SECTION 4

MECHANICAL SYSTEMS CONSIDERATIONS

The design of the building's mechanical systems should comply with current local building codes, State of Arkansas energy codes, and all other applicable codes, rules, regulations, and executive orders in effect.

HEATING, VENTILATION, AND AIR-CONDITIONING (HVAC)

The architects and engineers should follow current standards in the ASHRAE Handbook of Fundamentals for Comfort HVAC data and ASHRAE Standard 55. The ASHRAE new Comfort Zone is recommended for libraries. Consistency is important. Consideration should be given to geothermal.

Locating HVAC Equipment

Placing the HVAC equipment on the roof over the collection areas is undesirable for the following reasons:

- Vibration from the equipment can cause fractures to the roof's surface, leading to leakage;
- The equipment can allow water an entry point through the roof to the interior of the building; and
- The discharge of water from the system can back up until it overflows into the building.

For these reasons, locating the HVAC equipment alongside the building or within the building envelope is better than any roof location. If that option is not acceptable for aesthetic or space reasons it is recommended to locate the equipment away from collection areas. Any equipment located on the roof should be provided with adequate means for access including the ability to lift replacement parts.

Relative Humidity (RH) Specifications

Library materials absorb and release moisture when the surrounding air becomes damp or dry in an effort to achieve equilibrium with it. With each gain or release of moisture, the materials change in dimensions – not enough for casual observer to see, or perhaps even notice – but enough to cause damage when two different materials are bonded together and try to expand or contract different amounts.

Paper text leaves glued to cloth covers, microfilm emulsions on plastic film bases, and the multiple layers of a CD or DVD all expand and contract at different rates, thus creating tensions between the layers that will cause to them split apart. The results of not stabilizing relative humidity is significant – and potentially very costly because of:

- A shorter collection service life; and
- A more expensive program for collection maintenance.

At one extreme, materials that are too dry, i.e. less than 30 percent relative humidity (RH), desiccate and become brittle. At the other extreme, materials that are too damp, that is greater than 70 percent RH, encourage mold growth. Consequently, 35 – 65 percent RH is recommended at the maximum acceptable range for the Library's collections.

However, to minimize damage from expanding and shrinking layers, library materials ***must*** be kept as close as possible to constant relative humidity. For collections of mixed media, a design specification of 40 percent RH and a maximum of 5 percent fluctuation (i.e., 35 - 45% RH including fluctuation) around the clock is an acceptable compromise. This specification applies to both permanent and special mixed media collections, in storage areas and in reading environments, where maximizing the service life of the collection(s) is a major goal.

Of all the HVAC-controllable environmental parameters, high humidity is the most important factor, as indicated in the ASHRAE 2007 Handbook HVAC Applications. Therefore, exact design or extent of parameters should be determined in conjunction with the specific requirements of materials stored and utilized within the facility.

Temperature Specifications

Heat degrades all organic materials, including paper, photographic film, and prints. It also degrades analog and digital media. Too much heat accelerates the chemical reactions responsible for degradation of materials, thus shortening their service lives.

Therefore, colder is better, given reasonable tolerance limits for both the staff and the customers who need to work in/access the stacks. For collections where bookstacks and user spaces are combined the low end of the recommended comfort zone is 68 - 72°F, including fluctuation.

Stabilizing Relative Humidity and Temperature

For library collections the stabilization of the relative humidity is of greater importance than the stabilization of the temperature for the following reasons:

- Changes in relative humidity can cause mechanical damage from materials' internal pressures to shrink and expand; they literally tear themselves apart; and
- Reasonable fluctuations in temperature around a design specification do change the rate of deterioration of collection materials, but cumulatively have an impact little different from maintaining a single constant temperature.

Most HVAC systems are designed to favor the stabilization of the system at the design temperature. The expectation is that a stable relative humidity will follow. This type of design does work because relative humidity is dependent upon temperature and is destabilized by relative small changes in temperature.

The reason for this dependency is that the percentage of relative humidity is "relative" to the amount of moisture that air can hold at any given temperature. As the temperature rises, the amount of moisture that the air can hold also rises. And, as the temperature drops, the amount of moisture the air can hold is subsequently reduced.

Thus, in a closed environment with a given amount of moisture in the air, if the temperature rises, the relative humidity drops because the capacity of the air to hold moisture has increased. Conversely, if the temperature drops the relative humidity rises.

The relationship between temperature and relative humidity should be exploited to the benefit of the collections by using it to correct fluctuations of relative humidity beyond acceptable limits. HVAC system controls should be designed to adjust the temperature, if necessary, to maintain relative humidity fluctuation within the acceptable range, thus:

- Limiting the amount of expansion or shrinkage of materials
- Avoiding damage to the collections
- Extending the useful life of the collections.

Table 3 provides additional information on temperature and relative humidity.

Table 3
Temperature and Humidity Recommendations

Collection Category	*Temp. F (incl.) Fluctuation*	*RH % (incl.) Fluctuation*
User comfort	73 – 76	35 – 65
Permanent collections	68 – 72	35 – 45
Special collections	60 – 65	35 - 45

If Disaster Strikes

It is very important to bear in mind that the relationship between temperature and relative humidity ***cannot*** be effectively exploited by raising the temperature of the HVAC system to dry out the collections following a water disaster, e.g., a sprinkler discharge or major roof leaks because there is a great excess of water in the now wet collections, furnishings, and carpets. Raising the temperature only releases more moisture into the air, creating a high temperature, high humidity environment — ideal for rapid mold growth.

The recommended alternative is to set the HVAC system to its lowest possible temperature and relative humidity settings, and increase the airflow to maximum volume, or to use as much outside air as possible if the outside air is cooler and drier than can be produced by the HVAC system.

***Disaster Response and Collection Salvage* -** Good building design and preparedness practices reduce, but does not eliminate, risk of disaster. If disaster strikes the collections are best served by effective and efficient emergency response and salvage. A written disaster response and collection salvage plan, a trained staff collection salvage team, needed salvage supplies, and a list of priorities for collection salvage are essential elements of collection protection.

Every disaster response and collections salvage plan needs to include the following:

- Emergency notification procedures;
- An outline of the collection salvage operation, including authority and responsibility for the several roles;
- A set of step-by-step procedures for identifying and packing water-damaged materials;
- A list and location of on-site salvage supplies and resources for additional supplies;
- A list of priorities for salvage in the event that time and staffing are too limited to salvage everything before parts of the collection(s) become unsalvageable; and
- Floor plans of the collections storage areas with the location of high priority collections clearly identified.

Time is of the essence for water-damaged materials. Serious damage can occur within 36 - 48 hours, especially from growth of mold. The success rate for collections salvage can be quite high when actions are taken quickly and efficiently. A recovery rate of 95 percent and higher is possible if the library is prepared.

Air Pollutants

Gaseous pollutants (compounds of hydrogen, nitrogen, and sulfur in particular) and all kinds of particulates degrade organic materials. Too little is known about the costs relative to benefits of filtration systems for gaseous pollutants other than to state that fewer pollutants are desirable because they, the gaseous pollutants, are known to be absorbed by collection materials and then to combine with moisture to form acidic compounds which can attack paper and film-based materials. One precautionary step to take is to place fresh air intakes to the HVAC system away from areas where vehicular exhaust and other petroleum-powered equipment can introduce unwanted pollutants.

Particulate filtration is recommended because it provides tangible and visible benefits in reduced soiling of collections. It also reduces maintenance costs for building interiors, furniture, fixtures, and equipment. Most damaging among particulates is soot, a product

of combustion of organic compounds, very small in size, less than a micron in diameter. Unlike dust, soot is not easily removed from collection materials by vacuuming. This makes efforts to prevent its entry into the collection environment doubly advantageous. Filtration systems that can remove better than 50 percent of particulates that are 0.5 microns and larger are recommended. However, the 2007 *ASHRAE HVAC Applications Handbook* warns that high-voltage electrostatic filters may not be acceptable because they generate ozone, which is known to chemically break down paper.

ENVIRONMENTAL CONTROL

After collection protection, environmental control is the most cost-effective investment in building design to extend the service life of the collections. Creating environmental conditions that extend the service life of the collections will enhance protecting the investment the Library has made in these materials. The benefits of extended life and reduced maintenance costs of the collections justify good environmental control throughout the building.

OTHER CONSIDERATIONS

Design the system with enough redundancy so a breakdown of one zone will not impair continuous airflow to the public, staff, and the collection storage areas. In case of air conditioning failure, design the system for outside ventilation using air-handling units, except in the special areas requiring sensitive humidification as mentioned above. All filters should be located so they are easily accessible for cleaning and replacement. Particular care should be taken that sufficient air conditioning thermostatic controls are provided, secured against tampering. Locked covers for the sensors are acceptable, provided they are accessible to staff at all times. Interior sensors should not be located where wall shelving is to be installed.

Consider peak demand reducers that turn off major pieces of electrical equipment at regular peak electrical demand and time clocks for thermostatic control, and power-surge controllers. Utilization of low sound level generating equipment, such as low-velocity ducts and diffusers is important. Also, consider vibration isolation devices for all equipment and construction methods to reduce vibration.

Air Handling

The number of air handling systems to be used will depend on the characteristics of each space, operating hours, percentage of outside air required, zoning and shut-down needs, and the limitations with respect to the physical size of equipment to be selected.

Ventilation Criteria

In all spaces the maximum cubic feet per minute (CFM) per person of outside air and per square foot of floor area should be supplied, in accordance with current ASHRAE

recommendations and codes.

For restrooms and janitor rooms the greater of a minimum of 10 - 15 air changes per hour or two CFM per SF should be mechanically exhausted. Direct air supply should be provided to all Restrooms.

Air Filtration

The Library's collections of books, periodicals, and newspapers create paper pulp dust. Therefore, it is imperative the HVAC system have air cleaners and filters that can effectively deal with the dust while maintaining the temperature and humidity requirements as specified. All outdoor air and re-circulated space air should be filtered at the central air conditioning units by means of 40 to 45 percent NBS bag filters having maximum economical dust holding capacity. Bag filters should be 24" to 36" long with clip-on type pads at inlet. For areas with less stringent environmental conditions, MERV 7 prefilters and MERV 11 final filters should be provided.