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An Insect Pest Control Procedure: The Freezing Process

Temperature reduction is currently used as an effective pest control method for protecting National Park Service collections. It provides curatorial staff with a good alternative to the chemical fumigation method traditionally used by museums.

When subjected to freezing temperatures, objects do not freeze and ice formation does not occur within them; only the living insects possessing body water are frozen. The procedure, however, is neither simple nor fail-proof and can easily damage objects and natural history specimens unless exact procedures are followed.

The freezing process **should not be used on a routine or preventive basis**, but only when pest activity is evident or suspected. It is an interventive treatment and should not be employed indiscriminately. Its use requires justification, careful supervision, and thorough documentation.

Objects that are considered safe for the freezing process include **only** 1) dry (not waterlogged) objects made entirely of textile, leather, wood, and paper, and 2) dry natural history specimens (those not in fluid solutions). A conservator should be consulted to assist curatorial staff in evaluating the potential for damage before introducing any objects into a freezing atmosphere.

Freezing of insect pests can be accomplished with an inexpensive household freezer, since the required temperature level is -20°C (-5°F). A chest freezer without a frost-free cycle is required.

The length of exposure to freezing temperatures directly relates to the temperature level being employed; and an increased exposure period is required to compensate for infested materials which are well insulated. A survey of the pest control literature indicates an exposure of 6-10 days at -20°C will be sufficient for most museum pests (Strang 1992). Museum experience and practical tests have shown that two cycles of 48-hour exposures at a minimum of -20°C, as is recommended here, constitutes a lethal exposure (Florian 1990).

Advantages Over Traditional Approaches

Traditional methods of pest control have numerous drawbacks for both the museum object and the applicator. Commercial pesticides contain chemicals which may stain objects or alter their composition. Fumigants are reactive chemicals that can produce chemical changes in object materials. Insect control procedures that use toxic chemicals or gases have been shown to present both short-term and long-term health hazards to staff who routinely handle or work near the materials, and can affect visitors exposed to treated objects on display or used in interpretive programs.

Alternate cycles of freezing and warming to room temperature of infested objects is a non-chemical method by which insect pests can be effectively eradicated without presenting a health hazard. Exposing objects to freezing temperatures is effective because most museum pests (such as the dermestid beetle and webbing clothes moth) are *freeze-sensitive* rather than *freeze-tolerant* insects.

Potential Drawbacks

During the past decade the freezing process has been evaluated from the standpoint of its effectiveness and its potential for causing damage to museum objects. Conservators and conservation scientists have studied several relevant issues: moisture content changes within museum objects; cooling rates for various materials; condensation potential during thawing; and the freeze resistance of museum insect pests.

Research has concluded that not all materials can be safely exposed to -20°C (-5°F). Wet objects and objects in unstable condition should never be exposed to below-freezing temperatures. Objects made with components from non-absorbent materials (e.g., metal, glass), and objects containing glues and sensitive finishes (e.g., paints, resins) should not be exposed to below-freezing temperatures because the materials may react differentially.

Sensitive materials that **should *never* be treated** include:

1. Canvas and wood-panel paintings
2. Painted or inlaid wooden objects
3. Finished furniture
4. Lacquered wooden objects
5. Objects containing ivory or teeth
6. Objects under tension (e.g., drums)
7. Composite objects containing inorganic materials, such as glass, high-fired ceramics, and metal.

Even for those materials which can be subjected to freezing, damage can occur if the freezing procedure is not followed precisely. Moisture content changes in certain objects can cause damage through dimensional swelling or shrinkage; higher moisture levels and condensation can encourage microorganism attack, rotting, and corrosion.

The Freezing Procedure

Freezer Selection:

- Select a freezer that will maintain a minimum temperature level of -20°C (-5° F). Both domestic and commercial freezers can be used to treat objects safely; the lowest achievable temperatures are -25°C (-13°F) for domestic chest freezers and -30°C (-22°F) for walk-in freezers.
- Ensure that the freezer does not have a frost-free feature. A frost-free freezer allows the internal temperature to rise periodically to remove any accumulated ice crystals. This cyclic heating will also allow the objects to warm up, destroying the effectiveness of the freezing process. However, a frost-free unit can be used in an emergency.

Monitoring Equipment:

- Obtain a remote reading thermocouple or inexpensive indoor-outdoor thermometer. The temperature sensor should be located inside the freezer near the object (preferably between layered objects). The lead wire should be small enough to pass through the door gasket without causing loss of temperature.

Object Enclosures:

- Objects should be sealed in airtight polyethylene bags in the same room environment where they were stored. (If an object is physically unstable, place it in a box within the bag for support.)
- Use clear polyethylene bags, such as Ziplock™ bags that can be sealed and are large enough to hold the object(s) without physical damage. Clear polyethylene sheeting (minimum thickness, 3 mil) can be used to make large bags. A heat sealer or plastic carton sealing tape can be used for closure.
- Evacuate as much air as possible from the plastic bag before sealing it tightly and securely with tape or a heat sealer. A variable speed vacuum cleaner can be used cautiously to remove the air from the plastic bag.
- Before freezing, keep objects at room temperature and the relative humidity as close to 50% as possible (RH must be within the range of 35-65%).

Moisture-Absorbent Material:

- When freezing oversized objects or objects that include metals, place a moisture-absorbent material inside the bag (or box). Suitable materials include a small bag of silica gel, a mass of cotton wool, cotton toweling, or a cotton diaper. (If gel is used, ensure it is conditioned to the same RH as the object by exposure to the same room atmosphere for a minimum of one week.)

Introducing the Object into the Freezer:

- When placing the bagged object(s) into the already cooled freezer, ensure that adequate room is left to permit air circulation around each bag to assist in rapid cooling. Be careful that damage does not occur if objects are placed on top of one another.

- The object(s) should be left in the freezer for a minimum of 48 hours during which time temperatures should remain constant, though small fluctuations are acceptable.

Removing the Object From the Freezer:

- Remove the bagged object(s) from the freezer. Do not remove objects from their bags; bags are to remain sealed.

- Allow bagged objects to warm to ambient room temperature for 24 hours. Condensation should not occur inside the bag but may occur on the outside of the bag.

- Objects should be handled with extreme care at all times.

Repeat Freezing And Warming Process:

- Place the sealed bags back into the freezer after warming. Leave in the freezer for a minimum of another 48 hours.

- After the second freezing cycle, a final warming is required. Follow the same process as before.

- After 24 hours, remove the object(s) from the bag, and carefully inspect for any damage. Mechanically clean the object with a soft brush and a vacuum with a gentle and regulated suction to remove insect pest remains as necessary. See NPS *Museum Handbook*, Part I (Rev 9/90), Appendix K for vacuuming procedure. The object is now ready to be returned to exhibit or storage.

- Objects may be left in their bags for storage if the storage area has effective temperature and RH controls. Absorbent material may be removed and reused.

- Make needed arrangements for the object's follow-up care as needed, such as further cleaning and future routine pest inspections. A conservator should be consulted for advice both before and after the freezing process.

Documenting the Process:

- Ensure that a record of the freezing and cleaning procedures used is put in the object's catalog folder. Include dates of the treatment, temperature and equipment used, and any cleaning techniques that were employed. Record when the visual evidence or damage was first recognized and include any photographs taken.

- Three texts very useful in the identification of pests are:

  National Park Service. *Integrated Pest Management Information Packages*. Washington, D.C.: National Park Service, 1984.

  Story, Keith. *Approaches to Pest Management in Museums*. Washington, D.C.: Smithsonian Institution, Conservation Analytical Laboratory, 1985.

  Zycherman, Lynda A., and Schrock, J. Richard (editors). *A Guide to Museum Pest Control*. Washington, D.C.: Foundation of American Institute for Conservation of

Historic and Artistic Works and the Association of Systematics Collection, 1988.

Sources

Thermocouple thermometers, heat-sealing machines, and polyfilm tubing for use with heat-sealing machines are available from VWR Scientific, P.O. Box 626, Bridgeport, NJ 08014, (800) 234-9300; Cole-Parmer Instrument Co., 7425 N. Oak Park Avenue, Niles, IL 60714-9930, (800) 323-4340; and McMaster-Carr Supply Co., P.O. Box 44355 Chicago, IL 60680, (312) 833-0300.

Freezer thermometers, indoor-outdoor thermometers, and polyethylene bags and sheeting used to wrap larger objects are available from local hardware and variety stores.

Ziplock polyethylene bags in sizes from 4" x 4" to 12" x 12" are available to parks from the National Park Service's Curatorial Services Division Supply Program as well as local hardware and variety stores. See NPS *Tools of the Trade* stock number A45-A48.

Chest freezers, measuring 5 or 7 cubic feet and made by Wood, General Electric, and Whirlpool, can be purchased from local appliance dealers. Some models also are on the GSA Federal Supply Schedule.

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Burke, John. "Current Research Into the Control of Biodeterioration Through the Use of Thermal or Suffocant Conditions." *AIC News*, Vol. 18, Washington, D.C.: American Institute for Conservation of Historic and Artistic Works, 1993.

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Toby Raphael
Ethnographic Materials Conservator
Division of Conservation
Harpers Ferry Center
National Park Service
Harpers Ferry, West Virginia 25425

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