NATIONAL PARK SERVICE
DEPARTMENT OF THE INTERIOR

Conserve O Gram

July 1994 Number 4/8

Selecting Environmental Control Systems For Insulated Modular Structures

An insulated modular structure (IMS), such as the one manufactured by Bally Engineered Structures in Bally, Pennsylvania (see *Conserve O Gram 4/7*, "Museum Collection Storage Space: Is an Insulated Modular Structure Right for Your Collection?") is assembled from polyurethane foam panels sandwiched between sheets of galvanized steel, stainless steel or aluminum. An IMS is similar in construction to a large room-size walk-in refrigerator and has proven effective for collection storage because of its:

- superior insulation;
- vapor barrier characteristics;
- ease of construction; and
- lower cost than conventionally constructed buildings.

Because it is superinsulated and well sealed, an IMS often can maintain storage conditions that meet collection preservation standards without the need for mechanical climate control equipment. However, if after careful monitoring of the interior environment, it is determined that passive controls within the IMS are insufficient, a heating, ventilation, and air conditioning (HVAC) system is generally recommended to achieve the desired conditions.

Because NPS museum collection storage areas are found in all climatic zones and contain collections made of a wide variety of materials, no single standard type of HVAC system is universally appropriate. The HVAC system for an IMS should be designed or selected in consultation with knowledgeable specialists (architects, mechanical engineers, curators and conservators). HVAC consultants or commercial contractors also can be very helpful in determining what system will be most appropriate.

A specialist, consultant or contractor will need to have the following information in order to determine the optimum type and capacity of HVAC system. (This information is provided by Bally Engineered Structures, Inc., in relation to their buildings, which are the most frequently used in the NPS.)

- Size of space (both area and volume), ceiling height and the number, types, and sizes of doors and windows.

- Insulation specifications for walls, floor and ceiling panels:

Panel Thickness	**Thermal Conductivity**	**Coefficient of Heat Transfer**	
Inches	"K" Factor	"U" Factor	"R" Value
4	.139	.0348	29
5	.139	.0278	36
6	.139	.0232	43

- Air infiltration rates (vary with structure size):

1,000	cubic feet =	.44 changes per hour
5,000	cubic feet =	.18 changes per hour
10,000	cubic feet =	.123 changes per hour
50,000	cubic feet =	.050 changes per hour
100,000	cubic feet =	.035 changes per hour

- Air change requirements:

  There are no air change requirements, because there is minimal need for people to

be in the collection storage space; the space is not considered a human occupancy area. Museum collection storage areas are dedicated to storing objects and normally are occupied by staff only when they are placing and retrieving objects. Work areas are located in adjacent rooms or buildings.

- Temperature and relative humidity set points and ranges the HVAC system is to maintain. These ranges are determined by the park staff, the regional curator, and conservator based on the material makeup of the collection, the park's climatic zone, and prior conditions to which the objects may have become conditioned (i.e., the collection's storage history).

- Whether the conditioning set points can be adjusted seasonally (i.e., whether temperature or relative humidity may be lower than normal during the winter season or higher than normal during the summer season).

Suggestions for selecting HVAC system equipment:

- Use commercial-grade equipment for durability.

- Some manufacturers can provide a system matched to their structures. If the HVAC system is to be purchased independently, a split system heat pump with supplemental heating elements is recommended. The supplemental heating elements should be independently controlled by a humidistat. When the HVAC system needs to maintain extremely low relative humidity levels (i.e., 30% and below), most manufacturers suggest using a supplemental desiccant dehumidifier. In smaller structures (200 square feet or less), through the wall, self-contained HVAC units (sometimes known in HVAC vernacular as packaged terminal air conditioning or *ptak,* units) may be used.

- The system should be installed so that all coils, fan units, compressor(s), expansion valves, and other components except thermostats and humidistats are mounted outside the insulated modular structure and, ideally, outside the host building, if the IMS is used inside another building. With this arrangement, only conditioned air is introduced into the structure by insulated ducts. Equipment installed in this manner will reduce fire risk by eliminating many potential electrical causes of structural fires. If the system duct work can be designed to include automatically closing fire dampers, that should be done as well.

- If the system equipment is to be contained within the IMS rather than outside of it, as described in the preceding statement, containing the system components in a dedicated room within the structure is recommended. That dedicated room should have additional fire protection features, such as fire-rated drywall and a fire suppression system.

- When an IMS is placed outside, air lock entrances can contribute to more effective control of interior conditions.

- Since work should not take place regularly within a collection storage area, there is no need to maintain the storage room temperature at human comfort levels of 18-20°C (64-68°F). Since it is possible to control conditions humidistatically rather than thermostatically, temperature can be allowed to vary over a wider range, although not to change abruptly, while relative humidity is kept very constant. As a result, temperature should not be allowed to go below freezing 0°C (32°F) nor above 24°C (75°F).

- Ideally, the park should select systems that have or can accommodate high-efficiency particulate air (HEPA) and activated carbon

filters. All filters in the system should be easily accessed for maintenance.

Operating suggestions:

- The building should be monitored for a year prior to introducing the collection and continuously once the collection is stored. Monitoring will develop baseline data on how the IMS is reacting to surrounding temperature and RH conditions. The monitoring records should be analyzed to determine the maximum and minimum temperature and relative humidity levels and the greatest diurnal change. It is helpful to chart this information on a monthly basis, which will make evident any seasonal variations. The data will show whether the system is maintaining the required conditions or if any supplemental conditioning devices are needed. This rule applies to an IMS used inside another building as well as to one used outside.

- If the system in air conditioning mode is not adequately lowering relative humidity, add supplemental electric resistance heating coil(s) to the system or install baseboard heater units in the space. Use the supplemental heaters to raise the air temperature and activate the air conditioner. The air conditioner then will function as a dehumidifier by removing moisture from the air. A humidistat that operates independently from the main system should control any supplemental heaters.

- As mentioned above, in situations where relative humidity levels 30% or lower are desired, supplemental desiccant dehumidifiers will be effective. Desiccant dehumidifiers can be added to the main system or can be portable units that plug into electrical outlets.

- To reduce the threat of electrical fire, the HVAC system and all supplemental heating devices must be listed by Underwriters Laboratories (UL) or Factory Mutual (FM).

- The system should be set up as a closed system so only the air within the IMS is circulated and conditioned and no outside ambient air is introduced. This means the system should be set with the fresh air vent closed. Because the space is being used only for object storage and not for human occupancy, usual requirements for air exchange need not be met.

- If the system controls can be set for upper and lower conditioning limits, the setpoints should not be too close together, which would result in frequent cycling of the equipment.

- The system should not be placed on a timer, but should operate 24 hours a day, if necessary.

An IMS often can provide stable environmental conditions for stored collections because of its inherent characteristics of superinsulation and reduction of air exchanges. However, when passive controls cannot maintain the desired conditions, an HVAC system can usually provide appropriate, stable environmental conditions.

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