Realistic Preservation Environment

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There is a popular misconception that a realistic environmental criteria to preserve artifacts is that which is a compromise between opposed needs of the building, the occupant, and the collection at a cost which an institution is willing to pay. This philosophy completely misses the mark. Too much of our history has been lost using this rationale.

A realistic environment is not a compromise where two extremes are averaged into one, such that neither is appropriate. But rather, it is a balance in which the different needs can all be satisfied through a realistic analysis of factual data followed by cost conscious design choices to achieve that end, both in first cost and operating cost.

In the "realistic" world, this philosophy is often easier said than done. But it's not really all that difficult, so long as the design choices focus on factual measured data, from both the past as well as the present.

How then does one achieve this cost conscious balance? There are over 8,000 different combinations of climate control design choices in the commercial marketplace today. Only a step-by-step logical process of analysis will succeed in arriving at the one choice most appropriate. It is a team process which can be divided into the three following steps:

- classify envelope
- identify heat loads
- perform moisture inventory

Classification System

A classification system has been developed by Landmark Facilities Group, Inc., in which all buildings or individual room spaces are divided into classification categories.

Each category represents structures of similar thermal characteristics limitations. The kinds of collections each group might house safely is then identified. Occupancy limitations are also given. In all, there are three climate control categories. They are: uncontrolled, partially controlled, and climate controlled. Each has two sub-level classifications. Table 1 summarizes the classification system and Table 2 presents preservation approach examples.

UNCONTROLLED - An uncontrolled building would have no installed systems for heating or cooling.

Type I - No Mechanical Devices - A Type I structure is the simplest form of construction which is an open structure. Examples would include objects such as covered bridge, open sawmill, a privy, stocks, a well or gazebo. Environmental conditions in this Type I structure would essentially equal the outdoors. In temperate climates the temperature would likely range from 100°F (38°C) in summer to -10°F (-25°C) in winter. Humidity levels would range from saturation (100%RH) down to lows of perhaps 20%RH. It is noted that it is rare for humidity levels to fall below 20%RH in an unheated structure. The overall annual humidity range in a Type I structure would then be +/-40%RH.

The kinds of collections that may fare well in a Type I structure would be hardy materials such as farm tools, wagons, sculptures and the like. This is a good location to use reproductions or common materials which can be readily replaced. Obviously, these buildings would have no comfort occupancy use.

Type II - Ventilation Only - A Type II structure, also has no systems for heating or cooling, but it is enclosed on its sides and above for basic weather protection. Examples would be sheathed post and beam buildings such as a barn, shed, silo, cabin, or icehouse. Environmental conditions would be naturally improved over a Type I structure slightly, however infiltration rates would be high and day/night thermal "coast" would be small. Exhaust fans and natural venting would help reduce summer high temperatures and high humidities. In winter, it would rarely fall much below freezing inside and the natural infiltration would help dilute unwanted, internal moisture levels. Temperature would generally range from 90°F (36°C) to 32°F (0°C) over a years time. With no heating, humidity levels may likely vary from a high of 90%RH to a low of around 30%RH, or 30%RH year round.

The kinds of collections that would be relatively safe in these structures would be hardy collections. These might consist of tools, machinery, wagons, carriages and vehicles. Again, educational reproductions and other common materials would be appropriate here.

In a museum setting, none of these buildings would have comfort occupancy use except for specific events such as perhaps an open hearth cooking demonstration.

PARTIAL CONTROL - Buildings in the partial control category have some kind of mechanical systems installed to produce temperature control only. No specific devices are installed to add or remove moisture in a precision fashion.

Type III - Heating and Ventilation - Type III structure would have a practical limit of climate control consisting of simple low level tempered heating and exhaust ventilation. Typical construction features would consist of wood framing and siding or masonry. Windows would be single glazed and no insulation materials or vapor retarders would be present. Examples would be a rough frame house, boat, train, lighthouse, carriage house, or industrial workshop. By combining the use of exhaust fans in summer and minimum heating in winter, temperature conditions might likely be controlled between 80°F (26°C) in summer and 50°F (10°C) in winter. With no specific humidity control devices, humidity levels would likely drift from a high of 70%RH to a low of 30%RH. Thus, the usual range of humidity would be +/- 20%RH.

The kinds of collections that might be relatively safe within these facilities would cover a fairly broad range of materials which are not sensitive to fluctuations. Simple period room furnishings, hardy textiles, metals, ceramics, and common household goods would be reasonably protected. Highly restrained collections such as inlays or extremely sensitive compounds should be removed during seasonal extremes or separately controlled using buffered cases or similar.

It is important to recognize that wintertime occupancy would not be permissible in rooms where these collections are exhibited or stored. Room temperature must be maintained below the normal comfort range at these times.

Type IV - Basic HVAC - A Type IV structure would have a ducted system of heating and cooling. The system may also be capable of limited humidification and dehumidification re-heat depending upon the specific building's perimeter envelope construction. Typical building construction features would be heavy masonry walls or composite framing with plastered walls over several layers of wood. The general construction would be tight with low infiltration. Modest insulation characteristics would be present, along with storm windows. Attics would be insulated and vented to the outdoors. Examples of buildings would be a finished home, church, meeting place, store, inn or modern commercial building.

With an ability for year round temperature control and limited humidity control, environmental conditions in a Type IV building that holds collections would range in temperature from 75°F (24°C) in summer to about 60°F (15°C) in winter. Winter ambient above 60°F (15°C) could only be permitted with active monitoring in place to demonstrate a condensation free perimeter envelope. Relative humidity could be held below 60% RH in summer and around 30%RH in winter. Thus, the year-round humidity range would be +/-15 %RH.

The kinds of collections that would be relatively safe in these buildings would cover a host of museum materials including books and other paper-based collections.

Again, it must be recognized that winter occupancy must be limited in these facilities in order to protect both the building and the collections. Continued monitoring must be employed to assure the safety of this delicate balance.

CLIMATE CONTROLLED - Buildings in the climate controlled category are generally specifically designed from their outset to be humidified structures. Few buildings fit in this category naturally. Systems in these buildings have the ability to accurately control both temperature and humidity levels year round.

Type V - Climate Control with Drift - Type V facilities are equipped with ducted HVAC systems which also contain devices to mechanically humidify and perform process logic to dehumidify. These systems may be capable of year-round constant climate control without any drift, but are chosen not to function that way. Scheduled seasonal drift is intentionally selected by the user for either of two reasons. One reason might be the building simply can not tolerate outdoor winter extremes without condensation forming at its perimeter envelope. The other reason may be basic cost economics relating to the intense energy consumption required to achieve summertime room ambient conditions of certain temperatures and relative humidities. Buildings in the Type V group are all well insulated structures having at least double glazing, good vapor retardant characteristics, and vestibules leading to the outside. Examples of these buildings would be museums, research libraries, galleries, and storage buildings.

By having complete climate control capability and accurate controls devices, temperature and humidity environments in these facilities can generally be chosen at will. Reasonable ranges of conditions might be a summer high temperature of 75°F (24°C) and an occupant winter comfort of 70°F (21 CC). Over the course of a year, the humidity levels may be chosen to drift from, perhaps, a winter low of 35%RH to a summer high of 55%RH. This would yield an overall annual humidity range of +/-10%. Controls instrumentation in these facilities would need to have an accuracy of about +/-1°F and +/-2%RH.

The kinds of collections that would likely be safe in these structures would consist of all, but the most delicate of materials. Museum quality collections of fine arts, inlays, conserved collections, and finely crafted arts should all be safe here. There would be no occupancy restrictions relating to user comfort in these facilities.

Type VI - Special Constant Environments - Type VI facilities are specifically constructed to accommodate specialized environmental needs for a particular purpose. Precision climate control systems with specialty components are employed. These structures are generally small in size due to their high construction cost and operating cost. Examples are vaults, storage rooms, and specialty cases or enclosures.

Environmental conditions in these structures are specifically designed for their contents and are held constant within the limits of the chosen technology of precision accuracy. Temperature could likely be maintained between 70°F (21 °C) and 68°F (2°C) year round. Humidity levels might be selected to range between 50%RH and 40%RH or even smaller. This range presented is an overall annual +/-5 %RH. Controls instrumentation in these facilities would have an accuracy of +/-1°F and +/-1%RH or less.

These facilities are what might be considered the "intensive care" rooms for materials deemed to need special care. The materials might include unique minerals, chemically damaged objects such as some bronzes, composite materials with mismatched expansion coefficients, some photographs and perhaps extremely old materials.

Only limited access would be permitted in these facilities. Human comfort would have no priority; only the collections would be protected.

IDENTIFY HEAT LOADS

Once the natural thermal limits of a structure are known, it is then put to the test mathematically, as six heat loads are imposed on it. These heat loads are as follows:

- **Solar** - This is the heat energy of the sun which passes through glass windows, doors and skylights. It changes minute by minute and represents 10 times the heat energy of others but only in the concentrated point where its light lands.
- **Transmission** - This is heat energy that moves through a wall or roof caused by a temperature difference on either side. This heat load is most significant in winter when the difference between inside and outside are as much as 70°F (21°C) . During summer, the influence is only one third this amount.
- **Lights** - Lights and other electric devices are significant heat contributors to a space. However, they only contribute when they are on. Therefore, they can represent 90% of the heat added to a room when occupied and 0% when not occupied.
- **People** - People represent a heat load in a room which is normally about half water vapor and half warmth. However, if the room is very hot, say 100°F (38°C), then the body output is almost all water in the form of sweat. The opposite occurs if the room is below freezing. Usually, the influence of people heat energy in a room is very small, except in crowded auditoriums or during crowded exhibit openings.
- **Infiltration** - This is the culprit which does most of the damage and we know the least about it scientifically. This is the movement of moisture laden air from one space to another. This is the wind through an open door, window, or crack in a wall. It is also the movement of air through porous materials due to the "stack effect" created by hot air rising in a multistory building.
  The blade of the sword of infiltration has two edges, however. If the room's envelope construction is very tight, and thus has small infiltration, it is at risk to high humidity extremes if active moisture generation is present. On the other side, however, it is a friend that can protect against these accumulations in a loose construction wall by virtue of air dilution with the outdoors via mother nature at no cost.
- **Minimum Outdoor Air** - This is a legal heat load. It is the outdoor air mandated by building codes which must be introduced into all occupied spaces for indoor air quality purposes. Times are changing. In urban areas, we would rather take our chances with indoor air and recirculate it through filtration media.

By understanding the timing dynamics of these six heat loads and their magnitudes, a design team can avoid their unwanted characteristics as a design prerequisite and thus become magically "cost conscious."

THE MOISTURE INVENTORY

The third, and last analysis step involves the understanding of moisture behavior quantitatively. Numerous textbooks publish tables of moisture generation rates of various activities. By using these in the design process the team can actually take advantage of them for establishing a particular desired moisture equilibrium condition in a room. One can also gain a perspective of the significance between the various sources of moisture into a room.

For example, potted plants in a room are usually insignificant when compared to a person taking a shower. Both are small compared to a wet basement. By knowing the potential moisture generation rates of activities from these tables, a design team can avoid the disasters of inadequate water proofing and not get bogged down in excessive costs to isolate a decorative water feature.

MAKING THE CHOICE

Taking all this data and formulating it into an appropriate climate control solution is a task best left to experienced professionals. By combining their efforts in a team decision making process, the balance will occur, it will be cost effective, and a successful outcome will be enjoyed.

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Landmark Facilities Group is an engineering firm specializing in climate control for museums, special collections, and historic facilities. The firm also designs mechanical, electrical, plumbing, and fire protections systems for commercial, industrial, and retail applications.