Pest Treatment Case Study: Low Temperature Pest Management Treatment at the Smithsonian National Museum of the American Indian

Controlled low temperature has become a routine pest management and eradication method for museums because of concerns about the safety of chemical fumigation. The Smithsonian National Museum of the American Indian (NMAI) has used other forms of treatment for pest eradication in the past; including CO2, sulfuryl fluoride and low oxygen with scavengers, but low temperature is now the preferred treatment for several reasons:

- it is inert and non-toxic and thus safe for staff
- treatment time is much quicker than other methods
- it requires relatively little staff time
- although running the freezers does entail energy costs, overall the method is cost-efficient, especially because the museum made the initial cost outlay to install walk-in freezers at two of the museum's three facilities. Inevitably, there are some costs associated with upkeep.

Background

The NMAI follows the guidelines for freezing for pest eradication based on recent research on time and temperature exposures required to achieve 100 percent mortality for particular insects as described by Strang at the Canadian Conservation Institute (1997). These guidelines are based on the lethal temperatures and exposure times published in the entomological literature, on the knowledge of how insects survive cold, and on successful treatment over past decades at various institutions. In general, the length of time that objects are placed in a freezer depends on the temperature the freezer is capable of reaching. It is recommended that insect pests be exposed to the lowest possible temperatures for the longest possible time.

Collections materials treated with low temperature

During the recent five-year move of collections from New York to Maryland (completed in 2004), NMAI chose to use low temperature treatment for the majority of the large collection of organic or composite organic and inorganic archaeological and ethnographic objects – tens of thousands of items. Most of the collections items are composite and many include materials previously thought to be damaged by low temperature treatment, including restrained hide, material with propagating cracks, painted wood, and lamellar material. The museum has experienced virtually no damage to these materials, despite early apprehensions, and continues to use this method for nearly all organic and composite organic/inorganic objects. Currently the only materials not treated with low temperature are oil and acrylic paintings on panels or canvas.

Research on the safety of freezing museum materials has identified several areas of concern (Carrlee 2003.) Embrittlement, shrinkage, thermal shock, phase changes, and molecular alteration may pose threats and must be considered when determining if a material is appropriate to freeze. However, condensation, freeze-thaw cycles, dehydration, and swelling do not significantly affect objects properly prepared in sealed plastic bags with buffering material. Furthermore, practically speaking, the museum must balance the risks involved with potential wide-spread infestations caused by bringing infested material in contact with other collections items.

Procedures

Conservation staff work with Registration and Collections Management to determine which objects are appropriate to freeze. Typically, all organic materials or composite organic/inorganic items are treated

before being catalogued and brought into collections or exhibitions areas. This includes new accessions, props, items returning from loan, non-accessioned educational materials and personal materials which may be kept in staff offices or cubicles. This is done as a preventive measure even if no signs of infestation are evident. Objects are sealed in self-closing polyethylene bags or in cardboard boxes wrapped with polyethylene sheeting and sealed on all seams with tape that will not fail in low temperatures. Lightweight bagged objects are also placed in boxes so they are not subject to air movement within the freezer.

The boxes are placed on carts for loading into the freezer. After 5-7 days, the boxes are removed from the freezer. Until they return to room temperature, objects are extremely fragile. Handling is kept to a minimum and done very carefully during this time. Before being unwrapped and handled, items are given at least 24 hours to return to room temperature. This protects against any potential condensation onto the surface of the object itself.

Staff track objects undergoing freezing treatment in several ways. First, a hand-written log is kept next to the freezer. Second, a system of labels indicating objects to be frozen and those which have been frozen is used. Labels reading "freeze" are affixed to polyethylene wrapping or bags before objects are placed in the freezer. Upon removal from the freezer, labels reading "frozen" are associated with the items. Finally, barcode scanning is used to record the process and the information, including date of treatment, and that information is attached to accessioned object records in the museum's collections database.

Equipment

The NMAI has walk-in freezers built into the Cultural Resources Center storage facility in Suitland, Maryland, and the Mall Museum facility on the National Mall in Washington DC. These facilities regularly receive collections materials and non-accessioned props and educational material that may come into contact with accessioned collections materials on exhibit or in storage. Both freezers were included in original building designs. Each freezer reaches a low temperature of minus 40 degrees centigrade (equivalent to minus 40 degrees Fahrenheit). Based on this, 72 hours is probably adequate for treatment but the museum usually keeps materials in the freezer for about one week.

- **Mall Museum freezer**
  - Located in secure collections workroom, adjacent to loading dock and freight elevator. Internal lock in door handle, only Collections Manager has access.
  - Low velocity unit coolers Century Refrigeration Series FV
  - "FV units are a blow through design with two-way air throw, designed for flush ceiling mounting with no surfaces above the unit to be cleaned. The FV Series also has a hinged drain pan arrangement. Units are constructed of a heavy gauge smooth finish aluminum cabinet with copper tube, aluminum plate fin coil, and permanently lubricated fan motors with inherent thermal protection." http://www.rae-corp.com/fv.htm
  - Two automatically rotating systems alternate during 6 hour cycle for redundancy/backup.
  - Honeywell DR4300 Circular Chart Recorder on exterior of box provides continuous recording of internal box temperatures. http://catalog.sensing.honeywell.com/printfriendly.asp?FAM=rda&PN=DR4300%20Basic
  - Box manufactured by Elliot Williams Co. LLC walk-in coolers and freezers www.elliottwilliams.com
  - Dimensions: 7'8" wide, 10' 7" long, 8' 10" high. Door Dimensions: 4'4" wide, 8' high.

- **Cultural Resources Center freezer**
  - Located in secure hallway adjacent to loading dock, collections processing workrooms, and freight elevator. Secured with padlock, limited staff access.
  - Two-stage 10 HP refrigeration system with a 45 minute defrost cycle every 6 hours. Rooftop outdoor air cooled condensing units
  - Bohn Medium Profile, reaches minus 40 degrees Centigrade.
  - Walk-in box manufactured by Bally www.ballyrefboxes.com/products/coolerfreezer.htm
  - Internal dimensions: 8' wide, 16'5" deep, and 7'10" high (except where fans are)

- External dimensions: 15'5" x 9'8" x 9'6"

Points of caution, notes, and recommended features:

- Alarm system for problems with temperature controls.
- External chart recorder (on the outside of the unit)
- Double check rolling load capabilities with manufacturer. If freezing very heavy items and/or use of pallet jacks is anticipated, make sure the floor inside the freezer box is reinforced. NMAI had to retrofit one freezer with a ¼" - 3/16" aluminum diamond tread plate.
- Ensure that controls are easily accessible.
- If the freezer has heating strips around the door, make sure controls for these are accessible and will be turned off if the freezer is turned off or power goes out. Otherwise, if the heating strips are left on inadvertently while the freezer is off, the freezer box becomes a heating box, can cause damage to collections, and the heating strips will eventually burn out.

Pros and Cons

- Pros:
  - Almost all materials can be treated with this method; relatively fast; relatively easy; requires relatively little staff time and oversight; relatively inexpensive after initial outlay for freezer unit.

- Cons:
  - Some confusion and difference of opinion about low temperature treatment remains in the museum field, particularly about what items can be treated, and "cycling." In recent years, research has shown that low temperature treatment does not damage most materials previously thought to be vulnerable. Freezers of relatively recent manufacture can achieve lower temperatures than previously, obviating the need for cycling (see especially Florian 1997, chapter 12.)
  - More research is needed on some questions such as possible micro-structural damage caused by repeated freezing treatments.
  - Some maintenance required.
  - Freezing, like all non-chemical treatments, provides no residual protection against future infestations, so standard preventive policies including housekeeping, food policies, and monitoring must be in place as part of a successful integrated pest management policy.

Costs

TBD

References

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