

Low Temperature Treatment Fact Sheet

Low Temperature Treatment of Infested Cultural Materials Brief description of treatment Controlled low temperature treatment, also known as "freezing", has become a routine pest management and eradication method for museums, following the research and guidelines established, notably, by Strang and by Florian. The guidelines that follow are based on technical research in entomology and also on successful treatments performed in a number of major museums. Freezing an object or artifact in a standard freezer should not be confused with vacuum freeze drying, which is used for reclaiming materials that are wet, often after a fire or flood. Freeze drying is a two-step process. The freezing stops mold formation and prevents deterioration until further action be taken. Vacuum drying then removes the water directly from the frozen state. **What collections materials can be treated this way?**

- The literature on freezing includes many warnings about types of objects or materials that could be damaged from freezing. However, the staff of institutions that have frozen literally thousands of objects report no damage on most of the types of objects for which there are published warnings.
- Material that **should not** be frozen, based on specific examples in the published literature and the collective experience of members of the IPM-WG includes:
 - oil and acrylic paintings on canvas
 - plant specimens that are not completely dried
 - photographic materials other than acetate film and modern photographic prints
 - audio-visual items: check carefully for the following materials, they may not be at risk for infestation, and freezing may cause damage and permanent loss of information. These materials include:
 - computer media (tapes, discs, optical)
 - magnetic media (reel to reel, cassettes, VHS, Beta)
 - audio grooved media (cylinders, discs)
 - cased photographs (daguerreotypes, ambrotypes [pannotypes], tintypes [ferrotypes])
 - glass archival materials including plates negatives (collodion and gelatin [wet and dry plate methods]), glass color transparencies (autochromes), lantern slides, mounted glass slides

In general, freezing is considered so safe that some institutions freeze collections 'preventatively' to ensure that there is no infestation. Examples of this include: · Moving collections into a new space or facility from one that was known or suspected to have been infested. · Processing new acquisitions, or reintegrating collections that have returned from loan into collections storage areas · Bulk collections of material that cannot be individually inspected. **General procedures** Standard freezing of room-temperature cultural materials can be accomplished by using a chest-type, upright, walk-in freezer, or freezer truck. Whichever kind is used, a good rule of thumb is that it should be capable of maintaining minus 20 degrees F (minus 29 degrees C). Ultimately the appropriate exposure period for insect eradication will depend on both the minimum operating temperature of the freezer as well as the type of insect. For more on insect identification and why this is important click here [link to ID page]. For more specifics on freezer types see the "Materials and supplies" section below. A freezer that maintains this temperature will sufficiently lower the materials to the freezing point within four hours, which kills adult insects as well as their eggs. If the temperature drop takes much longer, some varieties of insect are capable of producing an 'anti-freeze' that allows them to survive freezing. With wood pests such as powderpost beetles, a second treatment may be necessary to insure complete kill. This is particularly important for large wooden objects, where temperature change may take longer than four hours to penetrate to the core. In order to avoid damage from ice build-up in the freezer or from condensation after removal, artifacts should not be put into freezers directly. They should be sealed in plastic either using re-sealable plastic bags or polyethylene plastic sheet sealed with tape that will not fail in low temperatures. If a number of objects are being treated at once, objects in bags should be put in trays or boxes for easier handling. Items may also be placed in boxes and the boxes wrapped. Typical low-temperature treatment for infestation involves freezing for a minimum of 48 hours, although many museums leave objects in freezers for longer; some, particularly when freezing wooden objects or tightly-packed paper in boxes, leave them for a week. Several older publications recommend repeated freeze/thaw cycle(s) as a precaution, but recent work indicates that one longer treatment at a low enough temperature should suffice. After removal from the freezer, objects should be allowed to acclimate to room temperature, still completely wrapped, until they are at room temperature, at least 24 hours. Because many materials become temporarily brittle at low temperatures, post-freezing handling should be minimized until the objects return to room temperature. There is no harm in leaving the objects in the plastic bags after treatment. On the contrary, it will prevent future infestation. While infested items can be placed in a refrigerator to halt activity (most museum pest activity will stop at 5 degrees C but insects will not be killed at this temperature), it is important that these items be allowed to acclimatize back to room temperature before freezing. An important part of any treatment of collection material is documentation. It should be possible to access the history of any one object related to both infestation and eradication. The IPM policy statements on this site give examples of the ways that various museums carry out documentation. Click here to access the Policy and Procedures templates. It is recommended that all pest incidents and any treatment such as freezing should be recorded, ideally in separate documentation (e.g. collection database, object treatment file), and in a note placed in the bag with the object or artifact. **Pros and Cons of this treatment**

- Procedure is non-toxic to humans
- Safe for almost all organic and composite materials
- Relatively time-efficient
- Low cost after initial investment for freezer
- Some freezers can be modified to reach appropriate low temperatures
- Does not entail extensive staff training or staff time for maintenance during procedure

Cons

- Requires initial financial investment
- Some smaller freezers are not large enough for oversized items
- Walk-in freezers require space planning and setup

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- Some maintenance is often required for large walk-in freezers
- Not appropriate for all materials
- Temperatures that do not fall fast or low enough will not achieve a good kill rate and treatment will not be fully effective.

Materials and supplies The success of freezing treatments, as mentioned above, depends greatly on the ability to quickly drop the temperature and sustain it through the length of the treatment. As a result, choosing the appropriate freezer is essential. According to Strang (2008) in practice, the most effective freezer systems for killing insect pests operate between minus 22 degrees F (minus 30 degrees C) and minus 40 degrees F (minus 40 degrees C). Institutions must choose a freezer setup based on these requirements as well as the costs and practical needs of the collection. The information below on freezers is drawn primarily from Strang's "Controlling Insect Pests with Low Temperature" (1997, updated 2008). The full text should be consulted for details. Click here to access the Bibliography [link to general bibliography]. *Household Deep-Freezers*: Household deep-freezers that operate between minus 4 degrees F (-minus 20 degrees C) and minus 13 degrees F (minus 25 degrees C) can be very effective, and are usually less expensive than commercial freezers. Most household freezers are "frost free" which is acceptable. While there has been some anecdotal concern about the defrost 'warming' cycles, these are of relatively short duration, and the general response time of bagged materials commonly 'frozen' is comparatively longer than the warming phase. The target insects will generally be kept cold though the cycle by the cooling or cold object and will experience the lowest temperatures the freezer can offer. They will have been immobilized early in the cooling. *Commercial freezers and Chest Freezers*: Commercial freezers and "top of the line" household chest freezers can usually achieve the necessary temperatures to ensure kill rates. Commercial "ice-cream hardening" freezers in vertical or horizontal configurations are designed to operate at minus 44 degrees F (minus 42 degrees C) and may not be much more expensive than standard commercial freezers. It is recommended that performance be monitored with a separate thermometer. Ensure that the freezer is well insulated, and provide for adequate air circulation inside the freezer around collections materials. Click [here](#) to access two published references on how to modify modifications to chest freezers to achieve colder temperatures if necessary [link to WAAC and SPNHC tips on Additional Resources page]. *Walk-in Freezers*: Some walk-in laboratory freezers allow users to set the operating temperature. "Air-blast" freezers are preferable because their forced air circulation increases the cooling rate. It is not necessary to set temperatures below minus 40 degrees F (minus 40 degrees C) to increase the effectiveness of using freezing to kill insects." Check local vendors and manufacturers for "off the shelf" and custom-designed units. Thermometers on outside of freezer to monitor interior temperature are recommended. *Freezer Trucks*: More information coming. **Selected bibliography** Bergh, Jan-Erik, Karl-Martin V. Jensen, Monika Åkerlund, Lise S. Hansen, and Martin André "A Contribution to Standards for Freezing as a Pest Control Method for Museums" *Collection Forum* 21(1-2) (Fall 2006): 117-125. Carlee, Ellen "Does Low-Temperature Pest Management Cause Damage? Literature Review and Observational Study of Ethnographic Artifacts" *Journal of the American Institute for Conservation* 42 (2003): 141-166. Florian, Mary-Lou. *Heritage Eaters: Insects and Fungi in Heritage Collections*. James & James Publishers; 1997. Chapter 12. Mibach, Lisa. *Modifications to Home Freezers for Pest Control*. WAAC Newsletter. 1994

Jan; pp. 26-27. Article included in page 11 <http://www.si.edu/mci/downloads/articles/pests9.pdf> **Strang, Tom and Rika Kigawa. Combatting Pests of Cultural Property. Canadian Conservation Institute. <http://www.cci-icc.gc.ca/crc/articles/mcpm/chap06-eng.aspx>** Strang, Tom "Controlling Insect Pests with Low Temperature" Canadian Conservation Institute Note 3/3, 1997, updated 2008. http://www.cci-icc.gc.ca/crc/notes/pdf-documents/3-3_e.aspx Strang T.J.K. 1992. A Review of Published Temperatures for the Control of Pest Insects in Museums. *Collection Forum* 8(2) (Fall 1992): 41-67.