

# MuseumPests.net

A Product Of The Integrated Pest Management Working Group

## Low Temperature Treatment Fact Sheet

### Brief description of treatment

Controlled low temperature (commonly referred to as “freezing”) has become a routine pest management and eradication method for museums, following research and guidelines established notably by Strang and by Florian. According to Strang (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 ... A major guideline to follow when using freezing to control insect pests is to expose them to temperatures that drop as low as possible, as quickly as possible, for as long as possible.” It is important to note that freezing provides no residual benefits, and if collections are not returned to a well-maintained storage area, reinfestation will almost certainly occur.

### What collections materials can be treated this way?

Low temperature treatment is appropriate for organic materials and composite objects, including those with inorganic components. Florian (1997) summarized research on effects of freezing on various materials. As noted by Florian (1997) and Carrlee (2003), condensation, freeze-thaw cycles, dehydration, and swelling do not significantly affect collections items properly prepared in sealed plastic bags. Temperatures lower than 40 degrees C below zero are not recommended as thermal contraction can occur with some materials.

Freezing does pose a risk to some collections materials and is therefore not appropriate for every type of object; research has identified several areas of concern that should be considered when determining if a material is appropriate to freeze:

- In general, the effects of repeated freezing are not well understood. This should be weighed against immediate risk of damage posed by infestations.
- Acrylic and oil paintings on canvas are not appropriate to freeze because the image layer may become embrittled, (although this is reversible on thawing) and thus will be more vulnerable to damage from handling. Materials with friable media (pastel, charcoal, some paints) may be more susceptible to loss from handling after freezing.
- Wet items or those with high moisture content (i.e. fresh plant materials, green wood) should not be frozen.
- Herbarium specimens:
  - Those prepared with high moisture acrylic glues may become tacky upon freezing and cause sheets to stick together.
  - It is possible that some specimens may be vulnerable to cellular damage with repeated freezing.
- Research collections: it is possible that DNA may be affected by freezing.
- Some plastics may not be appropriate to freeze as they may become embrittled, and thus will be more vulnerable to damage from handling.
- Archival collections: 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

## General procedures

1. Typically, items are securely sealed in polyethylene bags with most of the excess air removed or placed in boxes sealed with polyethylene sheet, and then placed in the freezer.
2. Walk-in freezers, upright, and chest freezers may be used as long as they reach and maintain 20 degrees C below zero or lower. The amount of time depends on freezer capacity and to some degree on the density of the object, and research (Bergh et al. 2006) indicates that adequate air circulation around the materials inside the freezer is especially important. A practical recommended treatment is 20 to 30 degrees C below zero for a minimum of 72 hours, Strang (1997) recommends one week. More time in the freezer will not lead to increased risk of damage.
3. Items removed from the freezer must remain wrapped for at least 24 hours so they may acclimatize to room temperature and ensure that moisture condenses onto the plastic rather than on the collections items themselves. Until they return to room temperature, objects may be more vulnerable to damage, so handling should be kept to a minimum and done very carefully during this time.
4. As with any other treatment, it is important to quarantine and monitor items after treatment, and to clean and remove signs of previous infestations. This will ensure that there is no confusion between old and new infestations. If any insects do survive then the treatment should be repeated.
5. Many publications do recommend repeated freeze/thaw cycle(s) as a precautionary measure, but recent work indicates that one longer treatment at a low enough temperature should suffice. As Strang (1997) notes "Repeat cooling was used from the 1890s to 1930s when freezers did not normally operate below -10°C to -15°C. In practice, a second cooling is often unnecessary if lower temperatures are used. However, this step re-exposes any resistant insects to freezing and should kill them. Failure to kill the insects after this stage indicates that the insects were previously acclimated, the temperature to which they were cooled must be lowered, or the time of exposure must be prolonged." Florian (1997:88-89) further notes, "Strang (1992) suggested the use of minus 30 degrees C in chest freezers, but stated that if this cannot be reached then repeated freeze/thaw cycles are recommended. He noted the disadvantage of excessive handling with the repeat treatments. The temperature of minus 20 degrees C for insect eradication for museums ... was chosen [by Florian] after a thorough review of the literature and because this is the temperature most household chest freezers reach easily... 48 hours at this temperature should kill all insects, but as a precaution the procedure requires that the treatment is repeated to ensure 100% lethal conditions. In reviewing the literature again, as well as new information, a longer period of time can be substituted for a repeat treatment. This would alleviate the problem of excess handling ... Thus minus 20 to minus 30 degrees C (the temperature range of commercially available chest freezers) for 72 hours is now recommended."

## Pros and Cons of this treatment

### Pros

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

### Cons

- Requires initial investment, walk-in freezers require space planning and setup.

- Some freezers are not large enough for oversized items
- Some maintenance often required for large walk-in freezers
- Not appropriate for all materials
- The effects of repeated cyclical maintenance freezing treatments is not fully understood.
- 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.

### **Selected bibliography**

Bergh, Jan-Erik, Karl-Martin V. Jensen, Monika Åkerlund, Lise S. Hansen, and Martin Andrén "A Contribution to Standards for Freezing as a Pest Control Method for Museums" *Collection Forum* 21(1-2) (Fall 2006):117-125.

Carrlee, 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 "Controlling Insect Pests with Low Temperature" *Canadian Conservation Institute Note* 3/3, 1997. [http://www.cci-icc.gc.ca/publications/ccinotes/pdf-documents/n3-3\\_e.pdf](http://www.cci-icc.gc.ca/publications/ccinotes/pdf-documents/n3-3_e.pdf)

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.

### **Materials, supplies, product manufacturers**

Walk-in freezers: check local vendors and manufacturers for "off the shelf" and custom-designed units. Thermometers on outside of freezer to monitor interior temperature are recommended. Walk-in freezers are typically capable of reaching 30 degrees C below zero (22 degrees F below zero or below).

Chest freezers: Choose a non-self-defrosting freezer – the self-defrosting models have built-in temperature cycles resulting in temperatures that are not low enough for insect eradication. Domestic chest freezers can reach 20 to 25 degrees C below zero (4 to 13 degrees F below zero) but check with manufacturer, monitor performance with a separate thermometer, ensure that freezer is well-insulated, and provide for adequate air circulation inside the freezer around collections materials. See Mibach (1994) for modifications to chest freezers to achieve colder temperatures. A typical new home vertical freezer reaches approximately 18 degrees C below zero which is not probably cold enough for eradication of all museum pests.