensity of the lighting is a key factor, as illustrated in the equation below from work by Stephan Michalski (1994):

  Light intensity x UV component = UV intensity
  [lux] x [µWatt/lumen] = [µWatt/m²]

  Light from fluorescent fixtures is often in the 3,000 lux range (300 lux is considered excellent for visibility for viewers of all ages). A standard UV filter reduces UV to about 75µW/lm. The best available filters will reduce the levels to the 0-10µW/lm range (Michalski 1994). As the formula above illustrates, reducing the intensity can result in substantial benefits in UV protection. While visible light is the portion of the spectrum responsible for much fading and color change, UV radiation causes cleavage of the chemical bonds in organic materials. At high UV intensities, damage to organic materials can occur very quickly. This is well illustrated by the CCI Light Damage Slide Rule (which also shows the potential for damage from virtually any lighting system), available from the Canadian Conservation Institute.

  Light Damage Slide Rule can be ordered on-line at www.cci-icc.gc.ca
  (price is $20.00 CDN plus shipping and handling)
  (Editor's note: This is no longer available. An on-line version is under development.)

  Lighting that offers a high degree of color rendering also reduces need for high intensity lighting. It is possible to see well under reasonably low intensity lighting, if the lighting has a high CRI (color rendering index). Internally filtered fluorescent bulbs with high color rendering capacity are available from:

  Verilux
  9 Viaduct Road
  Stamford, CT 06907
  T 203.921.2430 x 103 (Sales) F 203.921.2427
  Email: verilux@ergolight.com Web: www.ergolight.com

  Another lighting option for storage areas is to install fluorescent fixtures as indirect lighting, bounced from ceilings and walls to illuminate an area. It is still prudent to filter indirect lighting and any residual UV can be further diminished through appropriate choices of coatings for walls and ceiling.

- Paint walls and ceilings white or a very light color. White reflects much of the visible-light spectrum, thus the intensity of the light from various light sources can be reduced in work or storage areas. White or light walls and ceilings permit easy monitoring for dust, and cobwebs and other indications that insects may be present. Most white paints contain titanium dioxide, which absorbs part of the ultraviolet radiation from fluorescent lighting, reducing the UV in any reflected light. Avoid oil-based paints, single-component epoxies, alkyd paints, or oil-modified

polyurethane coatings. Select an acrylic emulsion latex (interior or exterior), vinyl acrylic, or acrylic urethane coating for the walls (Tétreault 1999).

- Coat concrete floors (after appropriate curing) with a solvent-borne epoxy sealer, topped with a moisture-cure epoxy sealer, and avoid all other floor coverings (anything else will require wet cleaning or will be a source of particulate or gaseous pollutants). When worn, the topcoat can be replaced without evacuating the collections from the area. The epoxy may be a clear or pigmented (do not use white, it will always appear scuffed).

- Install polypropylene fiber mats outside the doors to the storage rooms to reduce the amount of dust tracked into the rooms. Mats are available from:

  Consolidated Plastics Company Inc.
  8181 Darrow Road
  Twinsburg OH 440087
  T 800.362.1000 F 330.425.3333
  Web: www.consolidatedplastics.com

Housekeeping and Maintenance

- Develop a housekeeping plan for storage facilities that relies on vacuuming the floors and storage furniture and omits wet cleaning. Wet cleaning creates havoc with efforts to control relative humidity and is difficult to accomplish without leaving residues from cleaning compounds. The ideal tool for general housekeeping is an industrial-quality, High Efficiency Particulate Air (HEPA) filtered vacuum. HEPA vacuums do not redistribute fine particulates into the air, as do regular vacuum cleaners. HEPA vacuums are available from most companies that produce vacuums today. Heavy duty HEPA vacuums that are still small enough to move around in storage rooms, and can be adapted for artifact cleaning as well, are available from:

  Nilfisk-Advance America, Inc.
  300 Technology Drive
  Malvern P 19355
  T 800.645.3475
  Web: www.pa.nilfisk-advance.com
  Check web site or call for information on a local supplier.

- Keep all stored items 4-6” above the floor, on shelving, pallets, or dollies, or in cabinets. Manufacturers of museum storage furniture now offer cabinets that are on legs, with built-in leveling feet. All spaces under storage furniture should be clear so that they can be vacuumed on a regular basis. This will reduce the accumulation of dust under the cabinets, which can serve as a source of particulate pollutants and as a habitat for pests (Williams and McLaren, 1990). Keeping collections and supplies off of the floor will also help protect them in the event of a flood from any source and will facilitate post-flood cleaning.

- Do not permit storage of office and curatorial supplies in collections storage areas. These materials or their packaging can be sources of volatile acids, peroxides, and other compounds harmful to collections, constitute fuel for a fire, and are habitats for pests. After unpacking, supplies should be stored off the floor on shelving units, and in an area away from collections.

- Conduct routine inspections of collections storage areas for pipe leaks, voids in the seals around

duct and pipe chases, or any other problems.

- Maintain the fire protection systems on a regular schedule. Recommendations for routine maintenance are given by Wilson (1995) and in information available from the National Fire Protection Association:

  National Fire Protection Association (NFPA)
  1 Batterymarch Park
  PO Box 9101
  Quincy MA 02269-9101
  T 800.344.3555
  Web: www.nfpa.org

Most museums have a substantial investment in their collection storage furniture as well as having a public trust responsibility for their collections. Careful maintenance of storage areas can prolong the life of the equipment and the specimens or objects.

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